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Biology of Large Grazing Mammals on the Virginia Barrier Islands

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The biology of three large grazing mammals has been studied on Assateague Island since 1975: the native white-tailed deer, the exotic sika deer and feral pony. Pony populations have more than doubled since 1975 (45-152 animals). Over a 12-year period, the foaling rate was 54.4% and foal survival was 88.3%. Mortality was estimated at about 5%. Ponies lived in discrete bands that do not defend territories. The number of bands and their size and composition changed over the course of the study. At low population levels in 1975, there were three harem bands with an average of 14 animals and 5.7 sexually mature mares per band. At the high population levels of 1988, there were 19 harem bands that averaged 5.7 animals and 2.7 sexually mature mares per band. Pony grazing over the years seems to have caused a gradual deterioration of the dune vegetation. This negative impact may increase in the future if the pony population continues to increase. The deer population appears to be composed of 75% sika and 25% white-tailed deer. For sika deer, males comprise 42.8% of the population, females make up 41.8%, and fawns total 15.4% of the population. For white-tail deer, the population is comprised of 52.4% males, 38.1% females,and 9.5% fawns. The average weight of 18 male sika deer was 22.25 kg, while 17 female deer averaged 19.39 kg. Ten sika fawns weighed an average of 10.86 kg. The number of white-tailed was too small for analysis. Fecal analysis in late autumn indicates little dietary overlap between deer and ponies but considerable overlap between white-tailed and sika deer.

Key words: white-tailed deer, sika deer, free-ranging ponies,large-mammal ecology

INTRODUCTION

Large grazing mammals are capable of causing serious habitat degradation, especially on oceanic islands. In the Galapagos Islands, feral mammals, particularly the goat, have destroyed the endemic tree cactus (Dawson, 1966). Goats have caused the disappearance of at least 48 indigenous and 18 introduced plant species on Santa Catalina Island (Thorne, 1967), and in Hawaii they have eliminated some species of plants and greatly altered the abundance and distribution of others (Yocum, 1967). The removal of vegetation by these animals has been so severe in some areas that extensive erosion has occurred along with an associated decrease in soil fertility and moisture retention (Coblentz, 1978).

Assateague Island, the largest of the Virginia barrier islands, supports populations of three large mammalian herbivores: the native white-tailed deer (*Odocoileus*

virginianus), the exotic sika deer (*Cervus nippon*), and feral pony (*Equus caballus*). Sika deer were introduced to the island in 1923 (Presnall, 1958); feral ponies most likely were released onto Assateague Island in the late 1600's by early Eastern Shore colonists.

To determine the effect of the large grazing Assateague Island, data have been collected since the biology of the white-tailed and sika deer and pony these data include information on the social characteristics of the population, and effects of mammals on the ecology of 1975 on various aspects of feral pony. For the feral organization, reproductive grazing on the dune vegetation. The data are less complete for the deer, but include information on the sex and age structures of the populations and food habits.

METHODS AND STUDY AREA

Assateague Island is a 61 km long barrier island located off the Atlantic coast of Maryland and Virginia. The Virginia portion of the island consists of approximately 3,680 hectares administered by the U. S. Fish and Wildlife Service as the Chincoteague National Wildlife Refuge. The Maryland portion of Assateague Island contains 3415 ha primarily administered by the National Park Service as the Assateague Island National Seashore.

Hill (1984) divided Assateague Island, Maryland, into eight vegetative communities on the basis of dominant plant species. His descriptions follow. These vegetative communities with the areal extents of each are salt marsh (1104.3 ha, 35.4% of the total area), shrub succession (476.1 ha, 15.3%), fresh water marsh (465.9 ha, 14.9%), non-vegetated (330.7 ha, 10.6%), dunegrass (311.5 ha, 10.0%), woodland (210 ha, 6.7%), *Hudsonia* dunes (140.6 ha, 4.5%), and washes and pans (80.9 ha, 2.6%).

The dunegrass community occupies elevated dunes (man-made or natural) which lie just west of the high tide mark. Little plant species diversity is present in this habitat which is dominated by American beachgrass (*Ammophila breviligulata*) and seaside goldenrod (*Solidago sempervirens*).

The shrub succession habitat is bounded on the east by the dunegrass community and on the west by a number of different communities. Few plant species are restricted to this habitat, which is characterized by the presence of black cherry (*Prunus serotina*), persimmon (*Diospyros virginiana*), chokeberry (*Pyrus angustifolia*), blackberries (*Rubus* spp.), poison ivy *Rhus radicans*), common greenbrier (*Smilax rotundifolia*), and bayberry (*Myrica* spp.).

The *Hudsonia* dune habitat usually occurs as habitat islands within the shrub succession. This community is defined by the presence of beach heath or poverty grass (*Hudsonia tomentosa*) but is also characterized by pinweeds (*Lechea maritima*), and sand jointweed (*Polygonelia articulata*).

The woodland community is best described as a pine-deciduous woodland. The community occurs in isolated areas on stable dunes west of the shrub succession habitat, usually on the widest parts of the island (Hill, 1984). The dominant species in this community are loblolly pine (*Pinus taeda*), American holly (*Ilex opaca*), sassafras (*Sassafras albidum*), sweetgum (*Liquidambar styraciflua*), oaks (*Quercus* spp.), greenbriers (*Smilax* spp.), grapes (*Vitis* spp.), blueberries (*Vaccinium* spp.), and poison ivy.

Fresh water marshes are species-rich habitats found in transitional areas bordering the salt marsh and woodland communities (Hill, 1984). They are characterized by: salt marsh cordgrass (*Spartina alterniflora*), red maple (*Acer rubrum*), black willow (*Salix nigra*), bayberry, blueberries, cattails (*Typha* spp.), swamp rose (*Rosa palustris*), and common elder (*Sambucus canadensis*).

The salt marsh forms an extensive community dispersed throughout the entire length of the island. It is generally bounded on the east by either fresh water marshes or the woodland community, and on the west by the bay (Hill, 1984). The dominant plants in this habitat include salt marsh cordgrass, salt marsh hay (*Spartina patens*), slender glasswort (*Salicornia europaea*), sea lavender (*Limonium nashii*), spike grass (*Bistichlis spicata*),and marsh elder (*Iva frutescens*).

The washes and pans are mostly barren habitats and the plants they support are primarily succulent or fibrous halophytes. These include dwarf glasswort (*Salicornia bigelovii*), seabeach orach (*Atriplex arenaria*), low sea blite (*Suaeda linearis*), sand spurreys (*Spergularia* spp.), and large salt marsh aster (*Aster tenuifolius*).

Ponies

Since 1975, data were collected on the size, sex, and age composition of each of the bands living on the northern portion of Assateague Island (Keiper, 1976). Each pony living in the study area could be recognized individually by differences in color, sex, size, and markings. The birth date of each foal, its sex, and the age and identity of its mother were recorded each year (Keiper and Houpt, 1984).

Effects of pony grazing on the dune vegetation were studied using exclosures constructed in 1978. The exclosures were constructed on primary dunes, two near the northern tip of the island and eight at one mile intervals starting just south of Dune Crossing One. Each exclosure was 5 m^2 surrounded by a single strand of barbed wire strung tautly at a height of 78 cm above the ground. Ponies graze around the cages during the summer growth period. In late summer, 20 randomly selected 30 cm^2 samples of vegetation were cut from within and outside each cage. For sampling purposes, each cage and surrounding area was divided into four quadrants. Within each cage, one sample of ungrazed vegetation was obtained from each quadrat. Outside of the cage, two additional samples were removed from each quadrat from an area located within five meters of the perimeter of the cage. Two additional samples were removed from each quadrat in the area located between five and ten meters from the perimeter of each cage.

For each of the 20 samples removed per cage, all the vegetation within the 30 cm^2 sampling area was cut at ground level using hedge shears and collected in plastic bags. The bags were sent immediately to the laboratory at the Mont Alto Campus of the pennsylvania State University. Each sample was oven-dried for one week at 45°C and weighed on a torsion balance (Eline and Keiper, 1979).

Deer

Deer sex, age and weight data were gathered from inspections of hunter-killed sika and white-tailed deer during the 1981 and 1982 hunting seasons. The check station was located at the island's sole land vehicle access point. Harvested deer were sexed, aged (tooth replacement and wear)and weighed (dressed weight). These data were compared to information collected by the National Park Service

between 1978 and 1980 concerning the number of deer of each species killed by hunters.

Fifty pellet samples from known deer were collected from deer processed at the deer check station. Pellets were packed with table salt to dry them and prevent decomposition. Samples were sent to the Composition Analysis Laboratory at Colorado State University for analysis. Twenty microscope slides from each pellet sample were prepared and then the plant materials on the slides were compared to known plant reference slides.

RESULTS

Population Dynamics and Social Organization of the ponies

The pony population increased from approximately 45 animals in 1975 to 152 animals in 1988, an average increase of more than 8% per year. The size of the pony population during each year of the study is presented in Table 1.

Assateague ponies show a distinct seasonality of births. Foals are born from March to October with about half (52%) arriving in May. Eighty-eight percent of the foals are born in April, May, or June. Although the sex ratio of foals varies from year to year, over the course of the study the total number of colts (60) was almost equal the number of fillies (67).

The foaling rate (the percentage of sexually mature mares that foal each year) is low and variable, ranging from 40.9% to 70% with a 12-year mean of 54.4% (Table 2).

Survivorship of foals averaged 88.3%. Of the foals that died, 50% were colts indicating there was no differential mortality (Keiper and Houpt, 1984). Based on the number of ponies that disappear from the population and are never seen and cases of documented deaths, adult mortality was estimated at about 5% a year.

Effects of Pony Grazing

Results of the exclusion cage sampling are presented in Table 3. Data from the first year the cages were erected were compared with data collected in 1983 using a one-way analysis of variance with a randomized block design. For 1983 the experimental (*i.e.*, grazed) samples averaged less biomass than the control (*i.e.*, exclusion cage) samples. This difference was significant for samples taken within 5 m of the cage ($P < 0.05$) but was not significant for the samples taken in the area 5-10 m from the cage ($P > 0.05$). The reduced biomass outside of the exclusion cages may have resulted from increased grazing pressure related to the increased population size.

When the 1983 data were compared to those for 1978 (Eline and Keiper, 1979), no significant differences were noted between control samples ($P > 0.05$). The 1983 average control biomass was the same as that for 1978. Comparisons between 1978 and 1983 experimental samples show a decrease in biomass over the years outside the cages although only the difference between samples taken 5-10 m from the cage was statistically significant ($P < 0.05$).

Deer Sex, Age, and Weight

For the years 1978-1982, 260 deer were harvested on the Maryland portion of the Assateague Island National Seashore. Of this total, 200 deer (76.9%) were sika (Table 4), of which 42.8% were male, 41.8% were female, and 15.4% were fawns

TABLE 1. Age composition and population size of the pony population on Assateague Island National Seashore.

Year	Males	Females	(1-2 yr.)	Foals	Total
1975	6	18	11	10	45
1977	10	17	14	12	53
1979	11	22	20	9	62
1981	9	34	23	15	81
1983	17	44	18	23	102
1985	27	43	32	21	123
1988	38	58	28	27	152

TABLE 2. Foaling Rate (%) for Mares on Assateague Island National Seashore.

Year	Sexually Mature Mares	Mares Foaling	Foaling Rate(%)
1975	18	10	55.6
1976	14	9	64.3
1977	17	12	70.6
1978	20	14	70.0
1979	22	9	40.9
1980	30	17	56.7
1981	34	15	44.2
1982	35	18	51.4
1983	42	23	54.8
1984	39	19	48.7
1985	43	21	48.8
1988	58	27	46.6
Average			54.4%

whose sex was not determined. Likewise, of 21 white-tailed deer harvested in 1981 and 1982, 11 (52.4%) were male, eight were female (38.1%), and two were fawns.

Other comparisons between the data collected in 1981 and the data recorded during the period 1978-1980 cannot be made because the deer harvested during the years 1978-1980 were not properly sexed or aged. Deer were classified as male and female apparently on the basis of the presence or absence of antlers. Male fawns would not show antlers, and could not be identified as male deer because the reproductive structures needed for proper sexual identification were destroyed by field dressing. Male fawns, therefore, were probably classified as female deer, effecting the validity of male:female sex ratios and preventing valid comparison with 1981 sex data.

Similarly because the data collected for the years 1978-80 did not distinguish between fawns and older animals and did not determine the ages of older deer, accurate information on the age structure of the population could not be gathered. The data on dressed weights for those years also did not differentiate between

TABLE 3. Comparison of the dry weight (g) of vegetation removed from 30-cm2 samples within and outside of exclusion cages.

Exclusion Cage	Control Samples Within Cage		Samples Within 5 m Of Cage		Samples 5-10 m From Cage	
	1978	1983	1978	1983	1978	1983
1	15.3	27.8	16.5	22.7	18.9	15.9
2	11.7	14.0	14.5	11.9	15.8	14.4
3	20.9	34.0	19.0	12.4	23.9	19.8
4	17.5	15.8	15.7	13.0	17.7	13.0
5	17.8	13.0	17.9	14.6	16.5	11.8
6	22.7	19.6	20.6	12.1	19.6	17.6
7	11.6	19.4	6.7	9.5	13.5	9.8
8	30.5	12.8	31.6	14.5	41.4	16.2
9	20.1	15.4	20.5	11.2	23.3	13.1
10	22.6	18.7	14.8	8.7	20.1	10.9
Average	19.1	19.1	17.8	13.1	21.0	14.2

TABLE 4. Species composition of deer harvested on Assateague Island National Seashore, 1978-1982.

Year	Sika Deer	White-Tailed Deer	Total Deer	% Sika Deer
1978	26	10	36	72.2
1979	38	13	51	74.5
1980	37	16	53	69.8
1981	52	11	63	82.5
1982	47	10	57	82.5
Total	200	60	260	76.9

weights of fawns and weights of adult animals so that the data cannot validly be compared with the weight data for known aged deer collected in 1981.

The male:female sex ratio approached 1.0 (1.03 for sika, 1.37 for white-tailed deer). Since the number of males and females are about equal at birth, these data suggest that mortality was not sex specific: hunters apparently do not selectively harvest male deer of either species. The relative percentage of sika deer in the total harvest has increased from 72% to 82% in the last five years.

The ages of 44 sika deer killed in 1981 were determined and of these 27 (61.4%) were fawns and yearlings. The average age of the sika deer tallied 2.02± 0.20 y ($\bar{x}$± SE). Females were more prevalent in the older age classes, but their average age ($\bar{x} \neq$ 2.75± 0.37 years) did not differ significantly ($P > 0.05$) from that of males ($\bar{x} \neq$ 2.2± 0.21 years). The fawn:adult female ratio, an indicator of reproductive

success, was 62.5%. These results suggest that the sika deer harvest was fairly heavy, with younger animals making up the principal kill. The harvest, in turn, appeared to be balanced by good reproductive success and rate of increase.

The age structure of the 11 white-tailed deer harvested in 1981 was similar to that of the sika deer, with five of the 11 being aged as fawns or yearlings. The remaining six deer were aged as three year olds. The small sample size precluded a more detailed analysis.

The dressed weights of 45 sika deer killed in 1981 were obtained. The mean weight of 10 sika fawns was 10.86 kg. Eighteen adult male deer averaged 22.25 kg, while 17 adult female sika deer averaged 19.39 kg. Two white-tailed deer fawns averaged 14.77 kg. Three male white-tailed adults averaged 39.23 kg. (the fourth male was not field dressed) while five female white-tails averaged 24.73 kg.

Deer Food Habits

Thirty-five categories of plants were identified in the fecal samples from sika deer and 23 from white-tailed deer (Table 5). Except for *Hudsonia tomentosa* (beach-heath), *Quercus* spp., and *Magnolia virginiana*, the composite of sika deer pellets contained the same plants ingested by the white-tailed deer. Only one white-tailed deer sample contained these genera. Browse species constituted 36% of the diet of white-tailed deer and 42% of the diet of sika deer.

Four genera of plants composed 90% of the relative density of the plant fragments in the sika deer pellets: *Solidago* spp. (golden-rod), which was present in all pellet samples and made up 34% of the relative density; *Myrica* spp. (wax-myrtle), found in 97% of the samples and composing 27% of the relative density; *Spartina* spp. (cordgrass), identified in 72% of the sika deer pellets and contributed 17% to the relative density; and *Rhus* spp. (dwarf sumac and poison-ivy), found in all of the sika samples and composing 13% of the relative density.

Four plant genera composed most of the late fall diets of white-tailed deer. These included: *Myrica* spp., found in 72% of the samples and composing 18% of the relative density; *Rhus* spp., identified in 94% of the white-tailed deer samples and composing 16% of the relative density; and *Solidago* spp., present in 89 of the samples and composing 15% of the relative density. pinweed (*Lechea maritima*) was found in all white-tailed deer samples and made up the greatest relative density (35%). Pinweed also was identified in 45% of the sika samples, but composed only 1% of the relative density. Conversely *Spartina* spp., an important plant in the sika's late fall diet, composed 0.14% of the relative density of plant fragments in white-tailed deer pellets and was identified in only one white-tailed deer sample.

Similarity of diets was examined using Spearman rank-correlation. plants were ranked in the order of their relative densities in the diet, then a correlation coefficient was calculated between the orders of abundance of the foods in the two diets. The rank-order correlation coefficients for foods eaten by white-tailed and sika deer were positively ($P < 0.02$) correlated.

DISCUSSION

Assateague ponies live in social groups called bands. The most common social unit is the harem band, which consists of one adult male, one to several adult females and their offspring, which are usually no more than three years of age. Other bands

TABLE 5. Plants consumed by deer on Assateague Island during late Fall 1982.

Plant	white-tailed deer (n = 18) Frequency	% Relative density[a]	Sika deer (n = 29) Frequency	% Relative[a] density
Lechea maritima	100.0	34.73	44.8	1.25
Myrica spp. (2 species)	72.2	17.79	96.6	27.12
Rhus spp. (2 species)	94.4	16.42	100.0	13.19
Solidago spp. (6 species)	88.9	14.80	100.0	34.04
Rosaceae type	27.8	2.00	13.8	0.51
Rosa palustris	44.4	1.31	13.8	0.20
Composite type	11.1	0.87	3.4	0.10
Juniperus virginiana	22.2	0.77	13.8	0.46
Fern	22.2	0.76	34.5	1.08
Spartina spp. (2 species)	5.6	0.14	72.4	17.17
Distichlis spicata	0.0	0.00	34.5	1.42
Carex spp. (3 species)	0.0	0.00	24.1	0.38
Eleocharis albida	0.0	0.00	10.3	0.15
Panicum spp. (12 species)	0.0	0.00	13.8	0.15
Other		10.41[b]		2.78[c]

[a]Relative density = (Density of fragments for a species/Sum of densities of fragments of all species) x 100
[b]9 genera
[c]21 geners

include bachelor groups of two to four young males and mixed bands of young males and females. A few solitary ponies can be found.

The harem system of organization has been considered to be an adaptation to seasonally changing ecological conditions (Klingel, 1975). Because the stallion is non-territorial and defends his harem rather than a distinct territory, the group is not restricted in its movement and can wander about to make use of the best available food from season to season. Harem sizes range from two to 21 animals and average 3.4 to 12.3 individuals for a number of unmanaged populations with natural age and sex ratios (Table 6).

Apparently, the number of mares in a harem is related to the number of stallions in a population and to population density, so the number of harem bands and their size and composition on Assateague have changed over the course of the study. At low population levels in 1975 (45 ponies), there were only three harem bands with an average of 14 animals and 5.7 sexually mature mares per band. By 1984, when the pony population reached 110, 10 harem bands were present and averaged 9 ponies and 3.8 sexually mature mares per band.

With a population of 152 ponies in 1988, there were 19 harem bands that averaged only 5.7 animals and 2.7 sexually mature mares per band.

Harem bands are stable social units. Stallion tenure ranged from 0.01 to 4.2 years and averaged 2.11 years for 24 stallions in the Granite Range of Nevada (Besger, 1983); stallion tenure on Assateague Island, however, has lasted more than

TABLE 6. Feral horse harem band structure in North America.

Population	Harem Size Mean	Harem Size Maximum	Mares Per Band Mean	Mares Per Band Maximum	No. of Bands
Pryor Mountains, Wyoming (Feist and McCullough, 1975)	5	9	1.8	3	44
Toi Cape, Japan (Kaseda, 1981)	6	13	1.5	3	13
Sable Island, Canada (Welsh, 1975)	5.5	20	---	---	47
Grand Canyon (Berger, 1977)	4.5	6	3	4	4
Assateague Island (low population density)	14	18	57	6	3
Assateague Island (high population density)	5.7	12	27	7	19

10 years. The composition of adult mares in a harem band also is stable, with some mares remaining in the same band for life (Keiper, 1985).

Most of the changes in harem band membership resulted from the emigration and immigration of subadult animals. Generally, both colts and fillies leave their natal bands for other groups, although on Assateague Island approximately 25% of young females never dispersed and were bred by their fathers (Keiper and Houpt, 1984).

Dispersing fillies are integrated into existing harems or start a new family with a bachelor male. Others remained alone for more than a year (Keiper, 1985). Dispersal occurs primarily before the age of 2 years and may reflect the onset of sexual maturity. Those fillies who depart usually wander away without the stallion's intervention. However, some are chased away by adult mares.

Most young stallions dispersed between 12-24 months of age, wandering off with a sibling or by themselves (Keiper, 1985). In the Red Desert of Wyoming, young males were reported to leave their natal band on their own accord (Denniston, 1979), but on Assateague Island, they were usually forced to disperse by aggressive harassment by the harem stallion (Keiper, 1985). Bachelor males become harem stallions by abducting a mare from a harem band, joining mares whose stallion has died, joining with a dispersing young female, or ousting a harem stallion. Multi-male bands result when more than one bachelor joins a mare or family unit, when a young stallion stays in his natal band after reaching maturity, or when several young male and female horses disperse from the same harem band and remain together until they become sexually mature (Keiper, 1985).

The seasonality of births shown by the Assateague ponies is consistent with other studies of free-ranging horses. Feist and McCullough (1975) reported foaling between April 15 and June 30. Of 294 births in New Forest ponies, 96% occurred from April to June (Tyler, 1972). In Sable Island ponies, foals were born in all months but January. However, almost 77% were born in April, May or June, and only 5.6% of all foals were born between October and February (Welsh, 1975). With

respect to sex ratio, Tyler (1972) reported that 54.5% of all foals born in the New Forest were female. On Sable Island, female foals made up 51% of all foals born from 1970 to 1972 (Welsh, 1975).

Over a 12-year period, the percentage of sexually mature mares that foaled each year was 54.4%. This figure is comparable with the 59.6% foaling rate for mares on Sable Island, Canada (Welsh, 1975). Tyler presented a three-year foaling rate of 46% for the New Forest ponies in England.

The fluctuation in the foaling rate from one population to another and from one year to the next is probably the result of the age structure of the breeding population. Young mares begin to foal as early as three years, but foal at a lower rate than older mares. For western mustangs the percentage of females that foaled was only 13% for 3-year-olds compared with 66% for females 5 years old and older (McCort, 1984). Similarly, on Assateague Island the foaling rate for 3-year-olds was only 23%. For 4-year-olds, the rate was 46%, whereas for 5-year-olds the rate increased to 53% (Keiper and Houpt, 1984).

As the percentage of young mares in the population changed, fluctuations in the foaling rate occurred. For example, in 1977, when the foaling rate was 70.6%, the northern Assateague population consisted of 17 sexually mature mares. Fourteen of the mares were over 5 years, whereas only 3 of the mares were 5 years old or younger. On the other hand, in 1980 and 1981, mares 3 and 4 years old made up over 40% of the breeding population and the foaling rates were only 56.7% and 44.2% for those years (Keiper and Houpt, 1984).

The exclusion cage results suggest that the condition of the vegetation on the primary dune in the study area would not have changed greatly between 1978-1983 if ponies had not been grazing the dunes. Pony grazing over the years seems to have caused a gradual deterioration of the dune vegetation and this negative impact may increase over the years as the pony population increases. The difference in vegetation outside of and within the exclusion cages may also have been effected by the wind depositing excess sand on top of existing vegetation or eroding sand from beneath the plants.

Examination of the data on hunter-killed deer suggest that sika deer have been increasing in abundance on Assateague, perhaps at the expense of white-tailed deer. In several other areas following introduction, sika deer have out competed sympatric species of deer. This has been noted for populations of red deer (*Cervus elaphus*) in New zealand (Kiddie, 1962) and this may be occurring for sika and white-tailed deer in Dorchester County, Maryland (Feldhamer and Chapman 1978). The success of the sika deer may be attributed to their more diverse and adjustable feeding habits as opposed to any overtly aggressive behavioral traits (Feldhamer and Chapman, 1978). It may also be possible that white-tails are affected by differential hunting pressure, either because they are more easily seen or simply preferred by hunters because they yield more meat. In an attempt to diminish or reverse white-tail decline, the National Park Service has closed the hunting season for white-tails, and increased the bag limit for sika deer to three animals.

Although the late fall diets of white-tailed and sika deer appear similar, the actual degree of dietary overlap and possible competition is unclear. because plant fragments were identified only to the genus level. In groups where 1 species per

genera were present (like for *Rhus*, *Myrica*, and *Solidago*), the deer could have been foraging on different species.

Sika deer forage on a greater variety of plants than white-tailed deer. I attribute this observation to sika deer apparently feeding more in the fresh and salt marshes, as evidenced by plants like *Spartina* spp., *Carex* spp., *Distichlis spicata* (seashore saltgrass), and *Eleocharis albida* (spikerush) in the sika composite.

Sika deer seem to be well established on Assateague Island. They appear to have more diverse food habits, at least in late fall, and are better competitors in over-browsed habitats (Feldhamer and Chapman 1978), a condition that may occur on Assateague Island as deer populations increase.

Grasses were relatively unimportant in the deer diet, meaning there was little overlap in the diet between deer and ponies and hence little feeding competition in late autumn. Deer feeding also apparently has little impact on dune vegetation.

Since diet usually changes from season to season, diet overlap and hence feeding competition may occur between deer or deer and ponies, especially in late winter when food supply is limited. Dietary studies, therefore, should be extended to other seasons of the year before definite conclusions are drawn.

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