utahensis, which occasionally parasitized some of the other breeding colonies, particularly deer mice, and caused some mortality among very young animals.

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DAILY ACTIVITY OF NUTRIA IN LOUISIANA

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ABSTRACT: The purpose of the study was to determine nutria activity at all times throughout the day. The study was conducted on Rockefeller Refuge in Southwestern Louisiana and activity was measured with a recorder placed on a nutria trail. Each nutria crossing through the trail was determined within a five-minute period for each month during the year.

The study revealed that activity was greatest at night and began declining at dawn. After daylight activity was very slight, and less than one-fifth the number used the trail per hour as during the night. Activity increased at dusk but was less than at dawn.

Analysis of variance showed the data for nutria activity at various periods during the day to be significant at the 0.01 level of probability.

The nutria (*Myocastor coypus*) plays a very important role in the economics of the coastal areas of Louisiana, not only because of its value as a fur bearer, but also for its detrimental actions in agricultural areas (Ensminger, 1956). Numerous studies have been conducted on the life history, food habits and ecology of the animal; however, very little information is available on the animal's behavior patterns. Since the nutria is important economically, it is necessary that all possible knowledge be gained on the animal's habits.

Nutria may be seen moving about both night and day, but questions frequently arise as to the time of day when the animals are most active. It is commonly believed that nutria are crepuscular, with greatest movement at dawn and dusk; and, although numerous opinions have been expressed, none have been verified by detailed studies.

In December 1959, a study was initiated to determine nutria activity at various times throughout the day. The study was conducted on Rockfeller Refuge at Grand Chenier, Louisiana. Rockefeller Refuge, which is owned and maintained by the Louisiana Wild Life and Fisheries Commission, lies in southwestern Louisiana in Cameron and Vermilion parishes and consists of 85,000 acres of prairie marsh. The refuge borders the Gulf of Mexico, and is composed of salt, brackish and fresh-water marshes.

Nutria first invaded the refuge in the early 1950's and the population increased rapidly, reaching a peak in 1955. It then declined to a lower level and remained fairly static. Only moderate increases or decreases were noted each year. During the study the nutria population declined but this had no effects on the study, since only daily activity was considered.

Various studies on other rodents have revealed considerable differences among the various species. Field observations on muskrats (*Ondatra zibethica*) by O'Neil (1949) during bed-breaking studies indicate that 80% of the muskrat's activity is nocturnal. Observations under pen conditions revealed that muskrats were active from 4 PM until 6 AM. Svihla and Svihla (1931) observed that muskrat were active chiefly at night. Studies on the daily activity of white-footed mice (*Peromyscus leucopus noveboracensis*) by Johnson (1926), Behney (1936) and Orr (1959) revealed that the animals became active at dusk reaching a peak several hours after dark, then tapered off until dawn. Activity increased again at dawn but practically subsided after sunrise. Hamilton (1939) found that field mice (*Microtus pennsylvanicus*) were active at all hours but greatest activity was during the day. Observations revealed that activity peaks were reached shortly after dawn and in late afternoon.

Most reports on animal activity have been made on captive animals or casual observation, which may not present behavior patterns typical of the species. Various techniques have been employed to record activity. Johnson (1926) placed white-footed mice in small cages suspended by rubber bands. The cages were attached to a clock-driven chart by a recording pen and when the mice were active the movement of the cage recorded on the chart. Behney (1936) and Orr (1946) used special cages, and white-footed mice in the cages, when active, tripped electrical switches which recorded the movement on charts. Hamilton (1939) placed baits in field mice runs and checked the baits hourly, then listed the hours that the baits were eaten as an activity period. Southern, *et al.* (1946) suggested using infrared light to study animal behavior, since most species are sensitive only to lights of longer wave lengths. O'Neil (1949) used two methods of determining muskrat activity. The first method consisted of opening muskrat beds at various hours and the times that adults were not present were considered activity periods. The other method was simply observing animals in captivity. Godfrey (1954) attached 5 to 10 mg of Cobalt 60 to the legs of nestling field voles (*Microtus agrestis*), then later used a Geiger-Muller counter to locate the voles and trace movement activity.

From nutria tagging studies in Louisiana, Kays (1956) concluded that nutria usually remain in one general area throughout their life. Of 87 recaptured animals only 8 had moved beyond 1,200 yards of the release site. Several had moved extreme distances, 18.5 miles in 187 days and 15 miles in 67 days. However, this was atypical and during a 6-month period approximately 50% of the tagged males were recaptured less than 100 yards of the release site and 50% of the females were recaptured within 50 yards of the release site. Adams (1956) stated that data from tagged nutria strongly indicated that the daily cruising range seldom exceeded 200 yards and under favorable conditions the range may be less.

METHODS AND MATERIALS

Since nutria follow a well-defined trail when traveling from one place to another, a recorder placed on a trail made it possible to determine within a 5-minute period the time of day that a nutria used the trail.

A Stevens Water Level Recorder, Type F, was modified and used for the study. The recorder was placed five feet from a well used nutria trail and a trip-wire stretched across the trail, about three inches above the ground, so that each nutria crossing the trail would move the wire. Each movement of the wire was marked on a chart by a pen inside the recorder as it slowly moved across the chart. The pen was clock-driven and moved the full length of the chart, 9.6 inches, in 24 hours. The recorder was operated on the 10th and 25th of each month for one full year.

For the purpose of classification each day was broken down into 4 separate periods. These periods were set according to the light intensity, since light intensity seemed the primary factor regarding nutria activity.

Period 1 began one hour before sunrise and terminated at one hour after sunrise. This period extended through the dawn and covered only 2 hours, but still light intensity varied considerably during the period.

Period 2 extended from one hour after sunrise to one hour before sunset and included the daylight hours. The length of this period varied monthly, but the light intensity throughout the period remained fairly constant. In analyzing the data it was necessary to compute the number of hours in this period each day. The annual average for this period was 9 hours 50 minutes.

Period 3 began one hour before sunset and ended one hour after sunset, extending throughout dusk. This period was 2 hours long and the light intensity varied considerably.

Period 4 began one hour after sunset and extended through the night ending one hour before sunrise. Light intensity remained constant throughout this period, but the length of the period varied greatly. The annual average time for this period was 10 hours 10 minutes.

Since most of the periods were of different length, the results were expressed on an hourly basis for standardization. By doing this it was possible to compare each period with the others.

RESULTS

As shown in Table 1 nutria activity for the various periods followed the same general trend throughout the study with several exceptions. Therefore, the data were subjected to an analysis of variance using Student's *t*—distribution according to Snedecor (1956) and is shown in Table 2. This revealed that the data on the periods were significant at the 0.01 level of probability. Among Periods 1, 3 and 4 there was a significant difference at 0.05 level of probability; but using Least Significant Difference (L.S.D.) only Period 2 average crossings per hour were significantly different at the 0.05 level of probability from the other averages. Only in Period 2 versus Periods 1, 3 and 4 does the average difference equal or exceed the L.S.D. of 1.0994. Period 3 versus 4 approaches but does not exceed the L.S.D.

Significant differences at the 0.01 level of probability were also found for months. Interaction of Periods × Months was not significant at 0.05 level of probability; differences of Months and Periods did not change with each other. In other words the periods were constantly high or low regardless of month. Periods and months were not related to each other.

TABLE 1.—*Average number of nutria crossings per hour for different daily periods, 1960*

Month	DAILY PERIODS							
	Period 1*		Period 2**		Period 3***		Period 4****	
	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2
January	3.50	2.00	.82	.94	3.50	1.50	3.38	4.51
February	3.50	1.50	.10	.54	2.50	3.00	3.43	3.35
March	3.50	3.50	.00	.30	1.50	1.00	4.35	4.15
April	3.00	3.50	.28	.64	2.50	3.50	4.85	3.31
May	1.50	2.50	2.85	1.15	1.50	1.00	3.13	2.77
June	5.00	4.50	.25	.25	4.50	4.00	4.78	3.28
July	2.00	3.00	.08	.00	1.00	1.00	2.21	3.07
August	5.50	1.50	.53	.71	5.00	1.00	4.64	1.36
September	1.50	1.50	.38	.10	1.50	.50	1.02	.82
October	.00	1.50	.00	.10	.00	.50	1.32	1.42
November	1.00	2.00	.00	.00	.50	1.00	.79	.79
December	.50	.00	.12	.00	.00	1.00	1.01	1.11
Mean	2.40		.42		1.79		2.70	

* Period 1—One hour before sunrise to one hour after sunrise.
** Period 2—One hour after sunrise to one hour before sunset.
*** Period 3—One hour before sunset to one hour after sunset.
**** Period 4—One hour after sunset to one hour before sunrise.

TABLE 2.—*Analysis of variance of the number of nutria crossings per hour for each period on 24 days in 1960*

Source of variation	Degrees of freedom	Sum of squares	Mean squares	"F" values
Periods	3	73.5198	24.5066	21.0973**
Period 2 vs. others	1	63.2185	63.2185	54.4236**
Among 1, 3 and 4	2	10.3013	5.1507	4.4341*
Months	11	78.2682	7.1152	6.1253**
Months × Periods	33	38.3328	1.1616	1.5103
Days/Periods/Months	48	36.9208	0.7691	
Total	95	227.0416		

** Highly significant at the 0.01 level of probability.
* Significant at the 0.05 level of probability.

Nutria movement through the trail per hour was greatest on an average during Period 4 or at night. Period 1 which covered dawn and sunrise, ranked second and showed slightly less activity than did the night period. In third place was Period 3 which extended through sunset. The number of crossings per hour in Period 3 was one-third less than Period 4. Least movement occurred in Period 2 which included the daylight hours. Less than one-fifth the number of animals used the trail at this time as did during the night.

Since Period 1 and Period 3 represent the dawn and dusk hours respectively, both periods showed drastic changes in light intensity. Both periods were of 2 hours duration; consequently, in an effort to show more precisely the activity during these periods, both were broken down into one-hour intervals and the number of nutria crossings during each interval listed.

Table 3 compares the number of nutria crossings one hour before sunrise with those one hour after sunrise. The data were subjected to an analysis of variance using the paired "*t*" test (Table 3) as described in Snedecor (1956) as the test of differences. This test revealed that the data were significant at the 0.05 level of probability.

The effects of light changes on nutria activity is clearly demonstrated during this period. Over twice the number of nutria crossings were tabulated in the one-hour interval before sunrise as tabulated one hour after sunrise.

The difference in the one-hour intervals before and after sunset (Table 4) was also subjected to the paired "*t*" test. The difference was significant at the 0.05 level of probability. The data show that over twice the number of nutria crossings were made during the one-hour interval after sunset than one hour before sunset.

DISCUSSION

Although nutria crossed the recorder at all hours of the day, the study clearly shows that activity is far greater at night and that the animals can well be

TABLE 3.—*Average number of nutria crossings one hour before sunrise and one hour after sunrise for each month, 1960*

Month	Before sunrise X1	After sunrise X2	Difference $D = X1 - X2$	Deviation $d = D - \bar{d}$	Squared deviation d^2
January	3.0	1.0	2.0	0.375	0.1416
February	4.5	.5	4.0	2.375	5.6406
March	6.0	1.0	5.0	3.375	11.3906
April	5.0	1.5	3.5	1.875	3.5156
May	1.5	2.5	-1.0	-2.625	6.8906
June	4.5	4.5	0.0	0.00	0.0
July	1.5	3.5	-2.0	-3.625	13.1406
August	4.5	2.5	2.0	0.375	0.1416
September	2.0	1.0	1.0	-0.675	0.4556
October	1.5	0.0	1.5	-0.125	0.0156
November	3.0	0.0	3.0	1.375	1.8906
December	0.5	0.0	0.5	-1.125	1.2656
Total	37.5	18.0	19.5	1.525	44.4886
Mean	3.125	1.5	$\bar{d} = 1.625$ crossings		$SD^2 = 4.044$

$$SD = \sqrt{4.044} = 2.01 \text{ crossings. } S\bar{d}^2 = \frac{4.044}{12} = .34; \quad S\bar{d} = .58$$

$$t = \frac{\bar{d} - uD}{S\bar{d}} = \frac{1.625 - 0}{.58} = 2.80^*$$

* Significant at the 0.05 level of probability.

classified as nocturnal. Activity at dusk increased as light intensity decreased, while at dawn activity decreased as light intensity increased.

Although other animals such as the raccoon (*Pyrocyon lotor*) and muskrat may travel nutria trails occasionally and could have tripped the wire, errors from this source were believed insignificant. A careful watch was maintained for animal tracks along the trail during the study, but none was found other than nutria. The muskrat population in the study area was very low.

This study did not record stress movement where animals are forced to move in and out of certain areas at different times of the day. Rather, the recorder was placed in an area which was both a resting and feeding area and the nutria were not disturbed at any time, except possibly by the brief daily visit to the recorder by the person changing the chart.

The data did not show any change in nutria activity as affected by changes in temperature. It was thought that nutria were intolerant to the heat of direct sunlight and that the animals remained inactive during this period in the summer. However, no significant difference was found in activity between the daylight periods of the summer and winter months. O'Neil (1949) stated that

TABLE 4.—*Average number of nutria crossings one hour after sunset and one hour before sunset for each month, 1960*

Month	After sunset X1	Before sunset X2	Difference $D = X1 - X2$	Deviation $d = D - \bar{d}$	Squared deviation d^2
January	3.0	2.0	1.0	–0.333	0.1109
February	5.0	0.5	4.5	3.167	10.0299
March	2.0	0.5	1.5	0.167	0.0279
April	5.5	0.5	5.0	3.667	13.4469
May	1.5	1.0	0.5	–0.833	0.6939
June	4.0	5.5	–1.5	–2.833	8.0259
July	1.5	0.5	1.0	–0.333	0.1109
August	4.5	1.5	3.0	1.667	2.7789
September	1.5	0.5	1.0	–0.333	0.1109
October	0	0.5	–0.5	–1.833	3.3599
November	5	1.0	–0.5	–1.833	3.3599
December	1.0	0	1.0	–0.333	0.1109
Total	30.0	14.0	16.0		42.1668
Mean	2.5	1.167	$\bar{d} = 1.333$ crossings		$SD^2 = 3.833$

$$SD = \sqrt{3.833} = 1.96 \text{ crossings.} \quad S\bar{d}^2 = \frac{3.833}{12} = .32; \quad S\bar{d} = .57$$

$$t = \frac{\bar{d} - uD}{S\bar{d}} = \frac{1.333 - 0}{.57} = 2.339^*$$

* Significant at the 0.05 level of probability.

the diurnal activity of muskrats increased during adverse weather conditions, but the same behavior was not found among nutria during this study.

Food shortages may cause abnormal behavior patterns in nutria, but this was not determined during the study. Behney (1936) found that hunger extended the activity of white-footed mice into the daylight period. The writer has observed nutria moving about during the daylight period in areas with food shortages and the animals were believed in search of food. Also, captive nutria will feed readily at any time during the day when hungry. The food supply of nutria was more than ample in the study area and not considered a factor affecting daily activity.

Population pressure has certain effects on animal behavior, but its influence on the results of this study was considered negligible. O'Neil (1949) stated that muskrat demonstrated a great deal more diurnal activity under conditions of extreme populations. By increasing the number of white-footed mice in an inclosure from one to six, Orr (1959) found that crowding had little effect upon the amount of activity in this species. Kays (1956) stated that population pressure was a basic agent motivating animal movement, and when nutria were introduced into southwestern Louisiana the extremely high populations which developed increased interspecific strife. The resulting competition induced a segment of the population to seek out new areas. However, overpopulation increases competition for food, and hunger may be responsible for abnormal behavior under such conditions. Also, fighting among nutria using a common travel lane or competition for dens and resting platforms, particularly in flooded areas, probably alter normal activity with high populations.

Hamilton (1939) stated that predation possibly played a selective part in regulating the daily activity of field mice. Greatest activity occurred during periods when vertebrate enemies were least active. Nutria had no natural enemies in the study area and their activity was not influenced from this source. Nevertheless, even in areas where natural enemies existed, nutria seemed unconcerned and were frequently seen resting in open areas during the daylight hours.

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