DEER AND FORESTRY IN IRELAND: A REVIEW OF CURRENT STATUS AND MANAGEMENT REQUIREMENTS

A report prepared for

Woodlands of Ireland
(Coillearnacha Dúchasacha)

By

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November 2009

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Executive Summary

There is no national deer management policy in Ireland and no co-ordinated system of deer population distribution or density measurement. There is no single authority with jurisdiction over the necessary components of a comprehensive deer management policy. Due to a number of factors, deer populations in Ireland are increasing at unsustainable rates and in many areas are already at unsustainable levels. Deer are currently impacting significantly on both the economic and biodiversity values of forest habitats and these impacts will reach catastrophic levels in the next ten years if the current system of lack of management remains unchanged. The consequences of not addressing deer management will result in deteriorating conservation status of native woodland as well as a reduction in hardwood and conifer wood quality, an inability for broadleaf woodland to regenerate thereby compromising their future viability, increasing damage to agricultural crops as a result of increasing deer grazing pressure, severe difficulties regarding the control of disease outbreaks such as foot-and-mouth, and an increase in collisions between motor vehicles and deer, which may result in serious injuries or death for the motorists involved.

Deer population management in Ireland is not practiced to any significant extent and foresters and forest owners have an ill-founded reliance on recreational hunters to achieve the necessary levels of deer management which will only be achieved through the use of professional deer management personnel. There is no properly established quality control system in place that could facilitate the development of a domestic market for venison. Without such a market, there is little chance for a sustainable future for deer management given the high cost of carcass disposal and the need for a disproportionate cull of females over males, for which some sporting revenue can be generated. Deer management is not taught in any of the Irish 3rd level institutions, not even as a module of any of the three forestry schools. The financial cost of deer damage is difficult to quantify. It includes loss of timber value (estimated at €34 million for recently planted broadleaved plantations), loss of biodiversity, reconstitution costs, potential EU fines for non compliance with the Habitats Directive and potential loss of investment through failure to achieve the objectives of Forest Service grant schemes. In commercial conifer crops there is recent data that suggests that in areas of Ireland that have high deer densities presently, up to 22% of the potential revenue of the crop amounting to €3,800/ha may be lost. Much is to be learnt from our European neighbours where there are established deer management cultures, policies and practices. There is an immediate need for a fundamental change in deer management in Ireland. This can only be achieved through the establishment of a dedicated national or all-Ireland deer management unit, similar to the Scottish Deer Commission or the UK Deer Initiative.

It is recommended that an Irish deer management unit be established with adequate statutory powers and budgets to effect the necessary regulatory, management, research, educational and developmental changes that can result in a deer management system that is fully integrated with forest management and other land use and related policies. A National deer management unit can be established within an existing government Department, e.g. Department of the Environment, Heritage and local government via NPWS, as an inter-departmental agency or as an independent agency.

It is also recommended that the general public is made aware of the negative impacts of deer to counteract the current benign and vulnerable perception many people have of deer. This will require a public relations campaign at national level as well as educational initiatives starting at primary school level.

Other key recommendations are provided relating to the development of:

- A national or all-Ireland deer management policy.
- Formal deer management training in Ireland.
- A consistent and verifiable all-Ireland deer distribution records database.
- Regionalised professional deer management strategies.
- A cadre of professional deer managers capable of implementing deer management policies and strategies, leaving recreational hunters to hunt recreationally.
- A consistent and verifiable all-Ireland deer densities records database.
- A domestic venison market and the development of a quality assurance scheme for venison.
- A recreational deer hunting strategy.
- A more strategic approach to forest design, establishment and management taking deer management into consideration.
- A number of pilot local deer management groups.
- An awareness amongst road engineers and planners of the potential implications of increasing deer populations.
- A database that includes all records of collisions between motor vehicles and deer, i.e. instigated by the Road Safety Authority in co-operation with An Garda Síochána and Local Authorities.

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1. Introduction

This report was commissioned by Woodlands of Ireland in an attempt to distil current knowledge and experience of deer populations in Ireland, their effect on Ireland's growing woodland resource and the likely future consequence of relatively unchecked deer population growth. In the absence of any natural predators of deer in Ireland, it is necessary to manage their population in such a way as to maintain a balance between ecological, economic and social interests.

The purpose of the report is to advance policy change with respect to deer populations and their management in Ireland. The report focuses on the current and potential impacts of deer on native woodlands and hardwoods in general but also discusses wider issues relating to deer management in Ireland. There is not and never has been a national deer management policy in Ireland. In addition, there are no reliable datasets with regard to deer distributions and densities on which a solid policy platform might be based. As a result, this report relies heavily on limited datasets and the knowledge and experience of a small cadre of professionals who are intimate with the historic and current status of deer in Ireland. The report also draws on experience in both the UK and continental Europe where deer management is an established function of land and forest management and where there are specific legislative and policy frameworks that support such management.

A small number of site assessments were carried out to illustrate the financial and ecological effects of unchecked deer populations. These case studies, combined with supporting data and results from other projects were used in assessing the effect and potential cost of unmanaged deer populations on the achievement of policy goals in the areas of hardwood timber production, biodiversity, broadleaf forest cover etc. This report selects and discusses a number of the critical issues concerning deer populations and their management (**Sections 2 – 14**).

At the end of each section in the report, recommendations are presented as to how these issues should be addressed in Ireland. The most important of these are listed in the Executive Summary. The report also suggests how best the collective measures recommended should be co-ordinated and administered.

2. Statutory Responsibility for Deer Management

Deer in Ireland are protected and legislated for under the 1976 Wildlife Act and the Wildlife Amendment Act (2000) which the National Parks and Wildlife Service (NPWS) has responsibility for implementing. The NPWS has responsibility for the control of deer on their own properties and for the appropriate issuing of licences for deer hunting on other properties if sought.

There is currently no national deer management policy in Ireland and there is very little co-operation between the various State bodies with responsibility in this area. Indeed, there is currently no statutory requirement to undertake any form of deer management in Ireland. Historically, there has been a failure to either consider or address the emerging requirement for deer population management. Most of the staff in both the NPWS and the Forest Service, while generally aware of the problem, are unable to dedicate sufficient time to the issue to achieve any satisfactory level of management on the ground or leadership in terms of applied research and policy development. In many cases, even if time were available, most staff are also not sufficiently qualified or experienced in deer management to authoritatively and effectively deal with the issues involved. However, there are some NPWS, Forest Service and Coillte staff with academic qualification and technical experience in deer management which will be an essential element in any future national deer management initiative.

In Scotland, the Deer Commission of Scotland (DCS) undertakes a wide range of activities that previously were functions of a range of bodies[1]. These activities include:

- Exercising a range of regulatory functions (e.g. authorisations and statutory returns).
- Publishing best practice guidelines.
- Consulting and advising widely on Deer Management issues (including Annual Cull Targets).
- Promoting and actively participating in the operation of Deer Management Groups.
- Undertaking and commissioning research projects.
- Conducting deer counts.
- Disseminating best practice.
- Assisting in training.
- Working with other agencies on wider policy issues.
- Advising Scottish Ministers on all deer matters in Scotland.

The Deer Initiative in England and Wales has a similar function and is a partnership made up of representatives from partner organisations. It has responsibility for determining policy and setting priorities in pursuit of their stated objective. The Deer Initiative staff co-ordinate all activities agreed by the Partnership. The Deer Initiative is a registered charity with a Board of Trustees drawn from the full partners. An important and fundamental difference between the DCS and The Deer Initiative is that the DCS has statutory (governmental) power where as The Deer Initiative does not and relies totally on the voluntary participation of landowners, deer recreational hunters and staff of State bodies.

Requirements

- *While there is currently little political or public appetite in Ireland for new administrative bodies it is impossible to envisage how the issue of deer management can be addressed without the establishment of a dedicated team of deer management experts who can start to develop the applied research, policies, training programmes and management initiatives that are required to address the issue. This team can be established either a) nationally within an agency such as the NPWS or b) nationally as an inter-departmental agency or c) as a separate independent all-Ireland (north-south) agency with secondments from existing agencies with minimal additional cost to the State. Given the considerable issues to be*

[1] It is understood that the DCS is currently under review and while retaining its functions will be merging with the Scottish Natural Heritage.

addressed by such an agency, the latter all-Ireland option with an independent role and board is considered preferable. Such a body must have statutory powers if implementation and delivery of national and local deer management plans are to succeed, thereby providing coordination of deer management issues with legal powers. Over time it can develop its functions to include:

- *Administration of hunting licences.*
- *Overhauling and enforcement of legislation.*
- *Setting regional and national cull targets and quotas.*
- *Facilitating deer management groups.*
- *Engaging with all relevant State and other agencies (Forest Service, NPWS, Bord Bia, Food Safety Authority, NI Forest Service, Department of Ag., Coillte, etc.).*
- *Commissioning research.*
- *Training professional hunters, foresters and other land managers.*
- *Training recreational hunters.*

3. Forest Management Culture and Education

At present, Irish foresters qualify with no real knowledge of the necessary elements or importance of deer management. Equally, recreational hunters in Ireland know very little about forest management and have little or no training in this regard. The majority of Irish foresters have got used to a system whereby "deer management" is either not practiced, uses deer fencing as the only means of management or is outsourced to recreational deer hunters. However, there is a growing appreciation amongst foresters, principally due to bad experiences such as those illustrated in the case studies presented in **Section 7**, that deer problems do not go away and that there is a crisis of some form looming. There is also a growing appetite amongst foresters and forest owners for deer management knowledge as indicated by the recent holding of field days on deer management, e.g. the Society of Irish Foresters, Irish Timber Growers Association joint Field Day on Deer Management Challenges (April, 2009), the COFORD seminar on Deer Management and Control – policy and Practice (November, 2004). In continental Europe, deer management training is an integral part of forest management training and deer management is synonymous with forest management. Most European foresters can speak with authority about local deer population densities, annual cull rates and sustainable densities.

Coillte currently require all deer hunters that lease their land to have completed the Hunter Competency Assessment Programme (HCAP). This is an agreed deer hunting standard drawn up by a joint forum including Coillte, the Deer Alliance, the NPWS, The Forest Service, An Garda Síochána, the Irish Farmers Association and the Irish Timber Growers Association. Deer hunters can be trained, assessed and certified against this standard. HCAP is a very basic deer hunting competency programme. It represents a good first step in formalising training in deer hunting in Ireland. There is now an opportunity to develop and strengthen this programme with perhaps different levels of qualification resulting. The 1976 Wildlife Act does include a requirement (Section 28,1,b) for those who hunt and kill deer to be qualified persons but this does not include any requirement for training.

Requirements

- *Deer management training should become an integral part of forestry training in Ireland.*
- *Deer management training modules should be prepared and made available to registered foresters.*
- *Basic forest management appreciation should be incorporated into an upgraded HCAP qualification and made mandatory for all deer hunters under legislation.*
- *A formal and comprehensive qualification for professional deer hunting that is equivalent to international standards and recognised internationally should be established in Ireland.*

4. Deer Species and their Distribution in Ireland

Currently there are four species of wild-ranging deer present in Ireland. These are detailed in **Table 1** below. Detailed descriptions of each of these species, their identification, biology and habits and their history in Ireland are presented in Appendix 1.

Table 1: Wild deer species in Ireland.

Common Name	Species	Status	Expansion (1978–2008)[2]
Red deer	*Cervus elaphus*	Native[3]	565%
Sika deer	*Cervus nippon*	Introduced 1860	354%
Fallow deer	*Dama dama*	Introduced 12th Century	174%
Muntjac deer	*Muntiacus* sp., likely *Muntiacus reevesi*	Introduced c. 2006	-

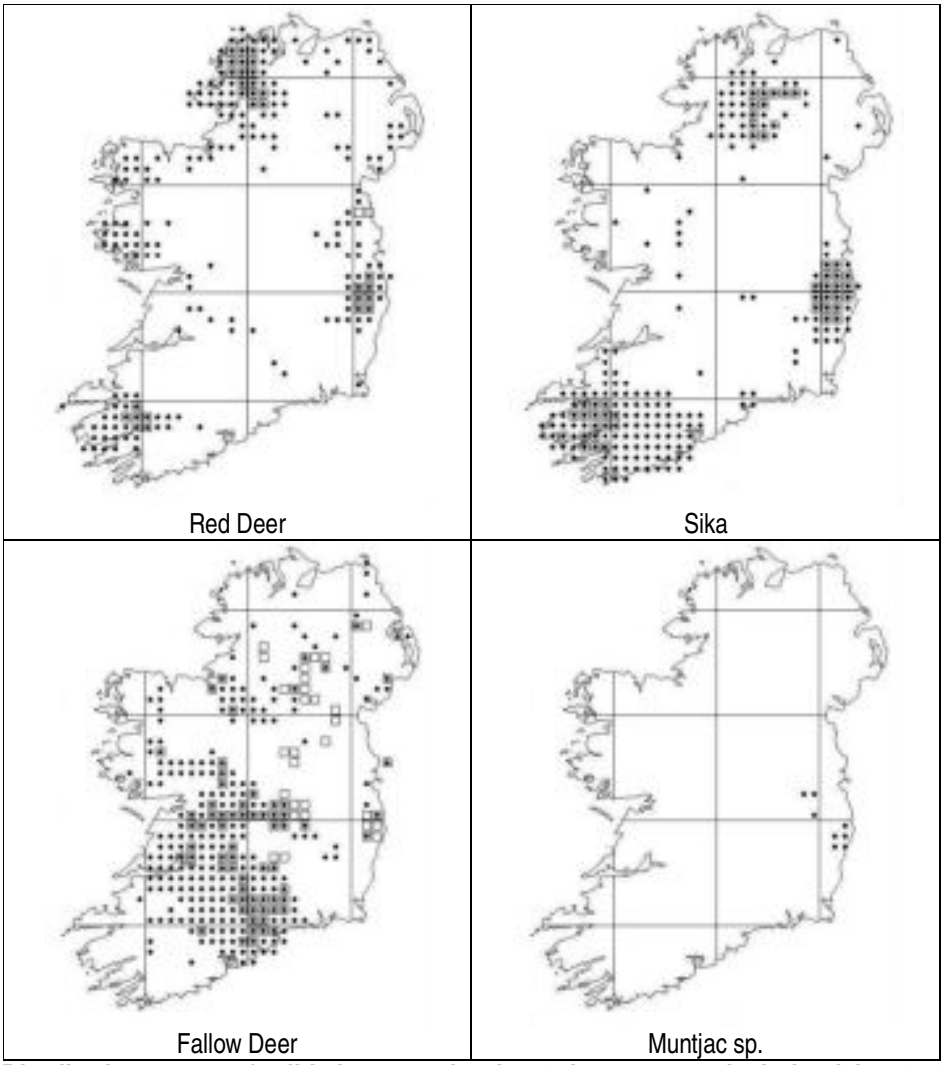


Figure 1: Distribution maps of wild deer species in 10 km squares in Ireland in 1978 and 2008. (Muntjac sp. (2009 validated distribution)). Locations with records in 1978 are represented with squares. Locations with records in 2008 are represented with black dots. Locations with records from both 1978 and 2008 are represented by a black dot in a square. (Source: Carden *et al.*, In Review)

[2] Expansion figures from Carden *et al.* (In Review).

[3] Although Red deer are native to Ireland, native provenance only applies to those found in County Kerry and surrounding areas through natural population expansion.

Red deer and Sika are known to be capable of interbreeding producing fertile hybrids (Harrington 1982; Goodman *et al*., 1999) and this is known to have occurred in Ireland from observations of hybrid phenotypes in the Wicklow region as early as 1884. The occurrence and distribution of hybrid Red/Sika deer throughout Ireland is unknown at present, although in some localised areas (e.g. Co. Wicklow) the extent of hybridisation may not be as extensive as once thought (see McDevitt *et al*., 2009).

Over a 30-year period from 1978 to 2008, total ranges of Red deer, Fallow deer and Sika on the island of Ireland (based on occupation in every 10km square) expanded considerably (**Table 1** and **Figure 1**).

There is no verifiable or consistent national system of recording deer distribution and these distribution maps are based on compilations of inconsistent and incomplete datasets and represent best estimates given the quality of data available. Anecdotal evidence would suggest that these figures are almost certainly conservative.

The expansion of the range of deer populations is due to a number of reasons, principally:

- Birth rates in deer currently greatly exceed combined non-harvest mortality and harvest rates meaning that deer are constantly under pressure to seek out new habitat / feeding areas (see O'Brien *et al*., 2007).
- Available habitat in the form of woodland has greatly increased (**Figure 2**). Over the 28 year period from 1980 to 2008, similar to that represented in **Figure 1**, forest cover in Ireland increased by 91% or 3.3% per annum.
- Shooting of deer in Ireland has not been focused on deer management and there has been no emphasis on female culling which would otherwise be an essential element of any national deer management policy (**Figure 5**). The shooting seasons were changed to encourage more female culling of all deer species, by allowing only antlerless deer after December to be shot.

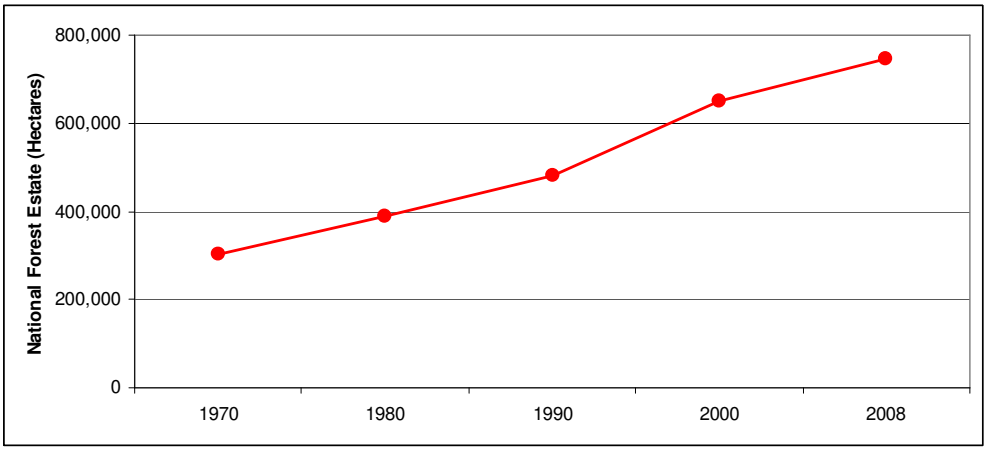


Figure 2: Increase in the national forest estate (1970 – 2008) Source: Forest Service

In addition:

- Recreational hunting has accelerated the dispersal of deer through the deliberate and illegal releasing / relocation of animals.
- Forest management practices such as clearfelling and deer fencing can push deer into new areas.
- Deer are both released and can escape from deer farms which have accelerated dispersal of deer throughout Ireland.

Requirements

- *A consistent and verifiable all Ireland deer distribution records database is required in order that accurate distribution and expansion models in relation to habitats and land usage can be created and used as a basis for policy development.*

- *A more rigorous system of policing and prosecuting cases of illegal releasing and relocation is required.*

5. Current Deer Management Measures

Deer management in Ireland is legislated for under the 1976 Wildlife Act and the Wildlife Amendment Act (2000) which the NPWS has responsibility for implementing. Currently, deer shooting in Ireland is controlled under a licence system whereby the NPWS issue annual permits to hunters who apply with permission from a land owner to hunt on lands holding deer. There are plans underway to extend the validity of these permits from annual to a three year period. This will ease the considerable administrative burden associated with this work.

There are currently over 3,350 hunters licensed to shoot deer in the Republic of Ireland, a figure that has risen from 2,808 in the 2005 / 06 hunting season. The NPWS and Coillte carry out some direct deer management on lands under their own management / ownership but in general terms, deer shooting is carried out by recreational hunters (not professional hunters) with little interest in deer population management. This is illustrated in **Figure 3** which shows that 83% of hunters shoot 10 or less deer annually. Although these data are unverified they provide clear evidence of the futility of attempting to address the substantive issue of deer management through extending hunting seasons or increasing the number of licences issued, both of which will have a negligible effect on deer populations. The current deer hunting seasons are presented in Table 2.

Table 2. Deer hunting seasons in Ireland.

Deer species	Co. Kerry	All other Counties
Red deer, male	NO SEASON	1st Sept. – 31st Dec.
Red deer, female & Antlerless deer	1st Nov. – 28th Feb.	1st Nov. – 28th Feb.
Sika, male	1st Sept. – 31st Dec.	1st Sept. – 31st Dec.
Sika, female & Antlerless deer	1st Nov. – 28th Feb.	1st Nov. – 28th Feb.
Fallow deer, male	1st Sept. – 31st Dec.	1st Sept. – 31st Dec.
Fallow deer, female	1st Nov. – 28th Feb.	1st Nov. – 28th Feb.
Muntjac, male	1st Sept. – 31st Aug.	1st Sept. – 31st Aug.
Muntjac, female	1st Sept. – 31st Aug.	1st Sept. – 31st Aug.

Under certain conditions outlined in Section 42 of the 1976 Wildlife Act, an out of season licence may be issued by the NPWS for capturing or killing deer. The conditions relate to damage to livestock, crops, pen reared wild birds, other fauna, flora, woodland / forestry and fisheries. The legislation does not specify conservation habitats or health and safety (ref. road traffic accidents) as grounds for issuing an out of season licence and this can actually restrict NPWS staff in some cases where there is a clear and obvious need to control deer populations.

As indicated by **Figure 3**, there are a small number of professional / productive deer hunters in Ireland who exercise deer management (only approximately 10 individuals shoot more than 100 deer / annum). These individuals are likely to be critical in the development and implementation of any future national deer management policy as they have the required knowledge and experience to devise, prioritise and implement practical deer management policies on the ground.

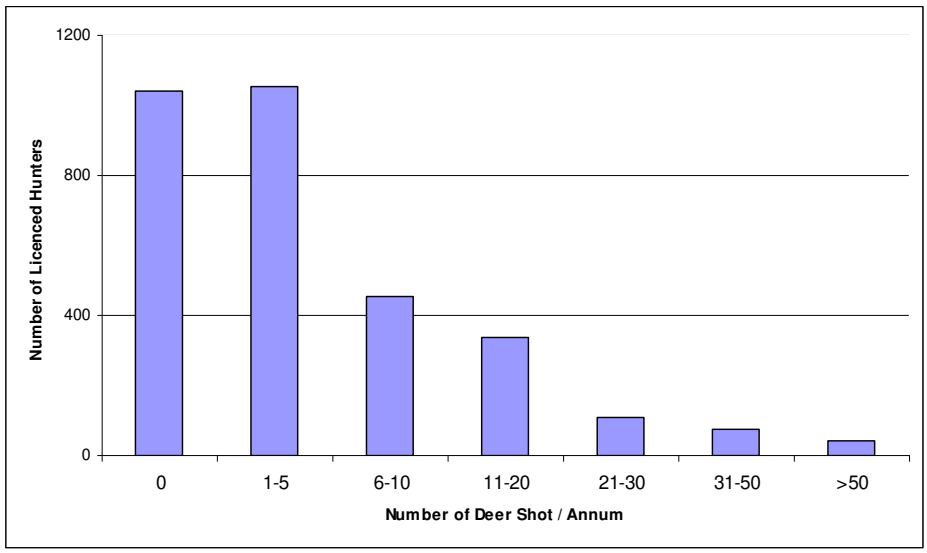


Figure 3: Numbers of deer shot per hunter per annum (averaged over 3 seasons 2005/'06, '06/'07, '07/'08) Source: NPWS

Bag return data provided by the NPWS indicates a steady increase in the number of deer shot per annum (**Figure 4**). These figures are unverified and are based on returns provided by licensed hunters renewing their licences. The figures do not include poached or illegally shot animals. **Figure 4** shows how the number of deer shot has increased in the last decade. However, the current figure of approximately 25,000 per annum is estimated to be approximately 8 – 10% of the total deer population which is a long way short of anything approaching what is considered to be adequate deer management.

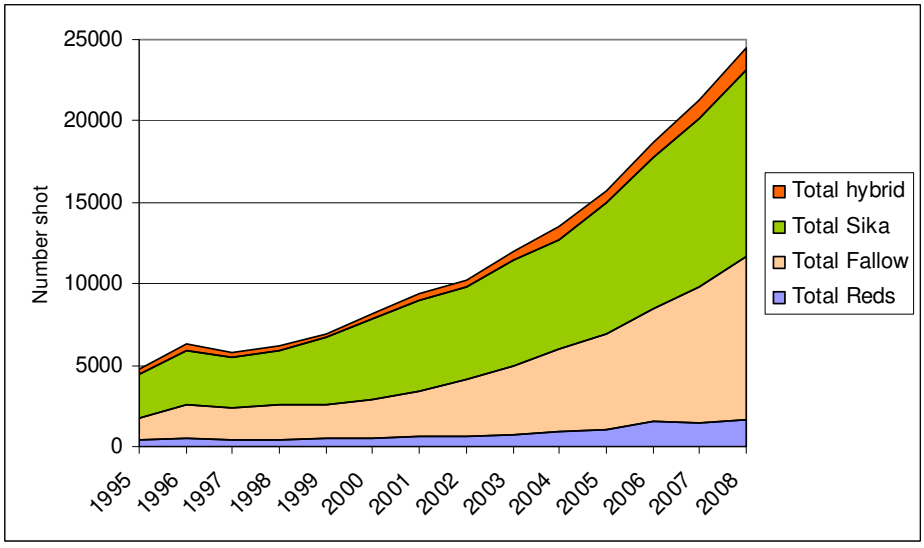


Figure 4: Number of deer shot per species per annum (1995 – 2008)

One of the most important measures in any deer management programme is to focus culling on females as this is clearly more effective in achieving population management (fewer females results in fewer fawns / calves). However, until 2006, the number of males shot exceeded the number of females shot and currently females account for only 56% of deer shot (**Figure 5**).

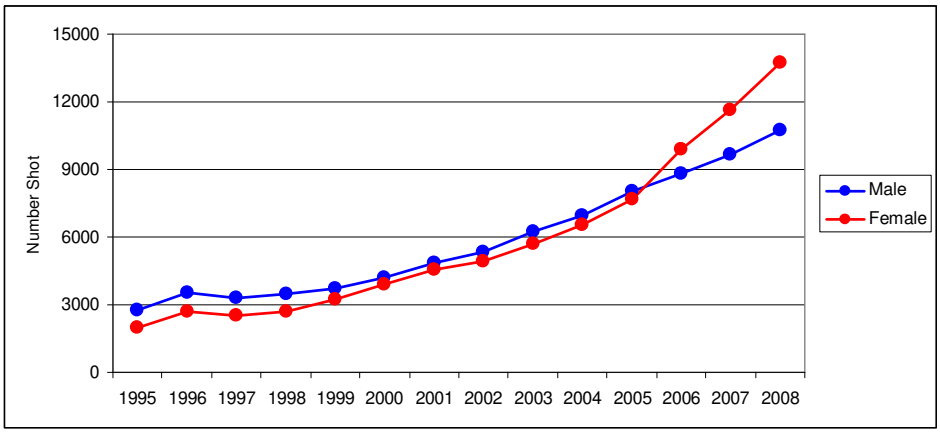


Figure 5: Number of deer shot per sex per annum (1995 – 2008)

Deer fencing is also used as a measure of management and the Forest Service currently fund deer fencing of certain sites through the various afforestation schemes (Afforestation, FEPS and New Native Woodland via the Native Woodland Scheme). Grant aid for deer fencing is available as part of these schemes at a rate of €12 per metre subject to a maximum of 150 metres per hectare. While deer fencing can be effective in excluding deer from small sites there are many examples both in Ireland and internationally of failed deer fencing due to poor design, poor construction or poor maintenance. Deer fencing is expensive and failure due to any of the above reasons can be a dreadful waste of resources. Despite this, well designed, constructed and maintained deer fencing remains an important means of excluding deer from relatively small areas and also serves as a means of dramatically demonstrating the effect that deer have on the regenerative function and associated biodiversity of woodland and other habitats. However, the total exclusion of deer from native and other woodlands for long periods is inappropriate as these ecosystems naturally incorporate a certain level of grazing / browsing, as yet un-quantified in Ireland. This appropriate level of grazing is certainly far lower than that resulting from current deer densities (see **Section 6**). Another difficulty with deer fencing is that it does nothing to manage or reduce the total deer population and can result in increased grazing pressure on adjacent or nearby habitats.

Some land owners may not actually own the hunting or shooting rights on their land. Instead, these rights may be held by a previous owner of the land or by another party. In these cases difficulties arise with deer management, particularly when the land owner suffers economic loss due to a lack of deer management by the owner of the hunting rights. This is a particular issue for Coillte in many properties. There is some confusion regarding what rights the land owner has in protecting their asset in these situations. If a right exists, there are still practical difficulties with regard to who has priority on the ground.

Requirements

- *The use of recreational deer hunting as a form of deer management / control must be abandoned, or at least incorporated where such hunters can achieve the required set harvest targets, within a new overlaid system of professional deer management. Recreational deer hunting should continue as just that and should form the basis of revenue generating deer stalking enterprises.*

- *Regionalised professional deer management strategies require development in co-operation with landowners and relevant stakeholders with deer culls carried out by deer management professionals.*

- *Deer fencing standards require ongoing review and completed fences require close and critical inspection before being grant aided.*

- *There is a need for a formal review of the Wildlife Act in relation to Deer Management that ensures that it reflects the current situation with regard to deer populations and impacts.*

- *Research is required into appropriate deer densities through the use of stocked exclosures in which deer numbers are known and managed.*

- *Statutory provision is required for both land owners who do not own shooting rights on their land and the holders of those rights as to how the land owner can protect the economic value of their asset from damage by deer (and other wildlife).*

6. Deer Stocking Densities

There is little by way of consistent data on current deer stocking densities in Ireland. Similarly, there is no reasoned population census for deer in Ireland. Burkitt (pers. comm.) suggests that in the greater Killarney area, Co. Kerry, densities range from between 5 to 28 per km^2. A study by Atkinson (1998) reported average densities in Wicklow, over a four year period, 1995 to 1998, ranging between 5 and 21 per km^2 in five different zones. Rooney & Hayden (2002) report preliminary census results from three areas in Wicklow that indicate Sika and hybrid densities of between 13 and 25 animals per km^2. Data provided by Baronscourt Estate in Co. Tyrone suggest stocking densities of Sika of approximately 16 per km^2.

The carrying capacity of land varies but in general terms more productive land (whether woodland or farmland) can sustain more deer than land of lower productivity. It is not known what the sustainable carrying capacity of different site types in Ireland is. Burkitt (pers. comm.) suggests that in Killarney National Park, Co. Kerry, it is in the region of 2 to 3 per km^2. Rooney & Hayden (2002) quoting Ratcliffe (2000) state that damage to broadleaves and susceptible conifers occurs when population densities exceed 5 animals per km^2 while species such as Sitka spruce and other less palatable conifers suffer damage at densities of 8 to 10 animals per km^2. They also state that these figures represent maximum desired deer densities from a forest management perspective. De Nahlik (1992) recommends deer densities when improving the profitability return of deer as a secondary product of forestry accompanied by a reduction of damage to a tolerable level of 2.5 / km^2 for Red deer and 4 / km^2 for Fallow deer. Forest and deer management experience elsewhere in Europe report densities per km^2 of 10 (Denmark), 4 (Czech Republic), 5 (Romania) and 5 (Holland) as reported by forest management colleagues in Pro Silva Europe, a forest management network of European foresters. In all these instances annual management culls are carried out in order to maintain appropriate numbers and in the case of Denmark, a reduction cull is planned in order to restore the balance between healthy woodland and deer numbers. In Ireland, forest managers do not generally accept responsibility for deer management and have no training in either the ecology of deer or appropriate assessment and management techniques.

Plate 1. Fallow deer droppings, Dundrum, Co. Tipperary.

Table 3 below is taken from the UK Woodland Improvement Grant Scheme which funds deer management and requires a prior assessment of deer populations by forest managers and the production of a deer management plan.

Table 3: Deer densities and associated evidence (UK Woodland Improvement Scheme).

Evidence	**4-8 per km^2 Low Density**	**8-15 per km^2 Medium Density**	**15+ per km^2 High Density**
Tracks	Difficult to find deer slot marks or defined paths.	Defined paths slot marks easy to find in areas of soft ground.	Many well defined tracks and paths often black with constant use.
Dung	Difficult to find with just the odd isolated pellet group.	Pellet groups relatively easy to find, particularly on woodland edges and good feeding areas.	Pellet groups very easy to find. Highly concentrated on favoured feed areas.
Browsing of Vegetation	Natural regeneration of broad-leaved trees taking place with no or little damage to current year's incremental growth.	Broad-leaved saplings present but showing significant damage.	No seedlings growing above dominant vegetation height. Often well-defined browse lines on established shrubs and plants.

Requirements

- *A consistent and verifiable Irish deer densities records database is required which can be used as a basis for policy development.*

- *Irish forest managers require training in basic deer ecology, assessment and management in order that they are informed as to how to predict, prevent and manage deer problems in their woodlands.*

7. Damage Case Studies

Two case studies in young grant aided broadleaved woodland were examined as part of this study. The woodlands selected were in areas of reported high deer densities where there was prior knowledge of extensive damage to trees.

Plate 2. Heavily browsed Spanish chestnut (*Castanea sativa*) at Co. Wicklow site.

The first site was selected in County Wicklow in an area near to the village of Ballinaclash, populated with Sika. The site had been planted in 1998 with diverse conifers and considerable areas of mixed hardwoods including ash, sycamore, Norway maple, Spanish chestnut and cherry. No deer fence was used at establishment and deer were not perceived to be a potential threat at that time. In some areas, probably due to exposure, the hardwoods were slow to establish and a subsequent colonisation of the site by deer resulted in very extensive damage. Results from this site are summarised in **Figures 6** and **7** below and show that in two plots, 98% and 46% of trees had been damaged respectively. Plot 1 was taken in an area that had been slow to establish and consequently, deer damage has been severe for 91% of damaged trees with 71% of trees now dead. Plot 2 was taken in a more sheltered part of the site where trees had established better before deer colonisation took place and in this plot 46% of trees were damaged with only 5% severely so.

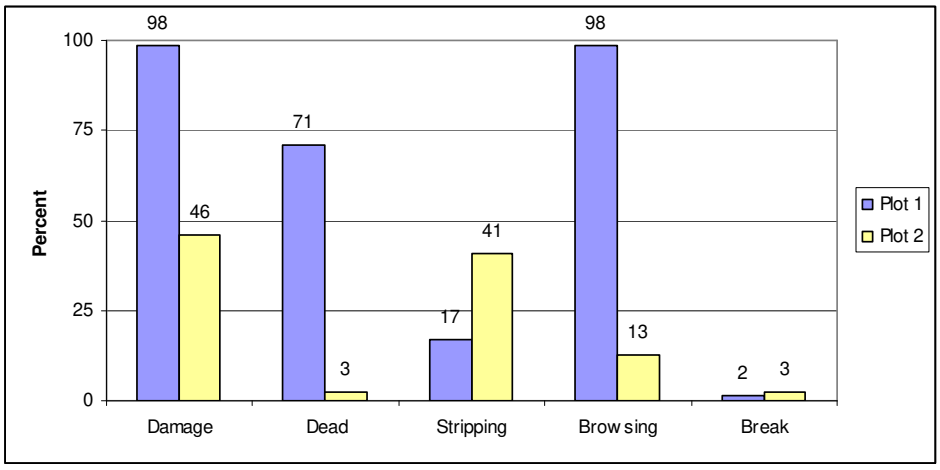


Figure 6: Percentage of trees damaged by Sika and the nature of this damage in two plots near Ballinaclash, Co. Wicklow.

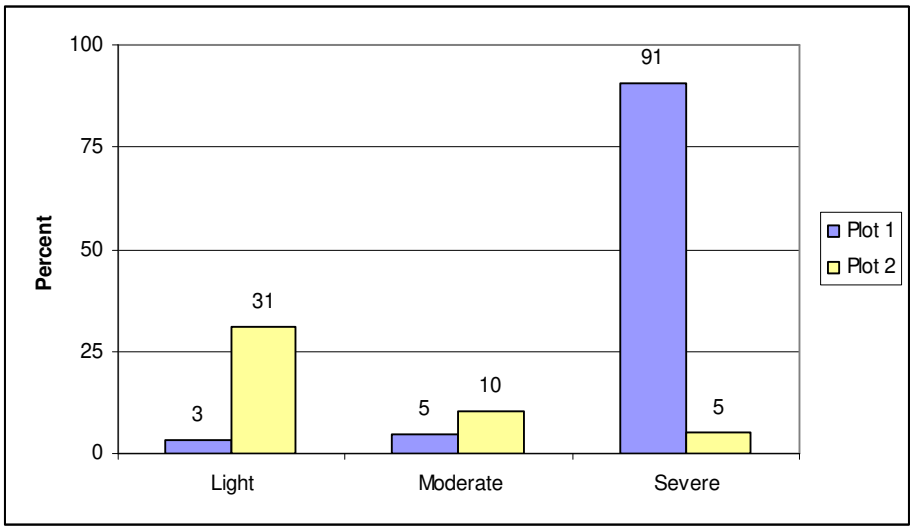


Figure 7: Percentage of trees in different damage categories in two plots near Ballinaclash, Co. Wicklow.

Plate 3. Extensive damage recorded to the broadleaf plantation at Co. Wicklow, resulting in damaged, dead and heavily browsed trees.

The second site was selected in Co. Tipperary in an area near to the town of Dundrum, populated with Fallow deer. The site had been planted in 1998 with conifers and considerable areas of hardwoods, principally ash but with some sycamore and Norway maple. In all areas, it appears that the crop established well and suffered little damage in its early stages. Indeed, no deer fence had been erected and deer were

clearly not envisaged as a potential problem at that time. However there has been extensive subsequent damage as presented in **Figures 8** and **9** below. These show that in two plots, 100% of trees had been damaged, with 95% of stems in each plot having had bark stripped. Stripping of exposed roots (the site had been mounded at establishment) was also a significant feature where 45% and 54% of trees were affected in Plots 1 and 2 respectively. This has particular significance in that it is unlikely that hurley butts, which can often be cut from stems of poor form, can be salvaged from these trees. In terms of the degree of damage, it was assessed that 61% of stems in Plot 1 and 28% of stems in Plot 2 were severely damaged.

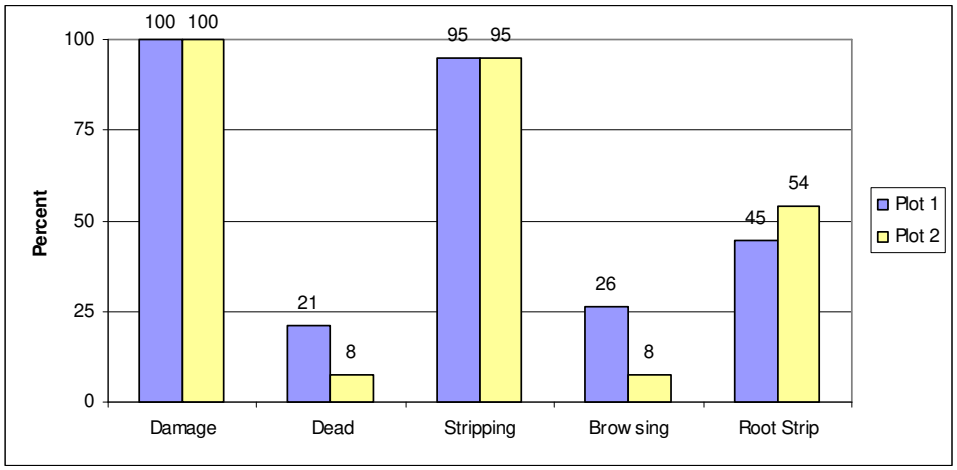


Figure 8: Percentage of trees damaged by Fallow deer and the nature of this damage in two plots near Dundrum, Co. Tipperary.

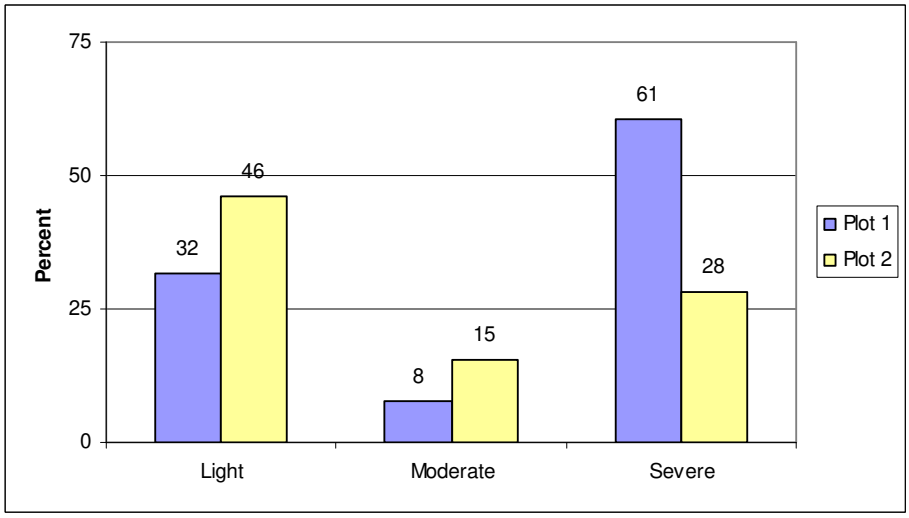


Figure 9: Percentage of trees in different damage categories in two plots near Dundrum, Co. Tipperary.

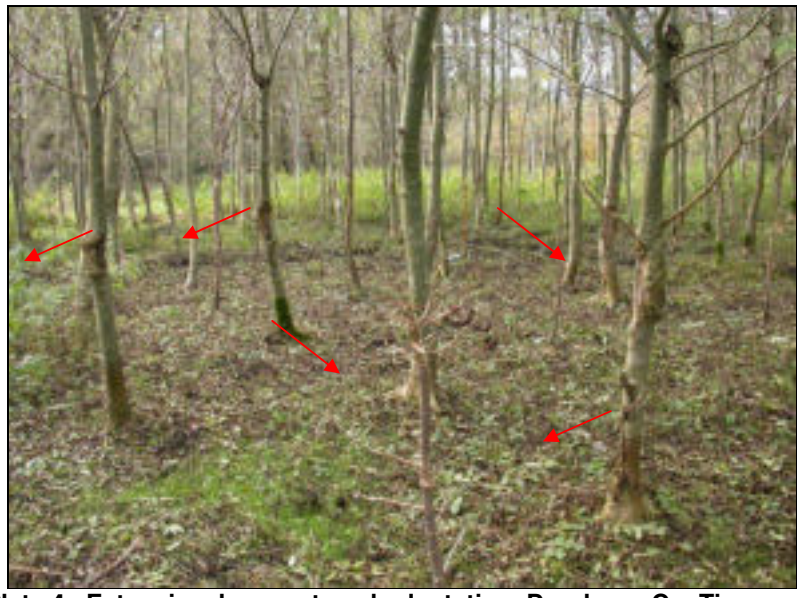


Plate 4. Extensive damage to ash plantation, Dundrum, Co. Tipperary.

The above examples are simple case studies selected to illustrate the severity of damage that can occur to young broadleaved forestry plantations due to deer.

8. Expected Damage & Potential Loss of Value

It is notable that for both case study sites (**Section 7**) deer were considered to be either absent or to pose no threat at the time of establishment. This is evident by the choice of species planted and the fact that no deer management measures were employed. This typifies the problem facing many woodland owners who have recently planted or that are yet to plant whereby deer move into newly created habitat and cause significant damage before the forest owner or forest manager either realises that they are present or can act to manage them. In cases where action is taken, this normally amounts to a call to a recreational hunter who offers to deal with the problem. A number of deer may be shot and the forest owner / manager thinks that the problem is under control. Unfortunately, in most cases, the damage continues unabated.

Broadleaved woodland currently makes up nearly 25% of total forest cover in Ireland (Forest Service, 2007). This predominantly (92%) consists of native species either growing as native woodland or in established plantations. Broadleaf plantations have been extensively established in the last 10 years and during this time their contribution to the annual afforestation programme has risen to 31% (**Figure 10**) and 15% of all broadleaved woodlands are now under 10 years of age (Forest Service, annual). While there are many other issues affecting timber quality, particularly with broadleaves, deer now pose a significant risk to the quality of timber in Ireland's new broadleaf woodlands. In the absence of proper deer distribution and density data it is not possible to quantify this risk, or to effectively plan to mitigate it. However, given that:

a) deer populations are expanding rapidly,
b) much of Ireland's forest estate is categorised as young woodland,
c) young woodlands are susceptible to deer damage,
d) woodlands are favoured habitats of most deer species,

it is clear that significant problems lie ahead.

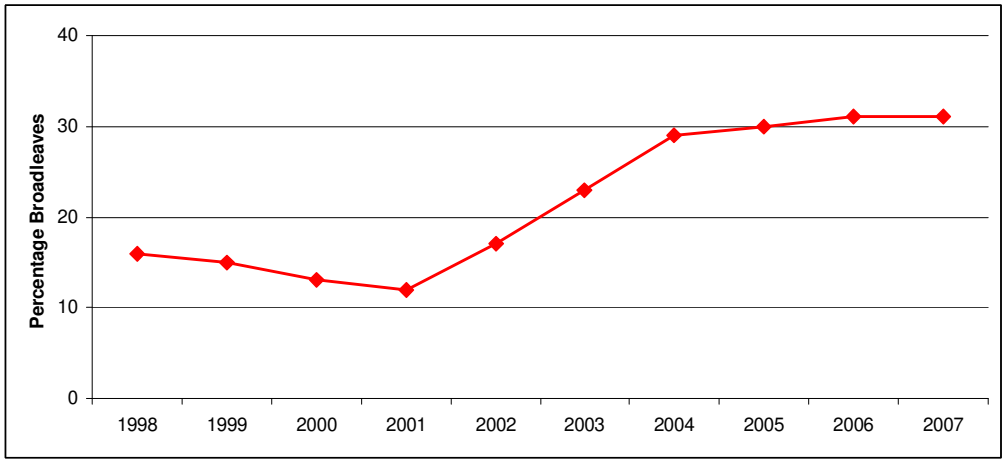


Figure 10: Percentage of Broadleaves in Annual Planting Programme (Source: Forest Service).

The regional breakdown of broadleaf afforestation for the 10 year period 1998-2007 is presented in **Figure 11**.

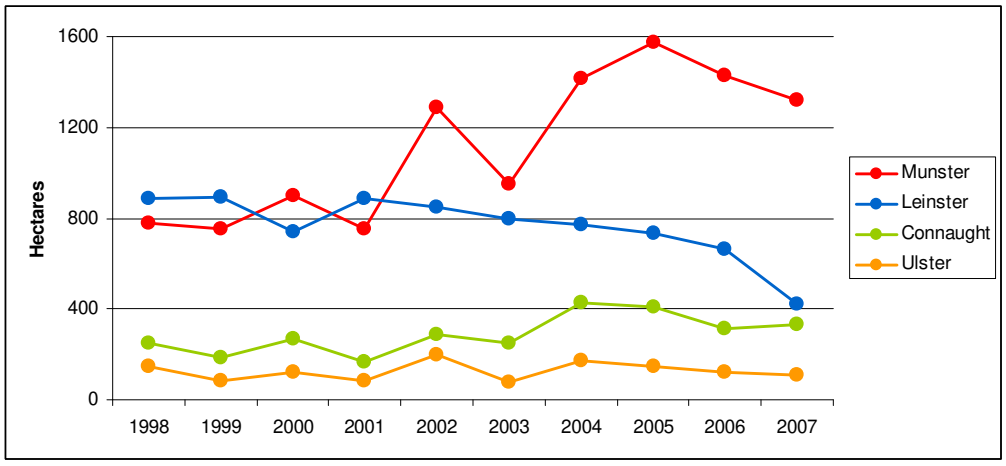


Figure 11: Broadleaf Areas Planted / Province (1998 – 2007) (Source: Forest Service).

8.1 Potential Financial Cost of Damage to Timber Value of New Broadleaved Planting

Unlike softwood, the value of hardwood timber is almost entirely dependent on timber quality. There are many factors which affect hardwood timber quality. These may be management related (e.g. species selection, pruning, thinning etc.) or may be associated with natural processes (e.g. frost, exposure, genetics, mammal damage etc.). In some cases, good management can mitigate the natural hazards (e.g. matching species and provenance to site, fencing, culling etc.). Generally a combination of all these factors will determine the quality and therefore the value of hardwood timber coming from any forest and it is extremely difficult to isolate a single factor and attribute an economic cost to it.

This study looked at a very small number of case studies from which it is not reasonable to extrapolate any conclusions with regard the economic impact of deer to the entire hardwood estate. The study was not resourced to carry out statistically valid sampling of sites from which to build an accurate assessment of loss. Instead, a simple economic model using a large number of assumptions was developed to examine the economic impact of different scenarios on young grant aided hardwoods in Ireland planted since 1998. There is little internationally relevant literature available on which to base such a model[4] and therefore a logical approach has been applied as a first attempt to relatively quantify this issue, in economic terms. The model is dynamic and all inputs and assumptions can be altered to run different scenarios. The model uses the following method and assumptions:

- Broadleaf planting figures from 1998 to 2007 were tabulated per county.
- These figures were broken down into fast growing and slow growing categories based on Forest Service statistics for same at county level.
- British Forestry Commission Yield Tables and Assortments were used to model growth and yield. In the case of fast growing broadleaves, the Yield Class 10 "Sycamore, Ash and Birch" Model was used with a 70 year rotation[5]. In the case of slow growing broadleaves, the Yield Class 6 "Oak" Model was used with a 120 year rotation.
- Roadside timber prices were applied to the various assortments as follows:
  - 7-14cm top diameter (all species) €35 / m^3
  - 14-20cm top diameter (fast growing broadleaves €40 / m^3 & slow growing broadleaves €50 / m^3)
  - >20cm top diameter (fast growing broadleaves €80 / m^3 & slow growing broadleaves €100 / m^3)
  - For final crop volumes, 50% of the >20cm category was assigned a premium value (fast growing broadleaves €150 / m^3 & slow growing broadleaves €200 / m^3) for 1st grade timber.
- Timber harvesting costs of €25 / m^3 for thinning and €12 / m^3 for clearfelling were assumed.
- Three different timber quality / value scenarios were run as follows:
  - **Scenario a)** Full realisation of potential yield and quality.
  - **Scenario b)** Full realisation of yield but 50% quality and value downgrade of more valuable assortments to firewood prices of €35 / m^3 at roadside.
  - **Scenario c)** Full realisation of yield but 100% quality and value downgrade to firewood prices of €35 / m^3 at roadside.
- A Net Present Value (NPV) per hectare was calculated for each of the planting years from 1998 to 2007 for each scenario and for both fast and slow growing broadleaves using an interest rate of 5%.
- These values were applied based on the level of planting of fast and slow growing broadleaves in each county and a NPV of the broadleaf estate in each county was calculated.
- The above three scenarios were run at a national level.
- An attempt was made to assess a more realistic scenario where each county was assigned a very crude risk level to deer damage of either low, medium or high. In order to reflect the variation within each county and the fact that even in high risk counties, adequate protection on individual sites is in place to protect broadleaves, the following table was used to apportion risk. This is referred to as **Scenario d**.

County Risk Level	% Sites With No Problems (Scenario a)	% Sites With Some Problems (Scenario b)	% Sites with Serious Problems (Scenario c)
Low	80	20	0
Medium	25	50	25
High	20	20	60

[4] Ireland is relatively unique in having young broadleaf plantations established on green-field sites whereas most literature on economic loss resulting from deer damage in forests relates to regeneration in mature forests or damage in young conifer plantations.

[5] Many of these broadleaf plantations will not be managed on a rotation basis and will never be clearfelled. However, using such a model allows more direct comparisons of economic cost.

- The model was run again at a national level.

The results from this exercise are presented in **Figure 12**.

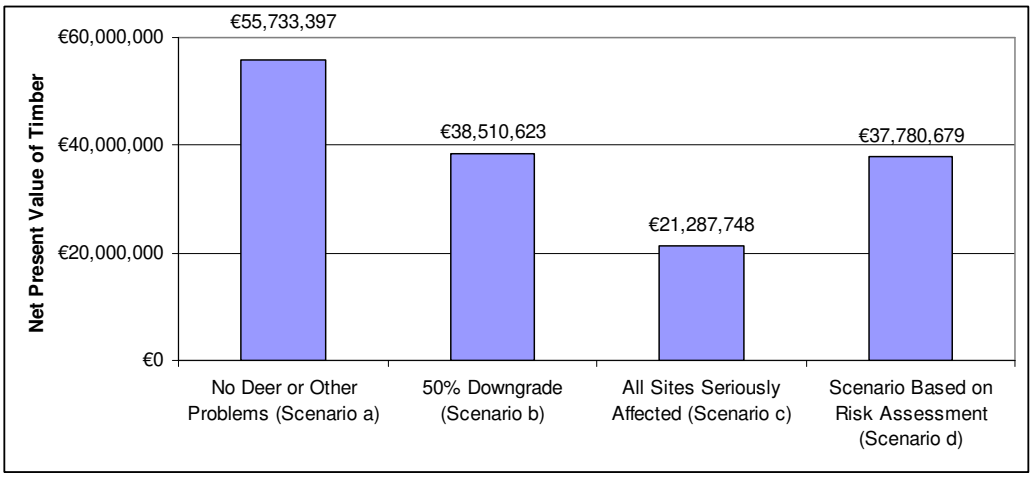


Figure 12: The Net Present Value of timber revenues from grant aided broadleaf forests planted between 1998 and 2007 under different scenarios associated with varying levels of deer related damage.

The model shows that, all other things being equal, a potential loss of 62% (€34 million) of revenue value will occur in the worst case scenario, but more realistically a potential loss of 32% (€18 million) attributable to damage caused by deer is more likely. As already stated, it is impossible to practically or accurately isolate any single factor that may result in sub-optimal performance of broadleaf forests. It is unrealistic to suppose, as is done in this exercise that all broadleaf woodlands would otherwise be managed or perform optimally. However, it is equally fair to say that the model has not factored increased mortality as a result of deer damage. Instead the model assumes full production and only uses a quality / value downgrade in estimating losses. Increased mortality is very common on young broadleaf sites (as with the Wicklow case study) and this will obviously greatly increase both the financial losses and mitigation costs.

This report concentrates on hardwoods and the current and potential damage to broadleaved woodland. However, conifer crops also suffer serious damage. A recent study commissioned by Coillte found that bark stripping in young Sitka spruce plantations in Co. Wicklow will result in an income loss of between 7% and 22%, depending on various end use and timber price scenarios. The same study found that 96% of plots had wounded trees and 53% of trees within these had experienced deer damage (Coad, pers. comm.).

Coillte are also currently conducting a study in West Co. Clare examining the impact of Fallow deer damage on plantations.

A separate recent study of private forests greater than 10 years of age in Co. Wicklow) found that 51% of forest owners had encountered problems with deer damage to their forests (Purser, 2009).

The model used in the current study assesses the economic loss of timber value associated with deer damage only. No value attributable to the cost of mitigation, the loss of biodiversity or other consequential losses is included. Quantification of such potential losses in financial terms is highly complex and is beyond the scope of this project. However, the following points discuss elements of these potential losses.

8.2 Forest Certification

The international forest products market is increasingly seeking assurance about the quality, environmental and social impacts of forest management. One way to provide this assurance is through independent verification against a published standard which defines appropriate and effective forest management. Forest products from forests which meet these standards can then be identified as such, and certified, when offered for sale in the market place. Given that deer management is an integral part of forest management and that most international forest management standards include requirements for the sustainable management of wildlife, it is reasonable to assume that the lack of sustainable deer management in Ireland will sooner or later become an issue for Irish forest owners seeking forest certification. Many of the markets held by the

processing businesses Irish forest owners sell their timber to specifically demand timber from certified sources. The loss of these markets would have very serious consequences for the Irish forestry sector as a whole.

8.3 Native Woodland Scheme (NWS) Areas

To date, approximately 5,000 ha. have been managed under the NWS. This is made up of approximately 4,500 ha. of conservation of existing woodland (Element 1) and 500 ha. of new native woodland (Element 2). This constitutes an investment by the State of approximately €25 million with ongoing commitments for premiums under both elements (Little, pers comm.). One of the principle objectives of the scheme is the enhancement of biodiversity and the restoration of native woodlands in Ireland. Increasing deer pressure constitutes a real and immediate threat to achieving this objective and to the substantial investment made to date by the European and Irish taxpayer.

8.4 Cost of Reconstitution

In cases where deer damage is severe and reconstitution is required, in addition to the loss of timber value discussed earlier, there are additional associated costs, including:

a) The loss of the initial investment due to plantation failure
b) The reconstitution cost
c) The cost of the time lost between a) and b), i.e. revenue foregone

Only the most severe cases are fully reconstituted and many woodlands suffer damage from deer that result in additional costs associated with:

a) Replacing damaged or dead trees
b) Retrospective deer fencing
c) Other means of deer control, primarily culling

The Forest Service introduced a deer fencing grant in 2007 for the "retro-erection" of deer fencing around plantations where no deer problem had been envisaged at establishment but had subsequently experienced significant damage. So far under this scheme 73.5 km meters of deer fence have been erected at a cost to the State of €662,158. Many of these plantations also required filling in (replanting trees that were lost to deer damage) at considerable cost to the taxpayer under the reconstitution grant scheme.

8.5 Potential Fines for Failure to Protect Habitats and Species in Ireland

In a recent report on the status of EU protected habitats and species in Ireland (NPWS, 2008) a large proportion of Ireland's native woodlands were identified as being in very poor condition as summarised in **Table 4** below:

Table 4: Current Status of Irish Native Woodland Types

Woodland Type	Range	Area	Structure & Function	Future Prospects	Overall
Old Sessile Oak Woods	Good	Bad	Bad	Bad	Bad
Bog Woodland	Good	Poor	Poor	Poor	Poor
Alluvial Forests	Good	Bad	Bad	Bad	Bad
Yew Woods	Bad	Bad	Bad	Bad	Bad

Under the EU Directive on the Conservation of Habitats, Flora and Fauna (92/43/ECC), member states are required to establish the necessary conservation measures involving, if need be, appropriate management plans specifically designed for the sites or integrated into other development plans, and appropriate statutory, administrative, contractual measures which correspond to the ecological requirements of the natural habitat types in Annex 1 and the species in Annex II present on the sites (Article 6(1)). Failure to do this will result in member states being fined and, given the recent report summarised in **Table 4**, this is now a real possibility with regard native woodland conservation in Ireland.

Requirements

- *A risk assessment for potential deer damage should be required for all new afforestation sites and should inform such decisions as to the species choice, the plantation layout, and whether or not deer fencing or deer culling etc. are required. The risk assessment should be based on best available knowledge of adjacent deer populations, their rate of expansion etc..*

- *Deer management should be regarded as an integral part of forest management. Where deer are present in forests, or considered an imminent threat, an informed deer management plan should be in place and implemented. Continued forestry premium payments should be conditional on its implementation.*

9. Damage to Commercial Conifer Crops

Deer damage to forestry and especially commercial conifer crops in Ireland has been highlighted more and more in recent years (Rooney and Hayden, 2002; O'Carroll, 2005; Forde, 2008; Sweeney and Nieuwenhuis, 2008; Anon., 2009). One of the most recent and detailed studies on commercial conifer forests was carried out in County Wicklow at the behest of Coillte Teo. (Anon., 2009). This report states that 'Wild deer can cause potentially serious financial losses in commercial forests through their habits of browsing the leading shoots of young conifer trees in the first few years after planting and stripping the bark from such trees in the first 25 years or so'. Levels of deer bark stripping of Sitka spruce on the study sites in Wicklow were 4-10 times higher than on an equivalent site in Scotland where the financial losses attributable to bark stripping were estimated at c. 3% of overall timber revenues over the course of a rotation (Anon., 2009). This implies that there is a much higher financial loss in Wicklow. Though levels of deer browsing damage on study sites in Wicklow were more similar to study sites in Scotland the recorded deer densities post culling in the Wicklow study sites were exceptionally high at around 25-40 per km^2. This compares with Coillte's stated target densities of around 5-10 deer per km^2. The potential losses from bark stripping in the stands studied when they reach maturity are in the range €1200 - €3800 per hectare depending on the exact range of assumptions used in the model to calculate them. The model used looks at a number of scenarios that result in downgrading the crop from sawlog by between 33% and 100%. This results in a potential loss of income of around c. 7% for the least damaged scenario to c. 22% in the worst case scenario.

A maximum cost of c. €50 - €75 per hectare was estimated to cover the costs of singling multi-leadered Sitka spruce stems caused by deer browsing at year 5. Moreover there is an opportunity cost associated with revenues foregone because Sitka spruce is planted on some sites that should ideally be planted with Douglas Fir were it not for the relative difficulty of establishing this species in the presence of high deer densities. The report states that that there is an urgent need to increase resources available for deer management and recommends a range of direct and indirect control measures applicable to the high deer densities in Wicklow (Anon., 2009).

Subsequent to a seminar hosted by COFORD in 2004 entitled 'Protecting Ireland's Forests – the threat from deer and grey squirrel' it was recommended that a 32 county Deer Management Agency should be established immediately. It was stated that; Evidence from research as well as experience on the ground show that the population and distribution deer are increasing in extent, as is the level of damage. Even areas currently free of deer are likely to be colonised in the future, probably within 5 to 10 years. At present there is no integrated control policy to reduce numbers to a sustainable level. The net result is that the deer population now threatens the ability to practice sustainable forest management as it is envisaged in terms of species diversification and economic return. Deer damage is not only a concern with respect to the economic impact on the national forest estate (i.e. Coillte Teo. and private forests) (O'Carroll, 2005).

Requirements

- *A co-ordinated national deer management strategy encompassing the 32 counties of the island of Ireland.*

- *At forest level, a range of measures that reduce the incidence of deer damage, including culling, silvicultural strategies and forest design (i.e. species selection, deer fencing, etc.), and adjustment of current shooting/game lease arrangements to maximise control over deer densities.*

10. Making it Pay (Stalking and Venison)

At present, the majority of deer shot and subsequently butchered / dressed in Ireland are exported to European markets. Apart from some small local sales, there is no established domestic market for venison. While there is no recent culture of wild venison consumption in Ireland there is a clear case to develop, brand and promote the product emphasising its wild / organic, low fat, low cholesterol properties. The development of such a market will be dependent on the implementation of a wild venison quality assurance scheme which ensures only venison of appropriate quality reaches the consumer.

Information on the legalities of processing and selling venison is difficult to come by in Ireland and there is much confusion amongst forest owners and managers as to what the current position is. It is illegal for anyone to sell venison for consumption without a holding a current game dealers licence. Deer hunters can sell carcases in their skin with heads left on and lower portion of legs and gralloch removed, to registered game dealers and do so for sums ranging from €0.50 / kg to €1.50 / kg, depending on quality and location of the shot. In order to be licensed, game dealers must have appropriate premises meeting EU specifications with regard to the larder and processing facilities. Considerable investment is required in order to satisfy such requirements and this is certainly a barrier to the development of more regional game dealerships. Every carcase for human consumption in a game dealer's premises is inspected by Department of Agriculture veterinary staff.

There are currently only three known licensed processing facilities for deer in the Republic of Ireland, i.e. in Wicklow, Kildare and Galway. Deer have to be processed and refrigerated within six hours of being shot and the lack of regional markets for deer carcases constitutes a major constraint to those shooting significant quantities of deer each season and also to the commercial development of a venison market. The majority of venison that is processed in these facilities is exported to Continental Europe.

In 2008, the Food Safety Authority of Ireland circulated draft proposals for national rules for small quantities of wild game and wild game meat. These proposals apply to the direct supply by the hunter of small quantities of Wild Game (as primary product) and the direct supply by hunters of small quantities of Wild Game meat to the final consumer or to local retail establishments directly supplying the final consumer. In the case of deer the definition of small quantities were “up to four (subject to the approval of the competent authority) large wild game (or the meat there from) per hunter per week of the hunting season or less than 25 per annum”. There were conditions relating to registration, food safety, record keeping and traceability, training, veterinary post-mortem examination, transport, larders and butchering. These proposals were open for consultation until June 5th, 2008. There have been no further communiqués on this process from the Food Safety Authority of Ireland.

Many individual hunters process venison for their own consumption or for friends and family (given in kind). Most hunters process their carcases in a shed or under a lean-to in their back gardens and most visually inspect carcases themselves. Most hunters will not have completed specific training in this area, for example on how to detect diseases in deer carcases. They may only spot a TB-infected deer when the TB is at an advanced stage. However, early stage TB infections are invisible to the observer eye – except by taking sections through lymph glands which is done by professionals. There are numerous health hazards associated if untrained hunters are allowed to visually inspect deer carcases and then sell on the meat. However, there is no reason why appropriate training and licensing would not overcome these concerns.

The limited resources for this report have not allowed the examination of comparative production costs per kilogram of different meats in Ireland. It is thought that such a study, inclusive of all input, administrative, subsidy and processing costs would be of interest. Given that wild deer incur no costs associated with feeding, housing or agricultural subsidy, pound for pound, venison may represent a low cost meat source for Irish households.

Bag returns from the NPWS report that approximately 25,000 deer are currently shot annually in Ireland. While there are no data to indicate what percentage of the total this is, Burkitt (pers. comm.) suggests it is between 8 and 10% of the deer population. This is nowhere near the required cull rate that would maintain the current population, quite apart from any initial reduction culling that is required in many areas. The lack of any reliable population figures makes it difficult to quantify the issue, but it is possible that an annual cull of 150,000 deer will be required in the medium term if the potential problems alluded to are to be averted. The current rendering cost for waste carcases and parts is €160 / tonne. Assuming an average weight per animal of approximately 50 kg, this would create a waste cost of between €0.6 and €1.2 million per annum depending on the level of utilisation achieved (figures based on 50% to 0% utilisation). Clearly, a market

needs to be developed which will incentivise hunters on the one hand and save significant costs on the other.

The development of a professional deer management service in Ireland should be largely independent of the recreational hunting sector. Effective deer management will increase the value of recreational hunting and will create opportunities for the development of a viable deer stalking market. This market does currently exist in Ireland for both domestic and foreign hunters but has significant potential if appropriately developed and managed. It is important to stress that deer management and recreational hunting, while separate operations, are entirely complementary and can be managed through appropriate use of seasons, the licensing system and good communication. The development of the deer stalking market would also dovetail with Fáilte Ireland's new focus and campaign on the market for outdoor recreation. It is thought that significant support should be garnered from Fáilte Ireland for the development of this sector.

Requirements

- *A quality assurance scheme for venison requires development and is a pre-requisite to the generic promotion of wild venison to Irish markets. This new market is a key component to achieving a sustainable deer management system in the forest estate.*

- *A comparative study of production costs of different meats and their nutritional / health values in Ireland is required which will hopefully make the economic case for investment in an indigenous venison industry.*

- *Following a separation of recreational deer hunting and deer management functions, a recreational deer hunting strategy requires development that will facilitate the further development of a viable recreational deer hunting sector.*

- *The initiative in 2008 by the Food Safety Authority of Ireland for the setting of rules for the sale of small quantities of wild game and wild game meat should be advanced and completed.*

8. Road Traffic Accidents

No county, regional or national statistics on road traffic accidents involving deer are kept by either local authorities or the National Roads Authority. All local authorities were contacted as part of this study and even though they are aware of a number of incidents down through the years, no records are kept. Undoubtedly, rising deer populations will lead to a greater incidence of such accidents and there is anecdotal evidence that this is the case in Ireland.

In the UK, research indicates that over 42,500 and up to 74,000 deer may be involved in vehicle collisions each year. These have significant human costs and are a major animal welfare problem. *DeerAware* is a programme to raise public awareness of the danger of deer on roads in the UK. The *DeerAware* programme is supported by Highways Agency publicity material that is available to regional road safety initiatives targeting local deer collision "hotspots". This is a development of the UK National Deer-Vehicle Collisions Project, which was set up in 2003 by the Deer Initiative. Funded by the Highways Agency and other bodies, this study records detailed information about deer related collisions, to identify high-risk areas and key factors. Trials have been carried out to test the effectiveness of different mitigation measures. A Driver Information Programme has been produced and made freely available to raise awareness of the issue. It is unfortunately beyond the scope of this study to attempt to model figures for Ireland based on UK data or to estimate what the equivalent statistics in Ireland might be.

This issue has been raised in the Irish media in recent times, notably in Co. Kerry in relation to the Red deer population there with reports of up to a dozen reported accidents involving deer in the various districts in 2004 (Irish Independent (08/03/2005)), and reports of damage to vehicles in 2008 – "Gardaí in Killarney said that in November - the rutting season - they received several reports of accidents involving deer on roads near Killarney. Cars were damaged, running to thousands of euro in some cases, but there was no loss of life or injury". (Irish Times, Tuesday, December 30, 2008). As part of this study, every local authority in the country was contacted. Only three responses were received from Counties Kildare (see **Table 4** and **Plate 5**), Louth and Offaly. Both Louth and Offaly reported incidents where deer had caused road traffic accidents but had no official or statistical records of such accidents.

Kildare County Council in conjunction with local Gardaí and the Kildare Deer Watch Group are voluntarily collating records on incidents of motorised vehicle/deer collisions. **Table 5** shows these records amassed since late 2008. There have been several other road traffic accidents involving deer and vehicles reported to the Gardaí, but these are unconfirmed as deer were removed from the scene of the accident. Further reports of vehicle/deer collisions have occurred close to Naas and Newbridge towns in Co. Kildare. It is noteworthy that the majority of these reported vehicle/deer collision records are of generally young male Sika during the months of September and October (coinciding with the rut). These may be pioneering Sika males expanding out from the main Wicklow populations and establishing new territories. However, the issue has become significant in Co. Kildare, particularly on the M7, N7 and M9 as the photographs presented in **Plate 5** illustrate.

Table 5: Confirmed Records of Deer Recently Killed in Road Traffic Accidents in Co. Kildare (Source: Kildare Deer Watch Group and Kildare County Council)

Date	Major/Minor Road – Co. Kildare	Deer species, age, sex
16/09/08	Junction 12, M7 (southbound)	1 Sika, yearling, male
19/09/08	Junction 11, N7 (southbound)	1 Sika, yearling, male
20/09/08	R448, nr Brannockstown	2 Sika, adult males
22/09/08	M7 (southbound), nr Ladytown Bridge	1 Sika, adult male
24/09/08	Kill, N7 (southbound)	1 Sika, yearling, male
29/09/08	Junction 10, M7 (southbound)	1 deer
07/10/08	Newhall, (northbound)	1 Sika, yearling, male
09/10/08	Rathangan Road Bridge (northbound)	1 Sika, yearling, male
12/10/08	Kilgowan, N9	1 deer
20/10/08	Kilcullen, N9	1 Sika, yearling, male
21/10/08	Junction 12, M7 (southbound)	1 Sika, adult female
23/10/08	Junction 13, M7 (southbound)	1 Sika, yearling, male
12/06/09	Between Junctions 5 & 6, N7	2 Sika, yearling, males
17/06/09	Junction 11, M7	1 Sika, yearling, male
23/06/09	Junction 8, N7	1 Sika, adult female
15/10/09	Between Junctions 11 & 12, M7 (southbound)	1 Sika, yearling, male
17/10/09	Near Moone, south Kildare	2 Sika, yearling, males

Plate 5. A photographic sample of deer killed in road traffic accidents in Co. Kildare in 2009.

The design of new and upgraded roads by the National Roads Authority appear not to consider the potential for deer related road traffic accidents. Linear woodlands with screening and landscaping functions are being planted right up to the road edge, thus providing cover for deer and very limited time for motorists to see deer about to cross the road. Deer fencing has been used along some stretches of road with little consideration for deer routes and behaviour and in some cases resulting in increasing problems elsewhere or in deer being trapped on the road side of fences. Concrete median barriers have been used on many roads which may be potentially jumped by crossing deer landing into the fast lane of oncoming traffic.

To date, there are no records of any human fatalities from road traffic accidents involving deer in Ireland. However, given the expanding populations of deer, it is unfortunately inevitable that human loss of life and severe human injuries will occur. This will raise the inevitable questions, in the case of legal action, as to who is responsible, who is liable to pay compensation and is the responsible party insured in these cases?

Requirements

- *The National Roads Authority, the Road Safety Authority (RSA) and Local Authorities should be made aware of the potential problems that will arise as a result of increasing deer populations.*

- *The design and construction of new roads and road upgrades should consider deer issues at the planning stage.*

- *A database dedicated to acquiring data on the number and locations of collisions between motorised vehicles and deer on a county-by-county basis. This should be instigated by the RSA with co-operation from Local Authorities and An Garda Síochána.*

12. Deer Management Groups (Baronscourt Case Study)

Deer do not respect property boundaries and in most cases, deer management is best achieved through co-operation between neighbouring land owners with a common objective of maintaining deer populations at a sustainable level. These groups can be effective in managing deer in a more strategic and co-ordinated manner and are a feature of deer management in Scotland, England and Wales and elsewhere in Europe. Their success depends on good knowledge of the local deer population, the setting of annual cull targets and the achievement of these through professional deer management. There is a Wicklow Deer Management Group in place but it has yet to co-ordinate an annual deer management programme or carry out any deer distribution or density mapping. The best case study of such a group in Ireland is the Baronscourt Deer Management Group in Co. Tyrone, which is case studied below.

Baronscourt Estate is a large private estate near Newtownstewart in County Tyrone which co-ordinates a deer management group involving neighbouring land owners. There is a resident herd of Sika, the population of which became unacceptably high in the 1970's causing disquiet amongst local farmers. An initial reduction cull was carried out (**Figure 13**) and the Baronscourt Deer Management Group was formed to encourage good communication between farming neighbours, the estate and the police. A "stalkers register" was established where people with an interest in deer stalking and in possession of a suitable rifle were enlisted to assist with the cull. The Ulster Farmers Union played a key role in establishing this group which is now known as the Baronscourt Deer Liaison Group. Ex-gratia payments are made to neighbours of the estate in respect of all deer culled by the group on their land. These payments equate to 20% of the carcass value. Farmers are encouraged to report any problems to the group and the group responds appropriately, either by culling when the deer season is open or by providing means of crop protection such as crow scarers, when out of season. An annual deer count is held at the end of March, after which the deer liaison committee meets and a cull target is agreed for the following season.

Deer culling statistics for the period 1978-2008 for Baronscourt Estate are presented in **Figure 13**. Early season commercial stag stalking is successfully offered at Baronscourt and is followed by a mix of professional and recreational deer management for the rest of the season with the goal of reaching the annual cull target. There has been a recent decision by Baronscourt Estate to change their forest management system to Continuous Cover Forestry. The success of this will be dependent on reducing the grazing threat to natural regeneration. This can be achieved with a good deer management system in place and **Figure 13** illustrates the commencement of increased culling in the most recent three seasons to achieve this forest management objective.

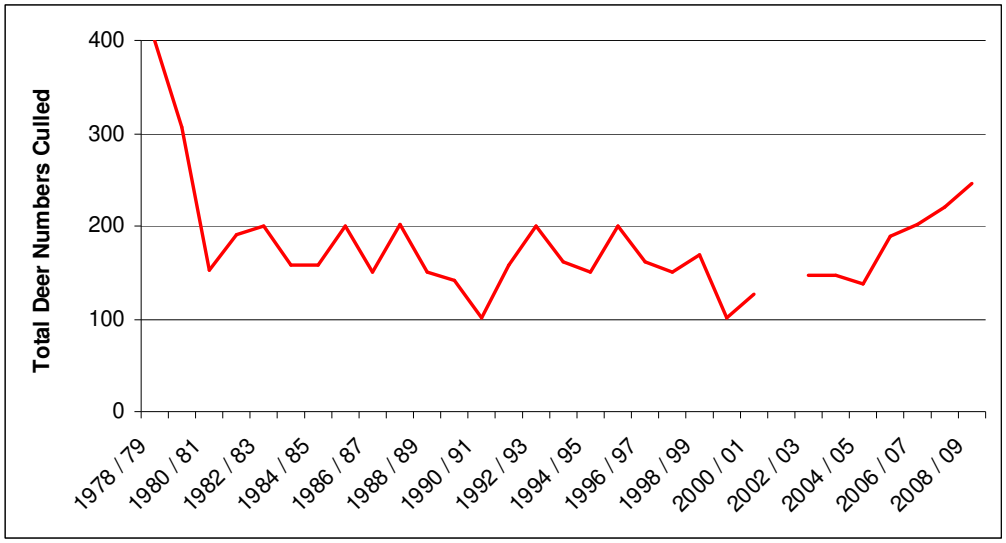


Figure 13: Total Deer Numbers Culled, Baronscourt Estate, 1978 – 2008 (Source: Baronscourt Estate, 2009).

The key lessons from this case study are the importance of stakeholder involvement and communication and the establishment of a consistent deer management system which can be tweaked as required (Robert Scott, Agent and Factor for Baronscourt Estate, pers comm).

This type of model is considered appropriate for use elsewhere in Ireland but will be entirely dependent on leadership from large land-owners such as Coillte and the NPWS as well as from small land-owner representative organisations such as the Irish Farmers Association.

Requirements

- *A number of local pilot deer management groups should be established as a priority. They should be developed and initially funded with leadership provided by Coillte, the Forest Service and the NPWS. These groups should prepare and implement local deer management plans.*

13. Impact of Deer and Related Diseases on Other Agricultural Enterprises

Transmissions of deer-related diseases are high when deer occur at high densities in local areas.

13.1 Foot and Mouth Disease (FMD)

FMD is an acute infectious viral disease that affects all cloven-hoofed animals, e.g. cattle, swine, sheep, goats, deer etc. FMD causes fever and subsequently the animal develops blisters in the feet and mouth. As evidenced in the 2001 outbreak of the disease in the UK, which is estimated to have cost the UK exchequer over £1 billion (UK Department of Environment, Food and Rural Affairs (DEFRA), 2009), this disease poses a significant threat to domestic and wild animal health and therefore the economic return of the livestock industry. FMD can spread rapidly through a population and geographical area due to the lack of restriction of movement in wild roaming species such as deer. Wild deer may increase the potential for a rapid and general outbreak of the disease amongst domestic livestock, as deer will graze in fields with other domestic livestock, such as cattle. Direct and indirect transmission of the virus can occur through the fluid from blisters, saliva, milk and dung. Contamination of these discharges with any objects/animal, including feed/fodder and troughs/water holes, is a danger to any other stock. Heat, sunlight and disinfectants will destroy the virus, whereas it will strive in cold and dark conditions, for long periods of time. FMD is extremely infectious and thus control at early stages, given both the concentration of numbers of domestic livestock and the wild deer population is paramount. The interval between exposure to infection and the appearance of symptoms typically varies between 24 hours and 10 days (average times, under natural conditions, are 3 to 6 days). FMD is fatal for very young animals or a severe form of the disease manifested in older animals. Roads and vehicles may also become contaminated with FMD viral particles, especially when vehicles transport infected animals from location to location without the vehicles being disinfected.

The current lack of knowledge of deer distributions and densities combined with regional overpopulation of deer and a lack of deer management experience could result in a very serious inability to control the spread of FMD in the event of another outbreak. The 2007 UK outbreak was successfully limited in Ireland to the Cooley Peninsula in Co. Louth where fallow deer and feral goats were culled as part of a national emergency disease containment and eradication operation. However, such action would simply not have been possible had the outbreak occurred, for example, in Wicklow, Tipperary or Kerry.

Requirements

- *The relevant government departments, agencies and partners in both jurisdictions in Ireland need to be fully briefed on the extent of the risk of unmanaged deer populations with regard the spread of FMD should another outbreak occur.*

- *Any contingency plans for the containment of FMD in the event of an outbreak must include measures relating to deer management.*

- *Ongoing monitoring of movements of deer (for farming and enclosed parks / collections) exports and imports from Britain to Northern Ireland and Republic of Ireland is essential.*

13.2 Bovine Tuberculosis (TB)

Bovine Tuberculosis (TB) is a contagious respiratory disease caused by the bacterium *Mycobacterium bovis*. Bovine TB can infect warm blooded animals such as domesticated cattle, wild and farmed deer, badgers, otters and other mammals, including humans.

Deer stalkers who perform basic carcase assessment and field dressing of meat for domestic use (non-commercial) may be susceptible to transmission of TB between infected wild deer and themselves. This can be transmitted through the air by coughing, sneezing and accessed via open cuts. Preventative measures include covering of all cuts with suitable plasters, wearing disposable gloves and face masks during field dressing, washing using suitable antiseptic and other hand washes etc. The incidence of transmitted TB from wild deer to humans is unlikely. However, in late stages when open pustules are found in deer, transmission may occur. There is however, insufficient data on this topic at present in the literature.

Requirements

- *Increased surveillance of wild and farm deer populations are required to ascertain the incidence of this disease in wild deer especially and the transmission risks between domesticated livestock and wild deer.*

- *Deer stalkers need to be informed of potential risks when preparing carcasses.*

13.3 Chronic Wasting Disease (CWD)

Chronic Wasting Disease (CWD) is a brain disease related to Bovine Spongiform Encephalopathy which has not been detected heretofore in wild cervids in Europe (De Bosschere *et al.,* 2006). Four species within the family Cervidae are known to be naturally susceptible to CWD. It is considered enzootic in free ranging populations of mule deer and white-tailed deer (*Odocoileus virginianus*), Rocky mountain elk (*Cervus elaphus nelsoni*) and moose (*Alces alces*) in some parts of the United States (De Bosschere *et al.,* 2006) though it is likely that other subspecies of *C. elaphus* are susceptible to CWD too. It is unknown if other deer species are susceptible. It was first detected in these species over three decades ago (Miller, Wild and Williams, 1998). CWD can be transmitted between animals in close proximity to one another; there can be a long delayed dormant period between when an animal is infected and when it displays clinical symptoms. In deer/elk 18 months or older, clinical symptoms (final stages) include poor body condition, tremors, stumbling, increased salivation, difficulty in swallowing, excessive thirst and urination.

Brain abscesses or cranial abscessation syndrome may be caused by the bacterium *Actinomyces pyogenes* which can enter wounds in the velvet antler growth stage, through broken antlers or through the pedicles after antlers are shed. Once the bacteria have entered a wound/opening it can eat through the cranium and cause abscesses in the brain. Symptoms include apparent blindness, uncoordinated movement, abnormal behaviour, swollen eyes, broken antlers weeping fluid, swollen ankles, foot sores and lameness.

Requirements

- *Consideration should be given by the Department of Agriculture to the possibility of the presence of this disease in Irish deer populations and a monitoring programme should be put in place.*

13.4 Ticks and Lyme Disease

Studies conducted in France (Pichon *et al.,* 1999) have indicated that the risks to humans of acquiring Lyme disease from deer related tick populations are mainly linked to tick nymph activity and are higher during the spring and autumn months. They have also recognised the role of wild deer as an amplifier of tick populations, and note that areas with a high density of deer should be considered as higher risk areas. Lyme disease is known from within the deer populations in Killarney National Park and public awareness of infection risk is currently low, although visitors from both continental Europe and North America would generally have a higher awareness level of the disease (Burkitt, pers. comm.).

Similarly, awareness amongst the medical profession of the risks of Lyme disease and its symptoms is low as evidenced in a recent case where an individual who had been bitten by a tick in Connemara later developed classic signs of the disease, which went undiagnosed for several weeks. This resulted in the disease developing to an advanced state, and resulted in the patient being admitted to the cardiac arrest unit in a Dublin Hospital as a precautionary measure (Selina Guinnes, pers. comm.).

Requirements

- *Consideration should be given by the Department of Agriculture and the Health Service Executive to raising awareness of the risks of Lyme Disease amongst farmers, deer stalkers, hill walkers and other recreational users of the countryside. The spread of this disease in deer populations needs to be monitored.*

- *General Practitioners and other medical personnel need to be made more aware of the incidence of this disease in Ireland and its signs and symptoms.*

13.5 Damage to agricultural crops

Damage to agricultural crops by deer is known to occur. Deer will trample crops either by walking through or creating areas to lie up during daylight hours to ruminate. Deer tend to prefer edge-habitats between older and mature woodlands and farmland, where they can quickly return to cover when feeding between dusk and dawn. Deer grazing in agricultural fields is a common form of damage, especially in winter cereals due to the shortage of suitable forage elsewhere. Red deer can cause lasting damage to root crops such as sugar beet and corn fields by laying-out during the summer months (De Nahlik, 1992).

13.6 Grazing impacts to Annex I habitats and Annex II species of conservation value

Damage to wild, natural vegetation such as upland heather by excessive deer grazing is evident in certain areas. Deer may graze off flower bearing young shoots and thus stop self seeding and self regeneration of heather (De Nahlik, 1992). Deer can also browse at a higher level than many other montane grazing species such as sheep resulting in the loss of many arctic-alpine botanical species in the Irish uplands which are of conservation value, such as the protected parsley fern (*Cryptogramma crispa*) which now appears to be extinct in Wicklow as a result of grazing pressure (Curtis and Wilson, 2008a, b).

A review of threats noted as negatively impacting on habitats and species listed under Annex I and II respectively of the EU Habitats Directive was conducted and is presented in **Appendix VI**. Note that there are no separate identification codes for grazing species shown in this data search so this broad category of grazing (code 140) includes deer, goats, cattle, sheep horses, rabbits and other grazing species. As can be seen, grazing pressures are impacting not only on Annex I woodlands but also on bogs, heath, upland rocky habitats, coastal, grassland and wetland habitats, as well as a number of species including fish, molluscs and plants.

Requirements

- *The co-operation of farmer groups, i.e. IFA, ICMSA, etc., State and Semi-State agencies, i.e. NPWS, Coillte Teo., private foresters (via grower groups, SIF, ITGA, etc.) and landowners at local and regional level to develop and implement deer management plans.*

14. Impact of Deer on Native Woodlands

14.1 The National Survey of Native Woodland

The native woodland estate in Ireland has recently been the subject of a five year national survey funded by the NPWS (Department of the Environment, Heritage & Local Government) and the Forest Service (Department of Agriculture, Fisheries & Food) and undertaken by Botanical Environmental & Conservation Consultants Ltd. (BEC). This survey, the National Survey of Native Woodland is hereafter referred to as the NSNW. The report from this survey is the source of the results and graphics presented in this section.

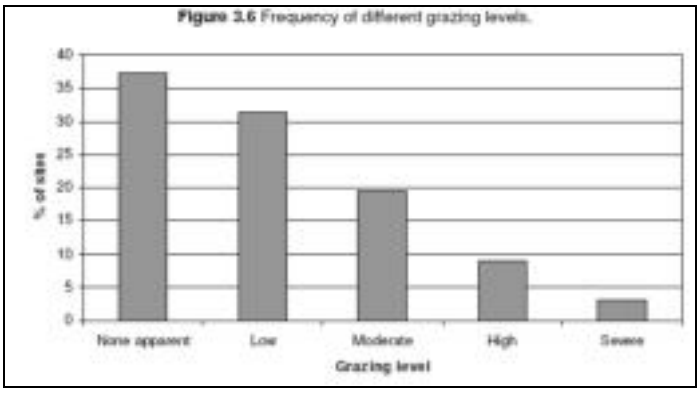
The NSNW survey, the first of its kind in native woodlands in Ireland, included the survey of 1,217 sample woodland sites across all 26 counties of the Republic of Ireland during 2003-2007. Surveys comprised the recording of site species lists and information at the site level on topography, management, grazing, natural regeneration, geographical situation, adjacent habitat types, invasive species, dead wood and boundaries. Data were also incorporated from trial surveys in 2000 and 2001 to give a total of 1320 sample sites.

The NSNW used both the Forest Inventory Planning System 1998 (FIPS) inventory of forest cover in Ireland and the National Forest Inventory (NFI) data which estimated that 625,750 ha of Ireland is forested land. Of this forested area, 21.3% or 132,990 ha comprise native (semi-natural) woodland, representing 1.9% of the land area of the State. Of the total, 60% of native woodlands are owned by private landowners.

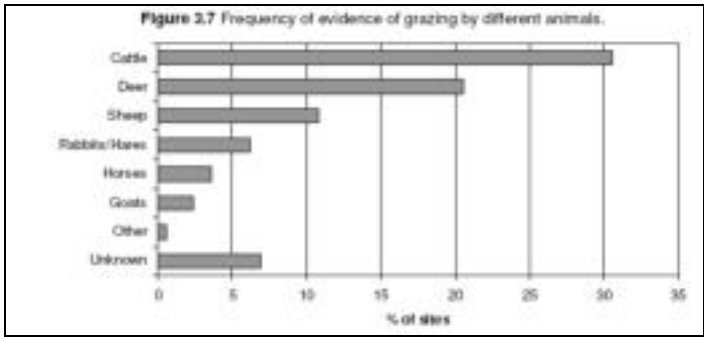
The impacts of deer were recorded as one of the threats to national native woodland cover in the NSNW and data on grazing and natural regeneration within native woodland samples were assessed in the field. Further information on the methodologies used in these field assessments are presented in **Appendix IV**.

Grazing in Native Woodlands

The NSNW reports that heavy grazing was not a feature of the woods surveyed. High and severe grazing levels were infrequently encountered, occurring at only 9.0% and 3.0% of sites respectively (**Figure 3.6**), while at 37.1% of sites, no grazing was apparent.



The NSNW identified cattle (30.6% of sites) and deer (20.5%) as the most frequently identified grazers (**Figure 3.7**) and report that deer tended to favour higher altitudes and steeper slopes compared to cattle. Co. Wicklow had the highest percentage of sites grazed by deer, at over 59.1%, followed by Co. Kerry at 43.5%. Both of these counties are mountainous and have well-established deer populations. By contrast, less than 10% of sites in Counties Cavan, Sligo, Wexford, Leitrim and Westmeath were grazed by deer.



The results of this survey are surprising to this team as our experience has shown that many broadleaved plantation and native woodlands are heavily grazed by deer and this opinion was also expressed by a number of other practitioners spoken to during the course of this study. It should also be noted that the 1300 or so sites sampled in the NSNW are only a subset of the entire native woodland estate and may not be representative of the problems posed by deer.

Natural Regeneration

The impact of deer grazing on natural regeneration in native woodlands has been long recognised (Forestry Commission, 2000). Results from a survey of 78 natural regeneration sites in the south of England found that 30% of all tree seedlings showed some evidence of browsing damage (Harmer, Kerr and Boswell, 1997). There was large variation between species and sites. Willow and rowan were browsed most with about 50% of seedlings damaged, whereas only 20–30% of seedlings of ash, beech, birch, oak and sycamore were browsed. Although palatability of tree species to deer varies, for example alder and birch are generally thought to be less palatable than oak and ash, the basis for the differences are not well understood and it is not possible to rank tree species precisely in order of susceptibility to browsing damage.

This has implications for the future management of many native woodlands and broadleaf plantations. In parts of England areas of woodland previously coppiced are being brought back into active coppice management at a time when deer populations are increasing, and after decades of no management (Joys *et al.,* 2004). It has been found that future restoration of coppice and growth of stools after coppicing is likely to be successful and worthwhile only if active measures are taken to reduce deer browsing damage and almost certainly, reducing deer populations as a whole.

Discussion

The extensive surveys completed during the NSNW indicate that high and severe grazing levels (by all species, not just deer) were infrequently encountered during the survey, occurring at only 9.0% and 3.0% of sites respectively, and that this is thought to be a localised rather than a national issue. Given the recent spread of deer on a national level this will no doubt be a rapidly changing situation, exacerbated by the increase in planting of additional private woodlands.

14.2 Native Woodland Case Studies

Two sites were selected as part of the native woodland case studies following discussion with local NPWS staff. Tomnafinnoge Wood near Shillelagh, Co. Wicklow was selected as it is mature woodland where only Sika (as opposed to any other species) is known to be present (Wesley Atkinson, NPWS pers. comm.). The other site selected consists of a number of locations within woodlands located in the Killarney National Park – these locations are under pressure from both Red deer and Sika.

Tomnafinnoge Wood, Co. Wicklow

A Management Plan for Tomnafinnoge Wood was prepared under the Native Woodland Scheme (NWS) in 2005 (Wann & Doyle, 2005). The main weaknesses and threats to the woodland were noted to be grazing pressure preventing the regeneration of oaks and the presence of exotic species. The threat from browsing deer and sheep was noted in an earlier study conducted by one of the authors of this report on the structural dynamics of the wood (Wilson, 1995). The NWS Management Plan recommended that areas with good levels of natural regeneration of oak be fenced off from deer grazing and that non-native species be removed, including the removal of beech in the long term. This work (principally the removal of Rhododendron) commenced in recent years and these areas were investigated during the field visit.

The main areas inspected are near the north eastern end of the wood. Extensive clearance of Rhododendron within this area below a canopy gap of approximately 20m has allowed extensive natural regeneration of oak, birch, holly, hazel, willow, rhododendron and beech many of which are located within a thicket of dense bramble.

Plate 6. Natural regeneration of oak and birch

Plate 7. Natural regeneration of holly

Some of these species (notably the birch, hazel and holly) show some evidence of browsing but this appeared to be light and was not inhibiting the future potential of woodland in this area. The ground flora was mostly sparse and limited to occasional wood rush (*Luzula sylvatica*), willowherb (*Epilobium* sp.), hard fern (*Blechnum spicant*), remote sedge (*Carex remota*) and the moss *Polytrichum commune* on a medium of leaf litter. In these areas most regeneration was approximately 5cm high in the herb layer.

Other areas were dominated by dense thickets of bramble and taller seedlings (up to 50cm high) were recorded. Many of these show evidence of browsing at c.40cm and it was thought that this was indicative of a once-off browsing event as opposed to a continuous browsing presence. Eamon Doran (the local NPWS Conservation Ranger for the site) indicated that there are typically up to 3-4 Sika within the site, but that a larger population of up to 25 – 30 are found in the wider adjoining plantations (mostly Christmas trees, conifers and some broadleaves).

One of the woodland old plots surveyed by Wilson (1995) was also inspected. Previous regeneration recorded in this area of the woodland, which dates from 1840-1850, was aged between 24 and 52 years old (core data) and was typically under 5m in height. It was noted then that the only regenerated trees (birch and oak) which were beginning to form an understorey canopy were those located within a light gap (Wilson, 1995). There was no evidence of any increase in natural regeneration in this area subsequent to that survey and this was attributed to lack of light and competition from bilberry (*Vaccinium myrtillus*) as opposed to grazing pressure. No evidence of anything beyond light grazing damage to bark was noted in this area.

Plate 8. Study plot used in the 1995 study (Tomnafinnoge Wood).

Several other areas of open canopy caused by either natural disturbance such as a windblow or man made disturbance such as Rhododendron clearance were visited within the woodland. Regeneration recorded in these areas was typically either oak or birch, some of which was lightly browsed, whereas regeneration of holly showed more severe damage, including bark stripping.

The principal factor in determining the successful regeneration of tree species within this woodland appeared to be controlled by light rather than grazing pressure and it is thought that ongoing surveys of this will determine if future fencing of such areas is required.

Killarney National Park

The woodlands at Killarney have suffered from extensive grazing for the last forty years by a wide variety of species including sheep, feral goats, Red and Sika deer (Burkitt, pers. comm.). A number of woodlands were visited during the site visit; these include the yew woodland on the Muckross Peninsula (including some of the old exclosures erected there and in Tomies Wood by Dr Daniel Kelly of Trinity College Dublin), and newly fenced areas to the east of the road from Killarney to Ladies View. The latter were part of a NWS Plan prepared for Ullauns Wood and Derrycunihy Wood by Heardman & Daly (2005).

Prior to the preparation of the NWS Plan in 2005, extensive removal and follow up spraying of Rhododendron had been conducted at Ullauns and Derrycunnihy Wood over several years.

As a result of Rhododendron invasion and overgrazing, the understorey in the woodland was sparse but contained characteristic species such as *Ilex aquifoilum* and *Sorbus aucuparia.* Overgrazing also meant that the ground flora and dwarf shrub layers were poorly developed and dominated by a layer of bryophytes. Although tree seedlings (oak, birch, holly and rowan) occurred in the ground flora they were heavily grazed and were only a few centimetres high.

The NWS Management Plan recommended the exclusion of grazing animals from the majority of the woodland by erecting deer fencing around 4 blocks of around 20ha each, with the retention of 'corridors' between each block to allow free movement of deer through the wood. The culling of deer and goats to reduce grazing pressure in the 'corridors' was recommended. The issue of sheep trespass was also to be addressed in consultation with the Department of Agriculture.

The areas of native oak woodland at Ullauns and Derrycunnihy Woods were deer fenced as recommended in the plan for the site. Within the fenced area abundant natural regeneration of a wide variety of species was recorded including oak, strawberry tree, birch, holly, hazel, willow, ash and mountain ash. The ground

flora also showed signs of recovery with good growth of heather (*Calluna vulgaris*) and a greater sward height of unbrowsed purple moor-grass (*Molinia caerulea*).

Plate 9. Natural regeneration of both trees and ground flora within deer fenced area (Ullauns Wood).

Plate 10. Regeneration of ground flora in Ullauns Wood following clearance of rhododendron and deer fencing.

Plate 11. Grazing plot in Killarney Woods (photo courtesy of Clare Heardman, NPWS).

Plate 12. Pre-enclosure grazing and subsequent free growth following fencing (Ullauns Wood).

Plate 13. Recent Red deer activity in the corridor outside the deer fence (Ullauns Wood).

Yew Wood, Muckross Peninsula

The level of natural regeneration and the recovery in ground flora within each of the fenced areas was quite dramatic and is best illustrated in a series of photographs taken on site. It appears that not all grazing animals have been excluded from the newly fenced areas in Killarney and, as evidenced by the research conducted by Kelly (2000), this may be the key to the development of a diverse ground flora, once deer numbers remain under control in these areas.

Plate 14. Browsed holly and ash outside the Yew Wood exclosure at Muckross Peninsula - this area has now been deer fenced.

Plate 15. Extensive regeneration within the exclosure at the Yew Wood at Muckross Peninsula.

Plate 16. Thicket stage woodland with limited ground flora diversity (due to absence of light and grazing) within exclosures erected by Daniel Kelly in Tomies Wood.

14.3 General Woodland Biodiversity

Deer populations, occurring at densities that are in balance with the habitat, ecosystem and availability of sufficient nutritious forage, are beneficial to plant biodiversity and woodland invertebrates. Browsing of vegetation by deer and its dung can create more habitats for invertebrates (and knock-on effects for other wildlife such as birds) as well as preventing loss of certain types of habitat. However, where a natural predator of deer species is absent from the landscape, such as the wolf, deer numbers must be controlled through human-mediated deer management plans. Otherwise, deer occurring at high densities in an area

can quickly over-browse and cause high levels of damage in terms of prevention of woodland regeneration, damage to tree saplings (stunted growth, browsing leader and side shoots, bark strip and so on) and other stages of tree growth, thus decreasing plant, invertebrate and consequently faunal diversity.

Ground flora

It has been observed that an overabundance of deer or other grazers ultimately results in a dense sward of more robust species such as wood rush (*Luzula sylvatica)* (Kirby, 2001) and increased deer populations are thought to have also contributed to the loss of a number of rare woodland species such as long leaved helleborine (*Cephalanthera longifolia*) at it's former stations in Co. Wicklow (Curtis & Wilson, 2008a, b). Conversely a complete exclusion of deer also results initially in a substantial rise in vascular plant species followed by a subsequent decline (Kelly, 2000). This substantiates work conducted in the UK, which has shown that extremes of grazing levels – both high and very low or zero levels lead to a relatively uniform ground flora (Kirby, Mitchell and Hester, 1994). This is also true for woodlands in upland area where 'a low level of grazing by large herbivores in woodland provides a greater diversity in vegetation structure and species composition than either the current prevalence of overgrazing or the absence of grazing in fenced woods' (Mitchell and Kirby, 1990). Clearly a balance needs to be found between herbivore populations and the natural vegetation of our native woodlands. Further research is required in Ireland to determine the optimum grazing levels required in different woodland types.

In the North Pacific studies on the Queen Charlotte Islands, British Columbia, Canada, Gaston, *et al.* (2006) have shown the biogeography of vascular plants on 10 islands ranging in size from 4.5 to 395 ha, which experienced a range of different browse pressures from introduced black-tailed deer (*Odocoileus hemionus*). This study found that small, isolated islands without deer were richer, especially in wildflowers, than the larger, less isolated islands, which is the reverse of the normal species–area and species–isolation relationships. This reversal of the normal trend was attributed to the effects of deer browsing.

Birds

The impacts of high deer populations on birds has recently been investigated by the British Trust for Ornithology (BTO) who are conducting a broad based survey of woodland bird species in the UK (**http://www.bto.org/research/woodland_and_scrub.htm**), which includes:

- understanding causes of population declines, especially in migrant birds,
- habitat requirements,
- edge effects on woodland birds,
- responses to habitat management,
- effects of deer browsing on habitat quality,
- implications of the creation of habitat networks,
- expansion of scrub and woodland in upland landscapes,
- effects of land abandonment,
- the ecological value of ecotonal habitats,
- interactions between non-native grey squirrels and birds.

This study is building on the work conducted by the Royal Society for Protection of Birds (RSPB) and the BTO (The Repeat Woodland Bird Survey) which has found that eight out of a total of 34 species, with sufficient data to permit analysis, showed large national declines (>25%) according to both RSPB and BTO datasets. (These included garden warbler, lesser redpoll, lesser spotted woodpecker, spotted flycatcher, tree pipit, willow tit, willow warbler and wood warbler and hawfinch). One of the strong hypotheses emerging from these analyses are that several declining bird species have been affected by changes in woodland structure, possibly arising from changes in the age structure of woodland stands, changes to woodland management (especially a reduction in active management) and intensified pressure from deer.

Other work by Gill & Fuller (2007) has shown that deer browsing resulted in a reduction of canopy cover, a reduction in density and cover of understorey vegetation, and an increase in grass cover. Abundance of bird species using the understorey, including all migrants, was significantly higher in coppice where deer were excluded.

The impacts of heavy browsing by other ungulate species such as moose, on the breeding success of the great tit (*Parus major*) has been studied in Norway (Pederesen *et al*., 2007). This study investigated the effect of intense browsing pressure by moose on downy birch (*Betula pubescens*) trees, which resulted in a reduced biomass of arthropods and a lower fledging rate for the breeding great tits.

Invertebrate diversity

There have been few studies conducted to examine the impacts of deer overabundance on invertebrate assemblages in woodlands. On the Queen Charlotte Islands, British Columbia, Canada, where Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) were introduced, a study by Allombert *et al.* (2005) compared islands with no deer, with deer present for fewer than 20 years, and with deer present for more than 50 years. The study found that in forest edge vegetation, invertebrate abundance and species density decreased with increasing length of browsing history. In forest interior vegetation, decrease was significant only on islands with more than 50 years of browsing. Insect abundance in the vegetation decreased eightfold and species density six fold on islands browsed for more than 50 years compared with islands without deer. This indicates that invertebrate numbers will almost certainly decline in Ireland if the deer population continues to expand unchecked.

Requirements

- *It is recommended that an Irish database of deer distribution is maintained in collaboration with an Irish database of both native woodlands and broadleaf afforestation and that GIS is used as a tool to highlight those native woodland sites, which were reported as having either light or no grazing damage, which may become vulnerable to deer damage.*

- *Applications for deer protection measures under the various Forest Service grant schemes should be strategically assessed using the site rankings s prepared by Perrin et al. (2008). This would identify the sites of high conservation value that are most threatened and thereby ensure that the implementation of protective measures (such as fencing) in conjunction with a deer management programme are most efficiently resourced.*

- *It is recommended that strong consideration is given to protecting all new native woodland establishment sites against deer, even if there is no current evidence of deer in the area, given the ongoing spread and increase in deer numbers nationally.*

- *Retro-fencing of newly established sites funded under the NWS should be considered and a funding mechanism similar to that recently in place for general forestry be put in place. In addition, research on alternative and novel fencing designs is required in order to attain best value for money and to ensure that grazing animals are excluded in the short and medium term.*

- *The importance of deer (at appropriate numbers) as a browsing animal in woodlands needs to be recognised and incorporated into any management plan developed for a site. This needs to be done on a case by case basis for each site and researched adequately.*

- *A clear differentiation is required in site assessments between browsing pressure from deer and other herbivores (including domestic stock, feral goats, etc.).*

- *A holistic approach to woodland biodiversity needs to be adopted in relation to deer management and requirements of specific woodland specialists such as redstart, which require stands of high crown trees and open areas in old and mature woodland maintained by appropriate grazing and management.*

15. Acknowledgements

The following organisations and individuals contributed substantially to this report. Contributions came in the form of time, data, experience and expertise and we are most grateful for this.

National Parks and Wildlife Service
Dr Tim Burkitt, Dr Ferdia Marnell, Dr John Cross, Dr Naomi Kingston, Dr Deirdre Lynn, Wesley Atkinson, Dr Tom Curtis, John Maguire, Clare Heardman, Eamon Doran.

Coillte
Barry Coad

Forest Service
Ciaran Nugent, Kevin Collins

Northern Ireland Forest Service
John Griffin

Irish Timber Growers Association
Denis Bergin

Woodlands of Ireland
Dr Declan Little, Dr John Cross, Paul Murphy, Cliona O'Brien (The Heritage Council) and Diarmuid McAree.

Other stakeholders who contributed to this report were as follows:
Thomas Becht (forest owner, Donegal), Robert Scott (Baronscourt Estate, Tyrone), Amanda Pedlow (Offaly County Council), Hal Chavasse (forest owner, Waterford), Brendan McSherry (Louth County Council), Kildare County Council, Kildare Deer Watch Group, Joe Murphy, Lee Green, The St. Hubert Club of Ireland, Prof. Rory Putman (Scotland), Fiona Beglane, Dr Allan McDevitt and Hugh Rose (Scotland).

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17. Appendix I. History of Deer Populations in Ireland

Currently there are four species of wild-ranging deer present in Ireland, Muntjac deer (*Muntiacus* sp., almost certainly *Muntiacus reevesi*), Sika (*Cervus nippon*), Fallow deer (*Dama dama*) and Red deer (*Cervus elaphus*).

17.1 Muntjac deer

The first sightings of wild free ranging Muntjac deer were reported in 2007 from Co. Wicklow. An emancipated male Muntjac was shot in the Avonmore river area (NPWS, pers. comm.). Since then there have been several substantiated reports of Muntjac in counties Wicklow, Kildare, Longford and possibly Wexford (Carden *et al*., In Review) and anecdotal reports in various locations in Northern Ireland (see Dick *et al.,* 2009) as well as a recent road traffic accident that involved a juvenile Muntjac near Newtownards, Co. Down, Northern Ireland (British Deer Society, 'Deer' Summer 2009, p5). These reports suggest that there have been recent multiple deliberate releases of this species, although the source(s) of these remain unknown at present.

Under the Irish Wildlife Acts (1976, 2000) and the 1985 Wildlife Order in Northern Ireland (presently under review) it is illegal to introduce new faunal species to Ireland. NPWS have declared a 12 month open season (August 31st to September 01st) on Muntjac deer in recognition of its threat to biodiversity (in terms of woodland ground flora and coppice) and in an attempt to control the spread of this deer in Ireland.

Reeves' muntjac is one of the smallest and highly secretive muntjac species (currently there are 6 muntjac species known), originating in south-east Asia (Taiwan and China). This deer species evolved during the Miocene geological time period, some 23 million years ago, when diverse plains, grasslands and desert faunas flourished. To this day, muntjac still retains the dual primitive traits of these early deer forms: the combination of the 'combat' canines/tusks and primitive short antlers. New species of muntjac continue to be discovered. As recently as 1994, a large form (*Megamuntjacus vuquangensis*) was found in the Annamite Range of northern Vietnam. This form has also recently been confirmed in Laos and Cambodia.

Reeve's muntjac got its name from Mr. John Reeves, who in 1812 was appointed the Assistant of Tea for the British East India Company. Mr. Reeves, a keen naturalist, on behalf of the Duke of Bedford (Woburn Abbey), subsequently organised the collection and live translocation of a small number of these deer to Woburn Abbey, Bedfordshire, Britain around 1900. Some of these 'Woburn' group subsequently escaped from the confines of these lands. In-conjunction with further accidental escapes from other importations and deliberate releases, this has led to the current distribution and numbers of muntjac currently found in Britain, the Netherlands, certain regions of France and now here in Ireland.

In their native country, muntjac dwell in relatively lowland subtropical forests and generally appear to prefer habitats close to water sources such as rivers. However, with the Reeves' muntjac this preference is not strongly demonstrated. Feral populations of Reeves' muntjac in Britain have shown a somewhat fluid adaptation to various habitats, they can be equally found in deciduous and coniferous forests, agricultural lands, suburban and urban areas. Deer species in general are highly opportunistic and can, in most cases, adapt readily to new environments, even if the habitats are not their preferred type, without any adverse effects on their biology and ecology. They feed on rapidly digestible foods, such as many understorey and ground woodland flora species, herbs, blossoms, succulent roots, grasses, bramble, bilberry, ivy, fungi and nuts. They have also been known to eat eggs and young of birds, carrion, snared game birds, and even 'hunt' small mammals. They vary their diet according to region and habitat type. In Britain, studies on the diet of the Red fox found that it predates on both adult and young Reeves' muntjac and thus may potentially act as a natural predator where densities of deer are relatively low, however foxes are opportunistic feeders/hunters and will tend to go for an 'easy meal' first. In its native south-east Asia, its predators include leopards, tigers, dholes (Asiatic wild dog), jackals, crocodiles and pythons.

General Characteristics

- The Reeves' muntjac are reddish/brown in colour and are small in terms of body size, approximate to the size of a red fox. Adult males weigh between 10 and 18kg. Adult females are lighter at between 9 and 16kg.
- Both sexes measure between 43 and 52cm at the shoulder.
- Females tend to live to much older ages than males. In captivity the former can live up to 19 years of age, whereas males can live up to 16 years. In the wild, longevity tends to be less, though with the absence of predators they may live reasonably long.
- The distinctive hunched appearance (where the hind legs are higher than the forelegs), facial markings (dark black V-shaped (males) / U-shaped (females) lines), presence of long canines/tusks and short antlers (males) and a short tail (c.10cm long) separate, these deer from similar sized foxes in a habitat.
- Furthermore, unlike other deer species that have two hooves of the same shape and size, the Reeves' muntjac has one hoof that is smaller than the other and is lined with hairs that are visible in its tracks.

Muntjac mark their territories and trackways with their large frontal and preorbital (just below the eye) scent glands. The musculature to open and close these glands and the large glands themselves give the peculiar skull morphology of this species. They tend to be predictable and use the same trackways (this can be usefully employed when managing this species in terms of culling plans) to check their territories. They regularly scent mark using a white liquid that oozes from the frontal glands. These deer do not have metatarsal glands (found in the lower regions of the hind legs of other deer species). They establish a network of trails and trackways which they predictably use. Resting spots are well pawed and free of vegetation. They generally feed for about 40 minutes at a time and are most active during dusk and dawn hours.

To minimise detection by predators, Reeves' muntjac move very little within their territories (especially during daylight hours), they tend to rest a lot of the time in between feeding bouts. This trait and its small size, makes detection of these deer extremely difficult in areas of diverse and extensive vegetation cover. When disturbed, both male and female muntjac will flash their tails, repeatedly bark and can take between 1 and 17 jumps, while 'yapping' at each jump away from site of disturbance. Barking occurs mainly during the hours at dusk and during darkness or in cover, especially when muntjac cannot establish the cause of the disturbance. When surprised at very close range, muntjac 'yap'. Both chemical (large scent glands) and vocal communications are important in the 'small' world of the muntjac.

Male Reeves' muntjac have 2.5 – 5cm long canines (or tusks) that are enamel coated and will defend their territories, that overlap many female territories, against rivals either through sparring or actually full scale fighting, thus gaining access to the females for mating. There appears to be no seasonal changes in territory usage and male territories tend to be between 11 and 30 hectares in size. The antlers are used in defensive positions. These antlers may or may not be shed, though in Britain, antler casting is somewhat seasonal. Growth of the short antler is achieved between 79 and 100 days. The long canines are offensive weapons that can inflict serious, if not fatal, wounds to the body of the opponent, especially in vulnerable areas such as along the flank and the underbelly. The skin of the neck region of male muntjac deer is very thick and even with its diminutive body size, a relatively large calibre of rifle (with appropriate bullet) is required when shooting to penetrate this thickened skin and muscular neck. Sexual reproductive maturity in male Reeve's muntjac is at approximately 3 to 6 months of age, in females it varies between 2 and 6 months. At these ages, the minimum threshold body weights have been achieved. The majority of the development of internal organs, muscles and skeletal growth has been attained and so further energetic inputs may be devoted to reproductive efforts. Studies on captive enclosed populations of Reeves' muntjac have demonstrated that 80% of females can conceive before 12 months of age. In its native home, Reeves' muntjac display a all year-round breeding cycle, however, feral populations in Britain have a somewhat modified breeding cycle which is semi-seasonal (late October to early March). This long breeding cycle contrasts to the relatively short cycles (late September to early November) for Sika, Fallow deer and Red deer. On average, adult female Reeves' muntjac, after a gestation period of between 6 and 7 months, will give birth to one offspring (weighing c.1kg) (sometimes two are produced per litter). Two litters can be achieved within any calendar year for each sexually mature female. Approximately four days after birth the female is ready to mate again. The oestrus cycle is relatively short, lasting 14 to 15 days.

Female muntjac may defend food/habitat resources on behalf of their fawns. Females can become very aggressive towards other females, males and young. This coincides with the time when their young emerge from hiding about 4 weeks after birth. The offspring grow rapidly after birth, with weaning occurring around 2

months of age. Total independence occurs when the offspring reach adulthood at about 6 months, when they leave their mother's territories.

In the case with Reeves' muntjac, their small size may place them in direct competition to a suite of other herbivores currently residing within an area - such as hares, rabbits, squirrels, other deer species and goats. Studies between the impacts of Reeves' muntjac on small sympatric mammals in Britain clearly illustrate density-dependent relationships. At high densities, the competition for resources (primarily food) in conjunction with habitat modifications through loss of vegetation cover will cause a decline in small mammalian populations, such as the pygmy shrew, wood mouse etc. In turn, these declines will affect the predators of these small mammals, predators such as the stoat, pine marten, red fox, owls and so on. Where unchecked by natural predators, the Reeves' muntjac as found in Britain, are currently designated as a pest to farmers and foresters, where they feed on vegetation, young trees and on coppice. It is currently the most widespread deer species in Britain, inhabiting a wide variety of habitats from urban settings to forests.

Containment of Reeves' muntjac to low densities in Ireland may be extremely difficult due to a variety of reasons that stem from its own ecology and reproductive cycle. Its small size and highly secretive nature will result in difficulties seeing and safely shooting this species. The lack of biological studies and associated data and information on this species from its native home in south-east Asia is certainly telling – the simple reason is that it is heard more often than seen.

17.2 Sika

Sika were first introduced to Ireland in 1860 by Viscount Lord Powerscourt of Co. Wicklow for ornamental purposes to the Powerscourt Estate (Powerscourt, 1884). Two females and one male were translocated to Co. Kerry in 1864 (Fehily and Shipman, 1967) as well as to other collections in England and Scotland (Whitehead, 1960, 1964; Goodman *et al.,* 1999; Pérez-Espona *et al.,* 2009) and Sika are now fully established in this region (Hayden and Harrington, 2000). Through escapees and deliberate releases Sika became established as feral populations from around early 1900s. The main epicentres for feral Sika were in the northwest, the east and the southwest regions of Ireland.

General Characteristics

- Ireland's smallest, non-native deer species (until the Muntjac arrived); adult males weigh between 50-60 kg, shoulder height 75-80 cm; adult females weigh 30-35 kg and measure 65-70 cm at the shoulder.
- Life span can be up to 18 years of age.
- Males are known as *stags*, females as *hinds*, offspring are *calves*.
- Antlers, borne only by males, are characteristically V-shaped when viewed from the front with short points branching from the main beam. Sika antlers are less complicated than those of red deer. Up to 8 points can be found in a prime adult stag.
- Black-bordered white rump is present year round; tail is medium-long (shorter than Fallow deer) and mainly white.
- Metatarsal glands (located on outside of the hind legs) are white.
- Dark facial markings towards end of snout give appearance of a facial frown; ears are relatively broad and rounded with black lower edge.
- Distinctive black dorsal (back) stripe extends from head through to the tail.
- Summer coats visually identified by a light-reddish brown colour with faint/clearly visible white spots along the flanks of the body, light grey/beige coloured belly and white between the hind legs.
- Winter coats visually identified by dark grey-brown colouration with no visible spots. The belly is greyish colour, with white/light grey colouration between the hind legs.

The earliest records of sikine deer are found in Europe and China, from the late Pliocene (~5 million yrs ago), and after the last Ice Age (10,000 yrs ago) they are distributed widely in north-eastern Asia. Presently, their geographic range extends from south-eastern Siberia, China, Korea, Vietnam, Taiwan and the Japanese archipelago. Sika have been introduced worldwide, including many parts of Continental Europe, Britain, Ireland, New Zealand and America.

Sika are intermediate feeders (grazers-browsers), influenced by season and availability, but yet highly opportunistic feeders. Sika are usually found in areas with open glades and dense thickets, but yet can be found on the open-hill. In Asia, their natural habitat is broadleaved woodland. They feed upon grasses, heather, broadleaf buds and twigs, heather, fruits, fungi and acorns. They can readily adapt to sparse conditions such as those found in conifer plantations, as they have a preference for acid soil habitat. This allows them to flourish in areas of pine, spruce and larch, as well as on heaths and moors. They are active throughout the 24-hour period, but more active during the hours of darkness in populations where they experience frequent disturbance. They generally feed early in the morning and in the evening, lying up to digest food during the day.

Like Fallow and Red deer, Sika are a threat to woodlands due to their feeding habits. They cause high levels of damage through browsing and bark stripping, but also through bole scoring action caused by stags with hard antlers. Factors such as high densities of deer and numbers of mature adult stags will affect the incidence of bole scoring. Damage only occurs when stags have hard antlers, peaking during the months of November and December. Tree species affected include Norway and Sitka spruce (*Picea* species), yew (*Taxus baccata*) and ash (*Fraxinus excelsior*), Douglas fir (*Pseudotsuga menziesii*), Larch (*Larix* sp.) and a wide variety of other broadleaves. Sika also feed on agricultural crops, such as kale, rape, turnip and carrots. They will also eat cereals on the stalk and hide among the crop and thereby cause damage by trampling.

Both sexes are segregated during most of the year and only come together during the rut, which commences in September and has a c. six week duration. During the rut, the stag utters a high-pitched scream, which may sound like a whistle at times whilst others have likened the call to the screech of the 'banshee' (a fairy in Irish folklore). The use of this 'whistle' may be to attract hinds, mark out territories and warn off potential rivals. The mating strategies of mature Sika stags are highly variable. Stags can hold territories and defend rutting stands that are visited by hinds. They will also gather and defend harems of hinds. Sparring (fights) occurs in early September when mature stags (4 to 8 years of age) reach their prime conditions and have

hard antlers. Mature stags defend their territories ruthlessly. Only towards the end of the rut, when the stag is exhausted will younger animals be seen taking advantage to mate with an unguarded hind. Territories are marked by the thrashing of heather and scoring of tree bark by antlers and scent marking from various glands of twigs and other types of vegetation. An oily substance that is produced from scent glands that opens on the face just below the eyes. Wallowing in a scrape or hollow by the stag is also done, here they tend to use their musk glands as well as urinate over themselves, thus creating a distinctive musky 'rutting' smell. During the rutting period the stags have an enlarged shaggy neck (common in most deer species).

Stags fight by locking antlers and attempting to subdue their opponent by wrestling and pushing him backwards. They also engage in parallel walks, like Fallow deer. These aggressive encounters are generally brief but may last up to 30 minutes, with injuries and broken antlers common. The resulting dominant stag ensures exclusive mating with the hinds. Hinds usually conceive for the first time at one and half years of age. However, in areas of rich forage calves may conceive in their first year. If a hind does not conceive at her first mating, she will come back into oestrus at 22-day intervals until pregnancy results. These late pregnancies can produce small calves late in the summer and early winter, but the calf's chances of survival are low due to harsh winter conditions and lack of suitable forage availability to the hind (production of high quality milk).

Hinds give birth to usually a single calf (twins are extremely rare), during the months of May and early June after a gestation period of 7 to 7.5 months. Calf birth weight is typically 2 to 3 kg. Hinds call to their calf with a short sharp whistle, the calf answers with a lamb-like bleat. Calves are born with a white-spotted deep brown-chestnut coat and they develop the black-border around the rump after approximately 2 months of age. The calf will not follow its mother until their third week of life. Calves are weaned between 6 to 8 months of age. The summer coat of the calf changes into its winter coat by the time it is between 3 and 4 months of age. Sika female calves will generally remain in the vicinity of their birth mothers, while young males will disperse at the age of one year.

17.3 Red Deer

Geological History

The origins of Red deer are unclear, but fossil evidence suggests that this species first appeared at the beginning of major glaciations (~1.7 million years ago) in western China. From primitive deer, three distinct branches of Red deer evolved: (a) western China, eastern Tibet and the Himalayan foothills, (b) Europe and Asia Minor and (c) eastern Asiatic. The Red deer are very widespread as a species and first appeared in Europe during the mid-Pleistocene times (~700,000 to 550,000 years ago).

The history of Red deer in Ireland is still debated in terms of native versus introduced. Red deer are present in the fossil record in Ireland from 27,730 ± 389 radio-carbon years before present (yrs b.p.) until 11,790 ± 120 yrs b.p., it is then notably absent until 4,190 ± 65 yrs b.p. (McCormick and Murray, 2007; Woodman, McCarthy and Monaghan, 1997). This absence suggests that it is most likely that the current Irish population, at least occupying much of Co. Kerry is derived from several human-mediated introductions (Woodman, McCarthy and Monaghan, 1997; McCormick, 1999; Hayden, 2002; Searle, 2008). Although preliminary results of an ongoing study suggests that the Red deer in Killarney valley, Co. Kerry are remnants of an ancient population and (all other populations of Red deer in Ireland have been introduced within recent times (c. 1200s and probably later) Carden *et al.,* in prep.),

The earliest recorded written Red deer reference in Ireland is from the 12th Century (*Topographica Hibernica* 1183-1185, G. Cambrensis). The first documented introduction of Red deer to Ireland was recorded in 1246 when an unknown number of deer were translocated from the Royal Forest, Chester, England to the then Royal Forest, Glencree, Co. Wicklow (Whitehead, 1960, 1964). It seems unlikely, unless given natural geographical barriers, that these imported deer did not range beyond Glencree Valley into surrounding counties over time. Between the late 1200s and the 1500s there is very little information with regards to Red deer in Irish early written records (Ryan, 2001), though importation of numbers from England appears to suggest relatively low numbers of Red deer during these times. In the early 1600s and onwards, there are reports of 'loosely scattered' groups of Red deer in the forests of the Earl of Ormond (Munster region) and the Earl of Kildare (Leinster region) and in the counties of Waterford, Wexford, Dublin and Kerry (Ussher, 1882; Scharff, 1918; Praeger, 1950; Whitehead, 1960, 1964; Ryan, 2001; Carden, 2007). Lord Powerscourt imported Red deer from the Island of Islay, Scotland to his estate in Wicklow at some stage in the late 1800s, as well as capturing 'wild Red deer' from outside of his estate (Whitehead, 1960, 1964).

During the 19th Century, Lord Kenmare and Mr. Herbert of Muckross (Kerry), both instigated strict polices in regard to the hunting of Red deer on their estates, where the Red deer could move freely, in the Killarney area, Co. Kerry. This was to ensure their own hunting parties of the return of quality trophy heads. Both Lord Kenmare and Mr. Herbert did introduce other Red deer to their estates in Killarney (Ryan, 2001). During the 1870s, five Red deer stags (adult males) from Co. Roscommon were translocated to Muckross, Killarney (Ryan, 2001). Furthermore, in 1900 Lord Kenmare obtained and released one Red deer stag from Windsor Great Park, England to Derrycunnihy Forest, Killarney. At about the same time, unknown numbers of Muckross Red deer stags were translocated to Scotland in exchange for some Scottish stags (Ryan, 2001). In 1688, 108 Red deer were introduced to Windsor Great Park from Germany and throughout the 19th Century, Red deer stags from Windsor and other English deer parks as well as from Germany and Austria were translocated to Scottish deer forests. There is a paucity of information relating to translocations of female Red deer. Red deer were exported from Ireland to Scotland at various times too: Glenforsa, Isle of Mull (1880-1895), Langass and Sponish (1906) and Ardlussa in 1910 (Whitehead, 1960, 1964). Within Ireland, various landowners strived to re-introduce Red deer from various British forests and deer parks (although exact sources and origins of these deer remain inconclusive) to their estates (Colebrooke, Co. Fermanagh; Baronscourt, Co. Tyrone; Powerscourt, Co. Wicklow) during the 19th Century. World War I and subsequent years of turmoil and unrest has large impacts on the distribution of Red deer in Ireland, with many escapees from deer parks and estates as they went into disrepair e.g. in counties Down, Meath, Tipperary, Sligo and Roscommon. In more recent times, two populations within Ireland are known to have been introduced (c.1990s and 1891, respectively) derived from continental Europe and British stocks (Screebe Estate, Co. Galway) and Britain (Glenveagh National Park, Co. Donegal) (Whitehead, 1960, 1964; Ryan, 2001; Carden, 2007; Carden *et al.,* in prep.).

Obviously with such a mixture of different stocks of Red deer (known) introductions to Ireland since the 13th Century the Irish Red deer populations exhibits a equal mix of genetic heritage and genetic diversities (see McDevitt *et al.,* 2009). McDevitt *et al*. (2009) used two molecular markers in their study, maternally-inherited markers (mitochondrial DNA) and bi-parental (microsatellites) markers. Similar haplotypes (mitochondrial DNA) are shared between Red deer populations of counties Donegal, Mayo, Down, Galway and Wicklow (McDevitt *et al*., 2009), these results are in agreement with the known current distributions of Red deer throughout the island of Ireland (Carden *et al.,* In Review), thus suggesting natural immigration and/or

emigration and subsequent gene flow between populations in different areas. The Red deer occupying Wicklow are the most divergent group according to the mitochondrial DNA, which suggest a unique introduction.

Of particular interest is the Killarney Valley, Co. Kerry Red deer herd which to date is genetically isolated using the two types of molecular markers (i.e. no other haplotype from any other Red deer population currently found in Ireland is present within this population) from other Red deer populations on the island of Ireland (McDevitt *et al.,* 2009). These are in agreement with the known distribution of Red deer on the island (Carden *et al*., In Review). The results from McDevitt *et al.*'s study clearly indicate a very low level of genetic diversity within the Killarney Valley population. Historical records pertaining to the Killarney population indicate bottleneck or population crash around 1860 (post Famine) and prior to or around 1970 (Ryan, 2001), which was prior to the Irish Wildlife Act 1976, where Red deer were protected by law in terms of hunting only within a defined hunting season. Furthermore, 18th Century records suggest that Red deer numbers continued to remain low even after the last wolf (*Canis lupus*) was shot in Co. Kerry in 1720 (Ryan, 2001). There are no reports of Red deer numbers increasing after the only natural mammalian predator was eliminated from the island. These factors, coupled with the population's isolation from the rest of Ireland, may have caused levels of genetic diversity to remain low (McDevitt *et al*., 2009). If the Killarney Red deer herd is a remnant herd of ancient stock subsequent conservation and preservation measures will have to be undertaken and perhaps changes in current deer culling policies as well as its designation in the new Red list (Marnell *et al.,* 2009). Further phylogeography investigations are underway at present on this population's history and the origins of all Irish Red deer stocks (Carden *et al*., in prep.).

General Characteristics

- The Red deer is Ireland's largest land mammal, and was depicted on old Irish £1 coin. Mature males weigh up to 220 kg, shoulder height ~1.5 m; adult females weigh ~140 kg and measure ~1 m at the shoulder. The body weights depend on habitat quality.
- Life span can be up to ~15 years of age.
- Males are known as *stags*, females as *hinds*, offspring are *calves*.
- Antlers, borne only by males, are characteristically U-shaped when viewed from the front. Antlers have many branches of multi-points, and are more complicated than those found in Sika stags.
- The tail is very short and broad (shorter than Fallow and Sika deer), with a dark stripe that extends upward along the spine.
- The rump patch and metatarsal glands (found on outside of the lower hind leg) are cream in colour. The rump patch extends higher over the rump than in most other deer.
- Summer coat is a deep reddish-brown colour with white/pale spots occurring along the spine, the belly is cream-greyish colour as is the inner thighs and rump.
- Winter coat is dark brown-grey colour with light patches on the undersides and rump.
- The rump or caudal patch extends higher over the rump than in most other deer and is a cream colour.
- The metatarsal glands, on outside of lower portion of hind legs is a cream colour.

Red deer are associated with open woodland and woodland edge. However, with increasing habitat changes and disturbance, they can now be mainly found on open upland mountainous areas and moorlands. Red deer are primarily grazers, but are opportunistic feeders when other food sources if available are taken advantage of. They eat grasses; oak, ivy and holly leaves, acorns, woody shoots and other fruit. They will also feed on heather; dwarf shrubs and rough grasses such as *Molinia* species found growing on the upland hills, and additionally browse on coniferous foliage. Heather plays an important food source to uphill animals during the winter months, especially if there is snow-covered ground. If the weather is harsh enough then the deer may be forced from the uplands to migrate to nearby farmland to feed upon farm crops and stored fodder, this occurs generally at night. They generally feed early in the morning and late evening and are active throughout the 24-hour period.

Red deer are a threat to both native and non native woodlands. They may cause damage in woodland by uprooting newly planted trees, browsing leader and side shoots of young trees, such as willow (*Salix* species), oak (*Quercus* species), Scots pine (*Pinus sylvestris*) and rowan (*Sorbus aucuparia*). Red deer will also strip bark from the trunk and branches of older trees, such as willow, Norway spruce (*Picea abies*), Scots pine and ash (*Fraxinus* species). The size, age and species composition of the woodland can greatly influence the browsing habits of Red deer. Browsed material from conifers (a small proportion of the diet) is important during spring and early summer, coinciding with fresh growth. Red deer strip the tree bark in the summer when the sap is rising and the bark is easy to peel, and also during winter months in response to food shortage. They will readily feed on agricultural crops, especially when in close proximity to woodland.

Red deer antlers are borne only by the stags and as stags age, the complexity in terms of number of points increases. Red deer antlers are more complex in form than those found in Sika stags. The antlers, when viewed from the front of a Red stag, have a characteristically U-shaped outline. Antlers are cast between mid-March and April and are re-grown every year. Antler growth is completed when velvet is shed in the month of August, revealing the hard antler. The breeding season or the rut begins in October, lasting up to 6 weeks. A special type of skin called 'velvet' protects the growing antler. Antler is made of bone, unlike horns of sheep, goats, cattle that consist of keratin. The velvet acts as a conduit for major blood vessels, through which nutrients are transported to the growing tissue, which occurs at the tip. After full growth is completed, late August, the blood supply is terminated. This is followed by mineralization and modified ossification (bone forming). The velvet is shed, due to increased levels of the male hormone, testosterone, to reveal clean, hard, dead antler.

These antlers are used in fights during the rut. Younger stags are generally displaced by the approach of a mature stag. If not then both will engage in a parallel walk and mutual roaring, followed by a locking of antlers. Red deer fight characteristically by pushing and shoving the opponent by the antlers, until one is pushed backwards, at which point the winner will chase off the loser. Stags will also fray trees and other vegetation during the rut and scent mark trees using an oily substance that is exuded from special glands that open below the eyes. Additionally, stags spray urine on their undersides and wallow in muddy, urine-soaked hollows. A characteristic musky smell hangs in the air around such places, akin to that of a Billy goat (*Capra hircus*).

Apart from the rut, the two sexes are segregated throughout the year. Males congregate together to form bachelor groups; these vary in the number of individuals present. They begin to become intolerant of each other from about August onwards. This is due to the now increasing levels of the male hormone testosterone which stimulates the increase in neck size (mane) and testicle size, as well as the shedding of the velvet covering from new antlers. The general thickness of the mane depends on the condition and age of the stag. The photoperiod or the changing lengths of light and darkness determine the level of testosterone. The hinds begin to congregate in their traditional rutting areas. Sexually mature stags (5-11yrs) take 'possession' of hind harems, which they will defend from other stags and herd in any hinds than wander near. Up to 20% of a mature stag's body weight may be lost during this rutting period, as they tend not to consume much at this time. The rut peaks in mid-October, where fights can escalate, resulting in serious injury and possible death. Many stags can be sufficiently weakened from the rut, especially older animals, and followed by a harsh winter they may not survive to the next spring.

Single calves (twins are rare) are born during the period of late May until early-mid June, after a gestation period of about 7.5 to 8 months. Newborn calves weigh between 6 and 9 kg. They are born with a spotty coat, which remains with them up until the age of about 2 months. This dappled coat camouflages the calf until its mother returns to suckle it. Calves will begin to follow their mother after their second week of life. Suckling occurs on average every 2 to 3 hours during the first few days, after which the time lapse is greater between feeds. The mother will return to the area where she left her calf, and call to it with a short bark to locate it. Apart from the rutting and calving calls, both sexes are generally silent throughout the rest of the year, only emitting an alarm call. Calves are generally weaned at the ages of 5 to 8 months. They gain weight rapidly after birth, increasing to about 30kg by November; thereafter the weight gain slows considerably. The offspring will stay with the birth hind until at least 2 years of age, when the male offspring will leave for the bachelor groups. The social structure of the hinds is quite close. A hind may have her calf and also the previous year's calf and yearling stag which form a 'family group'. An age-related hierarchy exists in both the hind and stag groups.

The life span of a wild Red deer may be about 15 years, but the highest mortality period is in their first year, with over 80% of deaths occurring within the first week of birth. Hinds generally start to breed in their third year of life, up to approximately 13 years. However, they do not necessarily conceive each year, due to poor forage availability and body condition. Stags usually begin to mate from the age of 5 years to 11 years of age. The intake of suitable nutritious forage and thus the ability of the animal's teeth to grind down such material determine death by old age. Hence once all surfaces of the teeth are worn down, the animal's condition and body weight decreases, until it is so weakened that death follows soon after.

17.4 Hybrids (Red X Sika)

Red deer and Sika are known to be capable of interbreeding, producing fertile hybrids (Harrington 1982; Goodman *et al*. 1999) and this is known to have occurred in Ireland from observations of hybrid phenotypes in the Wicklow region as early as 1884 (Powerscourt, 1884; Harrington, 1973, 1979, 1982), in Britain (Putman and Hunt, 1994; Abernethy 1994; Goodman et al., 1999; Díaz *et al*., 2006; Pemberton et al., 2006; Senn and Pemberton 2009), in the Czech Republic (Bartoš *et al*., 1981; Bartoš and Žirovnický, 1981; Zima *et al*., 1990) and in Continental Europe (Wotchikowsky, 2009; Bartoš, 2009). It was believed that several thousand hybrids exist in the east of Ireland (Harrington, 1982; Pérez-Espona *et al*., 2009). However, a recent preliminary study by McDevitt *et al.* (2009) suggests relatively low incidences of hybrid deer in this region. It is currently unknown whether hybridisation has occurred in Co. Kerry and in the north of the country where the two species' ranges overlap (Carden *et al*., In Review). Further research is underway at present (Carden and McDevitt, pers. comm.) investigating the occurrence of hybrids in other areas of the island where the species' ranges are sympatric.

Phenotypically, it is difficult to identify hybrid deer based solely on their respective external appearances (pelage characteristics). Body proportions (head, neck, body ratios) vary considerably depending on the dominant phenotype displayed and assignation of such characteristics can by highly subjective to the observer. This may be further confused by successive generations of hybrid deer that may favour assignation towards either Red deer or Sika based on either head or body exhibited characteristics that are similar to the pure form (Senn and Pemberton, 2009; McDevitt *et al*., 2009; RF Carden own data). The direction of breeding deer species to produce fertile hybrids involves a male Red deer and a female Sika (Harrington, 1982) and a male Sika and a female Red deer (McDevitt *et al.,* 2009). In the Wicklow region in McDevitt *et al.*'s (2009) recent study, 4 Sika were identified as hybrids from a sample of 33 from across the geographic region. The remaining 29 Sika appear to be 'pure' Sika. Furthermore, a recent molecular study (McDevitt, Barry and Carden, in prep.) on a further additional sample of 55 Sika from the Leinster region identified only one interspecific hybrid deer, while the remaining 54 were identified as 'pure' Sika. This may possibly be due to the direction of hybridisation being determined by colonising (or 'pioneering') Sika males (Pérez-Espona *et al*., 2009a; Senn and Pemberton, 2009). Hybridisation in wild, free-ranging Red deer and Sika still appears to be a rare event that is not understood at present (Pérez-Espona *et al*., 2009; R. Putman, pers. comm.). It is important to understand the underlying mechanisms as to why hybridisation occurs between Red deer and Sika and what preventative measures can be taken. Given the short period of time that Sika and Red deer have been in contact in Ireland (~150 years), hybridisation is still relatively rare and is not as widespread in areas as was previously thought (McDevitt *et al*., 2009; McDevitt, Barry and Carden, in prep.). However, it seems inevitable that sympatric populations will become hybridised over time (Pérez-Espona *et al*., 2009; Senn and Pemberton, 2009) and expanding Sika populations represent a very real threat to the genetic integrity of 'pure' Red deer populations that are genetically unique and isolated, such as the Killarney Red deer herd. Selective shooting of obvious phenotypically hybrid individuals as well as selective culling of pioneering Sika stags entering Red deer areas should be encouraged (Pérez-Espona *et al*., 2009) if such genetically integral or pure populations are to be maintained.

17.5 Fallow deer

The exact origin of the genus *Dama* is obscure due to little fossil evidence. There are two distinct subspecies of Fallow deer: the European Fallow and the Persian Fallow (*Dama dama mesopotamica*). In the past, approximately 10,000 years ago, the European form was confined to modern day Asian portion of Turkey. The Persian form was confined to areas of the east coast of the Mediterranean and is presently restricted to small areas within Iraq and Iran. This subspecies is world endangered and is threaten with extinction.

The archaeological record indicates that Fallow deer were utilised and held captive by Lower Neolithic humans as early as other domesticated animals such as goats, sheep and pigs (10,000 – 7,500 years ago). It is believed that early seafarers brought the deer from Turkey to the Islands of Crete and Cyprus, whereby they spread across Europe with Neolithic humans and the Romans (~800 B.C.).

The European Fallow is the most common species within deer parks around the world, as they have several coat colour varieties and males have the distinctive palmate antler form making them extremely pleasing to the eye.

Fallow deer were, presumably, introduced to Ireland by the Anglo-Normans during the medieval period (late 1100s / during 1200s) (Woodman, McCarthy and Monaghan, 1997; McCormick, 1998). Archaeological Fallow deer remains have only been found to date during excavations of Anglo-Norman castle sites and urban sites located in the eastern and southern areas of Ireland (Beglane, *in press*). To date no Fallow deer archaeological remains have been associated with Gaelic sites (pre 13th Century) (Beglane, *in press*).

General Characteristics

- Medium-small sized deer: adult male body weight 80-110 kg, shoulder height 100 cm; adult female body weight 40-55 kg, shoulder height 80-85 cm.
- Life span can be up to 18 years.
- Males known as *bucks*, females as *does*, offspring are *fawns*.
- Bucks have distinctive palmate antlers, prominent Adam's apple in throat and a penile sheath or brush.
- Fallow deer have the longest tail of any of the three Irish species.
- Several coat colour varieties exist, all have faint/distinct white spotting: black, brown-chestnut, menil (brown-ginger coloured body with brown tail stripe), common (brown-ginger coloured body with black tail stripe) and white. Summer coat colours are vibrant, whereas winter coat colours are a darker, duller, less than striking colour.
- Rump or caudal patch is a white colour.

Fallow deer prefer deciduous and mixed woodland habitats with good understorey as well as open pasture. They are grazers or non-selective bulk feeders, although they will browse on trees and shrubs. They will also supplement their diet with acorns, fruits, nuts, bramble and fungi when available. They feed mainly early in the morning and in the evening and they lie up during the day to ruminate ('chew the cud') and digest food, thus they can be elusive during the day. They can become quite habituated to humans and disturbance, e.g. the enclosed herd in Phoenix Park, Dublin. However, this deer species tends to be of a nervous disposition especially if the population is subjected to culling.

Fallow deer pose a threat to woodlands due to their feeding habits. During the winter months they tend to prefer conifer plantations, whereas during the summer they prefer broadleaves. Fallow will also utilise pasture and agricultural crops when such sites are in close proximity to woodland. Like all male deer, they will fray and thrash trees during the time when the antler velvet is shed (August / early September); young saplings tend to be favoured for such activities, during the months between August and November. Fallow deer can reach high local densities over a short period of time and thus inflict extreme levels of damage.

The antler form found in Fallow deer is unlike that found in Red and Sika deer. The large flat palmate antler is fringed with points known as spellers, which can be numerous. Antlers are borne only by the bucks, they are grown annually and the area of the palm becomes more triangular and the number of spellers increases with age. However, the antler size is not related to age. Older bucks antlers can be quite poorly developed ('gone back'), or indeed any injury to the growing antler or disease in the buck will impair normal antler growth. Antlers are shed in late spring (March – April); growth on the next set commences immediately. Growth is complete when the velvet is shed revealing clean, hard antler. Antlers are a unique biological phenomenon and it is the only organ to be fully regenerated annually by any mammal. The antlers are used during the breeding season, known as the rut that occurs during October – early November. They are used as combat weapons and display organs.

Both sexes are segregated during most of the year and only come together during the rut. Mature (6-9 years) Fallow bucks have a variety of mating strategies, from holding a rutting stand to herding does into harems. Fighting occurs during the rut usually between equal sized bucks, which mainly consist of shoving, twisting of locked antlers and parallel walks with the loser being run off. Due to a number of factors, including hormonal influence, bucks tend not to eat much during the rut, resulting in a loss of up to 25% of their body weight, where an 110kg buck in late September weighs about 80kg by mid November. The loss of body weight is mainly due to the depletion of fat stores rather than actual muscle loss. In older bucks, after a successful rut (in terms of matings attained and fights won), energy reserves can be quite low. If a harsh winter ensues, survival can be quite low especially during the months of January and February where available forage is scarce and weather is very harsh.

The bucks are vocal during the rut, emitting a characteristic 'groan'; it has been likened to a deep extended belch. The bucks only develop this groan during the rut, where they call every couple of seconds for a period of time. The meaning or significance of this call is still unknown, but a variety of theories have been suggested such as defence of territory, attraction of does and a signal to other potential rivals in the area. Bucks will also scrape out hollows or depressions in the ground and mark twigs and other vegetation with an oily scent. This is produced from special glands ('preoribital glands') that open on face near to the eye. After a gestation period of 7.5 to 8 months, single fawns are born (3-5 kg weight) between the months of June and July (later than Red deer and Sika calving periods). They are born with a dappled coat that helps camouflages them in the undergrowth, where there they will stay for the first week or so of life, with the mother coming back to feed it every few hours. Male fawns start to develop their antler pedicles (special frontal bones on the skull that bear the antlers) by the age of 6-7 months old. By about 9 months old they are clearly visible. Fawns are weaned by 7-9 months of age.

When disturbed and frightened, Fallow deer move away from the source of disturbance in a very characteristic manner known as 'pronking', where all legs are held stiffly at an angle and brought together and leave the ground simultaneously as the animal bounds away as if on springs. This mannerism is also shared with Sika and white-tailed deer in North America and termed 'stotting'.

18. Appendix II. Current Trends and Distributions of Deer in Ireland

Over a 30-year period from 1978 to 2008, total ranges of Red deer, Fallow deer and Sika on the island of Ireland (based on occupation in every 10km square) expanded considerably: Red deer expanded their total range by 564.5% or 6.5% p.a., followed by Sika (353.5%; 5.2% p.a.) and then Fallow deer (173.5%; 3.4% p.a.). Red deer expanded their annual range at the greatest rate (6.5%), followed by Sika (5.2%) and Fallow deer (3.4%) (Carden *et al.,* In Review). Ward (2005) calculated annual rates of range expansion for deer in Britain, also over a 30-year period, between 1972 and 2002 (0.3% for Red deer, 5.3% for Sika and 1.8% for Fallow deer). The expansion rates of total ranges over a similar period of time for Sika are remarkably similar between these two islands, whereas the rates of expansion for Red deer and Fallow deer are lower in Britain and may be due to near saturation of these species in Britain per unit of land (10km square). It is thought that Fallow deer may expand their distribution very slowly from the original release/escape area (Carden *et al.,* In Review). This slow expansion rate for Fallow deer also has been noted in other studies (R. Putman, pers. comm.; Liberg *et al.,* 2009).

As observed in the 1960s onwards in Britain (De Nahlik, 1992) and may be similar here in Ireland, programmes of afforestation undertaken by private individuals, companies, local and central government attracted and facilitated migration and expansion of deer into surrounding counties. The need for timber production drove these policies and thus forestry expanded considerably within a short few decades. These areas are difficult to maintain effective culling targets / quotas in and deer can cause large economic damage to trees in these areas by bole scoring, browsing and bark stripping. These plantations offer deer cover/shelter and forage and thus a safe habitat to live in.

Wildlife friendly landscaping of new forests were recommend in Britain, these features included wide firebreaks, rides and roads. These features provided areas where deer would use for foraging and thus could be observable to visitors/tourists and more importantly these areas could be used for control culling from a deer management point of view (De Nahlik 1992).

There are no accurate census figures available of the numbers for any of the wild deer species that occur in Ireland. Nor are there ongoing monitoring programmes pertaining to the fecundity or birth rate of these. There are little, if any, natural mortality records (e.g. associated with over-wintering) of deer recorded. There are few reported personal observations recorded by recreational deer hunters. Estimated age from tooth eruption patterns of shot animals (including sex and species) is not recorded. All of these records, if kept, would feed into a deer management plan in localised areas. For example, in general terms, Sika and Fallow deer give birth to a single offspring. Twinned foetuses have been found in Sika and Fallow deer in certain localised areas of County Wicklow (O'Brien *et al*., 2007; K. O'Reilly, pers. comm., 2008, 2009 & 2010). It is not know how frequently this occurs or if twins survive and reach full term, nor if this occurrence is related to age of the female. On occasion Sika in other populations (e.g. North America) produce twins (Feldhamer and Marcus, 1994). The twin neonates when born are generally smaller than one single normal sized neonate, subsequent body condition and or survival of twin neonates is unknown. The reasons for twin conception occurrences remain unknown but may be linked to milder climates, excellent body condition, genetic heritage, moderate populations sizes (in localised areas). Obviously, if this trend continues, deer numbers will increase though at a faster rate due to successful twinning and rearing of same.

The numbers and locations of privately owned estates, where deer are managed for commercial shoots and trophy antler heads, and deer farms in Ireland remain unknown at present. Neither the Department of Agriculture nor the NPWS can provide this information. Importation licences from outside Irish borders as well as within the country require monitoring. Quarantine procedures should be operational at all points of entry where vehicle inspections and licences should be required, and all animals should be tested for diseases and general health by suitably qualified veterinary personnel.

Further importation of deer species to deer farms or enclosed captive sites should be strictly subject to holding of all suitable licences and following strict quarantine protocols (screened for all diseases and parasites). All farmed and imported animals should be ear-tagged with unique identifiably codes and numbers per owner, estate and year and continually monitored and records kept for inspection. Follow-up monitoring programmes of these animals should be implemented to safe guard against deliberate releases of deer into the wild, or selling on to stock forests (privately owned or otherwise).

19. Appendix III. Descriptions of deer damage

Wild mammals and domestic stock will usually damage trees in two main ways:

(i) browsing, and
(ii) bark stripping.

An obvious indicator within any woodland to the presence of deer is the apparent 'browse line' where the foliage and side shoots will be cropped as high as the deer can reach (Rooney and Hayden, 2002).

Plate 1. Browse line clearly evident in Killarney National Park.

Other indicators involve the presence of deer droppings (faecal pellet groups), cast antlers, deer tracks or slots and used deer trackways (routes that are routinely (or not) used by deer through an area), wallowing holes/pits (mainly used by males during the rut for scent marking and territorial displays). Recent activities and fresh signs indicate an active deer population within an area. If fencing is present, inspection of the fence line may reveal the presence of deer hair trapped in wires (jumping over) or tracks along the edge of the fence. Deer tend to prefer to 'tunnel' under wire fences and the bottom line of wire / mesh should be checked, especially if hollows/dips in land are obvious. Fencing is costly and the type used can be very expensive given large areas of woodlands or crops that require protection from deer. It may not be economically viable to fence large areas as regular fence maintenance and monitoring must be employed.

Grazing and browsing indicators within coniferous and broadleaf woodlands range from light, moderate and heavy damage depending on population densities of deer, the use of this habitat by deer species and the availability of other types of forage. Additional factors such as the size of the plantation or woodland, the tree species present and amount of available cover will also influence the degree of damage to tree species by deer (Moore *et al*., 1999; Rooney and Hayden, 2002). Seasonal changes in weather (presence/absence of snow, hard frost, drought etc) will affect the feeding habits and behaviour of deer as well as localised deer densities.

Browsing – selective feeding on the buds, shoots and foliage of trees, shrubs and herbs. All deer species browse at all times during the year, especially during the spring growth period when buds and growing tips are tender (Rooney and Hayden, 2002) and when ground flora is dormant or absence (De Nahlik, 1992). Browsing may stunt or prevent normal tree growth and development rather than causing direct tree mortality (Putman and Moore, 1998), the former rendering commercial species unviable. Browsing of side shoots is

less damaging to browsing of the main leader, which may result in multi-leader shoots thus preventing normal tree growth (Rooney and Hayden, 2002). Not all tree species are equally vulnerable to browsing by deer. In mixed forests, some species will be targeted by deer while others remain untouched or browsed to a lesser degree (De Nahlik 1992).

Plate 2. Extensive browsing & breakage to young Spanish chestnut (*Castanea sativa*).

Bark stripping can be caused by Red deer, Fallow deer, Sika and hybrid deer (Red X Sika). This type of damage usually occurs during the winter and spring months. Deer gnaw or shave using their mandibular incisor teeth to pull the bark upwards, taking strips of bark from the trunk. Sika and Fallow deer can strip bark from a tree up to 1m height, Red deer bark strip to 1.7m high (Rooney and Hayden, 2002). The exact reasons for this behaviour remain unknown, though there are several hypotheses given including bark stripping may result from frustration or stress by deer, brought on by hunger, lack of certain minerals in the diet that is found in the tree sap and so on (De Nahlik, 1992).

Plate 3. Bark stripping.

Fraying and Thrashing. All deer species will fray and thrash branches and foliage that may result in removal of bark in some areas during autumn and early winter (removal of velvet from hard antler; territorial displays; scent marking). Predominantly this damage occurs on saplings of various species. All deer species will also browse leader shoots, side shoots and foliage of various tree species of different ages. This type of damage tends to occur from later winter to early summer, though it can also occur throughout the year. Economic damage results from trees developing multi-leader shoots rather than a single leader as well as damage to overall growth and development of the tree. Red deer, Fallow deer and Sika can bark strip the main trunk and low level branches up to a height of 1.8m for Red deer and 1.2m for Sika and Fallow deer, this can occur all year around on various tree species of different ages. Fallow deer can uproot newly planted coniferous and broadleaf saplings.

Sika will bole score (lacerate trunk with vertical and diagonal grooves) tree species such as mature Norway and Sitka spruce, yew and ash during the Autumn (rut). They do this with their hard antlers to mark territories and scent mark (summarised from Table 1.1, Rooney and Hayden, 2002).

Plate 4. Light bark browsing and breakage of branches by deer in ash plantation.

Fraying/thrashing is not related to forage intake by deer. Young immature trees with rough bark are preferentially used by the males of all deer species to assist in the removal of velvet from fully grown antlers during the months of August and September. Additionally, males will scent mark trees during the pre-rut and rut in the months of September and October. Foliage and branches are broken / damaged and younger trees tend to suffer more severe damage than older trees. The amount and type of tree chosen by the male deer depends on its age, older animals have thicker, larger antlers and thus will choose thicker, younger trees for fraying. If fraying encircles the trunk the tree will die.

Bole scoring – Male Sika and male Sika-Red hybrid deer will primarily lacerate tree trunks vertically and diagonally with their antlers as a territorial display (Carter, 1984). Species of tree will determine the extent of damage, male Sika tend to prefer smooth or thin-barked tree species rather than rough/thick barked varieties (Rooney and Hayden, 2002).

20. Appendix IV: Impact of Deer on Native Woodlands – Results from the National Survey of Native Woodland

The native woodlands of Ireland have recently been the subject of a five year national survey funded by the NPWS (Department of the Environment, Heritage & Local Government) and the Forest Service (Department of Agriculture, Fisheries & Food) and completed by Botanical Environmental & Conservation Consultants Ltd. (BEC).

This survey included the survey of 1,217 woodland sites across all 26 counties of the Republic of Ireland during 2003-2007. Surveys comprised the recording of site species lists and information at the site level on topography, management, grazing, natural regeneration, geographical situation, adjacent habitat types, invasive species, dead wood and boundaries.

20.1 Native Woodland Cover

The National Survey of Native Woodland (NSNW) provided estimates of national native woodland cover (Source Perrin *et al.*, 2008).

There have been two recent estimates of the national extent of native woodland cover. The Forest Inventory Planning System 1998 (FIPS) is a GIS-based inventory of forest cover in Ireland and was used extensively by the NSNW for site selection. FIPS was produced from aerial photographs and satellite imagery. According to FIPS, Ireland in 1995 had 571,234 ha of forested land with 82,321 ha of mixed woodland and broadleaf woodland not dominated by beech, representing 1.2% of the State (**Fig. 1.1**).

The National Forest Inventory (NFI) extrapolated its estimates from a systematic field sampling of the whole country between 2004 and 2006 and estimated that 625,750 ha of Ireland is forested land. Of this forested area, 21.3% or 132,990 ha comprise native woodland, representing 1.9% of the State. Of these areas of native woodland 38% of non-native forested land is in public ownership, whereas 60% of native woodlands are owned by private landowners according to the NFI'.

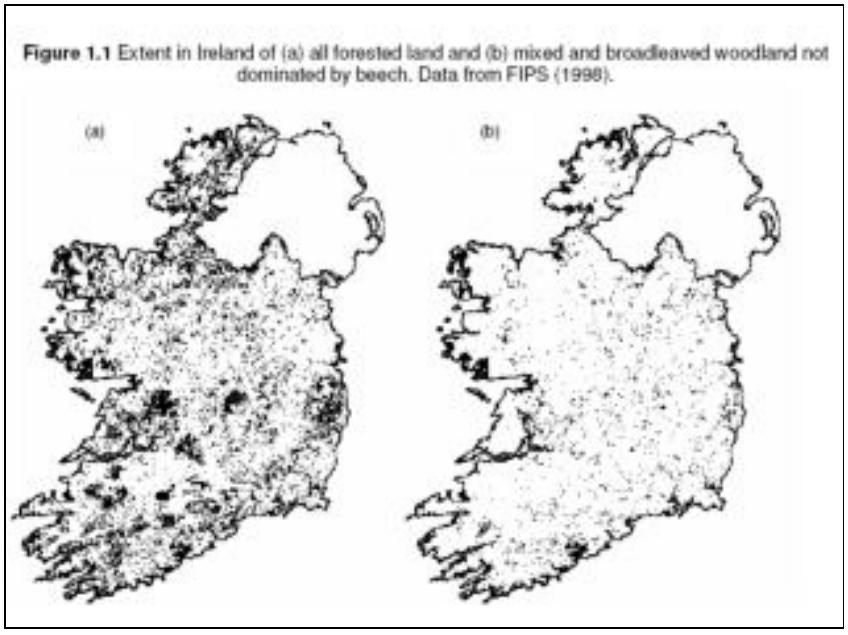


Figure 1.1 Extent in Ireland of (a) all forested land and (b) mixed and broadleaved woodland not dominated by beech. Data from FIPS (1998).

The threat to Irish native woodlands from deer is also noted in this report.

20.2 Threats to Irish woodlands

The National Survey of Native Woodland recognized the threats of grazing pressure to national native woodland cover (Source Perrin *et al.,* 2008).

The main contemporary internal, or ecological, threats are from inappropriate grazing and from invasive alien species, although in the past under planting with conifer species was a widespread practice which no longer occurs.

Field Methods Used: (Source: Perrin *et al*., 2008)
During the field surveys both grazing and natural regeneration were recorded within each woodland using the methodologies detailed below:

Grazing regime:
The general grazing level at each site was assessed using the criteria listed in **Table 2.1**, which is modified from Mitchell & Kirby (1990). In addition, the types of grazer(s) present were deduced where possible from available evidence, such as animal tracks and droppings.

Table 2.1 Definition of grazing levels.

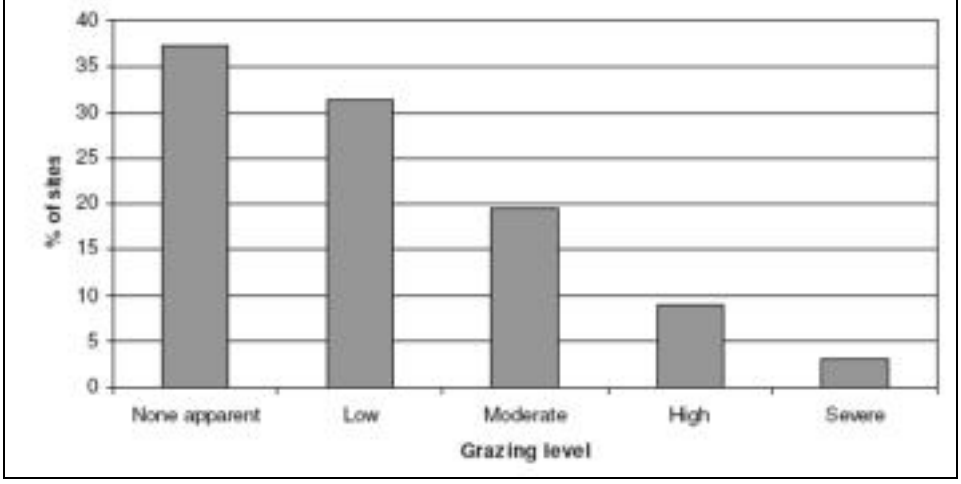
Evidence of grazing	Score
No grazing apparent.	0
Low: Regeneration abundant, shrub layer dense, no obvious browse line.	1
Moderate: Saplings localised, shrub layer patchy, field layer >30 cm in general.	2
High: Shrub layer severely checked/lacking, ground vegetation generally <20 cm, tree regeneration rare/confined to safe sites, some bare soil/poaching visible.	3
Severe: Shrub layer and regeneration almost completely absent. Definite browse line apparent, extensive bare soil present, ground flora confined to well bitten herbs grasses and bryophytes. Bark stripping at least occasional.	4

Natural regeneration:
The principal canopy and sub-canopy species were scored for regeneration during the general site survey. DAFOR was used to score each of the following classes:
- seedling (sd) _25 cm tall, <7 cm dbh;
- sapling (sp) 25.1 cm to 200 cm tall, <7 cm dbh;
- pole (p) >200 cm tall and dbh <7 cm;
- mature (m) dbh >7 cm.

20.3 Grazing Impacts on Native Woodlands
Grazing pressure in woodlands comes from domestic stock, chiefly cattle and sheep, feral populations of goats and wild deer. As deer lack any natural predators in Ireland, management of populations, typically through fencing or culling, is a major management issue. The National Survey of Native Woodland (Perrin *et al*., 2008) recorded data on grazing levels were recorded for the 1,217 sites in the main survey. Grazing is a natural feature of woodland ecosystems. Heavy grazing pressure can reduce and skew field layer diversity toward less palatable species and inhibit regeneration of tree species through damage or removal of seedlings and saplings, eventually affecting stand structure and species composition. Conversely, a complete lack of grazing can also be undesirable as strong competitors, such as *Rubus fruticosus*, can dominate the field layer, again adversely affecting diversity and species composition. Sustainable grazing levels need to be identified and applied.

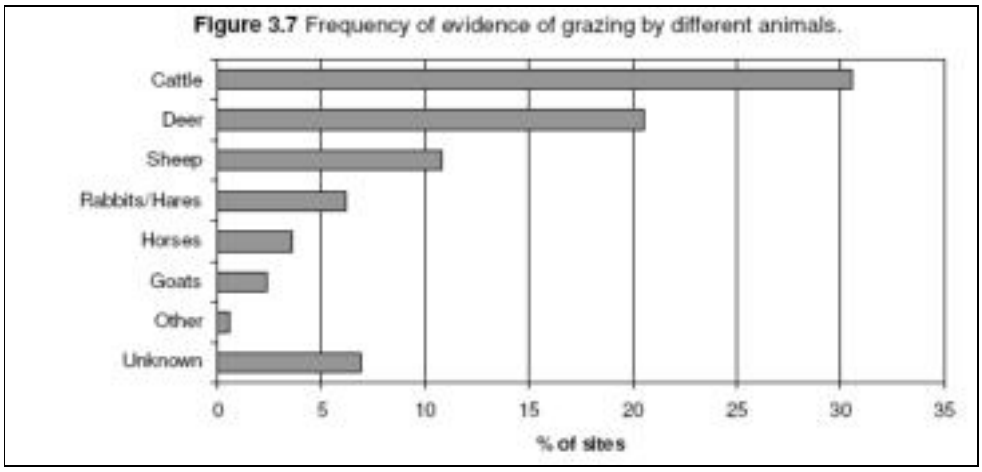
Overall, heavy grazing was not a feature of the woods surveyed. High and severe grazing levels were infrequently encountered, occurring at only 9.0% and 3.0% of sites respectively (**Fig. 3.6**), while at 37.1% of sites no grazing was apparent. These woods may have been ungrazed because they were enclosed by walls, ditches or fences, on particularly wet and boggy ground, or in arable or urban landscapes.

Figure 3.6 Frequency of different grazing levels.



Cattle (30.6% of sites) and deer (20.5%) were the most frequently identified grazers (**Fig. 3.7**). Cattle, unsurprisingly, tended to be recorded at more lowland sites (median maximum altitude 80m; median slope 7º), while deer overall tended to favour higher altitudes and steeper slopes compared to cattle (median maximum altitude 100m; median slope 10º). This is reflected in the county distribution of the two types of grazing: Wicklow had by far the highest percentage of sites grazed by deer, at over 59.1%, followed by Kerry at 43.5%. Both of these counties are mountainous and have well-established deer populations. By contrast, less than 10% of sites in Cavan, Sligo, Wexford, Leitrim and Westmeath were grazed by deer. Cattle grazing, however, occurred at only 20.5% of Wicklow sites and was highest in Clare (54.7%). Sheep, rabbits, horses, goats, and hares were recorded much less frequently than either deer or cattle. At a number of the sites, although grazing was apparent the animals responsible could not be identified.

Figure 3.7 Frequency of evidence of grazing by different animals.



The results of this survey seems surprising as experience has shown that many broadleaved plantation and native woodlands are heavily grazed by deer. This opinion was also expressed by a number of other practitioners consulted during the course of this study. It should be noted that the above figures are derived from a sub-sample of the entire native woodland estate and may not reflect actual grazing pressure nationally. Also, the survey did not look at new woodlands or plantations less than 10 years old. It also extended over a 7 year period in total, during which deer populations were expanding rapidly.

21. Appendix V. Deer Management

The balance between wild deer populations within certain habitats such as woodland (natural or planted) must be maintained in such a fashion that deer related damage to both economic and biodiversity functions is limited. Crop damage by deer can be species-specific, as well as daily and seasonally effected. Overall deer densities may contribute and be correlated to amount of damage sustained. However, this is not always the case as there are vegetative-related limiting factors that must be accounted for within such studies.

Effective management of deer populations requires knowledge of population sizes, correct identification of species present seasonally and distribution patterns such as geographical ranges throughout the calendar year. Ongoing monitoring programs of deer populations, with habitat-specific data, can provide data from direct fieldwork and from the culled deer on the reproductive rate, condition, age and sex ratios and mortality factors. This allows the assessment of groups within certain areas. Such programmes can provide recommended area-specific hunting sustainable management practices, on a long-term basis.

Hannan's study (1986) on mammal damage in Irish woodlands found that browsing was the predominant form of deer damage recorded. Hannan (1986) found that deer preferentially favoured newly planted areas that were adjacent to open land and these areas had plenty of cover available for deer to use. Additional findings of Hannan's study (1986) found that edge-habitats (or ecotones), areas that bordered woodland, open uplands and farmland, were preferential feeding areas for deer species. Young plantations suffered higher proportions of tree damage by deer (31 – 51%), whereas the thicket stage (just before thinning of trees) was less affected (Hannan 1986).

Current Management Methods

In the United States, harvest or culling efficiency of deer is primarily dependent upon the density and distribution of deer stalkers, landscape features (eg habitats, spread of trees within forests/woodlands), rural development, types of plantations (leased or privately owned), which in turn all effect the seasonal and daily activities and behaviour of deer and their distributions (Harden, Woolf and Roseberry, 2005). Increases in numbers and densities of white-tailed deer populations throughout America has led to direct conflicts with humans in terms of agricultural / other damages that cost an estimated $1.35 billion annually (Harden, Woolf and Roseberry, 2005).

In a review of the deer management policies and practices in 30 different European countries Putman (2009, 2010) found a high diversity in management objectives, priorities and management practices. Additionally, Putman found a high diversity in the level of State regulation when related to deer management. These numerous differences were primarily associated with the different deer species present within any country and the different species-mixtures. The management objectives differed markedly in terms of the control of deer numbers and importation of deer, managing deer for exploitation (commercially farmed / managed for venison and sport shooting) and managing deer in relation to active conservation. Underpinning all of these objectives, the management systems in the different countries largely reflect the legal status of same and the cultural approaches and different attitudes towards hunting of deer.

Management of damaging interactions between humans and deer is an important aspect of deer management programs. Deer culling by competent deer stalkers is recognised as the most effective tool to reduce such damaging interactions and control deer populations, especially given the lack of natural mammalian predators (e.g. wolf) in Ireland. If deer can move freely between contiguous refuges of cover/areas without observation or if this is not controlled by deer managers then inadequate culling and failure to meet set quotas will result and may lead to localised overpopulations of deer species. Female deer must be primarily targeted within any quota to reduce deer numbers, along with their calves if at foot. A new study by O'Brien *et al*. (2009), examined the sex ratio of harvested calves in the Wicklow Sika population and found a bias towards female calves when such calves were harvested along with a hind (presumed the dam). Such bias may be attributable to behavioural differences in male/female calf association with the dam, and thus has management implications for deer control (O'Brien *et al*., 2009). More research that examine the biological and ecological differences in-conjunction with behavioural aspects of deer species should be supported especially given that such data will be extremely useful in development of deer culling quotas within management plans.

Deer as pests can be effectively managed by culling (deer management plans/policies) and/or by fencing if implemented correctly. Firstly, damage must be attributed to the correct species or combination thereof. Other mammalian species can cause significant damage to woodland trees. These include rabbits, hares,

squirrels, voles and mice that cumulatively can create very significant damage especially during winter months (De Nahlik, 1992; Rooney and Hayden, 2002).

The most effective means of preventing damage is through planned management of deer numbers in localised areas. Such management will use culling practices that incorporate sufficient land areas to allow for the ecology and seasonal and home range patterns/movements of deer. Deer damage within a given area is expected and will have to be tolerated to certain limits, De Nahlik (1992; and references cited therein) suggested 15% through browsing and 5% attributable to fraying as being acceptable levels, as recovery potential if trees is significant. Levels should be set at a minimal amount whereby the forester/farmer/other does not lose out on economic return of the crop, biodiversity levels are maintained if not promoted and a balanced stock of deer and other herbivores are maintained annually. Sustainable management of deer stocks can produce satisfactory yields of venison, calving rates, antler development for trophy hunting and general health. Deer in Ireland have never been looked at as an asset in terms of economic viable long term return. Sustainable deer management plans and associated policies if implemented by the correct people/organisations/newly formed co-operative can provide local industry, employment and economic financial returns and in turn effectively reduce and manage deer numbers on this island which heretofore has not occurred. This can be accomplished once the primary objective of managing deer numbers in relation to for example, (a) conservation of a deer species, (b) negative impacts to forestry/agriculture crops/other, (c) maintenance of biodiversity in an area, etc, has been determined and a suitable plan thereafter implemented.

Assessment of deer density on a given area of land must consider the distribution of deer and land utilisation by deer. Deer ranging behaviour differs between seasons, ages, sexes and species, particularly in relation to their respective reproductive behaviours during their annual cycles.

Methods for Estimating Deer Populations

There are numerous methods available that estimate population size of deer groups, most are non-invasive methods. There are various levels where managers can distinguish between indices of relative abundance (faecal pellet group counts), abundance (direct animal counts) and absolute population size estimators (line-transects, mark-recapture methods). Although the faecal pellet group counts provide an index of relative population abundance within an area and at times can be problematic due to low accuracy rates, this method does not require individual identification of deer via tagging whereas the latter two methods normally do. All methods, depending on species' characteristics (size, behavioural patterns and *a priori* abundance) and managers' investment capabilities, budgets *et cetera* can make identification of individual deer unrealistic and expensive.

Appropriate Deer Populations

Deer populations, occurring at densities that are in balance with their environs (habitat and ecosystem) and the availability of sufficient nutritious forage, are beneficial to plant biodiversity and woodland invertebrates. Browsing of vegetation by deer and its dung can create more habitats for invertebrates (and knock-on effects for other wildlife such as birds) as well as preventing loss of certain types of habitat. However, where a natural predator of deer species is absent from the landscape, such as the wolf/bear/lynx, deer numbers must be controlled through human-mediated deer management plans. Otherwise, deer occurring at high localised densities in an area can quickly over-browse and cause high levels of damage in terms of prevention of woodland flora regeneration, damage to tree saplings (stunted growth, browsing leader and side shoots, bark stripping etc.) and other stages of tree growth, thus decreasing plant and invertebrate diversity in certain ecosystems.

Ongoing ecological studies on inter-relationships between deer densities and ecosystem processes illustrate clear positive and negative correlates. These are clearly visible in terms of floral (and in-directly, faunal) biodiversity in certain habitats, such as woodlands and forests. In the absence of a natural significant predator, deer must be maintained through sustainable management plans/models. These can be species-specific and habitat type specific. When deer are present at moderate to high density levels in the absence of other medium to large sized herbivores (grazers/browsers such as sheep, goats etc), adverse negative impacts are apparent and sustained within habitats. Species composition and habitat structure change, a reduced productivity and standing crop is clear and an overall floral and faunal species biodiversity and richness is decreased where certain species are eliminated entirely from a local level. Regeneration is non-existent. Recruitment and reproduction in deer species declines considerably, deer are found in poor health conditions, are disease susceptible, male antler quality and female offspring quality is very poor and deer are often seen in large numbers. When deer densities are maintained at low to moderate relative densities, the habitat species richness and biodiversity is high also. There may be some browsing of certain preferred plant species and standing crops by deer. Deer are seldom seen by humans at such densities. The ecosystem naturally maintains its own productivity, in such 'balanced' systems. Reproduction and recruitment is

relatively high when deer are in low densities, at moderate densities, reproductive rate declines but not recruitment. The harvest or cull figures range from sustainable at low densities to high for moderate deer densities (male antler and female offspring qualities are very high).

De Nahlik (1992) recommends deer densities when improving the profitability return of deer as a secondary product of forestry accompanied by a reduction of damage to a tolerable level of 1:40ha (2.5 / km^2) for Red deer and 1:25ha (4 / km^2) for Fallow deer (no recommendation for Sika provided). However, climatic and habitat (lowland versus upland) variables must be accounted for within these densities estimates.

22. Appendix VI. Habitats and species listed under Annex I and II respectively of the EU Habitats Directive negatively impacted through grazing

These data were provided courtesy of the NPWS

Broad Habitat Category	EU Code	EU name	Pressure
Bog	7130	7130 Blanket bogs (if active bog)	140
Bog	7150	7150 Depressions on peat substrates of the *Rhynchosporion*	140
Coastal	1210	1210 Annual vegetation of drift lines	140
Coastal	1310	1310 *Salicornia* and other annuals colonizing mud and sand	140
Coastal	1330	1330 Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	140
Coastal	1410	1410 Mediterranean salt meadows (Juncetalia maritimi)	140
Coastal	1420	1420 Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi)	140
Coastal	2120	Shifting dunes along the shoreline with *Ammophila arenaria* ("white dunes")	140
Coastal	2140	2140 Decalcified fixed dunes with E*mpetrum nigrum*	140
Coastal	2150	2150 Atlantic decalcified fixed dunes (Calluno-Ulicetea)	140
Coastal	2170	2170 Dunes with *Salix repens* ssp *argentea* (Salicion arenariae)	140
Coastal	1230	1230 Vegetated sea cliffs of the Atlantic and Baltic Coasts	140
Coastal	2190	2190 Humid dune slacks	140
Coastal	21A0	21A0 Machairs (in Ireland)	140
Coastal	2130	2130 Fixed coastal dunes with herbaceous vegetation ("grey dunes")	140
Fen	7140	7140 Transition mires and quaking bogs	140
Fen	7210	7210 Calcareous fens with *Cladium mariscus* and species of the Caricion davallianae	140
Fen	7220	7220 Petrifying springs with tufa formation (Cratoneurion)	140
Fen	7230	7230 Alkaline fens	140
Fresh	3160	3160 Natural dystrophic lakes and ponds	140
Fresh	3110	3110 Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	140
Fresh	3130	3130 Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoeto-Nanojuncetea	140
Fresh	3140	3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp	140
Fresh	3150	3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition -type vegetation	140
Fresh	3260	3260 Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	140
Fresh	3180	3180 Turloughs	140
Grass	6410	6410 *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	140
Grass	6210	6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	140
Grass	6230	6230 Species-rich *Nardus* grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)	140
Grass	6510	6510 Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*)	140
Heath	4010	4010 Northern Atlantic wet heaths with Erica tetralix	140
Heath	4030	4030 European dry heaths	140
Heath	4060	4060 Alpine and Boreal heaths	140
Rocky	8110	8110 Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani)	140
Rocky	8120	8120 Calcareous and calcshist screes of the montane to alpine levels (Thlaspietea rotundifolii)	140
Rocky	8210	8210 Calcareous rocky slopes with chasmophytic vegetation	140
Rocky	8220	8220 Siliceous rocky slopes with chasmophytic vegetation	140

Broad Habitat Category	**EU Code**	**EU name**	**Pressure**
Wood	91A0	91A0 Old sessile oak woods with Ilex and Blechnum in the British Isles	140
Wood	91J0	91J0 *Taxus baccata* woods of the British Isles	140
Wood	5130	5130 *Juniperus communis* formations on heaths or calcareous grasslands	140
	a	*Austropotamobius pallipes*	140
	t	*Saxifraga hirculus*	140
	t	*Petalophyllum ralfsii*	140
	t	*Trichomanes speciosum*	140
	t	*Geomalacus maculosus*	140
	a	*Margaritifera durrovensis*	140
	t	*Vertigo geyeri*	140
	t	*Vertigo angustior*	140
	a	*Salmo salar*	140
	s	*Vertigo moulinsiana*	140
	a	*Margaritifera margaritifera*	140