Review Article

Conservation value, history and legal status of non-native white-tailed deer *(Odocoileus virginianus)* on the Caribbean island of St. Kitts.

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Abstract
White-tailed deer (Odocoileus virginianus) have been introduced from North America to a variety of habitats throughout the world, including the Caribbean island of St. Kitts. Often, non-native species are considered detrimental to the environment; however, the social acceptance of non-native species appears to be resulting in a shift of the perceived conservation value of non-native animals, to the extent that they are sometimes viewed as normal or desirable in natural systems. White-tailed deer were protected by the government of St. Kitts and Nevis in 1987 but difficulties in administering and enforcing the laws have hampered conservation and research efforts. Recent progress in funding the implementation and enforcement of conservation laws provides an opportunity to explore the socio-political value of conserving the population of white-tailed deer before threats to their persistence cause their extirpation.

Key Words: invasive species; tropical conservation; Caribbean wildlife; island conservation, One Health, tourism

Resumen
El venado de cola blanca (Odocoileus virginianus) ha sido introducido desde Norte América a diferentes partes del mundo incluyendo la isla de St. Kitts (San Cristóbal) en el Caribe. Comúnmente las especies no nativas son consideradas perjudiciales para el ambiente; no obstante, algunas especies son aceptadas socialmente y ésta aceptación parece ser el resultado de un cambio en la percepción en el valor de conservación de dichas especies. Este cambio ha hecho que algunas especies no nativas son consideradas beneficiosas o normales en los ecosistemas. El venado cola blanca fue protegido por gobierno de St. Kitts en 1987, pero los esfuerzos de conservación en investigación han sido obstruidos por falta de vigilancia en el cumplimiento de la ley. Un progreso reciente en el financiamiento para la implementación y aplicación de las leyes de conservación podría brindar una oportunidad para explorar el valor socio-político de la conservación del venado cola blanco antes que se vea extinto.

Palabras clave: especies invasivas; conservación de los trópicos ; la fauna del Caribe ; conservación de las islas , una salud , el turismo

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Introduction

White-tailed deer *(Odocoileus virginianus)* have been introduced from North America to a variety of habitats throughout the world, including several Caribbean islands: St. Croix [1-3], Jamaica [4], Cuba [5], Puerto Rico [6], and St. Kitts [7]. Colonized by Europeans beginning in 1624, the island of St. Kitts (formerly known as St. Christopher), along with its sister island, Nevis, now make up the independent nation of the Federation of St. Kitts and Nevis. European colonization created a human legacy marked by abduction, displacement, slavery, and brutality, all of which are well documented. Colonization also brought about enormous ecological changes to the island of St. Kitts. Landscapes and native vegetation communities were radically altered to facilitate sugar cane production [8-9]. Non-native animals and livestock were brought to the island as pets, food sources and ecological control agents [10]. (Fig. 1).

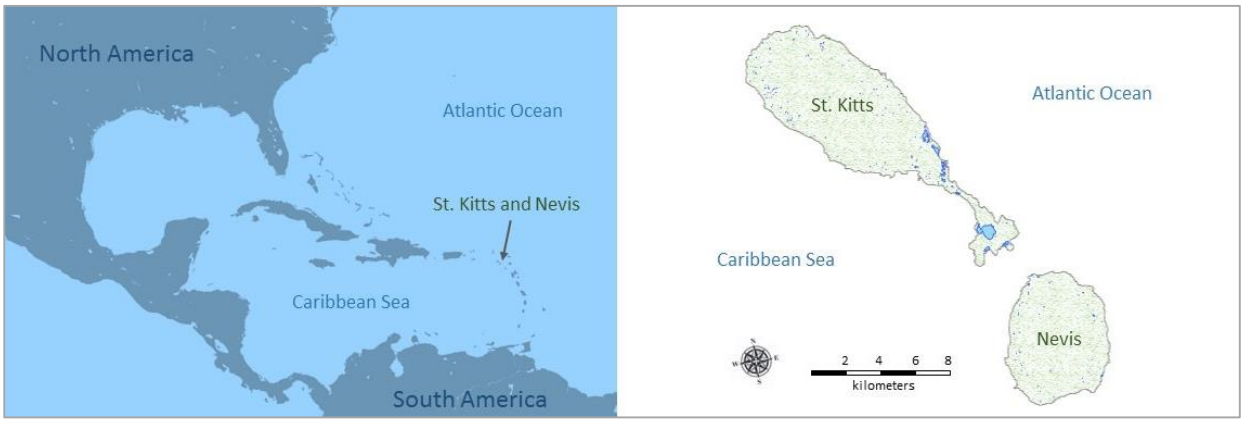

Fig. 1. Location of the Federation of St. Kitts and Nevis in the Caribbean Sea.

By the end of the twentieth century, a significant decline in sugar prices forced the government to take the nation in a new economic direction [11-12]. As part of the leeward grouping of islands in the lesser Antilles, St. Kitts is surrounded by the Atlantic Ocean to the north and east, and the Caribbean Sea to the south and west. Its tropical climate and relatively low land prices make the island attractive to foreign investors seeking "sun, sea and sand" investment properties for tourist destinations, and vacation homes tailored to the internationally affluent [13]. Although tourism has the potential to greatly increase the GDP of developing nations in the short term, through land sales and construction projects, if development of tourism is not done in an environmentally sustainable fashion the long-term natural beauty and attractiveness driving tourism can ultimately be lost [14]. In St. Kitts, as elsewhere, despite interventions that span nearly 400 years since the first European settlers arrived in the Caribbean, the difficulties of dealing with non-native species and their environmental impacts has proven to be especially intractable. [15-17].

In contrast to other non-native species on St. Kitts, such as the small Indian mongoose *(Herpestes javanicus)* and the African green monkey *(Cercopithicus aethiops)*, very little is known about the history of the white-tailed deer on the island or their conservation value to the people of St. Kitts. Historically, non-native species have been much maligned by ecologists [18-20]: they can cause the extinction of native species [17]; they could carry and transmit infectious diseases to humans and/or native fauna [21]; and they can damage economically valuable crops [22]. Substantial efforts have, therefore, been devoted to preventing the introduction of non-native species and to making their eradication a priority if they do become established [23]. For example, the small Indian mongoose, introduced to St. Kitts and Nevis from Jamaica in 1884 to eradicate rats from sugarcane fields, likely caused the local extirpation of multiple species of invertebrates, reptiles, amphibians, mammals and birds [24-26]. In addition, mongooses in various islands of the Caribbean, including Grenada, Cuba and Hispaniola, carry the rabies virus, which it can transmit to humans and other vertebrates through bite wounds [27]. Currently, the mongoose is considered among the top 100 worst invasive species anywhere in the world [28]. The African green monkey, on the other hand, which was introduced to St. Kitts around 1650 [29], has become something of a cultural icon from a tourism point of view, even though its economic impacts on agriculture are so great that few farmers are willing to commence local farming operations without first reducing or eradicating its population [30].

Since not all non-native species are economically or ecologically harmful [20], determining the conservation value of a particular species requires the balancing of multiple factors. This is increasingly being undertaken for both ecological and socio-political reasons [31]. Species that are considered ecologically or economically destructive, for example, will likely continue to be managed (controlled or eradicated). On the other hand, from a socio-political perspective, non-native species can become so integrated into the culture of the people with whom they co-exist that there may be a shift in their perceived conservation value, to the extent that some species may come to be viewed as normal or desirable in natural systems [15, 32-33]. As a result, efforts have been taken to protect some non-native species, such as the dingo *(Canis lupis dingo)* in Australia [20, 33], the red masked parakeets *(Aratinga erythrogenys)* in California, U.S.A. [20], the European mouflon *(Ovis orientalis)* in Corsica and Sardinia [33], and the porcupine *(Hystrix cristata)* in Italy [33].

Examples of culturally significant non-native species also exist throughout the Caribbean. European fallow deer *(Dama dama)* were introduced to the islands of Antigua and Barbuda in the early 1700s [34] and are now perceived to have a symbolic history having been brought to the Caribbean as a result of European colonialism. The deer are officially listed as Antigua and Barbuda's national animal [34].

The question of what to do with non-native species is not easily answered. A 'one size fits all' solution is no longer the consensus viewpoint amongst ecologists, and the socio-political value of many species can be difficult to determine [15]. Although the ecological, socio-political, and legal aspects of the conservation value of well-known non-native species, like the small Indian mongoose and the African green monkey on St. Kitts, have been thoroughly debated and established [35], the conservation value of lesser known non-native species such as the white-tailed deer on St. Kitts remains uncertain. It is unlikely that native flora and fauna communities could be restored to their pre-colonization stages, because human-induced changes in the vegetative associations and communities on the island over the last four centuries, including those attributable to the introduction of the deer, have been too great. It is also unlikely, on the socio-political side of the ledger, that the relevant stakeholders on St. Kitts would desire such restoration.

Against this background, this paper reviews historical and legal documents about wildlife conservation on St. Kitts in order to better understand the natural and legal history of the white-tailed deer. It also reviews the known and potential ecological, human health, and socio-political effects, both positive and negative, of the presence of white-tailed deer on the island, and recommends actions to further improve stakeholders', policy-makers', and citizens' understanding of the conservation status and value of the species.

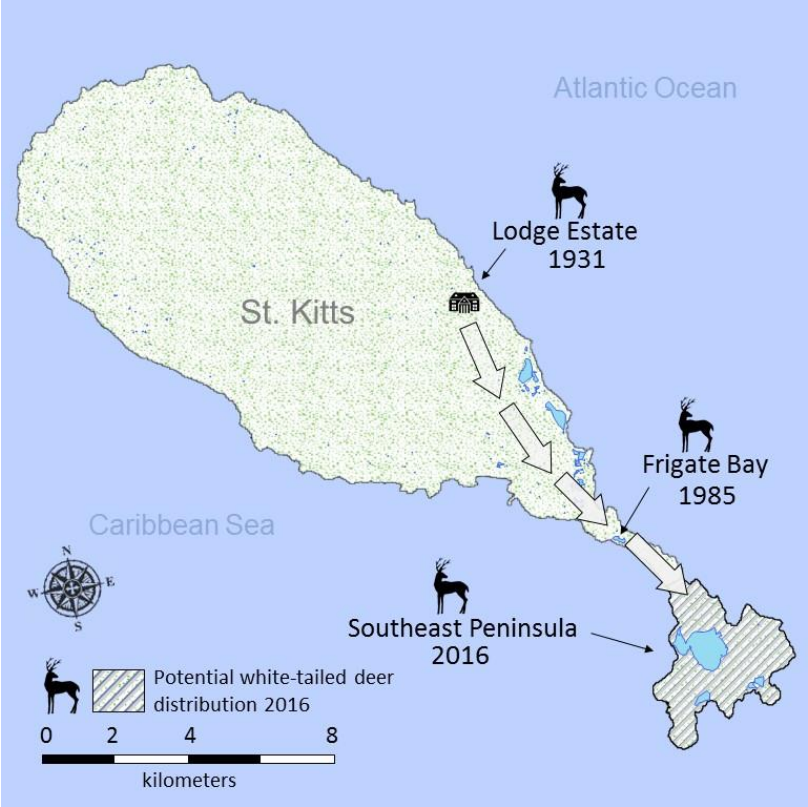

Fig. 2. Dispersal pattern of white-tailed deer since their introduction to the island of St. Kitts in 1931; and their potential distribution on the southeastern peninsula in 2016.

History and protection of white-tailed deer on St. Kitts

White-tailed deer were probably introduced to St. Kitts around 1931 by Phillip Todd, on the Lodge Estate plantation [7, 35]. Other reports claim the deer may have arrived as early as the 19th century [7]. Whichever the case, after they arrived some of the deer were released, 14-16 km southeast of the Lodge

Estate in the Frigate Bay area of St. Kitts [7]. For most of the twentieth century, Frigate Bay was a privately owned estate whose only commercial enterprise was small-scale salt mining, and this may have made it an excellent habitat for white-tailed deer. The only recorded activities were livestock grazing in the hillsides surrounding the estate and beach access by permits issued by the land owners. The area was purchased by the government of St. Kitts in the late 1950s and, after some lengthy legal disputes, tourism development began in 1972, and continued through the 1980s [36]. After their initial introduction to the Lodge Estate and their release into the Frigate Bay area, the history and status of white-tailed deer on St. Kitts remained markedly undocumented until, in 1985, a report was released by the Economic Commission for Latin America and the Caribbean (ECLAC) on "Tourism and the Environment: A Case Study of Frigate Bay, St. Kitts". (Fig. 2).

The report was commissioned "…to carry out a case study on tourism, development and the environment for the ... Frigate Bay area in St. Kitts-Nevis and to formulate guidelines and concrete recommendations on appropriate ways to introduce [an] environmental dimension in the tourism industry, including its related infrastructure…" [36 p.1]. This report mentioned deer as *regular* visitors to the Frigate Bay area, and noted the perception at the time amongst local wildlife enthusiasts that "The wildlife population has been decreasing as development increases and as preferred habitats are modified or eliminated…" [36 p.11]. The report highlighted two very important matters. First, St. Kitts was beginning to join other Caribbean nations in recognizing that, if tourism were to be a long-term economic endeavor, it would need to be introduced and developed in a sustainable fashion. And second, the report introduced the notion that wildlife, and specifically the white-tailed deer, could have conservation value to the people of St. Kitts.

In September of 1986, the government of St. Kitts and the U.S. Agency for International Development (USAID) concluded negotiations on a loan to construct a road into the peninsula south-east of Frigate Bay. This prompted the government to address some of the conservation and environmental prerequisites in order to receive the loan [35]. Just five weeks after this agreement with USAID was finalized, the South-East Peninsula Land Development and Conservation Act of 1986 (SPLDCA) was enacted in November of 1986. It was St. Kitts and Nevis' first piece of environmental legislation. Although the Act established a general legislative intent to impose environmental regulations on tourism development in the southeastern peninsula of St. Kitts, the only animal referenced by name in the statute appears in section (2) of the Act, where a wild animal is defined as "…any deer or other animal designated by the Minister by order under this Act." In a later section (Sec. 7, sub-section 2), the law then extended legal protection to wild animals in these terms:

> Any person who other than by authority in writing from the Minister- (a) willfully kills, wounds or takes any wild animal or wild bird; (b) takes, removes, injures or destroys any nest or egg of any wild bird; (c) exposes for sale or knowingly has in his possession any such wild animal or wild bird or any part of such animal or bird, killed, wounded or taken in the conservation area; (d) exports or attempts to export the carcass or skin of any wild animal or the skin or plumage of any wild bird killed, wounded or taken in the conservation area; shall be liable on summary conviction to a fine not exceeding two thousand dollars.

The white-tailed deer thus effectively became the first terrestrial mammal in the history of the newly independent nation of St. Kitts and Nevis to be afforded "protected status" by the government, and this despite the fact that it is a non-native species.

Six months after the SPLDCA was passed, St. Kitts drafted and enacted an additional statute that, at the time of this writing, is the basis for most of its environmental and conservation regulations: The National Conservation and Environmental Protection Act of 1987 (NCEPA). This Act reinforced the government's intention to protect the white-tailed deer on St. Kitts. Part VIII of the statute changed the definition of wild animal or wild bird to "any animal or bird specified in the Third Schedule", where the Third Schedule to the law lists only one wild animal, deer, along with 28 species of wild birds. The NCEPA also omitted language that had previously restricted protections for wildlife to the conservation area described in the earlier SPLDCA. Protection of wild animals and wild birds now extends across the entire Federation of St. Kitts and Nevis. The law also contains provisions to amend legislative protection for wildlife in the future, as needed. Thus, section 46 of the statute lays out conditions for the addition or removal of a species of wild animal or wild bird from the Third Schedule, saying that "The Minister may from time to time add or remove the name of any wild animal or wild bird in the Third Schedule by way of Notice published in the Gazette." The NCEPA clearly anticipates, in other words, that environmental and wildlife conservation policies in St. Kitts will be able to respond to the changing political will of the people.

Challenges implementing conservation and environmental legislation

Shortly after the passage of NCEPA, the USAID loan to construct a road system in the southeastern peninsula was officially finalized. The government of St. Kitts did not officially announce the law, however, until mid-1989 [14]. Although the NCEPA had mandated a Conservation Commission to guide the implementation of the Act, landowners on the southeast peninsula expressed concerns about how effective this would be, given that the five originally appointed members consisted of the permanent Secretary for Tourism, a private electrical contractor, a landowner/hotelier, a private engineer, and a public works engineer [37]. Among the primary concerns was that, short of the Conservation Commission, NCEPA failed to specify how the provisions and protections set forth in the statute would be administered or enforced. However, the USAID loan agreement yielded a resource management plan for the southeastern peninsula in May, 1989 [14]. Perhaps the most extensive treatment of the effects of development on the environment of the peninsula to date, the "Mammals" chapter of the report documented the presence of "no more than two dozen or so…" [38 p.1] white-tailed deer and claimed that the "Southern white-tailed deer are another favorite with tourists…" [38 p.8]. The report then went on to summarize the necessity of developing a National Parks and Protected Area System (NPPAS) for St. Kitts and Nevis and outlined how this might be done [14]. (Fig. 3).

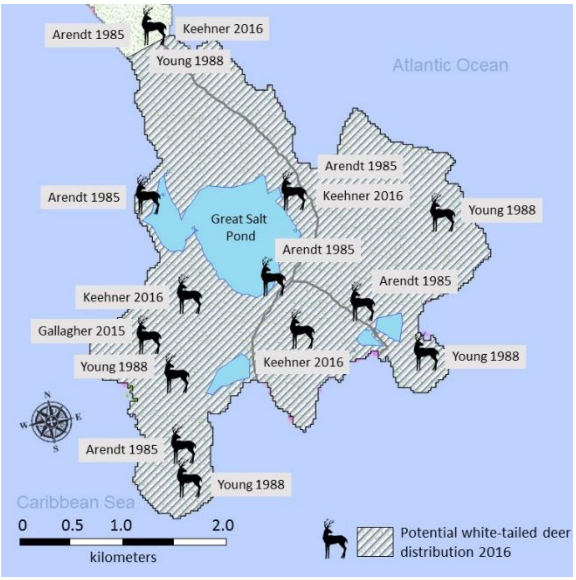

Fig. 3. Observers names and the locations of white-tailed deer sightings, tracks or fecal pellets on the southeastern peninsula of St. Kitts 1985-2016 [64-65].

A few years later, in 1991, the Caribbean Conservation Association prepared a Country Environmental Profile (CEP) of St. Kitts & Nevis in order to provide a framework for "…better knowledge and understanding of the region's unique environmental problems and the development of appropriate technologies and public policies to lessen and even prevent negative impacts on our fragile resource base." [10 p.3]. This report, again funded by USAID, recognized that economic growth in the Caribbean was contributing to the degradation of many of the region's ecosystems. There was specific criticism regarding the administration and implementation of the NCEPA:

> Finally, "wild animals" and "wild birds," as enumerated in the Third Schedule of the Act, are "protected". However, the legislation is not specific as to how "protection" is to be provided, monitored and enforced, nor does it specify which agency of Government is charged with wildlife protection responsibilities. Regulations to this important legislation await guidance from the now functional Conservation Commission; without regulations in place, the provisions for wildlife protection and biodiversity enhancement as provided in the NCEPA will lack sufficient specificity and authority to fulfill the intent of the lawmakers [10 p.112]

The report thus reiterated the concerns expressed in the May 1989 resource management plan, and made many of the same recommendations. It was clear that, while the SPLDCA of 1986 and the NCEPA of 1987 had succeeded in securing funding for the development of the southeast peninsula, critics were still concerned, in 1991, that the laws were not being properly administered, implemented, and enforced.

In 1994, St. Kitts developed a National Environmental Action Plan (NEAP) [30] to address the fact that more than eight years after the passage of the SPLDCA, and despite continuous and repeated calls for action, many of the environmental laws adopted in St. Kitts in nominal compliance with the terms of international development loans remained unenforced [37]. The Plan proposed that species of wildlife considered to be among the most endangered would now fall under a Protected Area System Plan (PASP), budgeted at US$3.2 million and designed to:

> Arrest [the] loss of bio-diversity and deterioration of cultural heritage by preserving sites of cultural, historic, scientific or educational significance, protecting endangered or threatened species of wildlife, controlling the rate of exploitation of economically useful species, preserving examples of terrestrial and marine ecosystems and maintaining the habitat of plants and animals in designated areas, and by creating national and marine parks [30 p.30].

Importantly, the NEAP stated that "Among the most endangered species in the islands today are marine turtles, some native species of birds, and deer." [30 p.16]. The NEAP thus suggested not only that deer were endangered on St. Kitts but also that they ranked in importance among marine turtles and native species of birds.

Over the next ten years, environmental legislation, administration, and enforcement continued to remain largely ineffective and perfunctory in St. Kitts and Nevis. By 2000, it was apparent that the Conservation Commission created by the NCEPA had failed to live up to expectations and it was disbanded [39-40]. In 2004, a National Biodiversity Strategy and Action Plan for St. Kitts and Nevis (NBSAPSKN) reiterated that white-tailed deer were protected, and noted that threats to white-tailed deer survival included habitat loss from overgrazing by cattle, sheep and goats. But, with the infrastructure for the development of the southeastern peninsula already in place, foreign loans dependent upon conforming environmental legislation were replaced by private foreign investment. In 2005, the sugar industry, which had been

owned by the government since 1972, officially ended. So, as dependence on a sugar-based economy ended and the transition to a tourism-based economy became a top priority [41] renewed efforts to improve conservation law in St. Kitts became imperative.

Transitioning from a sugar-based economy to tourism and development

In 2006, another report, this time from the Organisation of Eastern Caribbean States (OECS), ratcheted up criticism of the government's environmental policy [40].

> Clearly the Act (SPDLCA of 1986) meant for protected areas planning and management to be a central part of the development of the South-East Peninsula. There is no evidence to suggest that the South-East Peninsula Land Development and Conservation Board has ever undertaken any serious planning for protected areas, coastal conservation, or the maintenance of environmental quality, as required by the Act. As such, critical natural resources and fragile wildlife habitat continue to be threatened [40 p.20].

The report continues:

> What is unusual in the case of the South-East Peninsula is that an institution created to manage a development area established with conservation as a cornerstone of the development process has apparently ignored the provisions for conservation that are contained in the law…. The available information indicates that the Conservation Commission never functioned in the manner intended by the NCEPA [40 p.28].

The tangible effects of these failures to protect white-tailed deer started to become apparent in 2009. St. Michael's Development Corporation commissioned an Environmental Impact Assessment (EIA) on the construction of the Resort Villa Sub-Division in the hills above Cockleshell Bay in the southeast peninsula of St. Kitts [42]. The proposed residential portion of the development encompassed 152 acres in the southern portion of the southeast peninsula. But, surprisingly, the effects the development might have had on white-tailed deer were not reported or even mentioned in the EIA, although impacts on the non-native African green monkey and the small Indian mongoose were both briefly mentioned.

In 2013, a similar EIA prepared for Range Developments Ltd., prior to the construction of the Hyatt Resort and Spa at Banana Bay, also failed to address the impacts of the proposed development on the population of white-tailed deer in the southeastern peninsula [43]. However, in a separate document, the developers claimed to have installed "…deer feeders to support the growing white-tailed deer population." [44 p.11]. Whether or not the deer feeders are currently deployed is unknown.

The United Nations Development Programme collaborated with St. Kitts and Nevis on a project, beginning in 2014, which recognized that the impending collapse of the sugar industry forced St. Kitts to negotiate and accept loans to fund the transition to a tourism and development-based economy. The conditions under which the loans were granted, requiring specific environmental laws and regulations to be enacted, were difficult to implement, however, without the requisite funding to do so. Nearly 30 years later, with the infrastructure for development and tourism firmly in place, the funding to enforce and administer the legislation is still needed [41, 45]. As the UNDP observed, this failure could very well result in the destruction of the natural and environmental attractions which drew tourism and development to St. Kitts in the first place. The agreement funding this UNDP project was officially signed in August of 2015, and would create a government department solely funded and operated to protect biodiversity and habitat, the first of its kind in St. Kitts and Nevis.

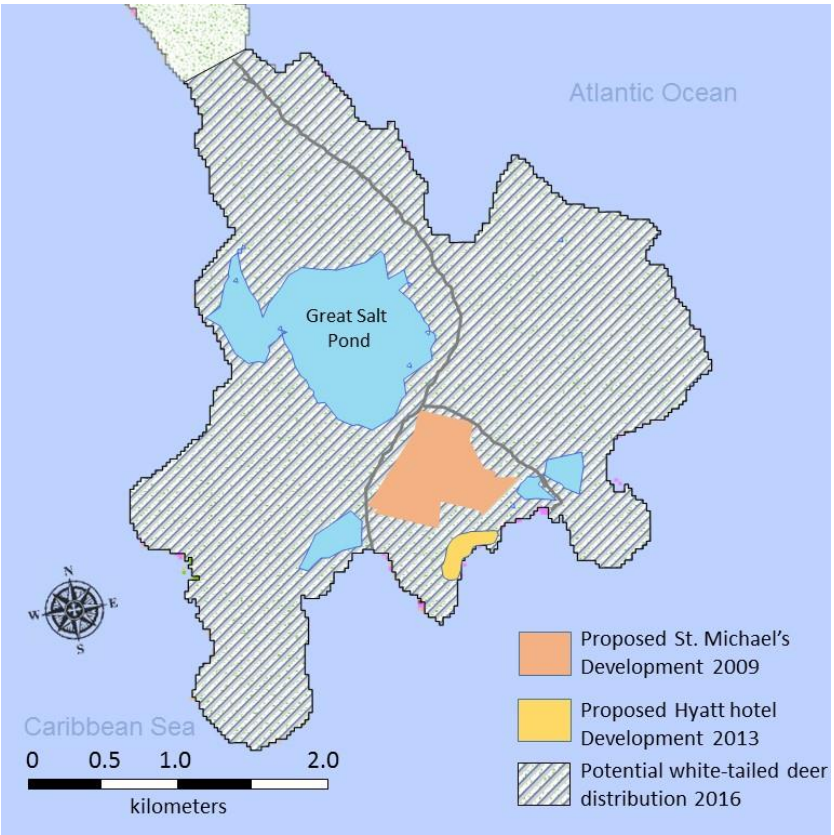

Fig. 4. Location of the proposed St. Michael's development (2009) and the approved Hyatt Resort development (2013).

Although the UNDP agreement now funded the protection of biodiversity in St. Kitts, evidence of white-tailed deer presence on the island had not been recorded since 1999 [8]. In February 2015, photographs (Fig. 5) and videos of deer were obtained with camera traps set up in the southeast peninsula as part of a monkey-tracking project. A year later, over the course of six weeks between January and March, informal searches for evidence of the presence of white-tailed deer were carried out. A mature, male white-tailed deer was observed near the Great Salt Pond on the southeastern peninsula and, on a separate occasion, a mature female was observed, and her accompanying fawn was photographed. This documents a reproducing population of at least one male, one female, and a viable juvenile offspring.

The desire to legally protect white-tailed deer in St. Kitts and Nevis began unambiguously in 1987 and the consistent references to the conservation of white-tailed deer in legal enactments make it very clear that their protection is important to the people of St. Kitts and Nevis. Furthermore, while many other non-native species, such as the African green monkey and the mongoose, have been slated for control or eradication, the white-tailed deer is excluded from these mandates. The white-tailed deer's socio-political value to the people of St. Kitts may, at first, seem dubious given the legal history of efforts to protect the species. However, it is worth noting that international funding for tourist-based infrastructure and development in St. Kitts [37] could not have been secured without bracketing that funding with the protection of the white-tailed deer. In subsequent years, the white-tailed deer population has increasingly been ignored, gone largely unnoticed, or has simply been forgotten (Table 1). But this should not blind us to its historical importance in wildlife conservation on St. Kitts.

Table 1. Historical and legal documents pertinent to the conservation history and legal status of white-tailed deer in St. Kitts and Nevis.

Year	Document title	Type	Commissioning body
1985	Wildlife Assessment of the Southeastern Peninsula, St. Kitts, West, indies	Report	United States Agency for International Development
1985	Tourism and the Environment: A case study of Frigate Bay, St. Kitts	Report	United Nations Environment Programme
1986	Environmental Assessment Report on the Proposed Southeast Peninsula Access Road St. Kitts, West Indies	Report	Government of St. Kitts and Nevis
1986	Southeast Peninsula Land Development and Conservation Act	Law	Government of St. Kitts and Nevis
1987	National Conservation and Environmental Protection Act	Law	Government of St. Kitts and Nevis
1989	The Southeast Peninsula Project in St. Kitts Volume 1: Resource Management Plans	Report	United States Agency for International Development
1991	St. Kitts and Nevis Country Environmental Profile	Report	Caribbean Conservation Association
1994	St. Kitts and Nevis National Environmental Action Plan	Action Plan	Government of St. Kitts and Nevis
2004	National Biodiversity Strategy and Action Plan for St. Kitts and Nevis	Action Plan	Government of St. Kitts and Nevis
2006	Review of the Policy, Legal, and Institutional Frameworks for Protected Areas Management in St. Kitts and Nevis	Report	Organisation of Eastern Caribbean States
2013	St. Kitts and Nevis Land Policy Issues Paper	Report	Organisation of Eastern Caribbean States
2014	St. Kitts and Nevis National Biodiversity Strategy and Action Plan	Action Plan	Government of St. Kitts and Nevis
2015	Conserving Biodiversity and reducing habitat degradation in Protected Areas and their influence.	Agreement	United Nations Development Programme

Risks and benefits of white-tailed deer conservation

The socio-political value of any non-native species must be weighed against the ecological effects of its conservation, both positive and negative, and the associated risks to human health. White-tailed deer are the widest ranging and most abundant member of the deer family *(Cervidae)* [46]. Endemic white-tailed deer populations are distributed from the northern latitudes of North America, south through Central America, and into the northern reaches of South America [46]. The high level of genetic variability inherent in the species results in considerable variation in body size, morphological characteristics, and behaviors [47]. There are 38 recognized sub-species, although many of these are based solely on morphological data [46]. The exact sub-specific origins of the founding population of white-tailed deer on St. Kitts is unknown. In the NEAP of 1991, the deer were referred to as Florida white-tailed deer *(Odocoileus virginianus seminolus)* but, in Young 1989 [38], they are referred to as Southern white-tailed deer *(Odocoileus virginianus virginianus).* Both species are very adaptable to variable habitat conditions and, with high reproductive rates, local populations can grow and expand their range very quickly in areas with few natural predators [48-49].

Fig. 5. Mature male white-tailed deer (left); mature female white-tailed deer (center); photographed from camera trap deployed on southeast peninsula of St. Kitts 2015 [66]. White-tailed deer fawn (right) approx. 6-8 weeks of age, photographed in 2016 on southeast peninsula of St. Kitts during survey [65].

White-tailed deer may exert a strong influence on vegetative communities as their diets are widely varied and they browse on herbaceous plants, fruits, nuts, and new growth of shrubs and trees [49]. In areas of agricultural production they can be very destructive to crops, causing large economic losses [50]. White-tailed deer can also become habituated to human development. They will often browse on landscaping shrubs near houses and, over time, can become quite tolerant of human presence [51]. In some cases, human development creates very attractive micro-habitats which increase deer group size, as deer remain in close proximity to one another for long periods of time. Larger group sizes and frequent interactions can put deer at greater risk of disease transmission [52]. Examples of such diseases in the United States are bovine tuberculosis [53], enzootic hemorrhagic disease [54] and chronic wasting disease [55]. In addition, deer encroachment near human settlements increases the risk of transmission of zoonotic diseases such as Lyme disease [56] and ehrlichiosis [57]. In many cases, the health of deer populations can be viewed as an indicator of overall ecosystem health. When deer are conserved, other species may thrive as well [58].

A healthy ecosystem is also good for tourism. Providing an alternative wildlife viewing experience, such as the white-tailed deer, may reduce the perceived value of African green monkeys amongst tour operators and also alleviate pressure on endangered sea turtles. For example, in St. Kitts, perhaps the most often asked question is "Where can we see the monkeys?" because few tourists have ever seen a primate in the wild [38]. This creates a conflict between the cultural and tourism value of the monkey and the ecological and agricultural damage the monkey has caused since its introduction to the region. In other cases, where unique wildlife is threatened or endangered, tourism increases human interaction with the species and may contribute to species declines. In addition to the African green monkey, various species of threatened and endangered sea turtles are common viewing requests from tourists [59], who are mostly oblivious to the potential damage that viewing or interacting with sea turtle nesting habitats can cause. But if white-tailed deer are going to provide lasting value to St. Kitts tourism, their cultural and historical relationship with the people of St. Kitts needs to be effectively highlighted [30].

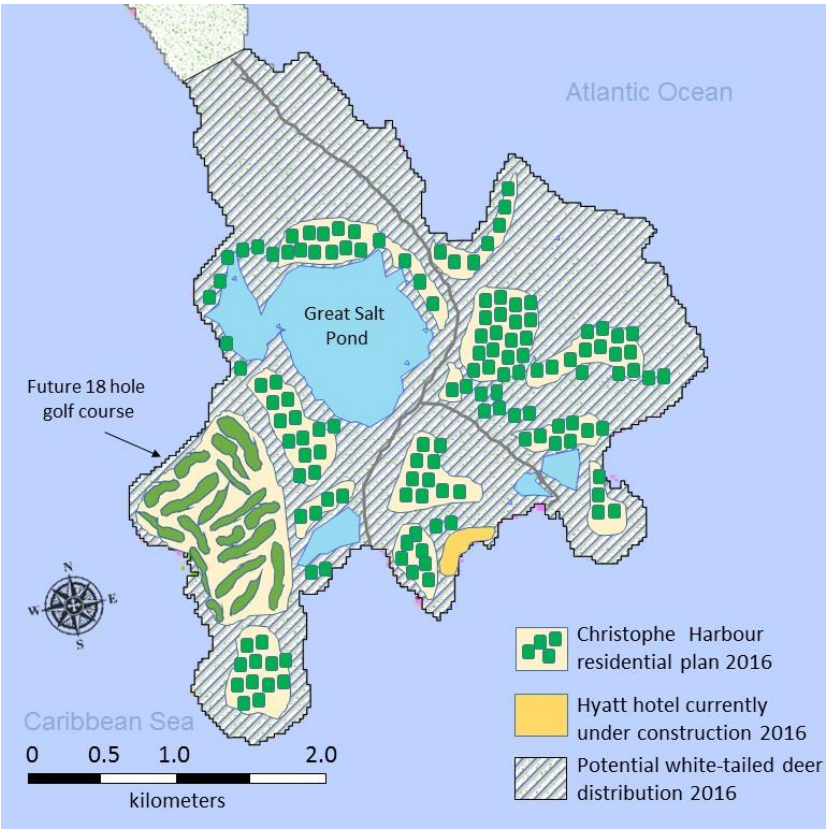

Fig. 6. Future golf course and Christophe Harbour development plan on the southeastern peninsula of St. Kitts.

Conclusion

Given the history of white-tailed deer on St. Kitts and the remarkable ability of the population to persist in 15.8 km^2 of habitat (southeastern peninsula) with apparently "less than two dozen or so" [38 p.1]" animals over the last 80-90 years, the population appears unlikely to deviate from its present equilibrium, unless there is some drastic form of anthropogenic intervention. Planned developments on the southeastern peninsula could reduce habitat for white-tailed deer by as much as 40% (Fig. 6.) As the primary stakeholder in the legislative and political process of making conservation policy, the public's perception of the relevant risks and benefits will surely influence decision making processes with respect

to the eradication, preservation or stagnation of the white-tailed deer population on St. Kitts. So, what needs to be done to inform this perception?

Future research on the white-tailed deer on St. Kitts should begin with an estimation of abundance, density, geographic distribution and disease parasite burden (e.g. parasite load). Methods such as distance sampling [60], fecal pellet counts [61], and camera trap surveys [62], could reasonably accomplish this goal relatively quickly and inexpensively. This data would form a baseline from which to move forward and begin assessing other important components of their conservation, as well as associated ecological and human health risks, such as population demography (survival, mortality, and growth rates); the probability of persistence, through a Population Viability Analysis (PVA) [63]; and observing and recording novel white-tailed deer behavior and life characteristics. Data should also be collected to assess their impact on vegetative communities and interference competition with African green monkeys. Samples allowing for future genetic analysis could be collected and archived with minimal effort and expense.

We think that the legal protection afforded the white-tailed deer and the consistently positive mention of them in historical documents suggests that their socio-political value on the island warrants further research into the ecological risks and benefits their conservation may present. We further suggest that the risk of habitat loss and fragmentation from planned development in the area of their primary habitat, the southeastern peninsula of St. Kitts, demands immediate action to prevent the possible extirpation of the species.

As a final word, perhaps the single most important observation in any of the historical and legal documents we examined appeared in the report published in May of 1989, summarizing the conservation outlook for the southeastern peninsula:

> If it were only the finances and futures of a few private land owners that are at risk here, there would be no need for concern on the part of Government. However, the risk is much more wide spread and affects the livelihood of many more individuals. It may be said, that in the long run, the entire economy of the island is at risk. In the short run, taxes collected on land sales and increases in Gross Domestic Product resulting from construction activities will benefit Kittitians, but in the long run, the sustainability of the tourist based development and resulting Government revenues depends on a positive competitive position in the Caribbean tourism market place. "Upscale hotels" and a healthy, vital, and attractive environment are the key to maintaining a competitive position.
>
> Ultimately, the affairs of humans, their economies and their social fabric depend on the surrounding environment. That tourism is dependent upon a healthy environment is quite obvious. Where environmental deterioration has occurred, and where environmental values are low, tourism does not flourish. The greater the environmental values, the greater the potential for tourism. That is why it is of utmost importance that the environment, both the terrestrial and marine environments, are protected and their continued health becomes the concern of all Kittitians [14 p.3].

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