

Chapter 30

History and Management of Sika Deer on the Delmarva Peninsula



Jacob L. Bowman, T. Brian Eyler, David M. Kalb, and Angela Holland

Abstract Clement Henry accepted a gift of five sika deer from the Duke of Bedford in 1916. After being released on James Island, Maryland, this population became the founders of the current population of 10,000–20,000 individuals on the Delmarva Peninsula. These deer are from the smallest subspecies of sika deer (*Cervus nippon yakushimae*), which are native to Yakushima Island and Kuchinoerabujima Island in Japan. These deer are small in stature with adult body mass of 25–40 kg. Although they are a valuable game species with 3,500–4,000 individuals harvested annually, they are non-native and may compete with the native white-tailed deer. Empirical evidence exists for interspecific competition via overlap in resource use and changes in resources use; however, no evidence exists for interspecific competition impacting population ecology of white-tailed deer. The current management philosophy of the state wildlife agencies is to slow or prevent the range expansion of sika deer to minimize impacts to native white-tailed deer and to reduce human conflicts.

30.1 Introduction and History on the Delmarva Peninsula

Sika deer have three free-ranging populations in the United States. The central Texas population occupies 11 counties with approximately 4,000–5,000 individuals (Feldhamer and Demarais 2009). The Kentucky population of <100 animals is spread across 3 northern counties (Feldhamer and Demarais 2009). The largest population is found on the Delmarva Peninsula, which encompasses Delaware and

J. L. Bowman (✉) · A. Holland

Department of Entomology and Wildlife Ecology, University of Delaware, Newark, DE, USA
e-mail: jlbowman@udel.edu; aholland@udel.edu

T. B. Eyler

Wildlife & Heritage Service, Department of Natural Resources, Clear Springs, MD, USA
e-mail: brian.eyler@maryland.gov

D. M. Kalb

Rhode Island Fish and Wildlife, West Kingston, RI, USA
e-mail: David.Kalb@dem.ri.gov

the Eastern Shores of Maryland and Virginia. This population numbers approximately 10,000–12,000 individuals. The majority of this Delmarva population is found in Maryland, which accounts for 85–95% of the population.

The origin of sika deer on the Delmarva Peninsula was traced to Yakushima Island, Japan, using genetic evidence (Kalb and Bowman 2017; Kalb et al. 2019). These deer are from the smallest subspecies of sika deer (*Cervus nippon yakushimae*), which are native to Yakushima Island and Kuchinoerabujima Island in Japan (Kalb and Bowman 2017). Kalb and Bowman (2017) detailed the probable route of the descendants of the deer moving from Japan through Europe into Woburn Abbey in England. In 1916, the Duke of Bedford gave five individuals to Clement Henry in Dorchester County, Maryland (Kalb and Bowman 2017). These deer were kept as pets for a short period before being released onto James Island (Fig. 30.1; Kalb and Bowman 2017).

The population on James Island continued to increase in abundance and numbered 280–300 individuals by 1955 (Christian et al. 1960; Flyger 1960). Local residents reported that sika deer were common on Taylors Island, to the south of James Island, and were established on the mainland (Flyger and Warren 1958). In August 1957, an uncontrolled wildfire burned across much of James Island reducing deer forage (Flyger and Warren 1958). The following winter, 1957–1958, was particularly severe, and a mass die-off of sika deer occurred on the island. Flyger and Warren (1958) found 161 skeletal remains of deer sika, which accounted for 50% loss of the population on James Island. The population on James Island continued to decline over time as the size of the island decreased and eroded into three smaller islands (Kalb and Bowman 2017).

By 1962, sika deer occupied the western third of Dorchester County (Fig. 30.1; Flyger and Davis 1964). The population has continued to increase in abundance and expand its range. Density of sika deer in western Dorchester County averaged 33 deer/km² and ranged from 17 to 42 deer/km² (Dougherty 2010; Dougherty and Bowman 2012). By 2021, the Dorchester population had expanded into adjacent counties with breeding populations occurring in Caroline, Somerset, and Wicomico counties in Maryland (Fig. 30.1). The populations in Caroline and Somerset counties are small with <10 sika deer harvested per year. The Wicomico population is larger with >100 harvests per year. The Dorchester population has also expanded into Delaware along the Nanticoke River with a small breeding population in Sussex County, Delaware. This population accounts for one to three harvests per year. Sika stags have been harvested in Kent and Cecil Counties, Maryland, and in Kent County, Delaware. All these stags were yearlings and likely were dispersing individuals.

A second population on the Delmarva Peninsula is on Assateague Island, which is a barrier island that stretches along the southern coast of Maryland and the northern coast of Virginia (Fig. 30.1). In 1920, Charles Law purchased five sika deer from the James Island population (Flyger 1960; Kalb and Bowman 2017). These deer were kept in Berlin, Maryland, as pets for few years before they and their offspring were sold to Dan Trimper in Ocean City in 1924 (Kalb and Bowman 2017). These deer were part of a roadside amusement park, but at some point, they were released onto

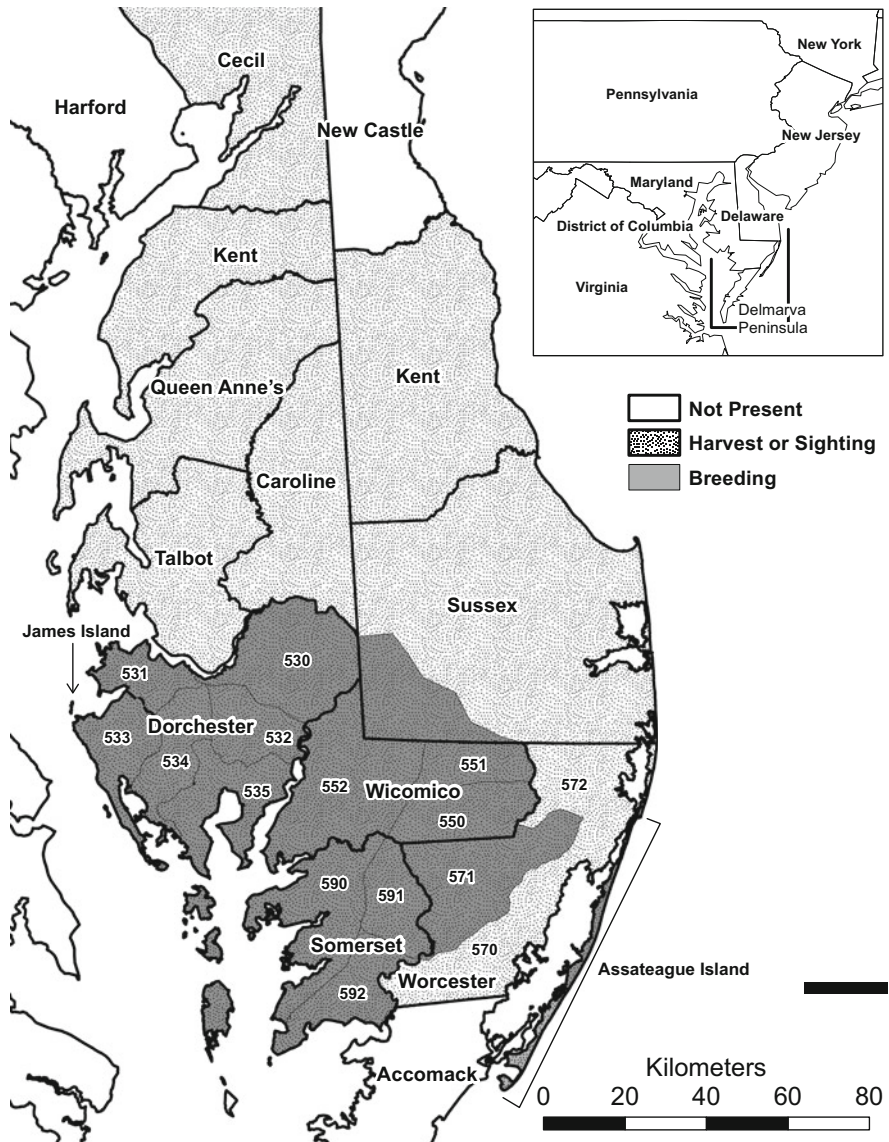


Fig. 30.1 The breeding range of sika on the Delmarva Peninsula in 2021. The numbered subsections in the counties are the private land codes used to track deer harvest

the northern end of Assateague Island (Kalb and Bowman 2017). This population expanded south into the Virginia portion of the island by 1943 (USFWS 2015). In 1958, estimates of the population ranged from 60 to over 100 individuals, but these estimates were likely gross underestimates (Presnall 1958; Flyger 1960). The population had reportedly grown to 1,000 individuals by 1962 (Flyger and Davis 1964).

By 1963, the sika deer population was estimated to be 1,300 individuals, which caused a clear browse line on the island (USFWS 2015). The Chincoteague National Wildlife Refuge (the Virginia portion of Assateague Island) initiated a harvest to reduce deer numbers in 1964 (USFWS 2015). The deer population on the Chincoteague NWR was estimated at 1,000 individuals in the mid-1990s. The current population estimate for the entirety of Assateague Island is 1,000–2,000 sika deer. A small population of sika deer is believed to inhabit the Maryland mainland adjacent to the island (Worcester County, Deer Management Units 570 and 572, Fig. 30.1), but it is unknown if there is a breeding population. Sika deer are not believed to occupy the mainland in Virginia.

30.2 Biology and Ecology

30.2.1 Genetics

The Delmarva population of sika deer originated from the island of Yakushima Island stocks and came by way of the United Kingdom (Kalb and Bowman 2017; Kalb et al. 2019). The introduction was a single release of five individuals (Kalb and Bowman 2017; Kalb et al. 2019). This population has reduced genetic variation resulting from founder and bottleneck events (Kalb et al. 2019). Although the population has lost neutral density from these events, the population does not exhibit any known physical abnormalities associated with inbreeding (Kalb et al. 2019).

30.2.2 Description

Sika deer exhibit a range of color patterns. They are typically chestnut brown in winter and more reddish brown in the summer with a dark stripe along the spine (Whitaker Jr and Hamilton Jr 1979). They often have seven to eight rows of white spots, which are more obvious in the summer and along the spine (Whitaker Jr and Hamilton Jr 1979). They exhibit a large white rump patch throughout the year (Whitaker Jr and Hamilton Jr 1979).

The sika subspecies introduced into Maryland is a small island subspecies and much smaller than their mainland counterparts. Stags obtain the maximum body size at 5.5–7.5 years (Feldhamer et al. 1985). Adult body mass is 30–40 kg with very large individuals exceeding 45 kg (Feldhamer et al. 1985). Total body length is 135–145 cm with a shoulder height of 78–84 cm (Feldhamer et al. 1985). Antler development follows patterns like other cervids. Antlers begin growing in May and harden in August. Antlers are retained until spring when they are shed. Young stags (0.5 years old) have button, and yearlings (1.5 years old) almost always have spike antlers. Adult stags have two to three points per antler beam with exceptional individuals having four points per antler beam (Whitaker Jr and Hamilton Jr 1979;

Feldhamer and Demarais 2009). Antler beam on mature males are 30–60 cm in length and 2.5 cm in diameter (Whitaker Jr and Hamilton Jr 1979). Hinds reach maximum body size earlier at 4.5–5.5 years (Feldhamer et al. 1985). Adult body mass is 25–35 kg (Feldhamer et al. 1985). Total body length is 122–128 cm with a shoulder height of 66–68 cm (Feldhamer et al. 1985). Most adult mortality is harvest related (Eyler 2001; Kalb 2010). Stags typically survive 1.5–3.5 years, with some living longer than 7 years (TB. Eyler, unpublished data). Hinds typically survive 1.5–5.5 years with some documented surviving 20+ years (TB. Eyler, unpublished data).

30.2.3 *Reproductive Ecology*

Rutting activity begins in late September and can continue into December with a peak in the middle of October (Feldhamer 1980; Mullan et al. 1988). Although hinds can breed at 6 months of age, most do not breed for the first time until they are 1.5 years old (Mullan et al. 1988). Adult hinds ovulate before yearlings, which likely extends the calving season (Feldhamer and Marcus 1994; Mullan et al. 1988). The conception rate is very high for adults and yearlings (94.4%, Mullan et al. 1988). The gestation period is 30 weeks with most parturition occurring in late May and June (Feldhamer 1980). Typically, single calves are produced with twins being extremely rare (Feldhamer 1980; Feldhamer and Marcus 1994). The size and weight of neonates on the Delmarva Peninsula are unknown.

30.2.4 *Diet*

The diet of the sika deer is flexible, likely resulting from their rumen physiology (Feldhamer and Demarais 2009). Sika deer diet during winter on the Delmarva Peninsula is forbs (1–3%), grasses (42–47%), sedges and rushes (12–16%), and woody browse (38–40%; Kalb 2015, Kalb et al. 2018). The most unique characteristic of their diet on the Delmarva Peninsula is the abundance of saltwater and freshwater marsh species (e.g., *Carex* spp., *Cyperus* spp., *Juncus* spp., *Scirpus* spp., *Phragmites australis*, *Spartina patens*; Kalb 2015; Kalb et al. 2018). This diet corresponds to them being more common in tidal marsh and bottomland areas. They also are responsible for crop depredation on corn and soybeans, which can be important food sources during the growing season.

30.2.5 Diseases and Parasites

Sika deer are host to a wide variety of diseases and parasites (Feldhamer 1980). Davidson and Crow (1983) reported that sika deer in Maryland and Virginia were less burdened with ticks, chiggers, and sarcocystis than native white-tailed deer, but sika deer in their original distribution area (i.e., Japan) were burdened by ixodid ticks (Yamauchi et al. 2009). Likewise, serology examinations of the same animals suggested that sika deer were exposed to fewer infectious disease agents than native whitetails. Feldhamer and Demarais (2009) summarized the little that is known about diseases and parasites within the introduced population in North America, much of which is from outside of the Delmarva Peninsula. A respiratory virus, *Myxovirus parainfluenza* 3, was detected via antibodies of sika deer from Assateague Island, but population level effects are unknown (Shah et al. 1965). Lyme disease is common on the Delmarva Peninsula. Deer are known reservoirs of *Borrelia burgdorferi* the causative agent of Lyme disease, and antibodies for it were detected in sika deer from Assateague Island (Oliver et al. 1999). Although deer serve as reservoirs of the pathogen, they do not exhibit any impact on their survival. Hemorrhagic disease is an important cause of mortality in white-tailed deer and typically occurs in outbreaks every 6–8 years (Haus et al. 2020). White-tailed deer on the Delmarva Peninsula exhibit annual survival rates of 72–98%, but annual survival rates as low as 38% have been observed in outbreak years (Haus et al. 2020). Observations by biologists in Maryland suggest that sika deer may not be impacted by hemorrhagic disease since the virus has not been identified in the species to date. Chronic wasting disease has been detected in Maryland white-tailed deer in the western part of the state, and the disease has been detected in captive sika deer elsewhere. While this disease has not been detected in Maryland or Virginia sika deer, biologists assume sika deer in these states are susceptible to the disease.

30.2.6 Vocalizations

Sika deer are often noted as being the most vocal cervid with upwards of ten vocalizations identified (Feldhamer 1980). The most common is an alarm call used by both sexes which is akin to a “sharp scream” (Feldhamer 1980). During the rut, stags vocalize a roar, which is common in other species of *Cervus* and has been described as “blood-curdling screams” in sika deer (Feldhamer 1980). The hinds are reported to communicate via “goatlike bleats” and to use “soft horselike neighs” when communicating with calves.

30.2.7 Spatial Ecology and Habitat Use

Sika deer are nocturnal and exhibit very little movement during the day (Feldhamer 1980). They are solitary except for hinds with calves (Whitaker Jr and Hamilton Jr 1979). Stags sometimes form bachelor groups after antler shedding (Whitaker Jr and Hamilton Jr 1979). Hind home ranges averaged 161 ha in Dorchester County, Maryland (range 35–546; Eyler 2001). Only 1 of 15 hinds dispersed suggesting a low dispersal rate for hinds (Eyler 2001). For stags, home ranges were highly variable in size and ranged from 464 to 4121 ha and were influenced by season and deer movement (Kalb 2010; Kalb et al. 2013). Stags exhibit three home range types: local, migratory, and nomadic (Kalb 2010; Kalb et al. 2013). The most common movement group (70%; 42 of 60) was local, and these deer exhibited short movements confined to a well-established home range (Kalb 2010; Kalb et al. 2013). Migratory stags (14 of 60) had well-defined seasonal movements between 2 distinct home ranges (Kalb 2010; Kalb et al. 2013). Nomadic stags (4 of 60) were least common and exhibited movements across the landscape without an association to season (Kalb 2010; Kalb et al. 2013). Most (19 of 20) yearling stags dispersed, but 1 dispersed at 2 years of age (Kalb 2010; Kalb et al. 2013). The average dispersal distance was 7.7 km (Kalb 2010; Kalb et al. 2013). Most stags (55%; 11 of 20) dispersed in the spring with an average date of 23 April (Kalb 2010; Kalb et al. 2013). Some stags (5 of 20) dispersed in summer with an average date of 19 June (Kalb 2010; Kalb et al. 2013). The remaining stags (4 of 20) dispersed in fall with an average date of 30 September.

Sika deer on the Delmarva Peninsula are typically found in freshwater and saltwater marshes and surrounding forests and cropland (Whitaker Jr and Hamilton Jr 1979). Much of what we know about sika deer habitat selection on the Delmarva Peninsula is based on ancillary observations since few studies have been conducted. Female sika deer in Dorchester County, Maryland, selected tidal and fresh marshes and wet woodlands more than other habitats (Eyler 2001). On Assateague Island, sika selected forest and tall shrub more than other habitats (Diefenbach and Christensen 2009). Assateague Island is a unique habitat and is home to white-tailed deer and ponies, which may partially explain differences observed with Dorchester County.

30.3 Interspecific Competition

Interspecific competition between sika deer and the native white-tailed deer has been a concern since the 1970s (Feldhamer et al. 1978). Interspecific competition occurs when the use or defense of limited resources by one species causes the availability of resources for another species to be limited (Feldhamer and Demarais 2009). These relationships are notoriously difficult to document in cervids (Feldhamer and Demarais 2009). Feldhamer and Demarais (2009) noted three ways to document

interspecific competition: “(1) overlap in resource use; (2) changes in resources use; or (3) changes in population density, age structure, fecundity, or survival in one or both competing species.”

The earliest empirical evidence for interspecific competition came from Assateague Island, which is a barrier island stretching along the coast of Maryland and Virginia (Fig. 30.1). The diet of sika deer and white-tailed deer had significant overlap with most plant species consumed by both species (Keiper 1985; Keiper 1990). An interesting finding for sika deer diet was the overall lack of grasses in their diets (Keiper 1985; Keiper 1990). Grasses are typically a dominant food item in other areas (Feldhamer and Demarais 2009) but represented less than 25% of their diet on Assateague Island (Keiper 1985; Keiper 1990). The presence of ponies on the island may have confounded these results because ponies are grazers and depend largely on grasses for forage. Keiper (1990) documented that ponies caused a decline in dune vegetation (i.e., grasses), which likely affected grass availability for sika deer. Additionally, the ponies likely reduced the availability of other forage types for both species of deer (Keiper 1990). Sika deer have greater dietary plasticity and are more successful in degraded habitats (Feldhamer and Demarais 2009). The lower white-tailed deer abundance may be a result of habitat degradation by the ponies and not interspecific competition with sika deer.

Understanding how sika deer and white-tailed deer use the landscape in space and time is necessary for understanding interspecific competition. Another study on Assateague Island investigated space-use of both species (Diefenbach and Christensen 2009). Survival rates and harvest rates were similar between the two species (Diefenbach and Christensen 2009). Harvest was the primary cause of mortality, and survival rates outside the hunting season were 98–100% (Diefenbach and Christensen 2009). These results suggest that interspecific competition is not impacting adult survival rates. Home range size of sika deer was greater than white-tailed deer (Diefenbach and Christensen 2009). Sika deer moved longer distances than were observed in white-tailed deer (Diefenbach and Christensen 2009). Diefenbach and Christensen (2009) hypothesized that these longer movements may have permitted sika deer to exploit food resources that were in limited quantity or higher quality, but without an assessment of diet, this hypothesis could not be investigated further (Diefenbach and Christensen 2009). Both species of deer used habitats defined as tall shrub and forest vegetation and were less likely to use areas away from these habitats (Diefenbach and Christensen 2009). These results may have been confounded by the presence of ponies, which use open habitats more than forested habitats. Diefenbach and Christensen (2009) recommended additional research to understand the interspecific competition between both deer species and ponies.

Outside of Assateague Island, research on interspecific competition between sika deer and white-tailed deer has occurred in Dorchester County, Maryland, where these deer are the only species of ungulates (Fig. 30.3). Eyler (2001) used radiotelemetry to investigate spatial use of both species. Female sika and white-tailed deer had similar home range areas (Eyler 2001). Using a 65% core-use estimate, the mean percent overlap within species was 32%, whereas the mean percent overlap between

species was 18% (Eyler 2001). Sika deer and white-tailed deer used habitats differently based on compositional analysis of habitat use (Eyler 2001). Female sika deer selected marshes more than other habitat types, whereas female white-tailed deer selected forested habitats (Eyler 2001). Although cropland was the second most important habitat for white-tailed deer, it was the least important for sika deer (Eyler 2001). Based on these results, sika deer and white-tailed deer appear to be partitioning habitat use, which would result in reduced competition (Fig. 30.4).

To better understand dietary overlap, Kalb et al. (2018) collected fecal samples from sika deer and white-tailed deer in three areas with similar habitat quality: (1) an area with sika deer but very few white-tailed deer, (2) an area with white-tailed deer but not sika deer, and (3) an area with similar densities of sika deer and white-tailed deer. These areas were selected to control for harvest pressure and resource availability (Kalb 2015; Kalb et al. 2018). Microhistological analysis was used to estimate the percentage of plant species used by sika deer and white-tailed deer (Kalb 2015; Kalb et al. 2018). The deer species exhibited significant resource overlap (range 63–88%; Kalb 2015; Kalb et al. 2018). When sika deer and white-tailed deer were both present, white-tailed deer niche breadth increased (108%), and diet quality (17%) was lower (Kalb 2015; Kalb et al. 2018). Sika deer and white-tailed deer had a 78% overlap in diet (Kalb 2015; Kalb et al. 2018). White-tailed deer were altering their diet in the presence of sika deer and consuming lower-quality forage. Sika deer are intermediate feeders, which tolerate greater fiber in their diets, whereas white-tailed deer require greater diet quality because they are concentrate selectors (Kalb 2015; Kalb et al. 2018). The changes in niche breadth and diet quality along with significant dietary overlap strongly denote dietary competition between these species.

Hunter harvest across time could provide an understanding of interspecific competition between sika deer and white-tailed deer. In the 1970s, the percentage of sika deer in the harvest increased as white-tailed deer decreased (Feldhamer et al. 1978). Part of this change likely resulted from a reduction in the bag limit for white-tailed deer and an increase in the bag limit for sika deer (Feldhamer et al. 1978). As previously noted, the harvest rates for sika deer and white-tailed deer were similar in 2006–2007 (Diefenbach and Christensen 2009). Data from hunter harvest in Dorchester County dating back to 1990 does not show a significant decrease in white-tailed deer harvest (TB. Eyler, unpublished data). An important limitation of harvest data is that it may not mirror actual changes in the population. The fluctuation in harvest numbers is related to harvest regulations, hunter behavior, and habitat.

In summary, empirical evidence exists for interspecific competition via overlap in resource use and changes in resources use; however, no evidence exists for interspecific competition impacting population ecology of white-tailed deer. Research in Texas suggests the competitive effects may be more pronounced during periods of resource limitations (Feldhamer and Demarais 2009). With the exception of Assateague Island, habitat quality is excellent across the Delmarva Peninsula. This high habitat quality may explain why population level effects of interspecific competition with sika deer have not been observed in white-tailed deer.

30.4 Management of Sika Deer on the Delmarva Peninsula

30.4.1 *Maryland*

Maryland's annual deer hunting season officially closed in 1902 after the near extirpation of white-tailed deer during the 1800s. The season did not reopen in Dorchester County until 1951. As a result, there was no formal harvest of sika deer for the first 35 years of their free-range existence in Maryland; however, local residents most likely made opportunistic use of the available resource, and there were scattered reports of their harvest as early as 1938 (Flyger and Warren 1958).

Sika deer remained a relatively small fraction of the total deer harvest in Dorchester County during the 1950s and 1960s. From 1951 until 1972, there was no differentiation in sika deer and white-tailed deer in Maryland Department of Natural Resources (MDNR) harvest records (Feldhamer et al. 1978). However, harvest estimates for the period suggest that less than 200 sika deer were harvested annually and comprised less than 20% of the total deer harvest for the county. Although the annual harvest was relatively small during the timeframe, evidence suggested the population was slowly increasing in number and expanding its range. Beginning in 1973, MDNR separated sika deer from white-tailed deer on their hunter harvest tags, enabling better tracking of harvest and population trends for the two species; however, both species still shared the same hunting seasons and bag limits.

The sika deer harvest has steadily increased in Dorchester County since the 1970s, and their harvest exceeded the white-tailed deer harvest for the first time in 2014 when hunters harvested 2,847 sika deer and 2,639 white-tailed deer. Since then, the harvest has increased to over 3,000 sika deer annually (Fig. 30.2). An increasing population, more opportunities to hunt them in the form of longer and more diverse seasons, and their increased popularity as a unique game species are largely responsible for the higher harvests. Maryland is the only state with a sizeable, free-ranging population of sika deer available for hunters. Likewise, the advent of social media has increased awareness of the species, and hunters travel from across the United States to hunt them.

Sika deer hunting seasons (hunting implements and dates) have generally followed those of white-tailed deer in Dorchester County. Early deer seasons prior to 1953 were limited to firearm hunting only. In 1953, the first archery season occurred for white-tailed deer; however, it was not legal to harvest sika deer with archery equipment until 1968. Since that time, both species tend to share the same seasons, but with different bag limits. Along with archery equipment and modern firearms, there is also a designated primitive firearm season (i.e., muzzleloaders), established in 1978, to hunt both species of deer. These additional seasons also provide increased opportunity for hunters to pursue sika during the peak rut.

Over the years, the bag limit for sika deer has varied and ranged from as few as one deer per year when deer hunting resumed in 1951 up to nine deer during the 1980s and today. During the 1980s, the sika deer limit was often more liberal than the white-tailed deer limit in an effort to reduce the population. However, as the

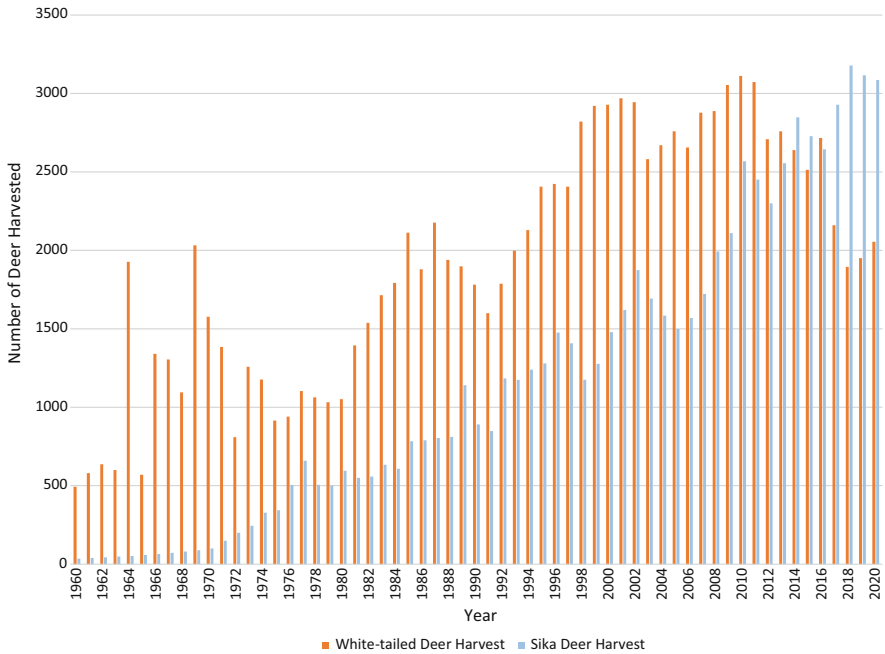


Fig. 30.2 The number of sika deer and white-tailed deer harvested in Dorchester County, Maryland, USA, 1960–2020

Fig. 30.3 Sika deer are more aggressive behaviorally than white-tailed deer. Sika deer acting aggressively towards a raccoon at a bait site for a camera survey



species gained in popularity with hunters and wildlife observers, MDNR revised their approach to sika deer management with a goal of stabilizing the population. Today, sika deer bag limits are more conservative than white-tailed deer limits, but given the harvest patterns of most hunters, who typically only harvest two deer at

Fig. 30.4 Sika deer hinds are smaller than the native white-tailed deer



most, the bag limit is not a controlling factor in the population trend for either species when set above two deer. Instead, the number of hunters in a given year and access to land to hunt sika deer are largely what drives population growth or decline.

MDNR sets seasons and bag limits biennially with the goal of maintaining the white-tailed deer and sika deer population at healthy levels that are compatible with humans and the environment. For sika deer, an underlying goal is to slow the expansion of the species beyond their current range. Flyger and Davis (1964) reported that sika deer had colonized the western third of Dorchester County. Since then, based on MDNR harvest records, the species has colonized nearly all of the remainder of the county and has spread into adjacent counties in some areas. The species is now commonly harvested in the south and east of Dorchester County and in parts of Somerset and Wicomico counties, and a small number are harvested in the northeast of Caroline County and the state of Delaware. Likewise, one individual, a yearling stag, was harvested in Kent County, Maryland, in 2014 and one in Cecil County, Maryland, in 2019, approximately 100 km to the north (Fig. 30.1). However, population expansion most likely has been slowed by a limited amount of preferred habitat, which includes tidal marshes and forested wetlands, and by the geography of the area, which includes several substantial rivers, which likely act as barriers to dispersal. As a result, the population may not be expanding as fast as was once speculated.

A significant number of sika deer remain on Assateague Island off the coast of Maryland and Virginia. Most of Assateague's land area is a federal wildlife refuge in Virginia (Chincoteague National Wildlife Refuge) and a national seashore and state park in Maryland (Assateague Island National Seashore and Assateague Island State Park). All three of these entities offer sika deer hunting as a way to manage the population. In recent years, approximately 200–300 sika deer have been harvested annually from the 63-km² island. The annual harvest on the Maryland portion of the island is incorporated into MDNR harvest records.

Sika deer are an important economic resource for Dorchester County. It is estimated that 5,000 hunters pursue sika deer each fall and winter. Many of these

hunters patronize the hotels, restaurants, and other stores in the area during a time of year when tourism is otherwise slowing down. Likewise, anecdotal information suggests that real estate and land lease prices are elevated in the county if sika deer are available on the property for hunting. Several guide and outfitter services specialize in sika deer hunting in the county as well. Future and ongoing research by MDNR is focusing on the economic impact of this species.

Like white-tailed deer, sika deer do cause some human conflicts in Dorchester County, predominantly in the form of agricultural damage from browsing crops. Agricultural damage by deer is a prominent issue for MDNR and many other state game agencies. MDNR has a Deer Management Permit (DMP) system that affords agricultural producers the ability to harvest deer on their property year-round if they are suffering damage. In 2019, producers in Dorchester County removed 367 sika deer and 420 white-tailed deer under the DMP system.

30.4.2 Delaware

Sika deer in Delaware do not have a separate season and are harvested during the white-tailed deer season (September 1–January 31). Hunters are required to report sika deer harvests to state wildlife biologists. Only 15 sika deer have been harvested and reported in Delaware as of January 2021. The first harvest was in 2008 with one to three being reported harvested annually, since 2016. Most harvests ($n = 12$) have been in Sussex County (Wildlife Management Zone 13, southwest corner of county), and most have been on or around the Nanticoke Wildlife Area. Harvest reports all sexes and ages in this area suggesting an established breeding population. A few sika deer ($n = 3$) have been harvested in Kent County (Zones 6, west-central part of county, and 8, south-central part of county). All of these harvests were spike antlered stags suggesting they were dispersing individuals and not part of an established population. Delaware's management goal for sika deer is to limit the range expansion in the state.

30.4.3 Virginia

Sika deer on Assateague Island in Virginia are managed via regulated hunting conducted by the Chincoteague National Wildlife Refuge (NWR). The Chincoteague NWR is comprised of approximately 40 km² of available deer habitat. Hunting on the island occurs annually in the fall by permit only. The Chincoteague NWR offers both archery and firearms hunting. In recent years, the daily bag limit has been set at five sika deer per hunter (no more than two antlered). Hunters have harvested an average of 195 sika deer per year from the Chincoteague NWR over the past 20 years. The goal of the Chincoteague NWR is to manage sika and native

white-tailed deer at population densities that will not degrade the island shrub vegetation by overbrowsing.

30.5 The Future of Sika Deer on the Delmarva Peninsula

Sika deer are an important hunting resource with significant economic benefit for the Delmarva Peninsula. Likewise, they are popular with non-consumptive users who enjoy observing them while enjoying other outdoor activities. However, the state wildlife agencies want to slow or prevent the range expansion of sika deer to minimize impacts to native white-tailed deer and to reduce human conflicts. Crop damage can be a significant issue for agricultural producers on the Delmarva Peninsula, so continued management of the species will be necessary. Hunter harvest will remain the most effective method to maintain sika deer at healthy levels.

Sika deer were introduced on the Delmarva Peninsula over 100 years ago, but we still lack a complete understanding of their ecology in the area. The reproductive ecology including calf survival and timing of calving is necessary to better understand population ecology. Additionally, understanding diseases and parasites that impact sika will also allow us to better understand population ecology. We need additional research addressing their habitat use, so we can better understand what areas they occupy and what areas they might expand into overtime. Finally, we need to continue to research possible interspecific competition with white-tailed deer.

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