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THE FOODS AND FEEDING HABITS OF THE NUTRIA ON HATTERAS ISLAND, NORTH CAROLINA

By ROBERT C. MILNE[1] AND THOMAS L. QUAY[2]

INTRODUCTION

Hatteras Island, in the Cape Hatteras National Seashore Recreational Area, is the longest and easternmost of the barrier islands that constitute the "outer banks" of North Carolina (Stick, 1958). The island is 40 miles long from Oregon Inlet to Cape Hatteras and another 15 miles on to Hatteras Inlet. The distance from ocean to sound is only 1,500 to 3,000 feet at most places. The land widens to about one mile at Pea Island, Avon, and Hatteras and to three miles in the Buxton-Cape Hatteras region (Figure 1). Pamlico Sound separates Hatteras Island from the mainland by 12 to 30 miles of open and often stormy waters. The inshore sound, from one to 12 feet deep, has extensive growths of rooted aquatic plants; the open sound is from 12 to 23 feet deep and has little or no rooted plant life.

The ocean dunes of Hatteras Island are relatively low. Topographic variations are slight, with the highest elevations occurring in the Buxton Woods where the wooded hilltops reach 56 feet in two locations. The island habitats between the ocean beaches and the sound-side tidal marshes, occurring in both linear and mosaic patterns, are: herbaceous beaches and dunes, herb-shrub habitats, shrub thickets, thicket woodlands, woods (Buxton Woods, only), fresh-water ponds and marshes, salt and brackish tidal ponds and marshes, and edificarian habitats (Quay, 1959; Parnell, 1962, Milne, 1963).

The maritime climate of Hatteras Island produces cooler summer temperatures than on the mainland (78 degrees F, midsummer mean), 90 degrees F being an unusual occurrence. Proximity to the Gulf Stream adds to the mildness of the winters, with freezing occurring only about half as many times as in the interior of North Carolina. There is a midwinter mean temperature of 46 degrees F. The annual mean temperature is 62 degrees F. Rainfall averages higher than at other points along the North Carolina coast, being 54.7 inches per year (United States Department of Commerce Weather Bureau, 1961).

The nutria was introduced on Hatteras Island at Hatteras village, at the southern tip of the island, by the Gooseville Gunning Club in 1941 (Quay, 1959). This original and only introduction on Hatteras Island consisted of one male and two females. Establishment and spread were immediately successful, with substantial numbers being found for the first time at Pea Island, the northern end of Hatteras Island, in

[1] African Wildlife Leadership Foundation, Nairobi, Kenya.
[2] Zoology Department, North Carolina State University, Raleigh, North Carolina.

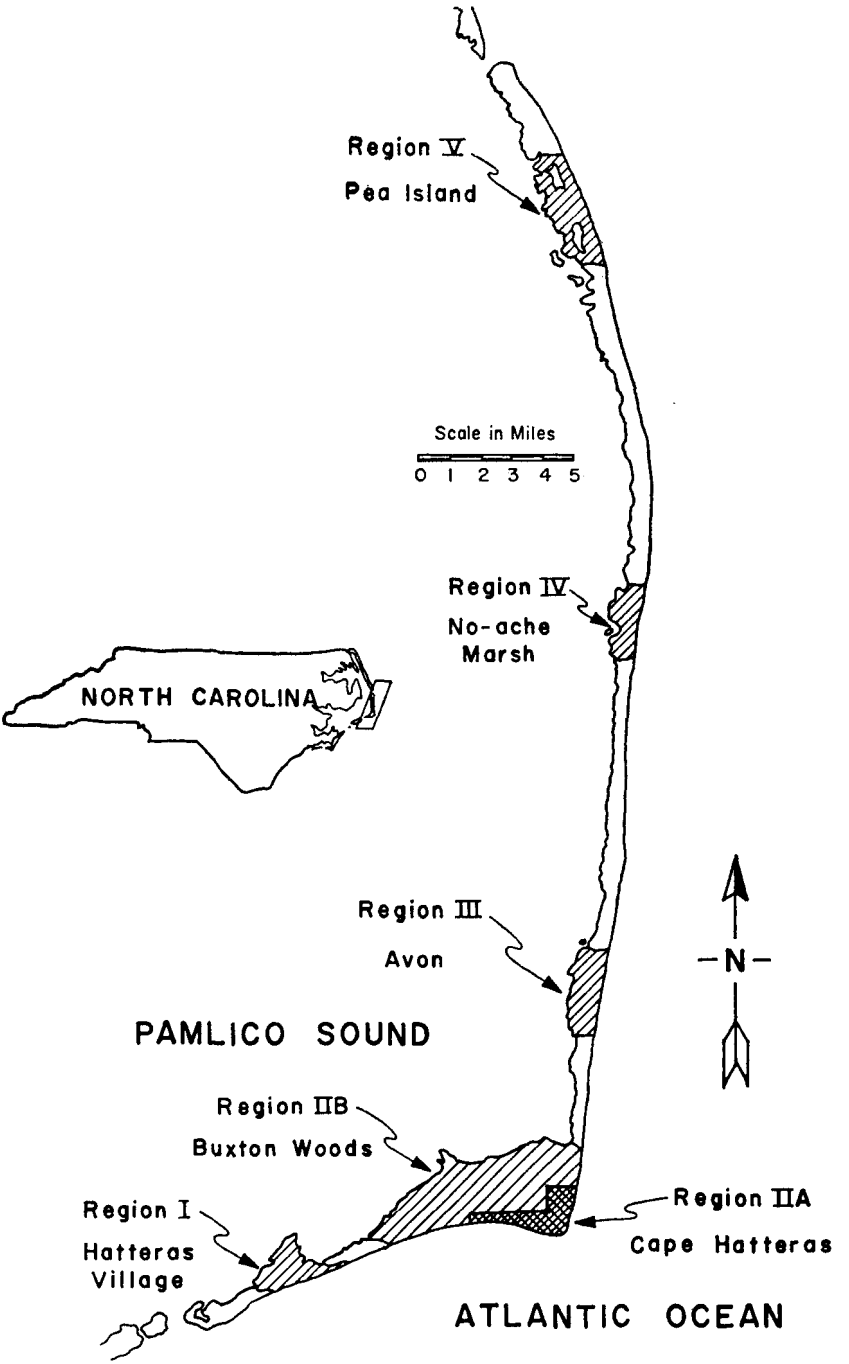

Figure 1. Study Regions on Hatteras Island, North Carolina

1957. Nutria were fairly common to locally common all over Hatteras Island in fresh, brackish, and salt-water ponds and marshes during 1957-1963, when the present authors and associates were actively in the field studying various vertebrate populations in the Cape Hatteras National Seashore.

Scientific and common names used in this paper are in accordance with: *Gray's Manual of Botany*, 8th ed. (Fernald, 1950); *The Mammals of North America* (Hall and Kelson, 1959); and *A Check-list of North American Birds*, 5th ed. (American Ornithologists' Union, 1957).

METHODS

The field research for this study was conducted at various times between the Summer of 1956 and the Spring of 1963. The junior author conducted an investigation of the vertebrate natural history of the Cape Hatteras National Seashore Recreational Area during the years 1956-1959 (Quay, 1959), making numerous field trips to the Park at all seasons and spending the entire summer of 1958 in residence on Hatteras Island. T. L. Quay and some of his graduate students made additional but less frequent trips to the Park between 1959 and 1962. The senior author carried on his investigation of the Hatteras Island nutria populations from February, 1962 until April, 1963, as a master of science thesis, according to the schedule outlined below. The 1956-1962 information gathered by the junior author served a preliminary function. In the present paper all the specific information on study regions, food and habitat analyses, and populations were gathered by the senior author during 1962-1963.

In 1962, the continuous field research started on May 29 and was terminated on September 3. During this period, the senior author made daily and full-time observations and records for the two weeks of May 29-June 12; thereafter, while working as a summer park ranger-naturalist, the weekly research schedule was about two hours each morning and evening Monday through Friday and full time Saturdays and Sundays.

Five trips were made to gather additional data during the 1962-1963 academic year, on the following dates: October 4-7, 1962; November 2-4, 1962; November 21-26, 1962; January 22-29, 1963; and April 10-12, 1963. Major emphasis was placed on the collection of information that would indicate seasonal changes in food selection and seasonal population relocations.

The selection of the five study regions was made after two weeks of preliminary investigations in June, 1962 (Figure 1, Table 1). Selection was based on the presence of relatively heavy nutria populations, with one exception. Although evidence of nutria in Region III was lacking, nutria had been there previously and the Region was selected for comparative purposes. The study regions were described in detail as to their location and physiognomy. Maps were made of the study regions from aerial photographs provided by the personnel at the Cape Hatteras National Seashore Recreational Area.

A partial census of plant species within the five study regions was made in the following manner. The dominant vegetational types, as well as the general plant associations and habitats, were noted. Records were made of all plant species appearing in circular sample areas one meter in diameter, located on sites of nutria utilization. In addition, several vegetation samples were taken at random in Regions III and V. The total number of times that an individual plant species appeared in these areas was divided by the total number of sample areas to produce an index to the frequency of each plant species. This simple calculation was used to determine the Availability Index (Takos, 1947).

$$\text{Availability Index} = \frac{\text{Number of plots species occurred}}{\text{Total number of plots}} \times 100$$

As the opportunity arose, members of the animal communities of each study region were recorded and notations were made of any interspecific coactions.

TABLE 1. SIZE AND GENERAL DESCRIPTION OF NUTRIA STUDY REGIONS, HATTERAS ISLAND, 1962-1963.

Study Regions No.	Name	Acres	General Description
I	Hatteras Village	1020	Primarily herbaceous and herb-shrub salt and brackish marshes, much dissected with tidal creeks and drainage canals, and interspersed with many fresh-water and brackish ponds.
IIA	Cape Hatteras	1500	Herbaceous sand flats and fresh-water ponds and marshes, just behind ocean beaches and dunes.
IIB	Buxton Woods	4260	Maritime woodland on old sand-dune ridges, dividing extensive fresh-water marshes; fringed on sound side by salt marsh, and on ocean side by Region IIA.
III	Avon	900	Primarily edificarian habitat of sand flats, shrub thickets, thicket woodland, herb-shrub salt and brackish marshes, and encircling drainage canals and spoil banks.
IV	No-ache Marsh	2000	Extensive herbaceous and herb-shrub salt and brackish marshes, with many deep and narrow tidal creeks; on sound side, behind the broad, herbaceous ocean-side sand flats.
V	Pea Island	1350	Two shallow, fresh-water impoundments, of 180 and 380 acres, respectively, with deep borrow-pit canals at inside bases of dikes (Parnell, 1961); dikes with dense herb-shrub cover; extensive sound-side salt marshes with wide tidal creeks.

A semi-quantitative evaluation of nutria foods was approached by the following methods. All observed plant species utilized for food were recorded as to study region, sample area, habitat, and location of where the plant was consumed. Portions that were utilized were noted. In addition, the total number of plots in which an individual plant species was utilized was divided by the total number of sample plots. This resulted in the Dietary Importance Index.

$$\text{Dietary Importance Index} = \frac{\text{Number of plots where eaten}}{\text{Total number of plots}} \times 100$$

This value was construed to indicate the relative importance of individual plant species to the nutria's diet.

In an effort to determine if nutria had definite preferences for certain plant species, calculations outlined by Takos (1947) were followed. The Utilization Index was obtained by dividing the total number of sample plots at which individual plant species were consumed by the total number of plots on which the plant species occurred.

$$\text{Utilization Index} = \frac{\text{Number of plots where eaten}}{\text{Number of plots where species occurred}} \times 100$$

Having obtained both an index to the availability and an index to the utilization of individual plant species, it was then possible to determine the Forage Ratio, by dividing the latter into the former.

$$\text{Forage Ratio} = \frac{\text{Utilization Index}}{\text{Availability Index}}$$

If a quotient, the Forage Ratio, for a particular plant species was equal

to 1.0, the species was interpreted as being eaten in equal proportions to environmental occurrence. Quotients less than 1.0 implied less consumption than would be expected from the plant availability. Ratios greater than 1.0, conversely, implied that the plant in question was being eaten in greater proportions than suggested by the availability. This selection was an indication of relative preference of plant species where an adequate number of samples had been taken (Takos, 1947).

Since the possibility of the consumption of shellfish in South America (Waterhouse, 1848; Parry, 1939) and Texas (Davis, 1960) was mentioned in the literature, droppings analyses were undertaken to determine if this were the case on Hatteras Island. Both fresh and old droppings from all study regions throughout the entire investigation were broken apart and examined macroscopically for animal remains. Over 500 droppings were examined in this manner.

Two types of field observations were useful in the evaluation of feeding mechanics. Both surveillance of the feeding nutria through binoculars and close inspection of feeding areas provided adequate data on the feeding times, locations, plant species used for food, and feeding behavior. No precise measurements of the amount of food consumed were made. However, comparisons of disturbed and nondisturbed vegetation were drawn on the basis of stem counts in Region IV, No-ache Marsh.

Habitat investigations were made in locations of nutria population concentrations which coincided with four of the study regions — I, II, IV, and V. These population concentrations were evaluated by the comparison of the relative numbers of burrows, runs, cut plant materials, droppings, and individual animals observed. Relative sizes of droppings were used as a partial index to population age composition where direct observations were not feasible. A fifth study region, Region III, was investigated for possible reasons why nutria were absent. Attempts were made to ascertain possible limiting factors. Records were kept of all possible predators coexisting in the study regions and their relative numbers were recorded. Villagers of Hatteras Island were questioned for pertinent information.

Climatic data were furnished by the U. S. Department of Commerce Weather Bureau (1961). Special efforts were made to secure information related to daily precipitation and change in water level at the various study regions. Data on wind direction and velocity were collected in relation to their effects on nutria populations in exposed salt marshes.

RESULTS AND DISCUSSION

Recognition of Nutria Cuttings

At the inception of the study, the recognition of nutria cuttings of plant material as opposed to those cuttings of other herbivores that lived in the same habitat posed a serious problem. Of greatest concern was the differentiation between nutria and muskrat cuttings, as these two animals were found existing in many of the same general areas on Hatteras Island. Detailed observations were made of known muskrat feeding sites and comparisons were drawn with known nutria feeding sites. The methods of feeding-site distinction were in categories of: (1) direct observation, (2) size of tooth marks on vegetation, (3) appearance of cut portions, (4) appearance of feeding area, and (5) presence of additional evidence.

Direct observation greatly facilitated collection of data on food species. Inspection of feeding sites from a distance through binoculars allowed the observation of both muskrats and nutria while they fed. This served to locate individual feeding sites as well as to gather plant material for comparative purposes.

The nutria was the bolder of the two animals and the more easily observed. Nutria were seen active and feeding in open, exposed, marsh borders from 2:00 p.m. to dark, while muskrats were observed only in the later afternoon and usually were quite secretive during the daylight hours, remaining close to heavy cover.

The width of the tooth marks on cut vegetation was useful in separating nutria cuttings from those of muskrats on thick-stemmed and wide-leaved genera of plants such as *Typha*, *Sagittaria*, and *Cladium*. Upon examination of nutria cuttings, it was found that the maximum width of bite of the incisors was 15.0 mm. Minimum total widths observed in the field were no less than 5.0 mm. The total incisor width on nutria two months old was found to be between 3.0 and 5.0 mm. (Walther, 1931). On the other hand, muskrat skulls examined in the mammal collection of North Carolina State University, Raleigh, had total incisor widths of a maximum of 7.0 mm. and a minimum of 3.8 mm.

When confronted with a feeding area in narrow-stemmed vegetation such as *Juncus* spp. or with tooth marks less than 7.0 mm. in total width, it was then necessary to bring several other factors into consideration. Vegetation utilized by nutria was bitten off cleanly, as if cut with a knife, while the muskrat cuttings were considerably chewed and frayed. Nutria cuttings were often scattered over large areas, while muskrats apparently gathered food material and consumed it in small, localized sites with remains often left in a pile. Muskrats apparently fed on plant rhizomes and tubers throughout the year, while nutria were found to eat these portions only in the late summer and all winter.

Concentrations of droppings in feeding areas aided in further separation. The nutria droppings were quite distinct: elongated, longitudinally striated, and enclosed in a gelatinous capsule. Nutria tail drags were rounded and the webbed hind feet were proportionately larger than those of the muskrat. Muskrat droppings lacked a capsular appearance and rapidly decomposed into an amorphous mass in wet conditions. The keeled tail of the muskrat left a grooved drag rather than a rounded one. The hind feet of the muskrat lacked webbing and were much smaller than the hind feet of the nutria.

The only other herbivore on the island that left cuttings similar to those of the nutria was the white-tailed deer (*Odocoileus virginianus*), found only in Region II. Deer usually severed stalks 12 or more inches from the ground and their tracks usually present and distinct.

Feeding Methods

The method of summer feeding differed considerably from those actions employed during the winter.

Summer Period (April through September). The summer period of study began May 29, 1962, and was terminated September 1, 1962. Only one major change in the vegetational aspect occurred during this period. The early summer *Cladium-Typha* fresh-water marshes of Region IIB were dominated by stands of wild rice (*Zizania aquatica*) in all sheltered areas by August 1. *Zizania aquatica* occupied the littoral zone up to the depth of two feet, extending out beyond the cattails (*Typha* spp.) in a broad border around the deep marshes and covering the shallow marshes completely.

Throughout most of the summer, the nutria confined their feeding activity to vegetation on the moist margins and in shallow littoral zones of marshes, ponds, and waterways. An abundance and variety of plant species were present in these locations. As the nutria would approach a prospective feeding area from deeper water, they would swim in a leisurely manner with only the head and the tail out of the water. The large, webbed, hind feet being the only means of propulsion, the fore limbs remained flexed under the chest until shallow water was reached. Often, it was noticed, the animal would climb completely out of the water and execute an elaborate cleaning ritual both prefeeding and postfeeding. This invariably followed a prescribed pattern. The animal would first nuzzle the upper portion of each fore limb, moving distally. When the forepaws were reached, the nutria would sit back on its haunches, rubbing both forepaws on the muzzle simultaneously. From this upright position, cleaning would then begin in the head region, using both forepaws to "wash" behind the ears and along the cheeks. Cleaning would then shift to the body. Starting on either side in the axillary region and systematically moving posteriorly, the nutria would

use both forepaws and apparently the teeth in grooming and smoothing the total ventral surface of its body. This ritual completed, the animal then would either return to the shallow water to feed or would begin to feed on land.

While feeding from the water, the nutria would hold themselves motionless with the hind limbs and would grasp low emergent vegetation with either forepaw, bending it over and clipping the plant off at the point of the bend, usually 1 - 3 inches above the water level. Using both forepaws, the severed stem or leaf stalk would then be maneuvered around to a vertical position, base up. Several inches were usually consumed in a rapid series of backward jerks of the head, pulling the stem into the mouth, clipping it off, and masticating it with rapid, continuous, lateral motions of the lower jaw. The less succulent portions of the plant were discarded and the feeding position was then usually shifted slightly to another clump of emergents.

Feeding on land was carried out in much the same manner as above, but with the nutria sitting on its haunches in an upright position. Feeding activity was not centered on a small clump of vegetation, but was rather a meandering browse pattern that covered 15 to 20 yards in a single feeding of 15 to 20 minutes. Often nutria were seen to abandon one feeding location for no apparent reason, enter the water, swim several hundred feet, emerge, clean themselves, and forage in the apparently more suitable location.

On occasion, with increasing frequency during the late summer, nutria were observed digging for rhizomes of various plants. The stereotyped manner in which this excavation took place was aptly described by Hailman (1961, p. 296).

> When an apparently suitable plant was chosen, the animal nuzzled it closely and then uprooted it immediately by pulling with its teeth or by digging at its roots with its forepaws. In digging, the paws are moved directly under the nose, either alternately or together. . . . When a small pile of sand and mud accumulates under the body, the nutria stops digging and begins kicking the material to the rear with its hind feet, moving them alternately only. After clearing the pile, the nutria resumes excavating with its forepaws until the root is free.

Winter Period (October through March). By October 4, a large percentage of the herbaceous vegetation had started to wither. Succulent littoral vegetation was affected in this manner and was greatly reduced in the summer feeding sites. Progressively less and less of the emergent, succulent vegetation was available during the winter period. Several radical changes in food selection and in mode of feeding were made by the nutria in response to this phenological phenomenon.

In deep marshes, ponds, and waterways where submerged and floating vegetation was present, nutria rarely fed on land. Instead, they would lie floating with heads and tails exposed in deep water over mats of aquatic vegetation, reaching down with their forepaws to grasp the plant material. Using both forepaws either alternately or simultaneously, nutria fed continuously for periods up to 15 minutes. When vegetation was beyond the reach of the floating nutria, a shallow submergence of the head and shoulders accompanied the feeding motions. Grooming took place on land at irregular intervals and did not accompany winter feeding of this type.

When floating and submerged vegetation was reduced or absent, there was a substantial increase in digging for food during the winter period. Winter digging methods were not altered from the pattern described for the summer period.

Plant Species Utilized for Food

From each study region, utilized plant species were listed in proportional importance to diet. This was based on the Dietary Importance Index. In addition, the Forage Ratio of the individual plant species was

calculated and listed. The Forage Ratio was indicative of the amount of selection, shown for different plants, suggesting species preference.

Region I. In the summer, the majority of feeding sites occurred along the water's edge where *Spartina alterniflora* and *Juncus roemerianus* were dominant. The percentage of utilization of these species showed them to be of major importance in the summer diet of the nutria. In areas of nutria population concentration, the upper portions of *Spartina alterniflora* were removed from wide segments of the littoral zone by the latter half of the summer.

Small isolated stands of *Typha* spp. were fed upon heavily in various sections of Region I. Only the nonchlorophyllous basal portions were consumed. Nevertheless, the desirability of cattails was reflected in the Forage Ratio. No portion of the abundant shrub vegetation present was utilized nor were such succulents as *Acnida cannabina* and *Borrichia frutescens* consumed. Floating and submerged vegetation was present in small amounts but not utilized. In the late summer, nutria were found digging for the rhizomes of *Juncus roemerianus, Spartina patens,* and *Distichlis spicata. Juncus roemerianus* rhizomes were up to 0.25 in. thick, while those of *Spartina patens* were rarely half that in diameter.

Winter feeding was limited largely to the rhizomes of *Juncus roemerianus* and *Spartina patens* and correlated with plant availability. Both the rhizomes and the stems of *Spartina alterniflora* were selected when present (Table 2). Duck hunters traversing the pond margins trampled the *Spartina alterniflora* to such an extent that the availability of this forage species was temporarily reduced in many sections of Region I.

TABLE 2. FORAGE PLANT IMPORTANCE AND PREFERENCE, STUDY REGION I — HATTERAS VILLAGE. TWENTY SAMPLE PLOTS IN SUMMER, SEVEN IN WINTER.

Plant species	Availability Index		Dietary Importance Index		Forage Ratio	
	Summer	Winter	Summer	Winter	Summer	Winter
Spartina alterniflora	70.0	57.1	60.0	42.0	1.2	1.3
Juncus roemerianus	90.0	100.0	50.0	100.0	0.6	1.0
Typha angustifolia	35.0	0.0	25.0	0.0	2.0	0.0
Typha latifolia	35.0	0.0	25.0	0.0	2.0	0.0
Spartina patens	50.0	85.7	25.0	85.0	1.0	1.1
Distichlis spicata	20.0	42.3	10.0	14.0	1.1	0.8

Region IIA. Spartina patens, Juncus roemerianus, Centella erecta, and *Hydrocotyle umbellata* were the most available plant species in this section during the summer months. *Typha latifolia, T. angustifolia, Nymphaea odorata,* and *Juncus roemerianus* were selected and comprised a major portion of the nutria's summer diet. Selection was also shown for *Bacopa monnieri, Spartina alterniflora,* and *Rumex crispa* (Table 3).

The winter period brought a dramatic shift in dietary composition. Three submerged plant species (*Potamogeton pectinatus, Utricularia* spp., and *Myriophyllum* spp.) and the rhizomes of *Juncus roemerianus* formed the bulk of the food consumed. Only two other plants (*Spartina patens* rhizomes and *Carex* spp. stems) were observed to have been eaten during this period. In this case, relative importance coincided with species preference (Table 3).

Region IIB. This region contained the greatest variety of plants recorded in any of the study regions. With such variety, it was with some reservation that major importance was ascribed to any one plant during the summer period. It was clear, however, that *Typha latifolia, Cladium jamaicensis, Sagittaria latifolia,* and *Zizania aquatica* did form

the bulk of food consumed by the nutria. *Typha angustifolia, Juncus roemerianus, Nymphaea odorata, Sagittaria falcata,* and *Scirpus validus*

TABLE 3. FORAGE PLANT IMPORTANCE AND PREFERENCE, STUDY REGION IIA — CAPE HATTERAS. TWENTY-EIGHT SAMPLE PLOTS IN SUMMER, SEVEN IN WINTER.

Plant species	Availability Index		Dietary Importance Index		Forage Ratio	
	Summer	Winter	Summer	Winter	Summer	Winter
Juncus roemerianus	53.6	57.1	21.4	57.1	0.6	1.8
Typha latifolia	21.4	57.1	21.4	0.0	3.9	0.0
Spartina patens	71.4	85.7	21.4	42.8	0.4	0.6
Nymphaea odorata	21.4	0.0	17.0	0.0	3.9	0.0
Andropogon glomerata	17.9	0.0	14.0	0.0	1.1	0.0
Typha angustifolia	21.4	28.6	14.0	0.0	3.1	0.0
Eleocharis spp.	25.0	0.0	11.0	0.0	1.7	0.0
Scirpus americana	35.7	0.0	10.7	0.0	0.8	0.0
Juncus scirpoides	28.6	14.3	7.0	0.0	0.9	0.0
Bacopa monnieri	14.3	0.0	7.0	0.0	3.5	0.0
Lippia lanceolata	39.3	28.6	7.0	0.0	0.5	0.0
Centella erecta	50.0	57.1	7.0	0.0	0.3	0.0
Solidago sempervirens	28.6	0.0	7.0	0.0	0.9	0.0
Hydrocotyle umbellata	46.4	57.1	7.0	0.0	0.3	0.0
Rumex crispa	25.0	0.0	7.0	0.0	1.1	0.0
Carex spp.	35.7	42.9	3.5	14.0	0.3	0.8
Spartina alterniflora	17.9	0.0	3.5	0.0	1.1	0.0
Potamogeton pectinatus	25.0	57.1	0.0	57.1	0.0	1.8
Utricularia spp.	17.9	57.1	0.0	57.1	0.0	1.8
Myriophyllum spp.	14.3	57.1	0.0	57.1	0.0	1.8

were consumed in moderate amounts, while numerous other plants were taken on occasion. *Typha* spp. were the first available emergents, appearing early in April.

Selected plants included *Sagittaria falcata, S. latifolia, Rumex crispa, Typha* spp., and *Juncus roemerianus.* It was felt that had more samples been taken, a selection preference for both *Scirpus americanus* and *S. validus* also would have been shown (Table 4).

Nutria feeding during the winter period again differed radically in plant importance and plant selection. *Potamogeton pectinatus, Utricularia* spp., *Myriophyllum brasiliense,* and *Potamogeton illinoensis* provided the main sustenance through the winter. The basal portions of *Typha latifolia, Zizania aquatica, Cladium jamaicensis,* and *Carex* spp. were eaten sporadically throughout the winter. Highest preferences for *Nymphoides aquatica, Nymphaea odorata, Juncus roemerianus, Utricularia* spp., *Potamogeton illinoensis,* and *Myriophyllum brasiliense* were indicated by the Forage Ratio values (Table 4). These plants remained abundant and suffered little winter kill during this period.

Region III. A total absence of nutria feeding signs characterized the canal system and small marshes around Avon. The availability of previously important and preferred plants was somewhat reduced due to environmental alteration, but was not thought to be the limiting factor.

Region IV. Nutria-foraging in the No-ache Marsh was studied with considerable interest as the dense nutria population seemed to reflect optimum habitat conditions. Best described as a mosaic pattern of xeric and hydric phases with representative plant species from both salt and fresh-water marshes, respectively, it offered a chance to compare directly food consumption with these habitats in a contiguous situation. It must be noted, however, that floating and submerged plant species were lacking in all waterways and ponds of Region IV.

TABLE 4. FORAGE PLANT IMPORTANCE AND PREFERENCE, STUDY REGION IIB — BUXTON WOODS. TWENTY SAMPLE PLOTS IN SUMMER, SEVENTEEN IN WINTER.

Plant species	Availability Index		Dietary Importance Index		Forage Ratio	
	Summer	Winter	Summer	Winter	Summer	Winter
Typha latifolia	70.0	47.1	40.0	18.0	0.8	0.8
Cladium jamaicensis	60.0	35.3	32.0	11.0	0.9	0.9
Sagittaria latifolia	45.0	0.0	24.0	0.0	1.2	0.0
Zizania aquatica	60.0	29.4	22.0	16.0	0.7	1.4
Typha angustifolia	35.0	5.9	19.0	0.0	1.2	0.0
Juncus roemerianus	30.0	23.5	15.0	12.0	1.7	2.1
Scirpus validus	20.0	0.0	15.0	0.0	3.8	0.0
Sagittaria falcata	20.0	0.0	10.0	0.0	2.5	0.0
Nymphaea odorata	45.0	17.7	10.0	0.0	3.8	0.0
Carex spp.	40.0	35.3	7.0	19.0	0.3	1.4
Rumex spp.	15.0	0.0	5.0	0.0	2.2	0.0
Ludwigia sp.	15.0	11.8	5.0	6.0	2.2	4.3
Nymphoides aquatica	25.0	11.8	5.0	6.0	0.8	4.3
Scirpus americanus	10.0	11.8	5.0	6.0	5.0	4.3
Smilax spp.	20.0	0.0	5.0	0.0	1.3	0.0
Hydrocotyle umbellata	60.0	11.8	4.0	0.0	0.7	0.0
Potamogeton illinoensis	40.0	41.0	0.0	29.0	0.0	1.7
Myriophyllum brasiliense	40.0	52.9	0.0	42.0	0.0	1.7
Utricularia spp.	40.0	47.1	0.0	47.0	0.0	2.1
Potamogeton pectinatus	30.0	64.7	0.0	52.0	0.0	1.3

The basal portions and rhizomes of *Juncus roemerianus* and *Spartina alterniflora* were considered to comprise the bulk of food during the summer period. Rhizomes of *Spartina patens* and both the stems and the rhizomes of *Scirpus robustus* were consumed to moderate amounts (Table 5). *Scirpus americanus* and *Typha* spp. were eaten in relatively small quantities.

TABLE 5. FORAGE PLANT IMPORTANCE AND PREFERENCE, STUDY REGION IV — NO-ACHE MARSH. TWENTY SAMPLE PLOTS IN SUMMER, TEN IN WINTER.

Plant species	Availability Index		Dietary Importance Index		Forage Ratio	
	Summer	Winter	Summer	Winter	Summer	Winter
Juncus roemerianus	65.0	90.0	60.0	80.0	1.4	1.0
Spartina alterniflora	50.0	100.0	50.0	30.0	2.0	1.0
Spartina patens	60.0	100.0	30.0	40.0	0.8	2.0
Scirpus robustus	45.0	0.0	19.0	0.0	1.0	0.0
Typha domingensis	20.0	0.0	10.0	0.0	2.5	0.0
Scirpus americanus	15.0	0.0	10.0	0.0	0.6	0.0
Typha angustifolia	15.0	0.0	9.0	0.0	4.5	0.0
Distichlis spicata	40.0	40.0	4.0	20.0	0.3	1.3

Preferential selection of *Typha angustifolia, T. domingensis, Spartina alterniflora,* and *Juncus roemerianus* was indicated during the summer (Table 5). The density of *Typha* stands was greatly reduced by nutria over-utilization during this period.

In the winter period, *Spartina alterniflora* and rhizomes of *Juncus roemerianus* were the most important food sources, while *Distichlis spicata* was consumed in moderate amounts. All three of these species

were selected during the winter months. Both *Scirpus robustus* and *Typha* spp. had been browned to the base by October 4, presumably by the salt spray of fall storms. In this desiccated condition, it seems unlikely that they offered adequate forage material.

Region V. As the Pea Island study region was located a considerable distance from the center of operations at Buxton, the opportunity to sample continuously was diminished. However, several intensive investigations of the region were made during the summer and winter periods.

In the summer, only two of five sample areas within Region V were nutria feeding sites. The remaining three areas were random samples of what were considered to be potential feeding sites. The roots and stems of *Setaria magna* were found utilized on both feeding sites, but played a relatively minor role in the surrounding plant community. *Spartina alterniflora* and *Juncus roemerianus* were found utilized only on one feeding site, but comprised a large proportion of the available understory vegetation in the region. *Typha latifolia* was found only outside the two fresh-water impoundments as a result of recent herbicidal treatments by Refuge personnel. *Typha latifolia* was eaten by nutria on one of the feeding sites. It was felt that in all probability *Spartina alterniflora, Juncus roemerianus,* and *Typha latifolia* were of great food importance, while *Setaria magna* was shown to have been a selected plant species (Table 6).

TABLE 6. FORAGE PLANT IMPORTANCE AND PREFERENCE, STUDY REGION V — PEA ISLAND. FIVE SAMPLE PLOTS IN SUMMER, FIVE IN WINTER.

Plant species	Availability Index		Dietary Importance Index		Forage Ratio	
	Summer	Winter	Summer	Winter	Summer	Winter
Setaria magna	40.0	40.0	40.0	40.0	2.5	2.5
Juncus roemerianus	40.0	60.0	20.0	60.0	1.3	1.7
Spartina alterniflora	40.0	0.0	20.0	0.0	1.3	0.0
Typha latifolia	40.0	0.0	20.0	0.0	1.3	0.0
Distichlis spicata	60.0	60.0	0.0	60.0	0.0	1.7
Spartina patens	80.0	20.0	0.0	20.0	0.0	8.0

Three nutria feeding sites were located during the winter period. Two random vegetation samples were included in the same manner as in the summer. The three feeding sites were within a 20-yard radius at the edge of the borrow-pit in the northwestern corner of the South Pond. Remains of the stems and rhizomes of *Setaria magna* and the rhizomes of *Juncus roemerianus, Spartina patens,* and *Distichlis spicata* were found on these sites. Selection was indicated for these four species (Table 6).

Although *Potamogeton pectinatus* was present in the borrow-pits, no feeding observations were recorded for this species. However, since *Potamogeton pectinatus* was a very important winter forage plant in all regions where it was available, it seemed likely that this species would be consumed by nutria in Region V also.

Droppings Analysis

Numerous nutria droppings were present in the vicinity of all feeding sites. It was apparent that nutria preferred to defecate in the water or at the water's edge rather than on dry substrate. Personal experience with a captive animal bore this out and Walther (1931) reported this to be the case. Decomposition of fecal pellets was relatively slow. Droppings were composed of a high percentage of finely divided, undigested plant fibers and were enclosed in a gelatinous capsule.

The most available potential forage animals were the blue mussel (*Modiolus* sp.) in salt marsh and a myriad of gastropods and insects

in all habitats. While in the field, droppings were broken apart and examined macroscopically by the senior author for chitinous or calcareous fragments. Fresh droppings were rinsed to remove the still soft, more finely divided plant material. Fecal pellets were inspected on all feeding sites and throughout the entire summer and winter periods. Special emphasis was placed on this examination during the more critical time of late winter when plant availablity was lowest. It was estimated that over 500 droppings were examined. From this sample, one pellet contained a 0.125 in. fragment of the bright orange enamel from the outer surface of the nutria's incisors. No other animal remains were present in any droppings.

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BREEDING SEASON OF WHITE-TAILED DEER IN LOUISIANA

JOHN H. ROBERSON, JR., *Biologist*, AND DAN DENNETT, JR., *Biologist*
Louisiana Wild Life and Fisheries Commission

New Orleans, Louisiana

INTRODUCTION

In order to efficiently manage deer herds within any given area, it is necessary for biologists to have a thorough knowledge of reproduction within each deer herd to be managed. Detailed investigations are required to obtain this type of information. A recently completed basic survey of reproduction in the white-tailed deer in Louisiana involved