The Management of Deer in Native Woodlands

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The management of deer in native woodlands has become a central issue in recent years. This is primarily due to increasing deer populations, the expansion of forest area through afforestation, introductions of new deer species and the re-distribution/ transportation of extant naturalised deer species. Native and broadleaved woodlands are particularly vulnerable to deer damage through browsing, grazing pressure, fraying and bole scoring. Conservation and wood quality objectives can be seriously compromised. Negative ecological impacts from excessive deer pressure on woodland structure and ground vegetation community composition has negative knock-on effects on all other assemblages including invertebrates, birds, mammals and soil fauna. Conversely, a sustainable deer presence has positive ecological impacts and recreational value, especially as revenue through game management can be appreciable to woodland owners.

The production of quality hardwoods, where applicable, can be undermined to such an extent that only firewood grade material is realised in the presence of excessive deer populations. This has severe implications for the sustainable management and revenue streams associated with native and broadleaved woodlands. Actions outlined in *A Strategy for Native Woodlands in Ireland 2016 - 2020* (Woodlands of Ireland, 2016) clearly highlight the need for enforceable measures to control introductions and the spread of non-native deer. It also highlights the urgent need for a co-ordinated national, regional and local approach to deer management, overseen by a national initiative such as the recently-established *Irish Deer Management Forum*.

Deer management includes a high degree of co-ordination, involving consultation with stakeholders, the strategic management planning of deer control, mitigation measures at forest design stage and in subsequent woodland management. These are essential components of effective deer and woodland management.

This Information Note examines all these issues in detail and provides guidance on deer management including planning, deer counts, good woodland design, fencing, the use of deer tubes and population control/culling. Most or all these measures are required together to ensure that deer and woodlands co-exist in relative harmony to the mutual benefit of both.

INTRODUCTION

Native woodlands are intricate ecosystems, at times requiring complex management prescriptions (Cross and Collins, 2017). Their status and conditions vary widely from very diverse ancient woodlands that are important core biodiversity hubs, to recently-developed, secondary or 'scrub' woodland (Perrin *et al.,* 2008). Threats include overgrazing/browsing, invasive exotic species, fragmentation and disease (e.g. Sudden oak death (*Phytophthora ramoran*) and ash dieback (*Hymenoscyphus fraxineus*)). Apart from their potentially high ecological diversity, further management challenges arise from a misconception that these rare, natural woodland resources are somehow 'pristine wilderness areas', often leading to a view that native woodlands should be left alone, without any human intervention and allowed to evolve 'naturally' and to develop freely. All of Ireland's remaining native woodlands require active intervention and ongoing management to secure their future viability and to protect them from a variety of threats, especially overgrazing and browsing, particularly by deer species.

In Ireland, the public has become increasingly aware of native woodlands because of key native woodland projects - such as the People's Millennium Forests Project (PMF) and the Native Woodland Scheme (NWS) - and their use for public recreation and amenity purposes. In many types of woodland, appropriate management is challenged by the presence of unsustainable deer populations, and the impact this has on the woodland resource. Deer are often the greatest constraint to native woodland establishment, development and subsequent management (Purser *et al.,* 2009). Conservation and wood production objectives, where applicable, are compromised by excessive deer populations. The absence of deer predators such as wolf (*Canis lupus*), brown bear (*Ursus arctos*) and lynx (*Lynx lynx*) in Ireland means that the primary limiting factors to increasing deer populations is food availability and disease (Fig. 1). In existing 'old' and 'ancient' woodlands*, very high deer populations compromise future viability by overgrazing the ground and shrub layers, with incessant browsing resulting in insufficient recruitment of trees and shrubs to supplement and replace the existing canopy as it ages.

Some species of deer are better adapted to woodland environments than others. However, the proportion of time spent in woodland depends on dietary constraints, disturbance, competition with other species and many other factors (Prior, 1994). Depending on population densities and deer behaviour, the impacts of deer can be potentially positive or negative across a range of forest management values, but most particularly regarding biodiversity and conservation attributes, which are often less well-monitored or apparent than economic or social values. These include, for example, beneficial and sustainable grazing that allows some vascular plant species in the ground flora to compete with more vigorous species that are grazed by herbivores.

Deer management is often defined as 'managing deer populations in balance with the carrying capacity of their habitat', but in practice the carrying capacity of deer in mixed Irish landscapes has not been established to date. Before natural physical limits to deer populations can be attained, a range of economic and social limits of human tolerance are generally reached that often result in conflicts between deer and a variety of rural and urban stakeholders. Since broadleaved woodland is very vulnerable to deer damage, it is not surprising that forest managers and woodland owners are among the first to limit deer numbers to an acceptable level in affected areas. In Ireland to date, the disparate response to the urgent requirement to manage deer has made it difficult to effectively control deer populations. Quite often 'deer problems' are characterised initially by very negative human reactions followed by an uncoordinated, reactionary response, based on little or no knowledge of deer ecology and behaviour.

When managing native woodland, managers should equip themselves with the knowledge to plan and manage this unique and valuable resource while being fully cognisant of deer. To be successful, the management of deer populations must incorporate the following measures;

- habitat design (especially applicable during the planning phase when establishing new native woodlands through afforestation and/or natural regeneration)
- appropriate physical protection of woodland (primarily fencing)
- vegetation/tree impact assessments
- direct population assessment and control (culling), and
- adequate management of stakeholder engagement, i.e. consultation, communication, education, co-ordination and co-operation. This will enable an integrated approach of the above measures across the range of land types necessary to implement adequate controls (Nugent, 2009).

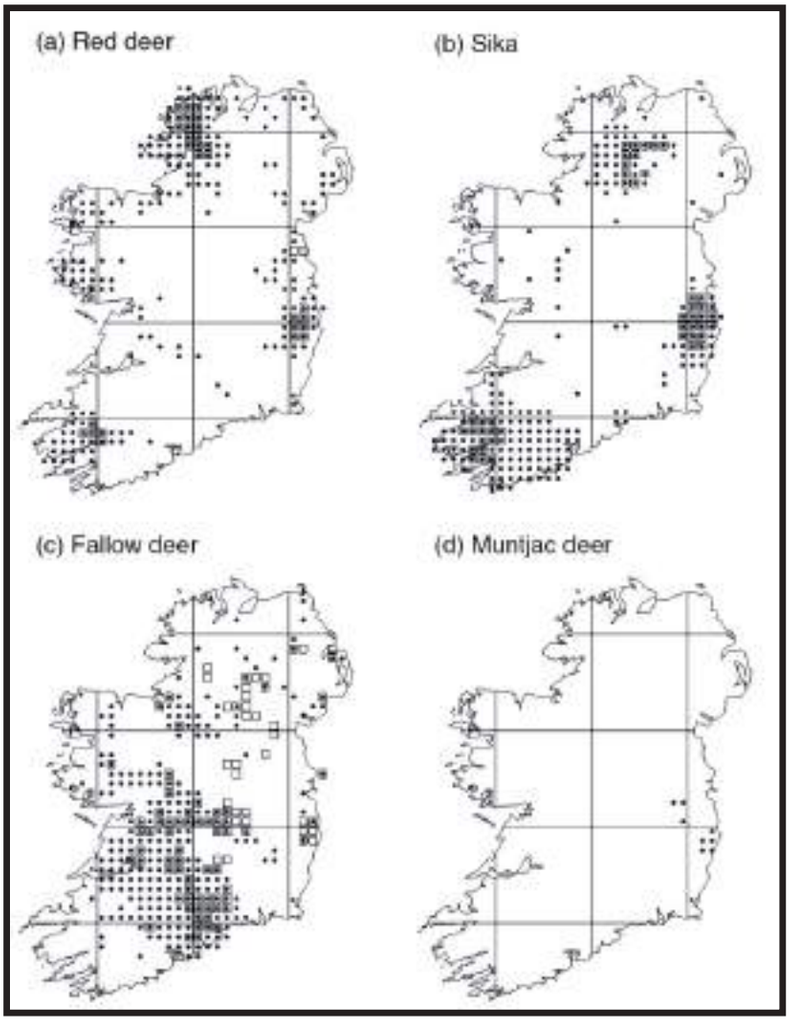
MANAGEMENT OBJECTIVES

The first step in defining deer management objectives is to adequately define woodland management objectives for a given woodland stand (Nugent, 2012). It is not enough to simply state that there are 'too many deer' or that

*Ancient woodlands are woodlands included in the inventories of ancient woodland based on the oldest reliable national information. In England and Wales this goes back to 1600 AD; in Scotland to 1750 AD. Northern Ireland and the Republic of Ireland do not currently have an ancient woodland inventory. In the Republic of Ireland a provisional date of 1830 AD has been set (based on the earliest reliable national records, i.e. the first Ordnance Survey of Ireland) and these woodlands are termed 'Old Woodland'.

Deer species distribution in Ireland

Fig. 1: Distribution maps of (a) Red deer, (b) Sika deer, (c) Fallow deer and (d) Muntjac deer in 10 km squares in Ireland (Carden *et a*l., 2011).



'deer damage' is taking place. The existence of damage can only be established by comparing current forest condition against clearly defined forest management objectives. It is only when these objectives can no longer be attained because of deer populations and their behaviour, can damage be confirmed and be considered unsustainable (Reimoser *et al*., 1999).

Determining clear woodland management objectives alone can be problematic, particularly where multiple use management objectives apply, as is often the case with native woodland, using close-to-nature, or continuous cover forestry approaches. Many of these silvicultural options can only be achieved at very low deer densities. Quite often there are inherent conflicts between multiple woodland management objectives, quite apart from deer issues, and the 'multiple problems of multiple use' will be exponentially expanded where external stakeholders are involved (Zivnuska, 1961). For example, sustainable deer populations will be different where objectives such as woodland conservation, wood production and deer hunting pertain in the same forest unit. These issues can be addressed through good consultation practice with stakeholders and this is essential, particularly where public land is concerned.

Native woodland management can be complex and native woodland managers must grapple with, and balance a range of forest management values. These traditionally were predominantly ecological in nature, but increasingly, socio-economic objectives have become prevalent. In this regard, the role of deer management as a commercial, recreational (hunting) activity is often overlooked in Irish forestry. If managed correctly, revenue from hunting and sporting rights can augment the returns from wood production. If managed imaginatively, revenue from hunting can contribute directly to other woodland management objectives and measures, while ensuring that deer populations are kept at sustainable levels.

The small scale of Ireland's native woodland sites also presents a challenge to defining deer management objectives. In Ireland, most old and new native woodlands are less than 10 hectares (ha) (Perrin *et al*., 2008). It is crucial to have a minimum physical space or area within which to implement management measures and/or accommodate specific design elements. Very small woodlands (< 5ha) can present challenges in achieving practical management goals. While larger holdings can easily accommodate adequate measures, smaller sites may require activities such as hunting to take place in the immediate vicinity, outside of the woodland. For example, where fencing has been utilised to protect small

woodlands, this reduces the available hunting area further.

The assessment of deer densities is vital in the planning of appropriate management strategies to facilitate sustainable levels of deer populations within different ecosystems. To effectively manage and control deer populations, density assessments must be carried out during the spring months to account for young calves and post-winter mortality of calves and yearlings. Assessment of deer populations can be done by direct or indirect methods. Direct methods include drive counts, aerial surveys and the use of thermal imagery. Indirect methods include faecal pellet group counts, clearance counts, and the use of line transects. Smart *et al*., (2004), Scott *et al*., (2002) and Mayle *et al*., (1999) provide a very detailed overview of the various methods available to land managers.

Numerous studies have been carried out outside Ireland of varying deer densities and the effects populations have on a variety of woodland types (Gill and Morgan, 2010; Côtê *et al*., 2004; Bugmann and Weisberg, 2003, and Ammer, 1996). Even though no comparable detailed studies have been carried out in Ireland, some UK and European studies can be used as an indicative guide by forest managers in Ireland. In their research of seedling browsing in forests with respect to natural regeneration, Gill and Morgan (2010) found that to achieve adequate seedling survival, target deer densities should not exceed 14 animals/km^2. A study of the regeneration in upland areas by Gill (2000) found that deer densities should be in the range of 4 – 7 animals/km^2 to maintain regeneration and plant diversity. Langbein (1997) examined the impacts of red deer (Fig. 2) on oak woodlands and heather moors in Exmoor and suggested densities of 5 animals/km^2 for the effective and sustainable maintenance of these habitats.

European studies have focused extensively on deer densities in relation to the natural regeneration of commercial woodlands, which forms an integral part of forest policy on the Continent (Ammer, 1996; Bergquist *et al*., 2003). Actual deer counts are rarely undertaken as densities are evaluated with respect to the extent of browsing of regeneration and subsequent adjustments made to cull targets, where necessary (Ammer *et al*., 2010). Given these complexities, deer management is best broken down into three distinct but interacting elements, each with their own underlying objectives:

- Population management
- Habitat management
- People management

Fig. 2: Red deer *(Cervus elaphus),* the only species of deer that is considered native to Ireland.

POPULATION MANAGEMENT - DEER MANAGEMENT AND WOODLAND DESIGN

The effects of deer predation on woodland regeneration

The main forms of deer damage that occur in woodlands are grazing, browsing bark stripping and fraying. Excessive deer browsing on newly planted or existing woodlands will reduce or negate conservation and silvicultural objectives (Putman *et al*., 2011; Höna, 2009; Reimoser and Gossow, 1996). Deer predation can adversely affect floral species abundance and diversity. Browsing can suppress tree growth, result in multiple leaders and create pathways for insect and disease infestation through bark stripping and bole scoring. Ecological damage, however, is more difficult to perceive and - to the untrained eye - more difficult to recognise. In general, deer either eliminate or continually retard the growth of young trees, shrubs and herbs, allowing unpalatable and inedible floral species, such as bracken (*Pteridium aquilinum*), wood-rush *(Luzula sylvatica*) and rushes (*Juncus* spp.), to proliferate and dominate the ground flora at the expense of more sensitive woodland species (Kirby, 2001). Shrubs and herbs - preferentially targeted by muntjac deer - constitute much of the species richness of the ground flora, and the loss or reduction of these will significantly reduce the diversity of woodland vegetation (Fig. 3).

In the long term, continuous grazing is very damaging, and vegetation recovery can be very slow after the reduction of deer pressure, as new ground flora assemblages favouring the less sensitive ground flora have often become well established. Ecological damage is also apparent when the effects of vegetation damage are transferred to other groups within the ecosystem, i.e. the depletion of the ground and shrub layers leads to the loss of insects, small mammals, their dependent avifauna and consequently, the breakdown of ecosystem function. Other biodiversity elements within the woodland, such as soil fauna and flora, are also negatively affected. Excessive browsing and grazing are especially detrimental to specialist woodland invertebrates that feed almost entirely on one, or a very limited number of plant species. For example, the brimstone butterfly (*Gonepteryx rhamni*) larval stages depend entirely on purging buckthorn (*Rhamnus cathartica*) and alder buckthorn (*Frangula alnus*), and their depletion will adversely affect brimstone butterfly populations. In contrast, predators are generally not so specific, but instead rely on strategies such as camouflage or stealth to obtain prey. The diversity of predators may therefore depend as much on vegetation structure and density as on plant species composition *per se (*Gill, 2000) and hence, excessive browsing will indirectly also impact negatively on them.

Most bird species in Irish woodland are insectivorous or granivorous (grain feeders). Typically, there are species occupying a range of niches such as;

- tits (*Parus* spp.; *Aegithalus caudatus*) and goldcrests (*Regulus regulus*), which forage in the canopy for invertebrates
- finches (Family: Fringillidae) and crossbill (*Loxia curvirostra*) which depend heavily on seeds
- treecreeper (*Certhia familiaris*) and the great spotted woodpecker (*Dendrocopus major*) which forage for insects on tree trunks and deadwood, and
- warblers (*Sylvia* spp.), wren (*Troglodytes troglodytes*), robin (*Erithacus rubecula*) and blackbird (*Turdus merula*), which feed in the understorey and/or in thickets.

Fig. 3: Muntjac deer *(Muntiacus reevesi),* a relatively recent arrival in Ireland, i.e. since 2000 AD, which at high densities can severely impact the herbaceous field layer. (Image courtesy of Jim Walsh).

The density and number of woodland bird species increase with the number of tree species in the canopy, as well as with stand maturity and structural diversity. By reducing the tree species richness and the height of the shrub understorey, excessive deer numbers almost certainly reduce the suitability of the woodland for many bird species (Gill, 2000; Allombert *et al*., 2004).

Woodland decline, deer grazing and legacy issues

Most native oak woodlands in Ireland (*Quercus petraea* and *Q. robur)* are generally assumed to be 'natural' in origin. Some result from natural regeneration almost certainly due to good mast years and low acorn predation followed by low grazing and browsing pressure. However, frequently, virtual oak monocultures persist with only a limited number of other species (such as holly (*Ilex aquifolium*) and birch (*Betula pubescens* and sometimes *B. pendula)*. In many cases. these are because of the underplanting of oak carried out in recent centuries. Many of these 'semi-natural' woodlands are in fact plantation woodlands, i.e. legacies of the landed estates where the owners managed for future quality timber and downstream wood products. It was fashionable in the 17th and 18th centuries to plant into existing old woodlands or to establish new woodlands comprising new oak provenances derived from elsewhere in Europe (Fig. 4). Most oak woodlands today are mature, even-aged oak coppices which were abandoned after silvicultural

management, resulting in multiple coppice shoots competing for limited space and light in the canopy. Their structure is relatively uniform, with a relatively high density of mature oak trees, and sparse or very poorly-developed shrub, ground and field layers. These woodlands are relatively low in species diversity, especially as most of Ireland's tree and shrub species are light-demanding and find it difficult to become established in closed canopy oak woodland derived from closely-spaced abandoned coppice.

There are many examples of predominantly native 'semi-natural' oak-dominated woodlands that may be in terminal decline due to lack of management and co-incident threats such as overgrazing and invasive species colonisation. In many cases, natural regeneration is not occurring, and deer overgrazing is often identified as being the primary cause, e.g. sika deer (Fig. 5) at Rossacroo-na-Loo Wood, Kilgarvan. Co. Kerry and fallow deer (Fig. 6) at Portumna Forest Park, Co. Galway. However, in such circumstances, deer impact is just one element of a myriad of interacting processes and pressures such as limited light, nutrients and space, tree species competition (exacerbated by the preponderance of shade-intolerant native trees and shrubs), and the predation of seed stores by small mammals and birds, i.e. rodents and jays (*Garrulus glandarius*). Other factors include infrequent mast years for oak (especially for sessile oak), invasive species (especially *Rhododendron ponticum* and *Prunus laurocerasus*), over- and under-grazing, disrupted succession, tree/shrub diseases, and possibly, insect pests.

Fig. 4: A well-defined row of even-aged mature oak in a 'semi-natural' oak woodland at Charleville demesne, Co. Offaly, which indicates that they were almost certainly planted.

Fig. 5: Sika deer *(Cervus nippon),* introduced to Ireland in the 19th Century.

Fig. 6: Fallow deer *(Dama dama)* introduced by the Normans to Ireland in the Middle Ages.

Vibrant, fully functioning, diverse native woodlands not only contribute to biodiversity and ecosystem function, but are also a potentially very valuable timber resource, where applicable. The key to achieving this is active, ongoing management, which also addresses the multiple interacting factors outlined above. However, the lack of management over many decades has led to the creation of many near-moribund woodlands that have perhaps reached an ecological stasis. In time, they are almost certainly in danger of being subject to catastrophic events such as windblow, resulting in collapse and potentially, substitution with predominantly pioneer woodland. Native woodlands that have evolved with little or no interference by human impact usually contain much lower densities of oak, with a richer assortment and a greater representation of species, depending on soil type, exposure, altitude and climate. Other native species that would normally be represented more frequently include mountain ash (*Sorbus aucuparia*), yew (*Taxus baccata*), spindle (*Euonymus europaeus*), guelder rose

(*Viburnum opulus*), birch, alder (*Alnus glutinosa*), willow (*Salix* spps.), hawthorn (*Crataegus monogyna*), holly, hazel (*Corylus avellana*), Scots pine (*Pinus sylvestris*), and both purging and alder buckthorn, amongst others. Most of these species are highly susceptible to browsing by deer (Fig. 7).

The foraging behaviour of deer species is governed by both morphological and physiological factors and these determine the basic dietary requirements of each species. In addition, for preferred food species to be 'available' to deer, it must be sufficiently accessible in terms of standing crop or biomass, which makes the time spent grazing that species worthwhile in terms of rate of intake achieved (Hofman and Stewart, 1972). All common species of deer found in Ireland (i.e. red, sika and fallow – Figures 2, 5 & 6) are intermediate feeders or grazer/browsers, and all three spend more time grazing (i.e. feeding on primarily vascular plants and grasses in the ground layer) than browsing (i.e. feeding on above-ground twigs and leaves).

In a study of dietary comparisons of red and sika deer in southwest Ireland, Burkitt (2009) found that almost 64% of the annual diet of sika deer was made up of grasses and rushes. In contrast, the proportion of these species found in the diet of red deer was only about half (54%). For both species of deer, the balance of their diet was made up of heathy and woody species, and deciduous and coniferous browsing material. Similarly, the annual diet of fallow deer in the New Forest in England, was found to contain almost 40% grasses and rushes (Jackson, 1974). In short, it is evident that deer are preferential grazers throughout the year and only take increasing amounts of browse through the autumn and winter to compensate for the lack of grazing material during these seasons (Putman, 1988). Negative impacts of deer herbivory are not quantified, and it is likely that much of their impact will depend on several factors such as deer density, competition between species, time of year, available standing crop and prior grazing history.

Fig. 7: Vigorous regeneration in a small exclosure in stark contrast with the overgrazed foreground, Tomies Wood, Killarney National Park, Co. Kerry. (Image courtesy of John Cross).

To optimise woodland diversity, especially in even-aged oak woodlands, deer control measures are implemented in conjunction with continuous cover silvicultural measures to optimise woodland biodiversity. These include small coupe felling of oak in windfirm locations, followed by coupe fencing, enrichment planting using other native trees and shrubs, the removal of invasive non-native trees and shrubs, and allowing some felled areas of oak to regenerate naturally. This will create a more diverse, uneven-aged woodland in time and, along with good woodland design to incorporate deer behaviour and deer management, should result in more viable and biodiverse woodlands.

ASSESSING DEER IMPACTS

The assessment of deer impacts on native woodlands, particularly the degree of browsing and bark stripping, forms an integral part of the management of deer. Objective discussion based on actual impacts can only take place where accurate data has been collected and presented. Data collection requires a robust, pre-defined data collection protocol and methodology that is fit for purpose for the habitat being assessed, in this case, native woodlands (Appendix 1 contains a worked example of a deer management plan).

The assessment of deer-related damage has received considerable attention in many European countries where deer damage is often referred to in national forest and wildlife legislation (Ammer *et al*., 2010; Moog, 2008). Effective and objective damage assessment methods are provided as very often, the forest owner is indemnified by those exercising sporting rights on his/her property against deer-related damage (Moog, 2008). Though such laws do not exist in Ireland, it is necessary to include deer damage assessment as a management objective to ensure that effective deer management occurs. Using an agreed assessment protocol will allow foresters and woodland owners to assess deer impacts with confidence and to incorporate the data into forest management prescriptions.

The assessment protocol focuses on the habitat being assessed with respect to the forest management objectives, for example, biodiversity and wood production objectives will tolerate different levels and types of damage. The habitat and objectives will define the required accuracy, intensity and scope of the assessment method. For the purposes of this Information Note, the assessment of deer damage on native woodlands should focus primarily on the percentage of browsing or bark stripping within a woodland stand. (For a definition of woodland stand see Cross and Collins, 2017). This can be related to percentage of damaged plants to undamaged plants, based on tree/shrub stocking assessments. More advanced characteristics such as intensity and age of browsing (i.e. the current or previous growing season) and type of browsing (apical bud, lateral shoot, combination of both) may also be assessed and recorded.

A basic but effective method of assessment can be designed and executed by utilising a line transect with systematic sample points at regular intervals (See Fig. 8a). The transect should be located along the longest section of woodland stand, with the first and last sample point located 5 meters (m) inside the woodland edge. The woodland stand in this case would preferably be a clump of natural regeneration or a planted area, i.e. not a glade, pathway or other open area. The length of the transect should be between 40m and 100m (Fig. 8a). If the woodland stand is very large, increase the number of sample plots (Table 1).

At each sample point, a plot comprising 15 trees is assessed (Fig. 8b). The distance from the sample point is measured to the 15th tree furthest from the centre of the plot. This will also give the radius of the sample plot. By selecting 15 trees and with a measured radius, stocking density can be assessed. The trees in each sample plot should be assessed for browsing up to a height of 1.3m. In addition, trees greater than 1.3m in height should be assessed for bark damage, i.e. either stripping, bole scoring or damage from rutting behaviour. It should be noted that varying degrees of browsing will negatively affect some tree species more than others. Data from worked example is presented in Appendix 1, Table 14.

Table 1: The number of sampling plots based on woodland size and uniformity using the line transect method.

Woodland Stand (ha)	*Minimum number of sampling plots (in uniform woodland)* <90%	*Minimum number of sampling plots (in non-uniform, multi-layered woodland)* <100%
0.5 - 2	6	8
2 -10	8	12
Over 10	10	16

Fig. 8a: Deer damage assessment protocol for native woodland

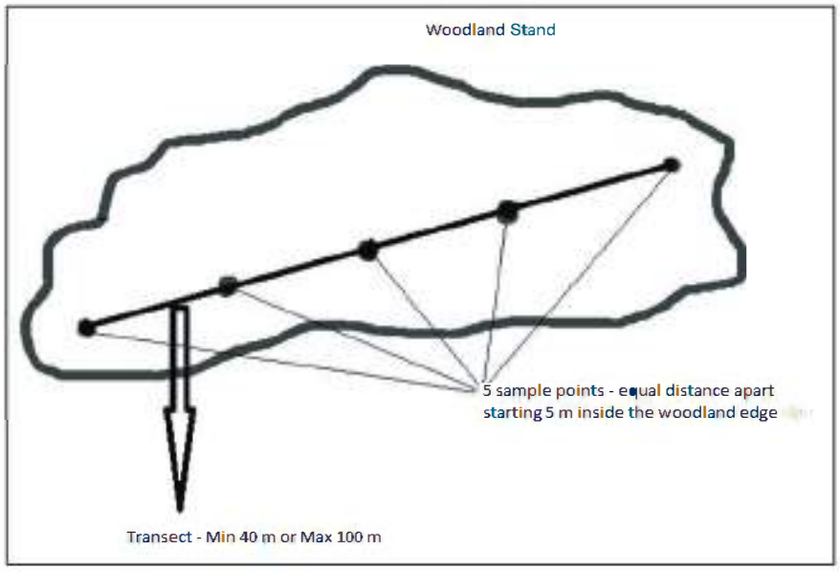
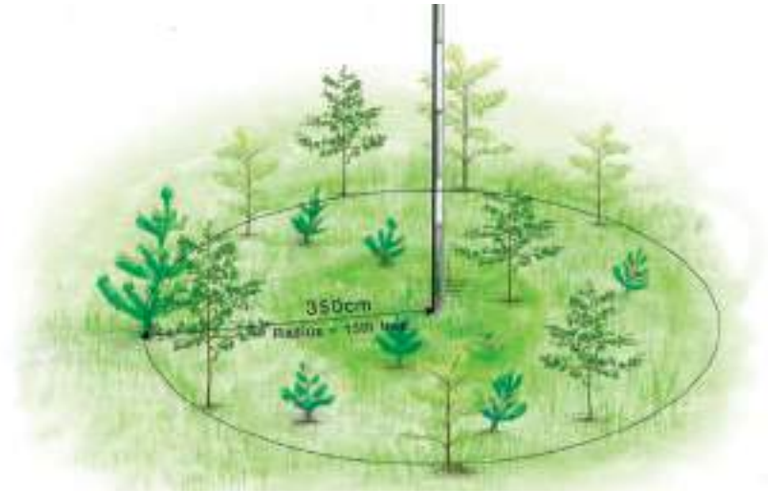


Fig. 8b: An illustrated sample point on the transect depicted above. It is established by measuring the radius of 350cm from the centre of the plot (pole) to the 15th furthest tree at the plot boundary. Only 15 trees are assessed for damage even if there are more than 15 trees in the plot.



DEER MANAGEMENT IN WOODLAND SETTINGS

Since approximately the mid-1900s forest cover in Ireland has increased steadily, primarily due to State-incentivised afforestation schemes. Forest cover has increased to just over 10.5% of the land area today from a low of c.1% at the start of the 20th century (Anon., 2017). This increase in forest cover also coincided with a subsequent steady increase in deer numbers, a trend that is typical in many

other temperate regions (Côté *et al*., 2004). The main aim of State incentives for afforestation is to plant the maximum number of trees per unit area for wood production and, in most cases, little attention is given to woodland design with respect to deer management.

During the first National Survey of Native Woodlands, native woodland cover in Ireland was estimated to be approximately 20% of total forest cover, which is equivalent to just over 1% of the land area (Perrin *et al*., 2008). It was noted during this survey that just over 20% of sites where grazing occurred was attributed to deer. Though it is not known what the sustainable levels of deer are in different native woodland habitats, it is important to note that a certain level of grazing is desirable to maintain optimum diversity of floral species, especially the herb layer (Mayle, 1999; Gill, 2000; Sumsion and Pollock, 2005; Naveh, 2007).

As native woodlands became more important in national forest policy due to their multi-functional attributes, the Forest Service (of the Department of Agriculture, Food and the Marine - DAFM) - in partnership with Woodlands of Ireland, the National Parks and Wildlife Service (NPWS - of the Department of Culture, Heritage and the Gaeltacht) and other key native woodland stakeholders - developed the Native Woodland Scheme (NWS), which was launched in 2001 (Forest Service, 2015a). It consists of two elements; NWS Conservation, which aims to protect and restore existing 'old' (Figs. 9 & 10) and 'emerging' (scrub) native woodland, and NWS Establishment, which focuses on the creation of new native woodlands on 'greenfield' sites, including those adjacent to watercourses. The NWS package facilitates landowners and foresters to create or manage native woodlands, cognisant of deer management, if present. Closed canopy woodlands with a dense shrub layer will have few open areas for deer to forage and to facilitate active deer management.

Fig. 9: Mature oak woodland and natural regeneration, ideal habitat for deer as it includes open areas for grazing and adjacent cover, Union Wood, Co. Sligo.

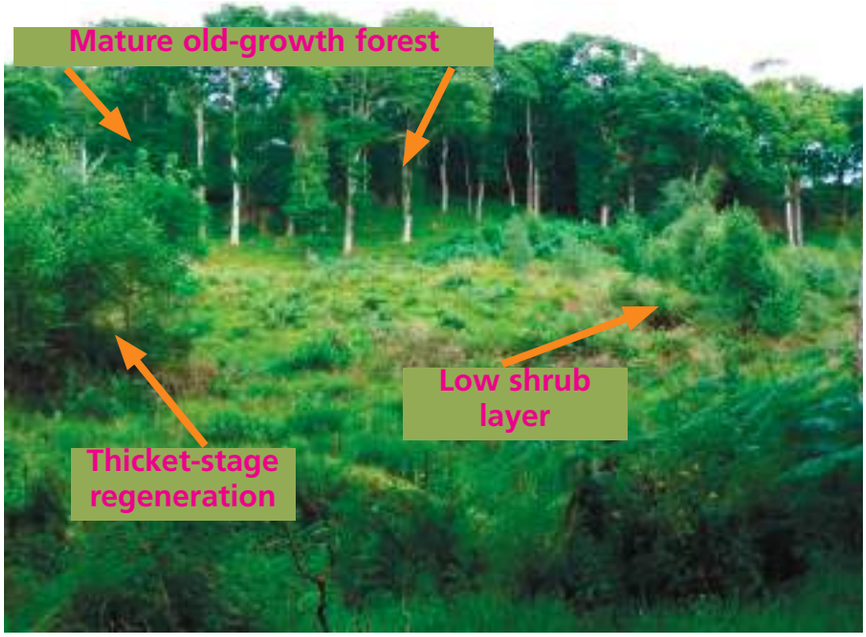


Fig. 10: Woodland edges should be managed to provide a diverse transition from open landscape to high forest structure. This provides ideal habitat for deer and steers them away from the woodland interior. A graded transition (as indicated by the arrows) edge is also ideal for enhancing floral and faunal biodiversity, Union Wood, Co. Sligo.

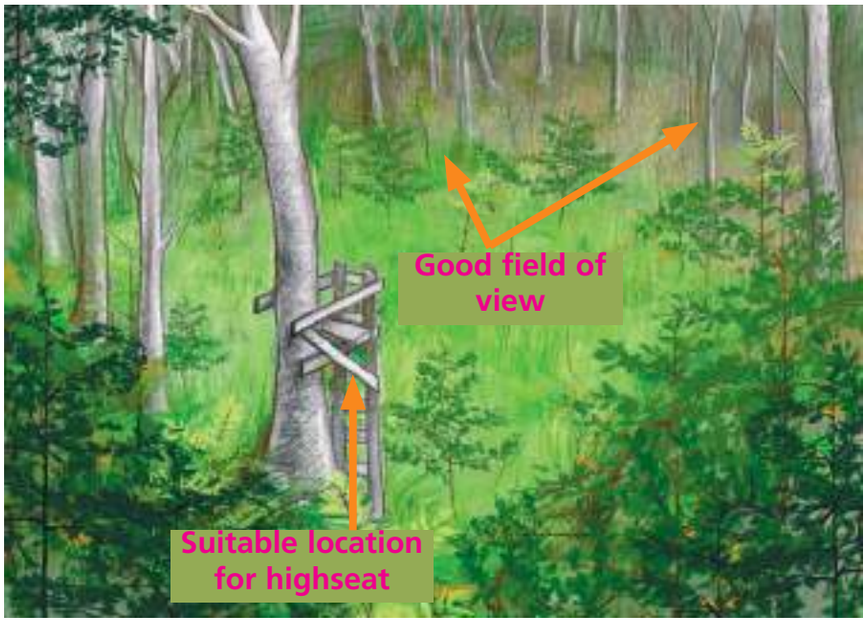
Native Woodland Conservation and Establishment allow up to 15% open spaces to be used as Areas of Biodiversity Enhancement (ABE). This provides an opportunity to manage deer by utilising open space, including grazing areas, lawns designed specifically for deer management, and/or other open spaces created primarily for retained habitats, access routes, water setbacks, etc. This strategy has been used on the continent for decades as a method for deer control management (Völk, 1999).

Deer hunting seats and hides

Deer hunting seats, i.e. high or ground seats, are excellent tools for targeting specific areas within woodlands. Their use allows the hunter to wait for deer to emerge from cover to feed or move from one area to another. It is vital to properly visualise and assess deer before they are culled. Sitting in a concealed position, either elevated or at ground level, permits the hunter to carry out a proper visual assessment of the deer. It allows for strategic culling and the positioning of seats and hides at specified locations also improves safety by ensuring there are appropriate backstops to reduce the potential occurrence of bullet ricochets.

Fig. 12: The view from a ground seat or high seat. Note the open valley is regularly used by deer which leave tree cover (on the left and right of picture). especially at night to graze. Union Wood, Co. Sligo.

Fig. 11: Mature trees are ideal for the placement of a high seat for deer shooting purposes. Open areas left unplanted provide grazing areas for deer. Backstops to reduce the risk of ricochets are also vital when placing deer hunting seats and hides.



The backstop is an essential aspect of hunting when considering the placement of hunting seats and hides (Figs. 11 & 12). It is imperative from a health and safety perspective that when a gun is fired, the bullet impacts an area directly behind the target, to eliminate bullet ricochets. The backstop should ideally be solid ground such as an earth bank (Fig. 12). Trees do not constitute a safe backstop and the shooter should always be aware of his/her surroundings, especially the backstop area, when preparing to shoot.

There are two types of seats that are particularly suited to the mature woodland setting. The first is a is a "lean to" type high seat, and the second, a free-standing ground seat, for woodlands with mature trees (Fig. 13). The movability of both options allows the hunter to position his/her hunting seat at various locations, such as along unplanted buffer zones, adjacent to watercourses or adjoining open space. Both types of hunting seats can be moved over time to more suitable locations, as the woodland structure changes and evolves.

Fig. 13: Two different hunting seats, i.e. a high seat (left) and a ground level seat (right).

WOODLAND DESIGN FOR DEER MANAGEMENT

Silviculture and forest design should be utilised in a way that compliments deer management over the long term. The use of deer fencing, or tree guards is only a short-term measure that allows for successful forest establishment or regeneration.

Leaving unplanted corridors, river setbacks (Fig. 14) and/or strategically creating an open canopy structure will create foraging areas for deer, thereby reducing impacts within the core forest area. Woodland edge management is also an important aspect of the overall forest design. Pioneer species including willow, birch and rowan will often regenerate or can be strategically established by planting (Fig. 15). Pioneer tree and shrub species - most of which are palatable for deer - also act as an alternative food source, which divert deer from other high forest tree species such as oak, beech, Scots pine, etc. This method of 'diverting' deer is an effective deer management tool that has been used by foresters in Europe in the past. Völk (1999) details the use of managed game grazing lawns as a method of diverting deer from browsing within woodlands. Where pioneer tree species are grown for wood production, other deer protection measures will be necessary, e.g. fencing and culling.

A graded, multi-layered mosaic forest edge provides deer with foraging areas and cover, both essential attributes for optimal deer habitat (Fig. 10). It also facilitates effective deer management. The main emphasis when designing woodland at establishment or subsequent woodland management is to make slight adjustments to the design that allows deer to use the forest, but which also facilitates the landowner to manage the deer effectively (Fig. 16). The use of specific tree and shrub species, the utilisation of open space, and the strategic placement of deer seats and hides, all improve the effectiveness of deer management while achieving silvicultural objectives.

Fig. 14: A NW Establishment project along the River Deel, Co. Mayo. Note the generous setback to the watercourse located at the bottom of the valley (to left of image). This setback complies with water quality guidelines and provides an open area for foraging and effective deer management.

Fig. 15: Rowan (or mountain ash) planted at the woodland edge and heavily browsed by deer in a private woodland, Co. Donegal.

PROTECTING WOODLANDS FROM DEER: PHYSICAL PROTECTION METHODS

Fencing – rationale in the Irish context

Fencing is the primary tool for deer management in Ireland (Figs. 17 & 18). It is a passive and non-controversial method favoured by forest managers, especially in native woodland management, often to the exclusion of other measures. However, national and local deer management groups (established in deer 'hotspots')

Fig. 16: Good forest design at afforestation allows for effective deer management.

typically advocate the use of other tools such as forest design and culling. Fencing is a relatively expensive option and in virtually all cases, is ineffective on its own.

Before deer fencing is considered it is necessary to ascertain if deer are present and if the population justifies its use. If not, fencing may be erroneously erected where there is no economic or ecological imperative or rationale for doing so. Therefore, fencing should ideally be used as part of a woodland management plan that includes deer management (Appendix 1).

Fencing and protection from grazing animals

In theory, woodlands should be able to develop naturally in the presence of a sustainable grazing regime. However, as deer management in native woodlands has generally only commenced in recent times in Ireland, especially due to the rising population of deer in some areas, almost all woodlands now need some form of physical protection at establishment. Nonetheless, fencing methods should not be considered in isolation but in conjunction with a strategic, continual reduction of deer density to appropriate levels.

Physical protection can be temporary or permanent and there are a variety of methods, materials and designs available. Before these are considered, several key questions need to be answered:

- Is it necessary to exclude deer or other grazers?
- Are there other species of grazing animals/livestock present?
- What species of deer are being excluded?
- What is the density of deer in the immediate area and, with respect to forest management objectives, what is the acceptable density?
- What are their movement patterns?
- What is the intended period of exclusion?
- Are resources (financial and human) available to maintain the protected area in optimum condition on an ongoing basis?
- What mitigation measures are planned when deer (or other grazers) gain access to the protected area?

1. Fences

The erection of deer fencing to protect vulnerable woodland should not always be presumed to be the principle method of deer control. Fences are costly, unsightly and in many cases, ineffective within a brief period if it's not monitored and maintained. In addition, fencing structures may conflict with other attributes on native woodland sites, especially aesthetic and recreational values, and can also inadvertently impact on other species, such as badgers, that utilise the fenced area. (Note: Badger gates can be included during the design and installation phase - see section 6. Gates and Stiles). Deer fences should be regularly checked by landowners to ensure they are fit for purpose on an ongoing basis.

However, there are some circumstances where few other options are available, such as culling, but most fencing projects can be greatly reduced when establishing new native woodlands. This can be done by planning and designing woodland structure and layout (species composition, open space and plantation boundary design) in a way that minimises the exposure to deer damage, while at the same time maximising commercial and/or conservation potential.

2. Planning fencing projects

Planning is the most important phase of any fencing project. It requires in-depth knowledge of the woodland area and its immediate hinterland. It is critical before a deer fence is considered, that the objectives are clear, and the species of

Fig. 17: A traditional standard deer fence, Charleville demesne, Co. Offaly.

deer present is determined beforehand, along with their movement patterns and densities (Appendix 1). Armed with this knowledge, fence lines can be planned so that animal pressure on the physical structure is minimised. Fence type and construction will depend on what species of deer are being excluded. In general, the smaller species (i.e. sika and muntjac) are more likely to go under or through a fence. Red and fallow deer are more likely to jump or go through the middle of fences. When fencing to exclude the smaller species, attention must be paid to securing the bottom wires to ensure that they are either lapped or pegged. For the larger species, bottom wires should also be secured but the height for red deer should not be less than 2.1m.

3. Fenced plots - size and design

Fenced areas should be designed so that they fit in with the landscape, are effective and consider animal movement patterns adjacent to the excluded area. In general, plot size should be kept as small as possible. Small plot sizes (i.e. < 1ha) have been shown to be highly effective and have the advantage that they are easy to erect and maintain, and if deer gain access the animals are easy to remove. Even smaller exclosures up to 0.15ha protected by livestock fencing or dead hedging (i.e. made up of brash from felling operations) can be very effective in protecting small, areas of planted trees and shrubs. Smaller plot sizes tend to be less attractive to deer which are not inclined to encroach into confined spaces. These can be fenced to a height of 1m or less, particularly where deer density is low (i.e. < 3/km^2). However, a disadvantage, especially in old and ancient woodlands, is that these exclosures will obviously not protect trees, shrubs and ground flora outside of the fenced area. Additionally, fencing small localised areas is relatively expensive and, in most cases, the fencing of larger areas is generally the preferred option, with or without internal exclosures. Nonetheless areas over 10ha should be compartmentalised with cross lengths to contain incursions. It is imperative that all deer fencing projects are examined from a cost-benefit point of view.

Subsequently, all deer fences should be checked regularly to ensure their integrity and that they continue to exclude deer. Short perimeter lengths result in deer being less likely to put pressure on fencelines and maintenance is a relatively easy task. Where possible, long straight lines should be avoided, and an effort made to follow the local topography. This helps to deter deer from attempting to gain access to exclosures and facilitates the fenceline to fit better aesthetically with its immediate environment.

Fig. 18: Simple, innovative and effective A-frame fencing, particularly suitable in difficult terrain, Derrycunnihy wood, Killarney National Park, Co. Kerry.

The design of fenced areas should consider the following:

- objectives of the fencing project
- the deer species being excluded
- local topography and size

For example, an exclosure of 50ha is planned for one side of a valley. Prior investigation has shown that deer are present at high density (i.e. > 12/km^2) in the general area and their movement follows a vertical pattern from the bottom of the valley to the top. To avoid persistent pressure on the physical structure, the enclosed area should be broken up into smaller plots with corridors between the plots to allow animals to move uninterrupted. This alleviates the need for large plots and negates any unnecessary pressure on the fence. In addition, within deer-fenced areas, internal exclosures using stock-proof fencing may be used to additionally protect groups of vulnerable trees, especially adjacent to watercourses. However, a reduction in deer density should ideally take place before fence construction commences and should be monitored throughout the initial period (i.e. for the first 5 years) after exclosure construction.

4. Fence type and materials

There are many fencing materials available from the traditional treated post and galvanised high-tensile wire (Fig. 17) to lightweight metal and plastic (Fig. 18). The current trend in fence construction is away from the labour intensive, expensive methods and materials towards

lightweight, temporary methods that can be readily constructed in almost any type of terrain (Fig. 18). New materials, such as lightweight hexagonal and high tensile plastic mesh netting offer many advantages, including the following:

- they can be made in a range of mesh sizes, strengths and colours
- they are lightweight (100m of 1.5m wide plastic netting weighs just 12.5kg compared to 126kg for 100m of 1.5m wide, high tensile wire netting), and
- they are re-useable and easy to dismantle and re-erect.

A fenceline is only as strong as its weakest point! Therefore, it is imperative that large drain and stream crossings are also addressed to ensure deer cannot access woodland, especially the smaller species such as sika and muntjac that tend to go under fences. A swinging gate that allows flood water and debris to pass through is recommended (Fig. 20). (For an overview of the standards and specifications of deer fencing materials and minimum standards regarding protection from grazing that apply in Forest Service Schemes see the *Forestry Standards Manual* (Forest Service, 2015b).

5. Leaps and Downfalls

Once a fence has been erected, it is never wise to assume that deer will not gain access at some point in the future. If the fenced area is too large to effectively remove all the animals, there must be other options available where animals may exit in their own time. Otherwise deer are effectively trapped within the fenced area and damage to newly-planted trees and shrubs may be worse than normal as the animals cannot escape.

Deer leaps to facilitate deer exiting exclosures should be positioned at bends and corners of fencelines or areas where the line of the fence takes a natural turn (Fig. 19). These are the most likely places where deer will try and exit (either through or over the fence!). Deer leaps or downfalls are a simple construction and can be made of materials occurring naturally or alternatively, timber ramps can be used. The leap is a ramp that is built from ground level up to the top wire. This allows animals to walk, run and jump over the fence from the inside, effectively forming a 1-way valve. Typically, leaps should extend to the height of the fence and are covered in natural vegetation to blend with the surrounding area. The dimensions of deer leaps are typically 4-6m wide at the base, extending to 2m in height at the top.

Fig. 19: A deer leap placed inside a fenced area, which allows deer to escape.

Fig. 20: A hinged in-stream barrier in a deer fence that prevents access to deer and livestock in an upland setting.

6. Gates and Stiles

Access to the woodland is essential to carry out forest management operations, including deer management and, in many cases to allow for recreation (see Trout and Pepper, 2006 for alternatives and construction). Simple hinged gates are the norm across forest roads, often with a person gate or stile adjoining it where access for recreation is permitted (Fig. 21). Person gates allow people to access the woodland through a confined area with a self-closing, spring loaded gate or through a sliding gate or turnstile. Stiles are usually constructed as simple three step ladders one each side of the fenceline. Badger gates, comprised of a hinged heavy timber gate, are inserted at the base of the fenceline and are not unlike cat flaps in external doors of domestic dwellings. In woodlands, they are however, heavy enough to prevent access by rabbits and hares.

7. Tree Guards and Shelters

Tree guards and shelters are normally used to protect planted hardwoods and are increasingly being utilised in Ireland (Fig. 22). There are a wide variety of commercial shelters and guards on the market and costs vary considerably. Tree shelters are usually continuous tubes of varying height that protect the entire stem from damage. They are normally made of mesh material, either from plastic or metal. There are also bio-degradable shelters that have a limited lifespan and will eventually disintegrate completely. Like fencing, the height of

Fig. 21: A spring-loaded hinged person gate in a deer fence line, Ballygannon Wood, Co. Wicklow.

guards and shelters will vary according to the species of deer. Those suitable for muntjac, sika and fallow deer (i.e. tube height 1.5m) are not suitable for red deer (i.e. tube height 1.8m). However, the effectiveness of many guards and shelters largely depends on the materials and the support system used. For example, as fallow and red deer are relatively large animals, they can destroy tree shelters and their supports if they are not made of robust materials and secured firmly in the ground. Certain types of protective tubes are not suitable for use in exposed locations due to pressure from high winds. Here, mesh type protection tubes that reduce wind resistance should be considered. Like deer fences, protective deer tubes require regular inspection and maintenance to ensure they remain effective. Once trees

Fig. 22: Extensive use of tree shelters in a woodland regeneration project, Charleville demesne, Co. Offaly.

are established and the tubes are in danger of bursting due to increasing tree girth, non-biodegradable tubes should be removed.

8. Maintenance

Maintenance of deer fences is critical but is generally the most neglected part of most fencing projects. Often, fences are erected, neglected and left unmaintained for their entire lifespan of 15 – 20 years. Regular inspection of fencelines will ensure that they continue to exclude deer.

Deer fencing projects should have a maintenance budget and schedule as part of the overall project. Maintenance schedules should include regular site visits with shorter time intervals in the initial weeks immediately after fence erection.

In short, maintenance involves:

- Integrating and maintaining an access path (which may also function as a firebreak) adjacent to the fenceline to enable fence inspection and repair
- Inspect fencelines as frequently as possible, especially immediately after erection and after storms. Remove any fallen branches from the fence and repair if necessary
- Check the stability of fence posts and vulnerable sections of the fenceline, especially where it crosses watercourses and ditches as these may provide access to deer which may get under the fence. Secure with wire netting which should be buried or weighted with stones
- If the area is used for recreation or the fenceline is damaged maliciously, ensure that people locally are informed of the requirement for the fenceline through adequate signage and/or stakeholder consultation.

PEOPLE MANAGEMENT

Of all the components of deer management, the human dimension is the most problematic. Many deer management initiatives are compromised due to a failure to reconcile different objectives, stakeholders' attitudes and subsequent responses towards deer. Very often, 'deer problems' are as much about human problems, politics and stakeholder communication deficits as they are about animal behaviour or impacts.

Deer conflicts are frequently reported in the media in Ireland and headlines are often alarmist and emotional. Media coverage is generally unhelpful, especially where sectoral stakeholder influence is concerned. However, less attention is generally paid to the study of the human factors involved in deer management conflicts and the key background local issues that often influence these. Views based on emotional, anecdotal or

personal perspectives and perceptions tend to be counter-productive. As deer management is complex, these are best resolved through improved stakeholder understanding and co-operation initiated at a local level.

National partnerships generally focus on high-level, strategic development and policy, while local partnerships focus on local-level deer management implementation. Stakeholder co-operation can be achieved through well-led partnership approaches, which require considerable time, patience and leadership resources to establish.

The Irish Deer Management Forum (IDMF) was established in 2015 to coordinate deer management at a national level (see http://idmf.ie/). Similar deer management group structures have been successfully applied in the UK for over two decades, through the work of the Deer Initiative in England and Wales, and the Deer Commission for Scotland (recently incorporated into Scottish National Heritage). Access to, and engagement with these resources and initiatives by forest managers will lead to informed and reliable management measures. In addition, supporting data can be presented and communicated effectively. The goal should be to generate hard data that contributes to effective deer management derived from professional surveys, reports, and peer reviewed research.

A local Deer Management Group can act as a forum for sharing experience, skills, best practice and training, and inform and address local deer issues. Partnerships exist in Ireland, for example in Co. Wicklow, through the Wicklow Deer Management Partnership, which was established in 2001. It is a partnership group aimed at devising and implementing collaborative strategies for the management and control of deer species. Conflicts between deer and land management interests have been acute in the county for many years, as deer populations range across multiple land ownerships. This group enables consensus between relevant stakeholders on the implementation of appropriate responses to deer issues in Wicklow. Membership of the Group includes representatives of the following organisations:

- Wicklow Deer Society
- Irish Deer Society
- Irish Farmers Association
- Irish Timber Growers Association
- Coillte Teoranta
- National Parks & Wildlife Service

Since its formation, the group has provided a useful forum for stakeholders to discuss deer management issues, to improve understanding, trust and respect between the different interest groups, and to agree a strategy for the sustainable management of deer in Wicklow.

With initial funding from the Heritage Council and subsequently from the Forest Service, a professional co-ordinator assists the Group in developing and overseeing the implementation of Deer Management Plans in specific locations. The co-ordinator also facilitates meetings of the Group, and collates and manages data collected, (e.g. deer counts, cull data, etc.), which is analysed and inputted to a management strategy agreed and adopted by the Group. Where there is a consensus to manage deer through collaboration, a Deer Management Group can:

- support the achievement of common management objectives
- promote compromise in the management of a shared resource
- enable the co-operative use of common facilities and human resources

It is recommended that woodland managers engage with national and local initiatives and avail of deer management training opportunities and education. Training should include deer population monitoring, damage assessment and the recording of management activities, as these elements are the basis for professional standard deer management. A forester or woodland manager should subsequently be able to assemble the building blocks of a deer management plan. Using this approach, a woodland manager and/or owner is well equipped to manage deer populations effectively.

Modern stakeholder management must encompass, not only traditional communications platforms and techniques, but increasingly, new digital and social media and online survey techniques. Direct face-to-face interaction and constructive dialogue followed by effective management measures is the basis for ongoing sustainable deer management.

SUMMARY

Deer will continue to form an integral part of forest ecosystems in Ireland. With continued incentives to increase forest cover, which include the creation of new and the restoration of old native woodlands under the NWS, the need to address forest and deer interactions on an ongoing basis is required. Native woodland establishment and the revitalisation of old woodland sites are an integral part of Ireland's forest vision and the necessity to manage deer in these habitats is an important management issue to achieve these goals. Under the Forestry Programme 2014 - 2020 and *A Strategy for Native Woodlands in Ireland 2016 - 2020* there are targets to restore 2,000ha of existing native woodland and to create 2,700ha of new native woodlands (Woodlands of Ireland, 2016). It is vital that deer are managed with

respect to woodland management objectives, as the deer measures employed will differ depending on whether conservation, wood production or recreation is the primary goal.

Foresters and land managers should be encouraged to understand deer ecology and behaviour, the effects of deer on woodlands, and the mitigation methods that are available with respect to forest design, forest protection and direct population control in the form of culling.

A positive outcome with respect to woodland development and deer interaction involves stakeholder consultation, forest and fence design, tree species choice and the use of high and ground seats to enable shooting, and the incorporation of leaps and downfalls.

Combining all these measures in a deer management plan is essential to effectively control and sustainably manage deer while promoting good forest management. The approach and measures for native woodlands outlined here are by no means exhaustive, and are also relevant, with modification, to other susceptible, non-native deciduous, coniferous and mixed woodlands in Ireland.

As further tools for managing deer are developed from experience and research in Ireland and elsewhere, especially regarding native woodlands, it is expected that further follow-up bulletins will be published in this series.

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Appendix 1: An example of a deer management plan and template for a native woodland

Deer Management Plan

Client: Mr X

Site Name: Native Woodland

Author: Deer Consultant

Plan Duration: 5 years (reviewed annually)

Designations: Special Area of Conservation (SAC) & Natural heritage area (pNHA)

Date: September, 2017

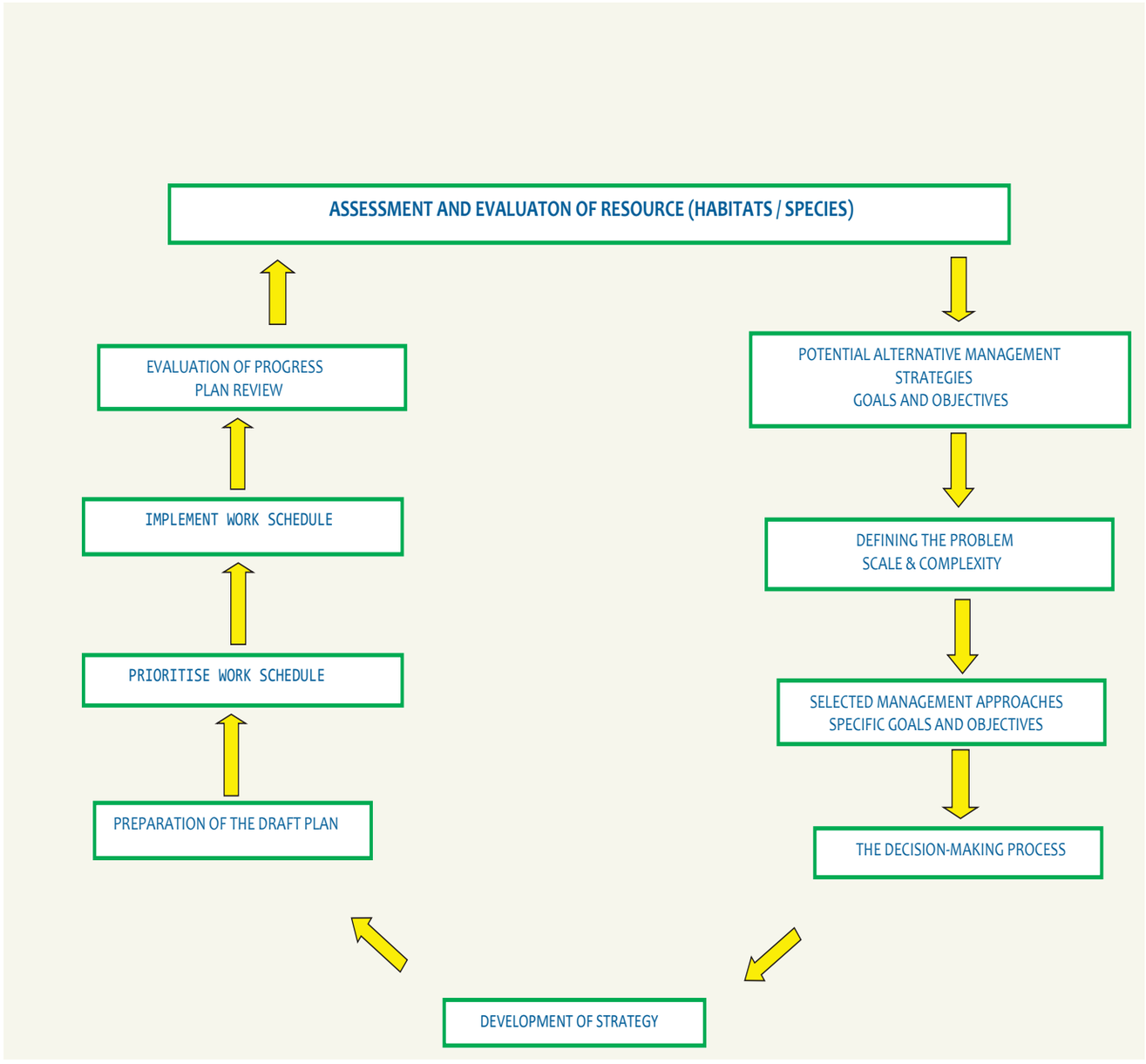
Principles for sustainable deer management

- To maintain and where possible, enhance biodiversity
- To pre-empt unacceptable damage to the habitat (including designated habitats and species, priority habitats & species under EU Directives), where applicable
- To take account of all legislative provisions contained in EU Directives, Wildlife Acts and other relevant legislation
- To achieve a balance between deer and their available habitat
- To promote and safeguard deer welfare always
- To adhere to and if possible, exceed best practice guidelines
- To integrate deer management with other objectives and associated activities

Deer management planning should support:

- the provision of a realistic, objective basis for deer management decision making
- the integration of deer management with other land uses and activities
- the collation of all available information on deer population and habitat condition
- a methodology for data analysis and interpretation
- the compilation of data to make informed and effective management decisions
- the basis for assessing the effectiveness or otherwise of deer management actions
- forward planning in all aspects of deer management to build confidence in a systematic approach toward managing deer populations on an ongoing basis

Fig. 1: A schematic representation of the deer management planning process



Part 1: Introduction - Habitats

Background

This native woodland was one of the original Native Woodland Conservation pilot projects approved for funding in 2003 under the Native Woodland Scheme (NWS). It was a 'multi-annual' project and the capital funding provided by the Forest Service was for deer fencing of the entire *c.* 100ha woodland area. Thereafter, the grant was drawn down over several years on a phased basis as the delivery of the work programme outlined in the original NWS Ecological Survey and Management plan was implemented. The primary focus of this programme was the removal of exotic species from the woodland area and the regeneration of this area with native species over ca. 85ha. During Phase 1 (2003 – 2006) the entire woodland area was worked over with respect to exotic species removal. After Forest Service approval, the NWS programme focused on maintenance operations carried out by the owner [1]. Localised exotic species regrowth/regeneration and enrichment planting with native trees and shrubs is being addressed in the revised maintenance programme (Phase 2: 2017 -2020).

While enrichment planting was scheduled and carried out within Phase 1 works, it was anticipated that, with successful deer control, the principle means of woodland regeneration would be via natural seeding. On-going deer pressure resulted in enrichment planting being internally protected from deer browsing, primarily with deer tubes. The existing deer culling programme has resulted in some areas of natural regeneration, however the culling programme needs to be stepped up to secure additional regeneration of native species and to protect additional enrichment planting within the new maintenance programme [1]. This deer management plan is a crucial component of the current Phase 2 programme.

Location and Description of the Woodland in the Wider Landscape

The wood is in Co. xxx (Grid ref: yyyy) and is bordered by a secondary road along the northern perimeter of the site and a tertiary route forms the eastern boundary. The total area of the site is 272ha of which 107ha is woodland and the remaining 16ha is water. (see Fig. 2(a) and (b) below). The woodland is surrounded mainly by agricultural pasture and crucially, by other woodlands in the vicinity. To the north lies a large area of broadleaved woodland, to the east, a large Coillte plantation, while to the south are small pockets of patchy, broadleaved woodland. In combination, these woodlands form the core range of the local fallow deer population.

The native woodland is a recreational woodland resource with an open gate policy, located beside a town with a population of *c.* 14,000. It is subject to myriad interests and pressures, which in many cases are impossible for the owner to control. From the outset of Phase 1, the perimeter deer fence was subject to on-going vandalism, which has led to the influx of deer from the surrounding area. The woodland is well serviced with tracks, most of which have been used by timber contractors for timber extraction. In the middle of the site is a small 16ha lake and this secluded area, is used extensively by the deer, mainly for refuge from disturbance elsewhere in the estate.

Management History

Both historical and ecological evidence shows at least 'old' woodland cover on the site and almost certainly, 'ancient' woodland. Estate records date back to the 1780s and the area is shown as 'high forest' at that time. Indeed, some trees present today pre-date these records, by at least a century. The estate has undergone very little management in recent times, aside from the localised planting of spruce in the 1960s and occasional oak and ash felling in the 1970s [2]

Deer Management - Factors to Consider

(a) Dogs are a problem and often chase and kill deer. High deer usage near the lake is most likely a consequence of marauding dogs and recreation pressures elsewhere.

(b) Recreational activities (i.e. walking etc.) may impact on deer control activities during the autumn and winter.

(c) Coillte Forest operations locally are likely to have an indirect effect on deer migration and movement patterns by exporting deer to the wider landscape. Collaborative agreement/liaison with Coillte is advised.

Future woodland management: Long-term policy and vision

This woodland clearly shows historical evidence of ancient, semi-natural woodland (see Table 1 for description). It is one of the few large semi-natural woodlands remaining in Ireland. The large area of woodland, long history, and continuity of native woodland cover make it a unique site to protect and conserve. The focus of NWS management is to maintain woodland continuity by removing or reducing the threats, and to enhance the features particular to each woodland community present. The ecological objective is to maintain as natural a structure as possible, ensuring all locally native species are represented. The reduction in deer density, removal of invasive exotics, and resulting regeneration of locally native species will ensure the perpetuity of the woodland habitat. The aim is to secure the long-term future and ecological integrity. If deer populations are managed effectively, the woodland will have the ability to regenerate and, as a result, a wide range of age classes will be represented, from veteran trees to new seedlings. The establishment works carried out in Phases 1 and 2 should produce good results with a satisfactory stocking of semi-mature trees. In areas earmarked for timber production, selected crop trees should show good stem quality [2].

Management objectives: Owner's objectives

The owner is very aware of the ecological/biodiversity and aesthetic value of these woodlands. His primary objective is the sustainable management of all woodland areas, to ensure that they are maintained in an ecologically balanced condition in perpetuity. Since the woodlands have been managed in the past for timber production and that it is a working estate, the owner wishes to continue sustainable native timber production integrated within the overall conservation management objective, where applicable, especially where this is in keeping with ecological priorities, particularly the SAC guidelines [2].

The high landscape and recreational values are also considered in the management plan [2].

Part 2: Deer Species, Impacts and Management

Current situation

There is little historical data on past deer management or control activities on the estate. Some deer have been culled on an annual basis but not as part of any systematic management strategy and reduction of deer density is likely to have been relatively ineffective. It is virtually impossible to drive deer from a large area and subsequently encircle the area with a deer fence and hence, it is inevitable that deer remain within the fenced area. In addition, this creates added unnecessary and continuous pressure on fence lines and structures. Consequently, they require specific management strategies to control them.

This woodland is almost certainly part of the core range of the local fallow deer population catchment. Deer species with relatively large home range sizes create specific challenges in relation to successful management and effective control. As a result, prior to any proposed management, it is essential to assess the total range size of local populations, including differences between seasons. Due to the woodland's location within the wider landscape and its attractiveness to deer, i.e. for forage and cover, a management strategy should proceed after a full evaluation of the potential risks to biodiversity, e.g. loss of woodland continuity due to lack of regeneration, and the consequent resource implications required for future management.

Deer species and the wider landscape

Fallow deer originated in the estate as an enclosed park herd. However, during 1920-22 the gates of the park were opened, the deer escaped and dispersed into the wider countryside and is now well established locally. Future management must account for their core range, seasonal migratory movements and how they utilise habitats within it. Failure to do so and not to understand the nature of deer movements within the wider landscape will continue to cost land owners in the form of retrospective corrective actions. Fences will continue to come under pressure from migrant deer, particularly during the autumn and consequently, the level of maintenance needs to remain very high.

Fallow deer are a non-territorial species that exhibit extensive home range overlap between the sexes. Range sizes are also seasonally variable and differ in size from approximately 180 – 200ha in summer to 350ha in the autumn. Mean core home range sizes for fallow can be as large as 600ha. Furthermore, within specific sites, fallow deer exhibit distinct habitat preferences, usually based on the

availability of different forages. In autumn and winter, they prefer deciduous or mixed woodland and readily browse an array of species of broadleaved trees. However, they are preferential grazers with grasses contributing over 60% of forage intake during spring and summer, hence they tend to concentrate their feeding on woodland rides or open grassy areas within woodlands. During winter, grasses still contribute over 20% of their dietary intake [3].

Table 1: Woodland information - description and habitats.

Native Woodland Unit	Classification	Description	Area (ha)
NWU 1	**FH1** (WN2 / B1)	Mainly oak, with a high proportion of ash and occasional birch trees. Contains Scots pine and stands of larch locally. Glacial ridges dominated by beech and/or sycamore regeneration. The understorey comprises hazel, with occasional hawthorn, blackthorn, goat willow, beech, sycamore, ash, oak, and holly. It includes the lake zone, which comprises reasonably intact ancient woodland, with a preponderance of large diameter oak stems [2].	67
NWU 2	**AF6** (WN6 / E3)	Similar to NWU1, however influenced by seepage from the lake and many small low-lying areas are present. Stilted tree roots and a higher frequency of alder and sally characterise this woodland type, though ash and pedunculate oak present (tolerant of occasional waterlogging) [2]. The south western corner is former pasture colonised by semi-natural woodland in recent centuries. Characterised by an open canopy of ash, birch, and sycamore, with a grassy field layer, including sedges mixed with calcicole wood false brome and wavy hair grass. Deer are regular visitors to NWU2 [2].	15
NWU 3	**BM4** (WN7 / F1)	Located on cutover raised bog between ridges of glacial till, the peat is underlain by glacial sediments, from sandy to heavy, base-rich material, resulting in a nutrient-rich fen soil. It is flooded close to the surface during high water periods and is crossed by several ditches which appear on old maps. Parts of NWU3 have been planted with conifers, primarily Norway and Sitka spruce. Canopy gaps have allowed the growth of large diameter downy birch. The understorey in glades contains some large diameter elder and hawthorn [2].	17
NWU 4	**BM5** (WN 6 / E1)	Fen woodland, low in stature, this woodland is waterlogged in winter and wet the rest of the year due to a high water-table. Trees present in the overstorey include downy birch, ash, oak, and alder, while the ground flora varies from marsh marigold and bog bean in muddy areas, to sedges and reeds in grassy areas [2].	5

Table 2: Woodland deer density indicators.

EVIDENCE	0-5 km^2 LOW DENSITY	0-5 km^2 MODERATE DENSITY	12 km^2 + HIGH DENSITY
TRACKS	Difficult to find slot marks or defined paths	Defined paths: slot marks easy to find in soft ground	Many well-defined paths: often black with consistent use/traffic
DUNG	Difficult to find with odd isolated group	Faecal Pellet Groups (FPGs) relatively easy to find particularly on woodland edge and good feeding areas	FPGs easy to find. Highly concentrated on favoured feeding areas
BROWSING	Natural regeneration taking place with little or no damage to current years incremental growth	Broad-leaved saplings present but showing signs of significant damage	No seedlings growing above dominant vegetation height. Well defined browse line on established plants.

Table 3: Current impacts on the native woodland site.

	Tick as appropriate			Deer species	Comments
	Low	Mod.	High		
Browsing			√	Fallow	Browsing extremely variable – reduction in density should alleviate
Fraying		√		Fallow	Some fraying but not terminal – usually related to male territorial behaviour (antler cleaning)
Bark Stripping	√			Fallow	Occasional and season specific – generally not terminal, unsightly
Ground flora		√		Fallow	Vulnerable at key times of the year – reduction in density should alleviate
Shrub layer			√	Fallow	Sparse shrub layer under canopy – deer impact needs assessment required as effects may due to canopy closure & lack of light rather than deer herbivory
Vehicle collisions	√			Fallow	Unknown – but should be monitored in relation to fencing regime
Trampling			√	Fallow	Defined paths and tracks throughout suggesting extensive movement within woodland – evidence of playing/lecking/congregating areas

Current deer management

No current deer management in place except unspecified annual culling. No records available currently.

Table 4a: Proposed future management and timetable - Objectives, tasks and responsibilities

OVERALL OBJECTIVES
1. To reduce the deer population from current 9.75km^2 to <5km^2 in the short to medium term to reduce negative effects on habitats & dependent species **2. To ensure all future deer management activity conforms to best practice over and beyond the lifetime of the Plan** **3. Set specific timetable to achieve management objectives** **4. Keep all records relating to deer management activities and update on a systematic basis**

Short-term goals and responsibilities (12 Months)

Tasks	Start	Finish	Responsibility	Description of work	Date completed
Deer Density Assessment	May 2017	May 2017	Contractor	Faecal Standing Crop Counts @ L1	May 2017
Prepare Draft Plan	June 2017	Sept. 2017	Contractor	Prepare 5 Yr. Deer Management Plan (DMP)	
Deer Density Assessment	Sept. 2017	Sept. 2017	Contractor	Repeat Faecal Standing Crop Counts @ L1	Sept. 2017
Population Control 2017/18	Sept. 2017	Feb. 2018	Contractor	Reduce deer density from 9.92km^2 to 5km^2. Record relevant biometric data. Use out of season license (if necessary) to achieve targets	
Annual Review	Mar – Apr. 2018	April 2018	Contractor	Review Progress of DMP	
Monitoring effectiveness	Annually		Contractor	Monitor effectiveness of reduction in deer density	

FSC = Faecal Standing Crop

Table 4b: The long-term deer management objectives and tasks.

Tasks	Start	Finish	Responsibility	Description of work
Annual deer density assessment	Each spring	Each spring	Contractor	Repeat FSC counts @level 1 to assess effectiveness of deer control & current deer density. Monitor female productivity rate
Population control 2017/18	Sept. 2018, 2019, 2020, 2021	Feb. 2019, 2020, 2021, 2022	Contractor	Maintain deer density below 5km^2 and record relevant biometric data. Use out of season license (if necessary)
Annual plan review	Year end	Year end	Contractor	
Collaboration	2018		Collective	Initiate collaboration with neighbouring landowners sharing the deer resource

Long term objective / vision

Long term objective / vision
1. To maintain the fallow deer population at sustainable densities within the estate and in the wider landscape **2. To minimise negative impacts on woodland habitats by allowing the positive effects of deer herbivory to drive the natural regenerative process** **3. Consider fencing only as a short-term protective strategy designed with the sole purpose of protecting vulnerable habitats / sites from deer** **4. The overall objective should aim to be fence-free within 10 years** **5. Initiate and enter into collaborative deer management agreements with relevant neighbours** **6. Ensure all future deer management activity conforms to best practice over and beyond the lifetime of the plan**

Table 5: Monitoring - fence maintenance schedule.

Structures	Checks	Frequency	Repair / reporting
Internal fences / tubes	Check for structural integrity, wire tension post integrity. Pay particular attention to bottom wires	Weekly for 2 months monthly thereafter	Repair immediately and note
Perimeter fence	Check for structural integrity. Pay attention to bottom wires. Assess wire tension and signs of deer hair on wire. Remove overhanging trees/branches	Weekly for 3 months monthly thereafter	Repair immediately and note
Gates	Check opening and closing mechanisms/locks	Every 6 months	Repair immediately and note

Table 6: Health and safety related issues.

Complete/delete as applicable	Risk assessments in place (tick)		Actions required	Comments
	Yes	No		
Access	√			Require vehicular access for removal of deer carcasses
High seats or other aids	√			High seats to be used for deer control
Use of vehicles	√			Vehicles to be used as aids for deer management
Use of all-terrain vehicles	√			Vehicles to be used as aids for deer management
Use of firearms	√			Appropriate license and land owner permissions
Lone working (safety statement)	√			Safety statement
Method statement				N/A

Part 3: Deer Management Plan Review

Final plan

Review – Agree and set out procedures for reviewing and modifying the plan. The plan should run for a maximum of 5 years but should be reviewed annually at year end.

Plan summary (prepared after the final plan has been completed)

- Describe the key biodiversity features and priorities within the plan area
- Summarise the full range of management objectives
- State the views (if/where applicable) of other land use agencies (e.g. NPWS, The Forest Service, Inland Fisheries Ireland)
- Summarise the economic costs and benefits associated with deer and/or deer management
- Record a commitment that the progress of the plan will be reviewed annually.

Reference Material

[1] Native Woodland Scheme revised maintenance programme (Phase 2)

[2] Native Woodland Scheme Management Plan (Phase 1)

[3] Moore, N.P., Hart, J.D., Kelly, P.F. and Langton, S.D. 2000. Browsing by fallow deer (*Dama dama*) in young broadleaved plantations: seasonality, and the effects of previous browsing and bud eruption. *Forestry* 73, 437-445.

Part 4: Deer Management Forms and Data for Example Native Woodland site

Table 7: Population Reduction Targets **Sex: M/F Age: Adult – A (2 years +) Juvenile – J (1 year +)**

SEASON	MALES		FEMALES		JUVENILES		TOTAL	
	Target	Actual	Target	Actual	Target	Actual	Target	Actual
2017/18	2		4		1		7	
2018/19								
2019/20								
2020/21								
2021/22								
Trends →↓↑	Density							
	Impact							
	Other							

Table 8: Sample deer observations: recruitment / productivity. Note: A = Adult (2 Years +) J = Juvenile (1-2 Years) F = Fawn (< 1 Year.) DMC = Deer Management Consultant (observer)

OBS	YEAR	NWS UNIT	SEX		AGE CLASS ♂			AGE CLASS ♀			TOTAL ♂			TOTAL ♀			NOTES
DMC	2017		♂	♀	A	J	F	A	J	F	A	J	F	A	J	F	
DMC	May	NWU 3															Does + yearling in BM5 and AF1
DMC	Sept.	NWU 4															Adult buck + yearling male in BM5 - Doe + fawn FH1

Table 9: Sample deer cull data sheet. Note: A = Adult J = Juvenile (>1 Year) F = Fawn (< 1 Year) P = Pregnant NP = Not pregnant

NUMBER	DATE	NWS UNIT	SEX	WEIGHT (kg)	AGE CLASS			PREGNANCY		LACTATION		NOTES
					A	J	F	P	NP	YES	NO	
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

Table 10: Results of Faecal Standing Crop (FSC) Counts, May 2017.

DEER MANAGEMENT UNIT: NWS Native Woodland

FSC Counts – native woodland example (Fallow deer) – Spring 2017

TS/ID	GRID REF.	100	200	300	400	500	∑PG	DR	∑DEER	KM^2	EDU	HAB. TYPE	AREA (ha)
xxx	xxx	3					3	241	4	5.26	L	FH1	67.4
xxx	xxx	4					4	241	5	7.01	M	FH1	67.4
xxx	xxx	4					4	241	5	7.01	M	Fh1	67.4
xxx	xxx	3					3	241	4	5.26	L	FH1	67.4
xxx	xxx	3					3	241	4	5.26	L	FH1	67.4
xxx	xxx	9					9	202	4	18.8	H	AF6	19.8
xxx	xxx	8					8	202	3	16.7	H	AF6	19.8
xxx	xxx	7					7	202	3	14.6	H	AF6	19.8
xxx	xxx	3					3	202	1	6.26	M	BM4	17.1
xxx	xxx	3					3	202	1	6.26	M	BM4	17.1

Population Density Estimation (Deer / Km^2) Fallow Deer

Deer Management Unit: NWS

No. of Transects: 10

Sample area (m^2): 1,250
Total no. of parcels: 100
Total no. of pellet groups: 47

Average density: 9.92 km^2

90% CI density is 9.92 ± 3.06 deer / km^2 (8 - 14 Deer)

EDU = Effective Deer Utilisation

Table 11: Results of FSC Counts, September 2017

DEER MANAGEMENT UNIT: NWS Native Woodland

FSC counts – Native Woodland (Fallow deer) - Autumn 2017

TS/ID	GRID REF.	100	200	300	400	500	∑PG	DR	∑DEER	KM^2	EDU	HAB. TYPE	AREA (ha)
xxx	xxx	4					4	241	5	7.01	M	FH1	67.4
xxx	xxx	3					3	241	4	5.26	L	FH1	67.4
xxx	xxx	4					4	241	5	7.01	M	FH1	67.4
xxx	xxx	5					5	241	6	8.77	M	FH1	67.4
xxx	xxx	2					2	241	2	3.5	L	FH1	67.4
xxx	xxx	14					14	202	6	29.3	H	AF6	19.8
xxx	xxx	10					10	202	4	20.9	H	AF6	19.8
xxx	xxx	4					4	202	2	8.37	M	AF6	19.8
xxx	xxx	3					3	202	1	6.27	M	BM4	17.1
xxx	xxx	4					4	202	1	6.27	M	BM4	17.1

Population density estimation (Deer / Km^2) Fallow Deer
Deer Management Unit: NWS
No. of Transects: 10
Sample area (m^2): 1,250
Total no. of parcels: 100
Total no. of pellet groups: 53

Average density: 9.92 km^2
90% CI density is 10.26 ± 4.7 deer / km^2 (11 ± 5 Deer)

EDU = Effective Deer Utilisation

Table 12: Summary of results: FSC counts, Autumn 2017: Native Woodland

DMU	HABITAT TYPE	AREA (ha)	SAMPLE (m^2)	∑ PG	∑DEER	Km^2	EDU
Native Woodland	FH1 (WN2)	67.4	625	18	6	8.14	M
Ditto	AF6 (WN6)	19.8	375	28	4	19.5	H
Ditto	BM4 (WN7)	17.1	250	7	2	7.91	M
Ditto		2.54	N/A	N/A	N/A	N/A	N/A
	ALL	**107.6**	**1,250**	**53**	**12**	**10.26**	**M**

Km^2	EDU
0	ABSENT (A)
0 - 6	LOW (L)
6 – 12	MODERATE (M)
> 12	HIGH (H)

EDU – Effective Deer Utilisation
Km^2 – Deer density / square kilometre
∑Deer – Total number of deer
∑PG – Total number of Pellet Groups
Sample (m^2) – Sample area in m^2
Area (ha) – Area in hectares

Table 13: Summary of Cumulative results: FSC counts: Spring + Autumn 2017 Native Woodland

DMU	HABITAT	AREA (ha)	SAMPLE (m^2)	∑PG	∑ DEER	KM^2	EDU
Native Woodland	ALL	107.6	1,250	50	90% CI 11 ± 2	9.75 ± 1.99	M

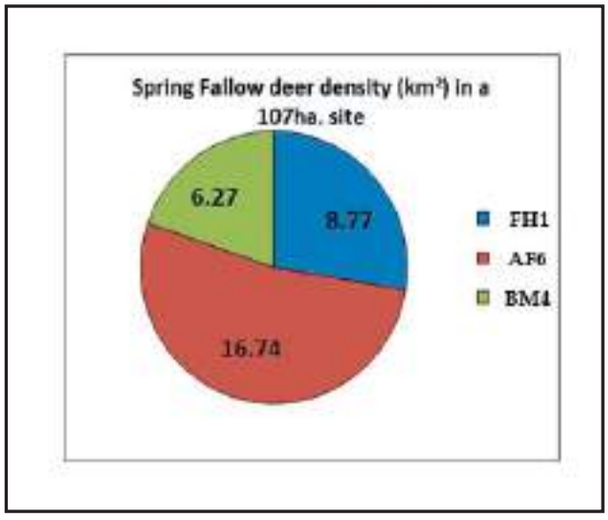
Based on the two FSC counts (Spring and Autumn)

DMU = Deer Management Unit

Estimated deer density km^2 (90% confidence) for native woodland = 7.76 – 11.7km^2

Equivalent to a Moderate Effective Deer Utilisation (EDU) or 9 – 13 deer

Fig. 2: Seasonal changes in Fallow deer migratory patterns at the Native Woodland site in 2017.



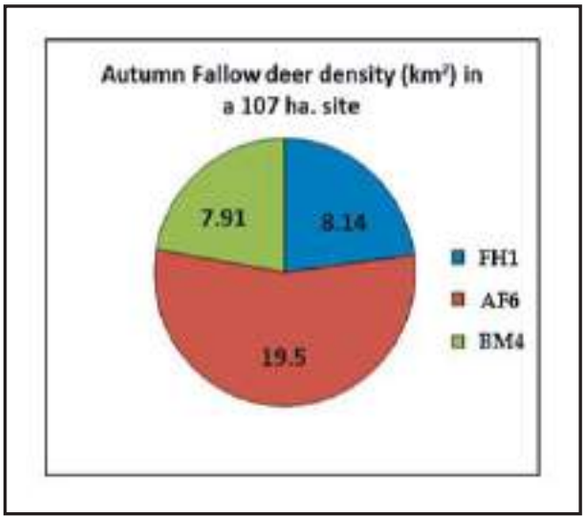


Table 14. Field sheet with recorded data from deer damage assessment - a worked example.

Forester	Joe Forester	**Date**	09/08/2017	**Location**	Native Woodland
				Radius of Plot (cm)	420
Plot	1 of 7	**GPS Ref**	455564, 777445	**Stocking/ha**	2700
Tree No	Species	Height (cm)	Leader Browsed (Y/N)	Other damage (Y/N)	Comment
1	Oak	25	N	N	
2	Oak	22	N	N	
3	Ash	45	Y	N	
4	Ash	53	Y	N	Old leader browsed
5	Ash	21	N	N	
6	Ash	63	Y	N	
7	Rowan	75	Y	Y	Fraying
8	Ash	83	N	Y	Fraying
9	Rowan	34	N	N	
10	Rowan	56	Y	N	
11	Ash	48	N	N	
12	Oak	33	N	N	
13	Oak	32	N	N	
14	Ash	41	N	N	
15	Ash	49	Y	N	
Result	**No of trees in Plot:**	**15**	**No of trees browsed:**	**6**	**% Browsing: 60%**

Results: The above figures indicate that in Plot 1, 40% of trees within the browsing range up to 1.3m in height have had their terminal leader browsed in the last growing season. If old browsing was evident and a new leader has grown above this, it is not counted as browsed. In addition, 13% of the trees recorded in the plot had fraying damage.

Fig. 3: A map (a) and aerial image (b) of the Native Woodland example referred to in the preceding text.