Establishment of the Invasive White-tailed Deer in Portland, Jamaica

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Summary

A small population of white-tailed deer (Odocoileus virginianus) was introduced to Jamaica in the 1980s through the accidental release of captive-held animals. This article is based on a 2003 investigation carried out on their distribution, population size, and socioeconomic impacts of the introduction. The investigation also sought to ascertain whether the deer represent a threat to biodiversity in the remaining natural forests of the Blue and John Crow Mountains.

O. virginianus in Jamaica is restricted to Portland, where it occupies a relatively small area of approximately 19 km² in and around the communities of Mt. Pleasant, Industry, Shrewsbury, Content, Darley, Little Spring Garden, Eden Wood, Paradise, and, Swift River. These areas are characterized by low altitudinal edge habitat interspersed with small agricultural fields growing cash crops like pumpkin, carrot, yam, and corn.

Interviews with local residents indicate that O. virginianus is a serious agricultural pest in the communities in which it occurs. Farmers in the area complained of deer damaging agricultural crops, and claimed average monthly losses of J$10,000.

By incorporating deer defaecation rate and dung decay rate into line transect surveys of deer dung, the total deer population in Portland was estimated at 182 individuals.

This alien invasive does not appear to have penetrated the forests of The Blue and John Crow Mountains, and at present, poses more of a threat to small scale agriculture.

Key-words: Odocoileus virginianus, alien invasive, deer dung transects, agricultural pest, introduced species
Introduction

One of the greatest challenges facing wildlife professionals, and indeed, native ecosystems world wide, is the increasing rate at which human activities are causing a homogenization of the earth’s species. Jamaica is no exception to this unfortunate trend, and it is threatened by 52 known invasive plant and animal species (IABIN, 2003).

Introduced species cause billions of dollars in damages each year. Their impacts include herbivory, predation, disease, parasitism, competition, habitat destruction, and hybridization with native species (Simberloff, 2000). The devastating effects of biological invasions are rivaled only by habitat destruction, with the latter being the greatest cause of species decline (Wilson, 1992).

Island systems are especially vulnerable to exotic species, due in large part to the absence of entire groups of species in insular communities (e.g. terrestrial mammals); hence island invaders may encounter resource rich environments that are free from competitors and predators, and such ecological release greatly enhances their prospects for successful establishment (Simberloff 1995).

*Odocoileus virginianus* Species Description

*Odocoileus virginianus* (white-tailed deer) is the most widespread and abundant member of the deer family (Cervidae). There are approximately 38 subspecies of *O. virginianus* recognized in America (Smith, 1991). White-tailed deer are so named because when alarmed, they hold their tails erect, exposing their white underside. Adult males weigh from 90-135 kg, and attain a height (at shoulder) of 53.3-106.7 cm, and a length of 104.1-240 cm. The length of the tail averages 10-36.5 cm, and the hind foot averages 27.9-53.8 cm in length. In general, females weigh 20-40% less than males (Taylor, 1956).

In the northern hemisphere, this species demonstrates seasonal variation in pelage. Their summer coat consists of short, thin, wiry hairs and varies from red-brown to bright tan. The coat is darker along the mid-dorsum and paler on the face, throat and chest. The winter coat develops in late summer to early autumn, and is a blue-gray to gray-brown colour with longer, thicker, and more brittle hairs. Adults have a white nose-band, orbital region, and throat patch. The underparts, including the lower tail, insides of legs, venter, and chin are also white (Guthrie,
Fawns have a red-brown coat, with white dorsal spots that disappear at 3-4 months of age (Hesseleton and Hesseleton, 1982).

Adult males possess antlers (rarely found on females), and male fawns have small bumps or “buttons” in their first year, and unbranched spikes or branched antlers thereafter. The size and shape of antlers is a reflection of age, nutrition, heredity and heterozygosity (Hesseleton and Hesseleton, 1982).

**Reproductive Capacity**

Deer have very high rates of reproduction, and given optimum conditions and low mortality rates, their populations can expand rapidly. McCullough (1979) reported that a population of 6 white-tailed deer (2 bucks and 4 does presumed to be pregnant) introduced to the Edwin S. George Reserve, a 1,146 acre reserve in southeastern Michigan, grew to a size of 180 individuals in six reproductive seasons (6 years), and reached a maximum of about 222 head in 7 years. Later, the population was reduced to 10 deer, and in a period of 6 years, it grew to a size of 212 individuals. The population growth rate in these examples was found to be over 50% per year (McCullough, 1983). Although remarkable, this population growth rate was not thought to represent the maximum rate of increase attainable by the population, as the growth rate of the herd decreased with increasing population size. An unimpeded rate would have yielded over 300 individuals, compared to the estimated 222 and 212 (McCullough, 1982).

In addition to their high reproductive capacity, white-tailed deer are among the most genetically variable mammals studied, and this high genetic variability is very advantageous, especially when a small number of these animals are introduced to an area, as it reduces the magnitude of potential founder effects.

**Natural Range and Habitat Preference**

White-tailed deer range from southern Canada throughout most of the coterminous United States, southward to northern South America (Smith, 1991). The animal has been introduced to many places, including The British Isles, Czechoslovakia, Finland, Yugoslavia, New Zealand, Cuba, The Virgin Islands, Curacao, and other Caribbean islands.

Deer prefer ecotone or edge habitats where fields and forests come together, producing an area with abundant shrubs and low growing trees. This habitat provides them with adequate
vegetation for concealment and ample food; deer tend to avoid mature forests where the undergrowth, and hence food supply, is limited (Severinghaus and Cheatum, 1956). Radio-telemetry studies in Scotland showed that deer used agricultural land primarily at dusk and dawn, and woodland areas were highly preferred in between these times (during the day and at night) (Idris, 1990).

**Deer Impacts**

Both native and introduced deer are considered pests in many parts of the world. Deer are known to pose a threat to native forests (Marquis & Brenneman 1981, Kay 1993, Relva & Veblen 1998, Manchester & Bullock 2000, Wardle et al. 2001, & Fuller & Gill 2001). Through predation of seeds, browsing, and trampling of seedlings, deer may exert a profound negative impact on forest regeneration. Deer also damage forests through browsing of the lateral branches or terminal buds of developing trees, bark-stripping of more mature trees, and fraying of bark from the main stem of small trees by rubbing them with their antlers (Putman and Moore, 1998).

In Pennsylvania, the disappearance of highly palatable plants was found to adversely affect other wildlife that rely on these plants for food and cover, resulting in a dramatic reduction of biodiversity in forests. deCalasta (1994) found that deer altered forest structure and composition by eliminating much of the intermediate canopy, which led to the local extinction of many intermediate canopy dwelling songbirds.

In its native range within the United States, for example, *O. virginianus* is a serious agricultural pest. Because of their large size and associated dietary needs, these ruminants are able to consume virtually all the foliage of the plants they prefer (Nugent, 2001). White-tailed deer allocate more time to feeding than to any other activity, and select the most nutritious forage available (McCullough, 1982).

In agricultural areas, farm crops are an important year-round source of high quality forage for white-tailed deer, representing up to 78% by mass of the total diet (Gladfelter, 1984). As a result, deer can pose a serious threat to agriculture, and can inflict considerable economic losses. Damage to farmland occurs in many forms, including grazing, flattening by rolling, lying, or trampling of crops, damage to fences or hedges, and damage to trees (Scott and Palmer, 2000). Doney and Packer (1998) report from a survey carried out in lowland England that the most
common type of damage was grazing, followed by damage to trees, flattening of crops, and damage to fences.

Conover et al. (1995) estimated crop damage in the United States agriculture industry at almost US$500 million per annum, and deer are responsible for much of these damages. In one survey conducted by the Pennsylvania Farm Bureau (2002), the average farmer lost over US$9,000 per year due to damages caused by deer.

Deer also affect the water quality of river systems through erosion and faecal contamination, and they carry diseases and parasites which can be transmitted to humans.

About 29,000 people are injured and over 200 people die each year due to deer-vehicle collisions in the U.S. (Conover, 1995).

**Deer Introduction to Jamaica and its Implications for Biodiversity Conservation**

The white-tailed deer was introduced to the island in the 1980’s. There are conflicting reports about the year and the number of deer that were introduced. One confirmed report is that in 1988 during hurricane Gilbert, 6 captively held deer escaped into the wild from their holding at Somerset Falls - a local tourist attraction in the parish of Portland. These 6 individuals were comprised of 3 males and 3 females (Shaw, *pers. comm.*). There was, however, probably more than one instance of deer escaping from this location, as residents in the area maintain that some of the animals escaped in 1980 during hurricane Allen.

The Blue and John Crow Mountains National Park is located in relatively close proximity to areas where white-tailed deer have now become established. Jamaica has been recognised as a biodiversity hotspot, and much of its biodiversity is contained within this park. The park is the largest remaining area of natural primary forest, and contains some 923 endemic species of vascular plants (NEPA, 2003). The area also serves as an important watershed that is vital for the water supply to the eastern end of the island, including Kingston. The possible penetration of *O. virginianus* into these forests is cause for considerable concern.

The already threatened state of the Blue and John Crow Mountain forest, due to charcoal burning and hillside farming renders this ecosystem more invasible, and coupled with these pre-
existing threats, the establishment of an introduced herbivore like the white-tailed deer could have serious implications for biodiversity conservation in the area.

Study area
This study was conducted near the centre of Portland, about 8 km west of the capital Port Antonio. The area is approximately 20 km², and is characterized by ecotone or edge habitat, interspersed with agricultural land (Figure 2.1). Many of the farms in the area are small (<0.5 km²), and do not show up on the land use map in Figure 2.1.

Altitude ranged from 50 m near the Swift River to 350 m on surrounding hilltops. There are some areas of secondary forest containing native trees and climbers like *Zygia latifolia* and *Entada gigas* respectively, while other areas are covered by introduced species of bamboo (*Bambusa vulgaris*), fern (*Nephrolepis sp*) and pine trees (*Pinus caribea*) (Plate 2.1). Much of the area is under cultivation, with carrot, pumpkin, banana, yam, and cocoa being the predominant crops.

The parish of Portland receives an average of 367 cm of rainfall per year, and 27.8 cm of rainfall in the month of June (Meteorological Service of Jamaica, *pers comm.*, 2003). Numerous watercourses like the Swift River, Daniels River, Kelly Brook, and the Black River permeate the area, and there are several small farming communities along the roads. The study was concentrated in and around the communities of Content, Mt. Pleasant, and Shrewsbury, as these communities appeared to contain the highest densities of the introduced deer.
Figure 2.1. Land use map of study area showing area surveyed (Forestry Department, 1998)
METHODS
Field work for the study was carried out in the summer months of June and July, 2003. Visits were made to communities within Portland where deer presence had been reported. Initially, surveys were conducted over a broad area in order to map the full extent of the distribution of *O. virginianus* (Figure 2.1). Subsequent surveys and field work were conducted in areas identified as containing deer. A questionnaire was administered to community members (concentrating on farmers), and using this method, the presence of deer, and their impacts in different communities were ascertained. Deer abundance was estimated using line transect surveys of deer dung, as described by Buckland (1993).

RESULTS

*Odocoileus virginianus* distribution

Survey results show that deer are present on the outskirts of the following communities: Mt. Pleasant, Shrewsbury, Content, Darley, Little Spring Garden, Eden Wood, Industry, Paradise and Swift River (Figure 4.1). The animals were found to occupy a total area of approximately 19 km$^2$, but they were not distributed evenly over this area, as there were core areas with relatively high density, and areas where only occasional sightings were recorded.
Figure 4.1 Study area showing survey points and area occupied by white-tailed deer in Portland
Twenty eight farmers and thirty two other residents, within the area occupied were interviewed. Many people living in towns or larger communities within the area occupied by *O. virginianus* had never heard of deer occurring in Portland; and, as expected, farmers were the most knowledgeable about the animals, as they had had the most encounters with the creatures through crop raiding (Figure 4.2).

![Figure 4.2 Percentage of farmers and other survey respondents within the area occupied by *O. virginianus* who had knowledge of deer presence in Portland](image)

*Crop Damage*

Farmers reported deer in their crops at dusk and especially at dawn. Herd size according to farmers is 2-3 individuals, often consisting of a doe, and one or two fawns. This is the characteristically small herd size of *Odocoileus* (Anderson & Wallmo, 1984). Grazing damage was the only type of perceived damage reported by farmers. They complained that crop damage from deer has escalated in the past 5-6 years, and estimate loosing on average $10,000 per farmer per month from crop damage due to deer. Crops that received the most damage include pumpkin, carrot, yam, okra, pepper, peas, and corn (Figure 4.3). Crops like banana, plantain, coco, and dasheen were generally not taken during deer raids. For some crops such as carrot and pumpkin, only a few bites of individual fruits are taken, and many more crops are damaged than are actually consumed. As a consequence, deer are able to destroy entire fields of crops overnight. Such extensive damage can apparently overwhelm small-scale agricultural operations,
as some small farmers have reportedly gone out of business as a direct result of losses attributable to deer (Plates 4.1 & 4.2).

Figure 4.3. Chart showing crop types preferred by deer according to the number of farmers that reported damages in particular crop types. This pattern probably reflects both the availability of various crops and deer crop preference.

To deter deer from raiding crops, farmers have employed a number of measures. Some have hung makeshift scarecrows sprayed with perfume in their plots (Plate 4.3). Others have rubbed the fence posts surrounding their crops with bath soap, hoping that the scent will deter raiders. And some farmers have left lit lanterns burning in their plots overnight.

Plate 4.1. Farmer from the community of Content showing damage to pumpkin by white-tailed deer
Plate 4.2. Only a few bites of individual immature pumpkins were taken on this farm in Content, resulting in the destruction of the entire plot.

Plate 4.3. Makeshift scarecrow on farmland near the community of Mount Pleasant, Portland.
Damage to Woodland Areas

Although damages to woodland areas were not directly investigated, there were some obvious signs of antler damage to trees within the area occupied (Plate 4.4). The damages trees were observed in highly degraded woodlands interspersed with agricultural fields. There were no reports of deer presence within the forest reserve of the Blue and John Crow Mountains National Park.

Plate 4.4. Bark fraying of a young tree near Mount Pleasant, caused by deer thrashing the antlers up and down against the stem during territorial displays.

Deer hunting

Some farmers set rope snares for the animals, but deer are very trap wary, and have seldom been caught using this method. Deer hunting with the help of hunters from the Kingston area is becoming increasingly popular, and deer are tracked and shot on a weekly basis with the help of tracking dogs. Only one community member (a farmer) is involved in leading deer hunting expeditions, and he reports seeing approximately 300 deer killed over the last 3-4 years.
Income from deer
Economic gain from deer presence has been negligible. Only one community member is actively involved in leading deer hunting expeditions, from which he receives a small financial gain for his services as a guide. This only offsets the losses he receives through crop damage. Hunters return home with their catch, and either sell it or consume it. Local catch is rare, and only used for subsistence. One local touring organization conducts the occasional deer-photographing outing, charging $1500 per person.

Deer Abundance
Five dung piles were recorded along 20 transects (Plate 4.5). Density calculations were done for the core areas totaling approximately 7.6 km$^2$, within the total 19 km$^2$ area occupied (Figure 4.4).

Plate 4.5. O. virginianus dung pile in an area dominated by bamboo near the community of Content

Using DISTANCE (Buckland et al., 1993), a dung density (T) of 23914.86/km$^2$ was estimated, based on the number and distances of the dung piles from the transects. Deer density (D) was estimated at 23.90 deer/km$^2$, and deer abundance (N) was estimated at 182.
DISCUSSION

The distribution of *O. virginianus* in Portland was smaller than anticipated. Given that the animal has been established in the island for approximately 15-20 years, its dispersal has been fairly minimal, and its range has been confined to a relatively small area. Marchinton and Hirth (1984) found that movements and home range in deer are variable, and are influenced by age, sex, density, social interactions, latitude, season, and habitat characteristics. Therefore any number of factors could be influencing the distribution of *O. virginianus* in Portland.

*O. virginianus'* distribution in Portland is characterized by relatively low altitudinal areas (50m-300m) permeated by streams, and set apart from towns and communities. Areas occupied consist of degraded forest in close proximity to the animal’s preferred agricultural crops.

The area occupied by *O. virginianus* appears to be constrained by a number of factors. In the southern region of the range, they are probably constrained by crop type, as coffee, banana and plantain (which are not the animals’ preferred crop types) are the main crops grown. To the east of their range, the species is probably inhibited by more densely populated towns and communities like Mount Pleasant and St. Margaret’s Bay. These towns also probably have a greater occurrence of dogs, the presence of which will work to deter deer. In those communities occupied by *O. virginianus*, farmers rarely keep dogs, for fear that they would prey on goats and other reared animals. The Swift River, and a change in crop type (from pumpkin and carrots, to plantain, banana and coffee) probably restricts the animals to the west of their range.

It appears that deer have not managed to establish themselves in the Blue and John Crow Mountain forests. These mature forests are probably unsuitable habitat as they contain little undergrowth which deer need for cover and browsing.

The density of *O. virginianus* (23.9 deer/km$^2$) in the core areas occupied, was found to be relatively high. Aulak and Babinska-Werka (1990) note that in small wooded areas surrounded by agricultural fields, the abundance of roe deer is 3 times as high as the density levels for woodlands in Poland. The animals were found to temporarily leave the shelter of the woodland, move into nearby fields, and use the vegetation as an additional food source. In their study of a small forest area (200 ha) in Poland, surrounded by agrocoenoses, they found a high roe deer density of 45-62 deer/km$^2$, and not surprisingly, the agrocoenoses bordering the forest were intensively used by deer. Areas with numerous small agricultural plots in Quercus-Carya forests
in North Carolina were found to support high densities of 80 deer/km² (Torgenson and Porath, 1984).

My *O. virginianus* density estimate is limited by a number of factors. Ideally, defecation rates and dung decay rates should have been estimated from independent studies done on the population under consideration. These parameters are highly variable and habitat specific, but such investigations were not practical given the scope of this study. In addition, the relatively small number of dung piles found (5) resulted in large confidence limits. Nevertheless, the abundance estimate of 182 deer in the core areas occupied, with an upper 95% confidence limit of 373 deer appears to be reasonable, based on (1) the relatively small, yet high quality habitat occupied, and (2) farmers’ estimate of 500 – 1000 deer. Farmers’ estimates are however, based on sightings and crop damage, but the same group of deer could be returning to raid crops in each instance, and as such, a population size of 500-1000 individuals is likely to be an overestimation. Using the population growth rate of white-tails on the George Reserve (McCullough, 1982 and 1983), with a founding population of 6 individuals (Shaw, pers. comm.) growing over a period of 15 years, the result is a potential population size of 12, 416 individuals in Portland. The population size in Portland would probably approach this value if it was uninhibited, and this is an indication that there are inhibiting factors to deer population growth in Portland, one of which might be hunting.

A more accurate deer population size estimate could have been attained if a larger sample size (number of transects), with longer transects was taken, and if the area occupied was divided into strata (woodland versus cropland).

*Odocoileus virginianus and the Portland farmer*

Portland is primarily an agricultural parish, and the vast majority of farmers operate relatively small farms (<0.5 km²). The small farm sector is the country’s largest source of employment, supporting an estimated 150,000 rural families (NEPA, 2003). It is these small farms in Portland that receive the highest damage levels. Smaller farms have a larger perimeter to area ratio, which leaves them more susceptible to damage from deer entering the edges of plots, from adjacent woodlands. Smaller farms also have fewer crops, and so the effect of deer raiding can be catastrophic.
Farmers reported that deer raiding had intensified over the past 5-6 years, suggesting that the deer population has been increasing. On the other hand, some farmers reported that deer raiding had lessened in the past 1-2 years, perhaps reflecting reduced density attributable to hunting mortality.

In general, farmers have apparently met with little success in their measures to deter crop raiding by deer. After a few weeks, the animals usually become accustomed to the scarecrows and other frightening devices employed by farmers. Further, none of the farmers interviewed had switched crop types to those less preferred by *O. virginianus*; they explained that this would not be feasible, given the local market conditions.

Some farmers experienced losses in certain crop types, while others did not. This was probably due to the location of the crops within the field, or the location of the field itself, as fields located closer to woodland areas are more likely to be raided than are fields further away from wooded areas (Aulak & Babinska-Werka, 1990).

**CONCLUSION**

*Odocoileus virginianus* in Portland is a serious agricultural pest, causing thousands of dollars in damages to small farms. Given their present distribution, the animals seem to pose more of a threat to small scale agriculture than to forested areas. Their presence may, however, have implications for forest restoration in edge habitats.

Future numbers and geographical expansion of *O. virginianus* are strongly dependent on land use patterns and hunting regimes. As is the case in lowland Britain (Putman and Moore, 1998), farmed woodlands create refuges for deer, and serve both to increase densities in those areas already occupied, and to provide migration corridors to new areas. If such migration corridors containing the right crops continue to be made in The Blue and John Crow Mountains National Park, it will only be a matter of time before *O. virginianus* invades this unique and vulnerable ecosystem.
To better assess the status, and impending threat of *O. virginianus* to the Blue and John Crow Mountains National Park, additional research, survey work and monitoring is clearly warranted, in particular, along the northern foot hills of the Park.

**RECOMMENDATIONS**

1. *O. virginianus* is an alien invasive species, and the population in Portland should be eradicated or controlled in an effort to safeguard the native biota, and to spare agricultural losses. Since this is largely the view of community members, control efforts are not likely to be met by opposition, as is often the case with introduced animal control programmes. The most suitable method of control would probably be to have hunters or members of the Jamaica Defense Force come into the area at prescribed times (set during community consultations) to shoot deer. This could be regarded as a community service, and the meat could be divided up among community members. In the meanwhile, farmers should be compensated in some way for deer damage, to ensure that immediate losses do not result in unemployment and social disruption.

2. Farm owners should be given technical support to help prevent deer raiding. One potential method of deterring deer on farms in the Portland area is to keep dogs around crop beds, although such an approach would not come without potential negative consequences (example, adding to the feral dog problem and risking predation of reared animals).

3. There is currently no legislation that addresses the issue of bringing alien animals and plants into Jamaica, nor is there a coherent, national strategy aimed at ameliorating the deleterious impacts of introductions that have already occurred. More stringent laws should be established that prevent the importation of any non-native species except under special circumstances identified by the relevant authorities. An alien watchdog group should be established that would be contacted on the first sign of a newly introduced species, and the government and other relevant organizations should mobilize to control or eradicate alien invasives wherever they occur.
REFERENCES


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