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Policies and management of overabundant deer (native or exotic) in protected areas

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Abstract. A workshop was convened in Chile in August 2010 as part of the 7th International Deer Biology Congress (IDBC). Its aim was to explore global differences in the policies and management of overabundant deer in protected areas. The main goal of the workshop was to provide South American researchers and managers with a snapshot of some of the approaches to management of deer overabundance used in a diverse array of case studies from North America, Europe, Australia and New Zealand. Various case studies were presented to illustrate the different methodological approaches in implementing deer control measures. Some general recommendations were formulated.

Additional keywords: animal damage control, conflict of interest, harvest strategy, wildlife policy.

Introduction

As human populations increased many deer populations experienced large reductions in the 20th century. With the advent of regulated hunting, increases in forest cover, and the continued absence of large predators, in North America and Europe, however, many of those populations have bounced back to high levels. Elsewhere, deer had been introduced and often also increased to large and dense populations. Hence 'overabundance' of deer (native and exotics) is now an ecological and economic issue in many parts of the world. Overabundance arises wherever deer have unwanted impacts on biodiversity and ecosystem services, where their numbers exceed thresholds desired by hunters or land managers, and where they cause direct conflict with humans (most particularly via vehicles collisions). At the same time, however, deer are valued both in their own right and as a commercial or recreational hunting or agricultural resource. Finding socially and economically acceptable solutions is difficult and complex.

Managing deer overabundance where they are regarded both as 'pests' and as 'resource' is particularly problematic in protected areas in which the primary goals is to protect native biodiversity and ecosystem processes. The problem is made worse in 'non-economically-productive' areas that depend on scarce government funds for their management.

This workshop, convened in Chile in August 2010 as part of the 7th International Deer Biology Congress (IDBC), aimed to explore global differences in the policies and management of overabundant deer in protected areas. The need for the workshop is the emergence of a deer overabundance problem in South America resulting from the introductions of several exotic species, including red deer (*Cervus elaphus*). Many protected areas set aside for conservation of indigenous biodiversity are already invaded, particularly in southern Chile and Argentina. However, there is little established expertise or knowledge to guide management of deer in these areas. The main goal of the workshop was therefore to provide South American researchers and managers with a snapshot of some of the approaches to management of deer overabundance used in a diverse array of case studies from North America, Europe, Australia and New Zealand. The various case studies presented illustrated different methodological approaches to diagnosis and monitoring of the system, different socio-political approaches in implementing deer control measures, and in the actual control methods used. During a subsequent work session, some general recommendations were formulated.

Case studies

New Zealand (G. Nugent)

This paper summarised the long history of conflict over the management of introduced deer in New Zealand between those focused on conservation of the native biota (who see

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deer largely as pests) and hunters (who see them as a resource). In New Zealand, seven taxa of deer were introduced a little more than a century ago, and wild deer now occupy most of the country (particularly red deer). This includes most of the 8 million ha (31% of NZ) of public land managed by the Department of Conservation which has a primary goal of protecting native species. The deer are farmed as livestock, and are also valued as a commercial and recreational hunting resource, but are also widely seen as a conservation pest because there is a substantial body of research showing deer can cause major changes in the composition of native plant communities. As a result, the *only* legal status of wild deer in NZ is as pests. Despite that they are subject to active control programs in only a few places. Instead an apparent 'laissez faire' management regime prevails over most conservation land, but that includes unrestricted access to the deer populations by recreational and commercial hunters alike. The consequence is that in many areas unrestricted commercial (helicopter-based) hunting keeps deer densities low, often obviating the need for additional control. In addition, hunter opposition to deer control can constrain conservation aspirations somewhat, particularly by requiring a strong and clear justification of the need for control (rather than allowing deer control to be undertaken as a precaution).

The resulting long-standing conflict between hunting and conservation interests lead to a governmental review in 2008. That confirmed that there are few legal or other impediments to imposing deer control aimed at conserving native biodiversity, other than the lack of resources to do that at any large scale. The review also concluded that hunters had a legitimate interest in deer as a hunting resource, and therefore arguably had some right to greater say in how deer were managed, particularly in areas where the conservation values threatened by deer were minimal. The ecological evidence available indicates that where highly valued native species are extremely vulnerable to deer, there is little prospect of successful management for both conservation and hunting, but where the native species are less susceptible to deer, there is scope to both protect such species and provide for a moderate sustainable harvest. While such game management is technically feasible, however, it is politically difficult to achieve given that the view of wild deer as conservation pests continues to predominate in law and in governmental policy. Instead a largely laissez-faire approach that encourages unrestricted commercial and recreational hunting ensures that in most protected natural areas in New Zealand deer are mostly well controlled by private hunting, sometimes to very low levels, at little cost to the government.

Australia (J. Parkes)

Eighteen species of deer have been introduced and six of these (red deer, Sambar deer *C. unicolor*, Rusa deer *C. timorensis*, hog deer *C. porcinus*, spotted deer *Axis axis*, and fallow deer *Dama dama*) now have well established wild populations. It is also thought that sika deer (*C. nippon*) have been illegally introduced and released in recent years. Importation of new species is now likely to be prohibited by the Federal Government but some other species already present in the country may also establish wild populations. Each of the six states and two territories within Australia has its own laws on deer management, with (Tasmania, New South Wales) treating them as game animals, whilst others treat them as pests to be excluded (Northern Territory) or controlled (Western Australia, South Australia) or as a mix of pest and hunting resource (Victoria).

For those who see deer as pests, the key questions that should lead to management actions are: (i) where do Australians not want any exotic deer? (ii) what density or number of deer is tolerable in areas where deer cannot be eradicated? and (iii) who should harvest or cull deer to achieve the desired densities? These issues have been debated after new laws enacted in 2002 in New South Wales gave significant management and regulatory rights to an agency representing game hunters. Hunters claim that their hunting efforts provide low-cost deer control, but management agencies are dubious about the efficacy of that control, whilst conservation groups claim that deer, as non-native species, must adversely affect native biodiversity (although exactly how they do so has not been assessed in Australian ecosystems), and therefore should be removed or controlled more rigorously than can be achieved by recreational hunters. The debate is complicated further by the views of hunters that exotic deer are a hunting resource. The question of what deer density is desirable from the hunters' perspective is then couched in hunting-focused goals such as 'optimal' hunting opportunities, or maximum sustained yield, or a few large trophies – with obviously different consequences for the ideal herd density and structure. Sometimes conservation- and hunting-focused goals are compatible, but often they are not.

In the author's opinion the answer to the question 'How should managers set management targets for deer populations?' depends on whether deer are native or exotic species, their impact on native biodiversity when they are exotic species, the value placed on them by hunters and the willingness and ability of private hunters to harvest deer. For threatened native deer species, the management goal is to maintain sustainable populations at carrying capacity. For abundant and non-threatened native deer the management target might be a MSY. For introduced deer in protected areas in which conservation of native biodiversity is the management priority, the management target should not be the harvest but rather be a *density* of deer set to meet wider biodiversity goals. Since the assumption is that deer are 'out of place' and the reality is that most jurisdictions would either not now introduce deer or would prefer to limit their spread, these target densities usually range from zero (the deer is a pest and should be extirpated) up to some modest density below MSY where their impact is tolerable. The target density sets the required harvest, and that harvest will tend to determine who can achieve it. For exotic deer in protected areas, then, the interest is not regarding how many are killed but how many are left.

United States (W. J. McShea)

In general, deer in the US are regarded as native, with only sika deer introduced along the east coast considered to be an invasive species. Four criteria for designating a population as overabundant are (*sensu* Caughley): (i) when they cause significant economic loss or pose a risk to human health,

(ii) when they adversely affect biodiversity, (iii) when their density poses threat to rare species, and (iv) when they significantly alter pathways for productivity or succession. High densities of deer often make it difficult to maintain biodiversity in some desired state. The impact of deer browsing on plant communities is not a linear correlate of density, as feeding preferences result in widely divergent impacts on individual plant species at any one deer density. In a forest community, a variable deer density over time would result in pulses of recruitment into a forest tree community. In contrast, a chronic high density would invert the demographics of a forest towards older age classes and cause the eventual senescence of that system. Chronic high deer densities (as a result of loss of predators, hunting bans, and enhanced habitat productivity) appear to be a new ecological condition for many US ecosystems. Such chronic high density deer populations have become common in urban or peri-urban landscapes or public areas where deer are protected from hunting, and include not only white-tailed deer (*O. virginianus*), but elk (*C. elaphus*), moose (*Alces alces*) and introduced sika deer.

The response to overabundance varies. Municipal communities have tended to use either culling (professional or volunteer) or contraception in conjunction with culling/removal. For large areas of public land the response has been generally one of inaction, with some exceptions in the east where regulations have been modified to allow culling. The effectiveness of culling in reducing deer density depends on accessibility of the deer herd, and the acceptance of culling as a management tool (which in turn rests on both safety and bioethical concerns). The loss of predators in many forests, and the reluctance to reestablish deer predators, adds to the difficulty preventing overabundance. Where it is possible, the problem is much more tractable, as shown by the successful restoration of wolves to the Yellowstone ecosystem.

As with designation of overabundance, the management response required depends on both biological and cultural components. Present densities of deer are often 30–50/km^2 in large forests and 70–100/km^2 in small forest blocks. However, ecological studies indicate that the maximal or threshold densities above which some ecological processes cease to function are varied and sometimes very low: 15 deer/km^2 for migratory bird survival; 10 deer/km^2 for oak seedling recruitment; 8 deer/km^2 for forest shrub/vine regeneration; and 3 deer/km^2 for white cedar regeneration. If, for example, survival of saplings is the criteria for reduced ecological impact, then deer densities would have to be kept low for periods of 5–10 years depending on site growth conditions. Whether the necessary density reductions can be achieved and sustained for such extended periods will rely on the efficacy and cost of culling through either volunteer and/or professional hunters. There is, as yet, little data showing the feasibility of such management at whole-landscape scales in the USA.

Overall, high ungulate densities are problematic in their own right, and also indicative of other problems (degraded habitat and communities, or increased productivity through exotic species). There are no reports of such problems solving themselves without active management. Currently, lethal culling is still the best available option for lowering deer densities, but for restoration, often needs to be accompanied by other measures.

Canada (S. Woodley and J. Waithaka)

This case study summarised Canadian policy on management of hyperabundant wildlife populations in Canadian national parks. In these parks, the maintenance or restoration of ecological integrity is specified by law as the first priority when considering all aspects of park management. Ecological integrity is defined as an ecosystem being in a state that is characteristic of its natural region and which likely would persist, with that state including abiotic components and the composition and abundance of native species and biological communities, rates of change, and supporting processes. Under this mandate, the development of a new national park policy was triggered by the growing challenge of managing hyperabundant wildlife populations, particularly in southern Canada where parks are small. Many of these parks exist in human-dominated landscapes where competing land-use activities have resulted in the disruption of some of the processes that have historically regulated wildlife populations. A hyperabundant species was defined as one whose local density clearly exceed the upper range of natural variability characteristic of the particular ecosystem, and that was demonstrated to have an adverse impact on ecological integrity. At least seven species with hyperabundant populations have been identified in 10 of Canada's 42 national parks. These include black-tailed deer *Odocoileus hemionus*, white-tailed deer, moose, and elk, which, in a few parks, also pose significant threats to public safety, particularly due to collisions with cars.

The policy was approved in 2007 and aims to provides a nationally consistent approach to the evidence-based management of hyperabundant populations. It affords priority to methods that maximize ecological integrity, and uses an adaptive management framework in which management, research, monitoring and evaluation are combined to provide for flexibility and innovation. As far as possible, management actions are targeted at the cause(s) of hyperabundance. Participation of Aboriginal peoples and other interest groups in the management of hyperabundant populations is encouraged, and public consultation and education are integral components of the entire planning and implementation processes.

As an example, in Gros Morne National Park, humans have introduced moose and exterminated wolves, and moose densities are 10–15 times the boreal average. As a result the ecosystem is experiencing impacts outside the historical or modelled range of variation, with widespread conversion of canopy forest to open areas, with strong scientific evidence providing clear evidence of cause and effect. Survival of native species was threatened (4 dominant trees species, 6 herbs/shrubs species declined by 90% over 20 years). To actively restore the degraded parts of the ecosystem, a control target was set. The aim was to reduce moose density to 0.7 moose/km^2 (using public hunting to cull moose in winter), and maintain those densities for 10–20 years – long enough to allow the successful forest regeneration across the park landscape.

Implementation challenges included conflict between the conservation mandate and opposition by some sections of the public to lethal culling. In particular, interest groups sometimes challenged or disregarded scientific evidence and methodology. There can also be tension between the urgent need to act and the lengthy process required to achieve meaningful and effective

public engagement. The expertise, cost and personnel needed for developing and implementing hyperabundant population management plan can be a hurdle.

Southern Spain (J. Moro, R. Gutierrez and C. Azorit)

This case study evaluated the efficiency of management culls for reducing deer density in the Sierra Morena mountains in Southern Spain, an ecologically important area with stable populations of several emblematic protected species, but also containing deer that are an important economic resource. From the 1970s deer management in the area was characterised by the use of game fences to close hunting estates perimeters, and the use of supplementary feeding to generate deer densities that at times exceeded 55–60 deer/km^2. However, such high densities were considered incompatible with the maintenance of vegetation and optimal animal conditions. As a result changes were made in deer management from 1997 onwards, in two estates Lugar Nuevo (LN) and Selladores-Contadero (SC) in Sierra Andújar Natural Park (10,000 ha). The aim was to solve the deer overabundance problem via regular management culls and suppression of supplementary feeding. The culling level applied between 2002–2009 reduced red deer density by 26 and 34%, respectively. The density of fallow deer did not decline significantly due to underestimating the population size. The management culls were therefore effective in reducing red deer density. Because it is difficult and expensive to estimate deer density accurately and precisely over large areas, a set of indicators of animal and population performance is being developed as an alternative approach to obtaining information on the population-habitat system and monitoring changes.

Argentina (F. Mendez Guerrero)

This case study documented the role of exotic red deer in national parks and the efforts being made to balance their effects on conservation and production. Red deer were introduced to Argentina in 1905 and now occupy >50,000 km^2, including portions of three large national parks. Deer have locally reached high densities of 100/km^2 in ecotonal areas and 50/km^2 in steppe areas. They threaten native forest regeneration via their browsing on seedlings and saplings and can cause a decrease in vegetation cover, with their effects adding to those of domestic livestock and native herbivores. The puma (*Puma concolor*) preys on deer, but radio-telemetry data suggests that such predation causes <10% of mortalities. Competition from red deer may affect native deer such as the endangered huemul (*Hippocamelus bisulcus*), whose protection is one of the main conservation objectives of Patagonian national parks.

The general objective of Patagonian national parks is to minimize the environmental impact of red deer. However, the deer populations also provide opportunities for a large public sector interested in hunting large-antlered males. The red deer management plan, contemplating a scientific approach, therefore aims to avoid further expansion of the deer range within national parks; to maintain deer numbers at or below current densities; and to use public hunting as a tool to reach conservation objectives.

Use of public hunting to control exotic deer numbers and spread began in Lanin National Park in 1947. Despite hunting (and predation), however, deer have continued to expand their range, with an increase of 33% between 1985 and 2005. After accepting that eradication was not feasible, public hunting was also started in 1987 in Nahuel Huapi National Park (NHNP). Several national parks also include extensive National Reserves which are composed of private ranches, some small communities of settlers, and some fiscal lands. On these lands, livestock production is allowed, but recently, the red deer management program has included efforts to reduce overall numbers of large exotic herbivores by offering settlers in NHNP to decrease their number of domestic livestock (which forms their livelihoods) in exchange for the economic returns derived from the sale of deer hunting privileges. The emphasis has been on the harvest of large-antlered males because they generate enough economic benefit to maintain the management program. The area open to hunting in NHNP is 62,000 ha, with annual harvests between 2001 and 2007 of ~99 trophy males per year (68% in private hunting areas and 32% in fiscal areas) and 88 females (private areas only, for the purpose of control). In 2005, a National Park Public Hunting Council was created (composed of four hunting organizations) with the objective of providing advice, and helping implement the management plans developed by the national park administration.

This approach to deer management faces major challenges. As it is based on the generation of funds by providing large-antlered males, hunting guides and hunters require high levels of expertise in judging trophy potential, but there is seldom sufficient continuity of access and use to generate the local knowledge needed for that. In addition, factors such as deer density and the density of livestock, have a major influence antler quality, but usually there are insufficient resources for the monitoring needed to manage those factors appropriately. There are also financial issues. Ideally, the funds generated from the sale of hunting rights through public auction should be re-invested in deer management, by (for example) providing economic incentives to hunters to not only kill trophy males, but also exert some degree of culling to provide a form of population control. Unfortunately, the funds generated are not reinvested in deer management, increasing the likelihood that too few deer are killed to prevent population increase and spread. A potential worst case scenario is therefore a decrease of quality and number of high-value large-antlered males due to overabundance, resulting in decreased revenue from trophy hunters. This would make it difficult to maintain any public hunting program, resulting in a continued absence of control on the red deer, and the likelihood that settlers would want to return to using park areas for raising domestic livestock.

Ultimately, the biology of deer dictates that the use of commercial trophy hunting as a deer management tool for limiting their impacts on native biodiversity is self limiting, especially where there is no private hunting culture or funding that can be used to control numbers of female deer.

Chile (W. T. Flueck and J. M. Smith-Flueck)

This case provided a review of the history and status of introduced cervids in Chile. In 1928, red deer from Europe were introduced to the central valley of Chile. Since the 1940s, populations have expanded from Argentina into Chile, by way of easily accessible, low-laying mountain passes of the Andean range, accompanied

by further direct shipments from Argentina. Fallow, axis and roe deer (*Capreolus capreolus*) also have been introduced to Chile. By 1990, the area occupied by red deer was estimated at 3400 km^2, and increased to 7700 km^2 by 2002. Based on eight populations, the rate of range expansion was estimated (in 1983) to be at least 1 km/year, but is likely to have been more rapid in many places where cattle use and intentional fires have allowed the red deer to advance more easily. By 2002, across Argentina and Chile combined, deer were present in the area between 37°42′S–54°55′S and 73°36′W–69°50′W. The pre-Columbian northern limit of native huemul deer was 30°S. As red deer have invaded all habitat types within their current range that are known to have been used by huemul, the potential northern limit for red deer could be >750 km further north of the present distribution. To the south, all areas are suitable for red deer. The overall invasion patterns will be determined not only by the spread from existing populations but also from the number and locations of new introductions or releases, with several new populations recently established and beginning to spread. These may result from intentional introductions, but of more concern are accidental but inevitable escapes from the increasing number of new approved deer enclosures. Overall, red deer are by far the most widespread of the exotic cervids in southern South America, and have spread across the Andes between Argentina and Chile, making coordination of deer management policies between the two countries highly desirable if invasion of either country is to be minimized.

Exotic deer are now present in many provinces, including Tierra del Fuego, except for possibly Region III (Atacama). It appears most are in captive herds, of which there are more than 100. Fallow deer were first brought to Chile in 1887, were released to several sites, currently occur in regions IX, X, XI, and V (Araucania, los Lagos, Aisen, and Valparaiso, respectively). Fallow deer have also escaped from an enclosure on Chiloe Island, and established themselves in the surrounding area. Total numbers were estimated at more than 8000 deer. Axis deer are held in a semi-captive state in Region VII and XI (Maule, Aisen) to provide hunting opportunities. As ungulates can easily cross the Andes, captive enclosures on both sides represent high risks for new source populations in case of escapees, and Chile and Argentina thus should coordinate policy moves in order to prevent the entry of unwelcome invaders like Himalayan tahr (*Hemitragus jemlahicus*) which was introduced to Argentina in 2000 and to Andean foothills a few years later.

There is little published scientific data (even simple presence/absence distribution data) on wild deer populations and demographics in Chile. Adverse ecological impacts have been attributed to red deer since 1981 and red deer figure in the Chilean Pest Manual. This lack of information about wild deer in Chile is likely to reflect the stringent controls on firearms ownership which has largely precluded the development of a hunting culture and therefore, the flow of information that such a culture could provide. Moreover, recreational hunting is not permitted on public lands, with most hunting being undertaken by paying clients using private hunting ranches. Overabundant deer on such private lands are managed by the owners, but on public land such management would likely require intervention by the government, which usually lacks the resources to do so. Preventing the continued invasion of Chile by wild exotic deer is therefore likely to be a major ongoing challenge for conservation of protected areas.

Conclusions

Overabundance of *native* deer in protected areas has emerged in North America and elsewhere where humans have removed or impeded the processes (such as hunting or predation) that previously provided population control. This adversely affects biodiversity and ecosystem function, and solutions are only possible through active management. The Canadian National Parks policy for management of overabundant species provides a good model for identifying the problem, designing solutions, and gaining societal acceptance for the need to maintain or restore ecological integrity. Lethal means of control are considered the best options which have been practiced either through park staff, through public hunting or a combination.

Overabundance of *exotic* deer in protected areas can sometimes occur even when the density of deer is low relative to the potential carrying capacity of the area. Where the aim is to maintain the ecosystem in a completely unmodified state, eradication of deer may be desirable. Where eradication is not feasibly, the conservation aim is usually to control deer density to meet wider biodiversity goals. Given the abundant evidence globally that exotic deer modify ecosystems, it is arguably appropriate that the aims and targets for management of introduced deer can be much more easily justified under the precautionary principle than where the deer are native. Unlike contexts in which deer are managed as a hunting resource, the management of exotic deer in protected areas is centred not on the harvest or kill achieved, but on the residual density of deer remaining. Where deer are managed by (or for) recreational or commercial hunting, the appropriate density varies. Where the deer are native, the density target should, in principle, be at MSY or above, but where they are exotic, the target should always be MSY at most, and often much lower.

In countries or states where wild exotic deer are officially viewed as pests, providing unrestricted access to recreational and/or commercial hunters can be effective in reducing deer densities to very low levels, often obviating the need for state-funded deer control. However, hunting impact is not always high in the areas of greatest conservation concern, especially where such areas are remote and difficult to hunt.

In countries or states where at least some groups view exotic deer as game animals, programs to control or eradicate deer in protected areas tend to be much more controversial. Often hunters claim their efforts provide sufficient control, whereas conservation groups would prefer much lower deer densities. The conundrum is that generating a high level of interest from private hunters requires a sufficiently large hunting resource to generate that interest, so the ability of hunters to control deer densities is self limiting, depending more on the ease with which deer can be hunted, and the number and technical skill of the hunters competing for the resource, than on the type of hunting system. Hunting systems aiming at recovery of both male and female deer for meat have the potential to exert a major influence over deer density, whereas hunting systems focused primarily on the sale of hunting rights to harvest large-antlered males do not usually provide much population control. Unless the revenue

generated by the latter is used to control the female component of the population, the latter system may have little or even negative conservation benefit for protected areas.

Thus having a strong public hunting sector can potentially provide a low cost tool for addressing deer overabundance problems, but the hunting sector can also easily become an impediment where the primary goal is protection of native biodiversity.

Recommendations

For dealing with overabundance (where that results in a wide and complex range of major changes in ecosystem composition and health, the quality of ecosystem services, and/or issues such as human health and accident risk) the *most reliable, sustainable*, *and effective* approach will be to gain public support (via governmental funding) for dealing with the problem. The Canadian National Parks model is a good example of this. However, the workshop recognised that this is usually difficult, particularly where conservation and wildlife management budgets are small or nonexistent. Nonetheless, this highlights the need for science to inform policy makers and politicians, by working to increase the understanding and raise awareness both of the threats to conservation and human health and the need for action. The consensus was that the primary target should be to achieve an acceptably low deer density by whatever means are available and socially acceptable.

Where funds for control of overabundant deer populations are scarce, it is sometimes possible in favourable circumstances to still obtain good deer control by developing or allowing commercialization of the deer resource as a source of meat and hides. This results in a market-driven equilibrium between harvest rate and recruitment to the deer populations. The position of that equilibrium will be driven by meat price, but, in at least some instances worldwide, local densities have been reduced low enough to solve the problem of overabundance.

Where no other options are available, some control of overabundant deer can be achieved by encouraging sport hunting. As with commercial exploitation, this should in principle reduce deer abundance, but risks being counterproductive if the values sought by sport hunters become the reason for deer management (as opposed to management for conservation or other reasons), which then causes a dilemma for the agency in charge. Active management for both conservation and hunting goals is likely to be difficult in most instances, and especially so where the hunting interests are centred on maximizing the harvest of large antlered males.