Spring and Summer Movements of Muskrats in a Louisiana Coastal Marsh

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Abstract: Muskrat (*Ondatra zibethicus rivalicius*) movement and activity patterns were studied in a Louisiana coastal marsh. Trap success was 8.2% in January–February, but only 3.3% in June–August. Of 46 muskrats captured, 65.2% were males. Lodge use was greater than expected in January–March and less than expected in April, July and August ($\chi^2 = 92.5$, $N = 557$, $P < 0.01$). No radio-collared muskrats (11 males and 6 females) were observed rearing young. Five (33.3%) muskrats emigrated in the spring and 3 of the dispersals occurred during a storm tide (29 March–3 April). Long movements (>70 m) within the study area were associated with high water levels (>20 cm). Average home range (0.7 ha, SE = 0.2, $N = 44$) and hourly movements (33.8 m, SE = 1.8, $N = 695$) recorded on diel tracking sessions varied widely among individuals.

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Louisiana trappers account for approximately 20% of the annual wild fur harvest in the United States (Ensminger and Linscombe 1980). The Gulf Coast muskrat (*Ondatra zibethicus rivalicius*) is partly responsible for Louisiana's outstanding fur production. In the 1978–1979 season, 445,525 muskrat pelts from all areas of Louisiana were sold for almost $1.5 million (Ensminger and Linscombe 1980). This amount accounted for 13% of the value of all pelts from all furbearers taken in Louisiana that season.

Much basic information on coastal muskrats is lacking (Hoffman and Bart 1982). Little is known regarding the behavior of the species in relation to changing environmental conditions in coastal marshes. The purpose of this study was to determine movement and activity patterns of muskrats in relation to weather factors and water levels during the spring and summer in a coastal marsh.

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Methods

The study area was at the extreme eastern end of St. Tammany Wildlife Refuge, on the north shore of Lake Pontchartrain, 6.4 km southwest of Lacombe, Louisiana. It was bounded by Bayou Lacombe, Lake Pontchartrain, and Louisiana Route 434 and encompassed approximately 34 ha. Water levels in the study area were directly affected by tide levels on Lake Pontchartrain. The climate in the Pontchartrain basin is humid and subtropical and the average annual rainfall is 162.56 cm (Saucier 1963). Following Cowardin et al. (1979), the study area is classified as an estuarine, emergent wetland with tidal, mixosaline (brackish) water and semipermanently flooded, organic soils. *Spartina patens* was the most abundant plant species on the study area and was usually associated with *Scirpus olneyi*. Portions of the refuge have been burned annually as part of a marsh management program.

Trapping activity was divided into 2 periods. Period 1 (cold weather period) extended from 19 January through 14 February 1982 (573 trap-nights) and period 2 (warm weather period) extended from 28 June through 13 August 1982 (90 trap-nights). Unbaited Tomahawk live traps (62 × 17 × 17 cm) were used and placed at plunge holes and in runways that appeared to be used by muskrats. Traps were placed where muskrat activity appeared high; no systematic grid or randomized pattern was followed. Each muskrat was immobilized with an intra-muscular injection of Ketaset (ketamine-hydrochloride) for handling. Dosages were 0.1 cc/1,000 g of estimated body weight. Muskrats were sexed and aged (juvenile and adult) as described by Baumgartner and Bellrose (1943) and Dozier (1942). A serially-numbered, metal ear tag was placed in the webbing of each hind foot between the first and second digits for identification. Muskrats were radio-collared (frequencies of 150 to 152 MHz) for subsequent tracking. Each radio collar weighed approximately 46 g and was placed only on muskrats weighing more than 500 g.

Three procedures were used to locate instrumented muskrats. Muskrats were located during the day with a radio receiver and a hand-held "H" antenna by walking toward the peak signal strength. A fix was marked where the strongest signal was found or where the muskrat was seen. The distance and azimuth from the preceding location were measured with an optical rangefinder and a hand-held compass. Muskrats were pinpointed exactly with the handheld antenna at close range when they were relatively immobile. Their locations were less certain (within a radius of 3 m) if they appeared to be moving while being tracked. The type and size of any shelter in which the muskrat was located were recorded for each fix. All radio-tagged muskrats on the study area were located as frequently as possible, usually 4 or more times/week from 25 January through 13 August.

The second procedure involved diel tracking of radio-tagged muskrats. Seven diel radio-tracking sessions were conducted during 15–16 and 25–26 February, 23–24 March, 5–6 and 13–14 April, 14–15 May, and 26–27 July. On diel sessions, a dual, 2-element yagi antenna array on a 3 m mast was used at 2 permanent tracking stations. Azimuths were read on all transmitters that could be heard from 1 station; the antenna was then carried to the other station to record azimuths from a second position. The stations were approximately 300 m apart and both sets of azimuths were recorded during periods of 15–20 minutes. Locations were made hourly beginning on the hour.

For each signal heard, the muskrat number, azimuth, and time were recorded. These azimuths were later plotted on a map of the study area and the fixes were converted to X and Y coordinates according to an arbitrary grid on the map. Coordinates were measured to the nearest 10 m. Two transmitters were kept at known locations during diel sessions and azimuths were read on them to confirm that the antenna and compass boards were aligned consistently. The azimuths on these beacons never varied by more than 1 degree. These variations resulted in "movements" of about 5 m. Both beacons were within 100 to 200 m of either tracking station (at least 76% of all collared muskrats were usually within that range), and were in positions that minimized parallax error.

Muskrats that emigrated from the study area were tracked by airplane so that they could be located later by a ground search.

Lodge use through the months was analyzed with an 8 × 2 contingency table (Walpole and Myers 1978). The months of January through August formed the rows and the number of muskrat locations inside and outside of lodges formed the columns. The chi-square statistic was used to test the null hypothesis: lodge-use-frequency was independent of the time of year (month).

The likelihood of moving long distances was evaluated as a binomial experiment. The probability of an unusually long movement was the number of long movements divided by the total number of locations. A long movement was defined as the average of all hourly movements recorded during the daylight hours during diel sessions, plus 1 standard deviation. This probability was used in a binomial function to calculate the probabilities of long movements occurring as often as, or more than, observed during high or low water. High water was defined as 20 cm above marsh level. Throughout the study period, marsh water depths, rainfall, relative cloud cover, and maximum and minimum temperatures were recorded daily.

Minimum home range areas (Mohr 1943) were calculated by cutting the areas from plots of diel locations and weighing the paper. Unit areas of the same paper were weighed to determine the weight-to-area conversion.

Results and Discussion

Trapping

During the cold weather trapping period, 47 muskrats were captured in 573 trap-nights (1 muskrat/12.2 trap-nights = 8.2%). Of these, 2 adult males were dead and 1 adult male was a recapture. Thus, 44 individual muskrats were tagged and released. During the warm weather trapping period, 3 more muskrats were captured in 90 trap-nights (1 muskrat/30 trap-nights = 3.3%).

Radio-collars were placed on 6 adult and 4 immature males and 4 adult and 6 immature females during the cold weather trapping period. However, only 15 (5 adult and 4 immature males and 3 adult and 3 immature females) survived more than 24 hours and were included in the study. Two more adult males were radio-tagged in the warm weather trapping period, thus data are available for 17 muskrats. Muskrats were radio-tracked from 16 to 136 days ($x = 78$, SD = 28).

Lodge Use

Of 557 daytime muskrat locations, muskrats were found in lodges or other shelters 292 times. Lodge use was greater than expected from January through March and was less than expected in April, July, and August ($\chi^2 = 92.5$, $N = 557$, $P < 0.01$) (Table 1).

Table 1. Test of independence between month and muskrat lodge use ($\chi^2 = 92.5$, $P < 0.01$).

Month	*N* times in lodges		*N* times outside lodges		Total *N* locations
	Observed	Expected[a]	Observed	Expected[a]	
January	24	14.2	3	12.8	27
February	90	68.2	40	61.8	130
March	94	75.0	49	68.0	143
April	39	56.6	69	51.4	108
May	25	26.7	26	24.3	51
June	0	1.0	2	1.0	2
July	18	39.3	57	35.7	75
August	2	11.0	19	10.0	21
Total	292		265		557

[a] Row total times column total divided by 557.

As lodge use decreased with warmer temperatures, muskrats were often located in dense stands of grass or in areas away from any apparent shelter. Arthur (1931) described the use of underground beds in widened sections of tunnels during periods of low water. Arthur (1931) also referred to a report by Vernon Bailey stating that muskrats used beds of grass or sod under dense stands of vegetation and these beds may take the place of lodges in the summer. Such behavior was common for the 2 adult males in July and August, and to a lesser extent with other muskrats in April (Dell 1983).

The muskrats displayed 3 apparent patterns of lodge use. Eight muskrats (47.1%) were associated with specific lodges and were consistently found in them. Five other animals (29.4%) had apparent home ranges but used several lodges or huts. Four muskrats (23.5%) were never associated with any area or shelter. Sather (1958) reported the use of more than 1 lodge by a muskrat and also noted that individual muskrats were associated with certain lodges and that family groups did not overlap. In this study, none of the muskrats that frequented certain lodges (nor any of the other radio-collared muskrats) was believed to be rearing young.

All (4) muskrats that were not associated with a lodge or a specific area died. Two were victims of predation, and the remains of the others were found after they had made long movements of 300 to 500 m (1 emigrated and the other remained on the study area). Only 2 (15.4%) of the muskrats that used lodges and had apparent home ranges died during the study. One was killed by a predator and the cause of death of the other was unknown. The fidelity of 1 adult male to his home range was disclosed when his carcass was found on 14 January 1983, 33 weeks after his signal was lost. The carcass was approximately 20 m from the hut he had used during 84.6% ($N = 52$) of the daylight locations between 27 February and 28 May 1982. The case histories of all radio-tagged muskrats were discussed by Dell (1983).

Home Ranges

The average of 44 estimates of home ranges recorded during the diel tracking sessions was 0.7 ha ($SE = 0.2$) (Table 2). Average home ranges varied from 0.2 ha (adult males in April and immature females in February) to 1.7 ha (immature males in February). Three muskrats were wide-ranging wanderers and many home range areas of several others were affected by "outlier" locations. Much individual variation was noted and probably resulted from varying sample sizes (number of radio-locations/diel session) as reported by Smith et al. (1981). The average hourly movement also varied widely (Table 3). The average hourly movement was 33.8 m (SE = 1.8, $N = 695$) for all muskrats and diel dates.

The diel home ranges and hourly movements agreed with past studies (Errington 1963, Snead 1950, Mathiak 1953, Dorney and Rusch 1953, Aldous 1947, Sather 1958, Shanks and Arthur 1952, Williams 1950, Takos 1944, Wragg 1955, Stevens 1953, Fuller 1951, O'Neil 1949, Stewart and

Table 2. Average home range size (ha) of each sex and age class recorded on diel sessions each month.

Month	Adult males	Immature males	Adult females	Immature females
February	0.6 ± 0.3[a] (6)[b]	1.7 ± 1.9 (7)	0.6 ± 0.8 (6)	0.2 ± 0.1 (4)
March	0.5 ± 0.2 (4)	0.5 ± 0.5 (3)	0.5 ± 0.4 (2)	
April	0.2 ± 0.1 (2)	0.5 ± 0.3 (2)	0.4 ± 0.4 (4)	
May		0.7 (1)		0.4 (1)
July	0.3 ± 0.4 (2)			

[a] 95% confidence interval.
[b] Number of home ranges.

Bider 1977). These authors analyzed muskrat movements by recapturing tagged individuals and by studying sign.

MacArthur (1978) radio-tracked muskrats in a Canadian marsh during the winter. Of 870 locations of 11 muskrats, more than 50% were within 15 m of a den or lodge. No muskrat moved more than 150 m from the shelter it was using. These studies indicate that muskrats are associated with a home range usually not extending more than 100 m in any direction.

Table 3. Mean hourly movements (m) of the sex and age classes during 2 seasons and the periods of day.

Periods of day	Adult males	Immature males	Adult females	Immature females
February–March				
Sunrise	30.9 ± 13.9[a] (19)[b]	74.6 ± 61.2 (17)	39.5 ± 18.4 (16)	42.9 ± 27.2 (8)
Midday	35.4 ± 10.8 (58)	30.4 ± 14.9 (55)	36.9 ± 14.9 (50)	32.2 ± 13.9 (28)
Sunset	39.0 ± 18.8 (20)	45.3 ± 16.3 (24)	33.8 ± 12.0 (18)	37.3 ± 24.9 (9)
Night	37.0 ± 11.2 (40)	31.9 ± 15.3 (37)	25.9 ± 9.4 (40)	27.4 ± 13.1 (22)
April–May				
Sunrise	11.4 ± 6.7 (9)	47.6 ± 25.9 (10)	11.4 ± 8.2 (10)	155.6 (1)
Midday	13.9 ± 8.6 (10)	18.2 ± 11.0 (15)	16.3 ± 5.7 (20)	58.3 (1)
Sunset	22.4 ± 5.1 (9)	40.1 ± 23.3 (12)	60.2 ± 51.4 (14)	128.1 (1)
Night	39.8 ± 11.8 (22)	47.0 ± 21.4 (16)	27.8 ± 11.6 (18)	78.6 ± 95.3 (2)

[a] 95% confidence interval.
[b] Sample size.

Emigrations and Long Movements

Sex and age ratios.—Five muskrats radio-collared during winter emigrated from the study area. These included 3 immature males, 1 adult male and 1 adult female. No immature females moved from the study area. The mean distance moved by all emigrating muskrats was 987 m (SE = 234.3). Most dispersing muskrats observed by Errington (1940, 1943) and Erickson (1963) were males. However, Beer and Meyer (1951) concluded that emigrations occurred in both sexes in proportion to the sex ratio of the population. During this study, 4 (44.4%) of the males and 1 (16.7%) of the females monitored over an extended period emigrated from the study area. Errington's (1943) studies disclosed that most emigrating muskrats were immature. In this study, 3 (42.9%) of the immature animals and 2 (25.0%) of the adults left the study area.

Effect of season and water depth.—Three male muskrats emigrated almost simultaneously. They used specific lodges prior to emigration and usually did not travel far from them. On 28 March, a storm tide raised the water level on the study area to a depth of 33 cm, and the water remained high on 29 March (30 cm) and 30 March (24 cm). Two animals dispersed after 28 March and the other left the study area between 29 March and 3 April.

The fourth male never used any specific area and emigrated between 28 February and 8 March. The female used an established home range through 19 April when she left the study area. We could not associate the emigrations of these 2 muskrats with water-level changes.

Spring muskrat dispersals have been noted in many studies (Warwick 1940, Errington 1940, 1963, Lay 1945, Freeman 1945, Beer and Meyer 1951, Sprugel 1951, and Erickson 1963). Errington (1940) stated that muskrat dispersals may be associated with floods: a flood at the right time may "precipitate" an early dispersal. Erickson (1963) noted that dispersals in New York were associated with spring thaws and ice breakup and that movements occurred downhill from high ponds to lower ponds. Sprugel (1951) concluded that floods did not affect the initiation of dispersal. He noted that predispersal floods in 5 years did not affect the initiation of dispersal, but floods occurring soon after dispersal began accelerated the movement of animals from their wintering areas. Spring and fall migrants may be stimulated to move by normal physiological cycles and will take advantage of the most favorable water conditions (Beer and Meyer 1951).

Since 60% of the emigrations during this study took place in a period of high water (28 March–3 April), emigration was apparently encouraged by water conditions that aided travel or flooded dens. However, these animals may have emigrated without high water. The 2 muskrats that emigrated during normal water levels may have been driven by endocrine cycles or population pressure, as described by Beer and Meyer (1951).

High water seemed to facilitate long movements. There were 22 long movements (>70 m) out of 556 daytime observations. Thus, the probability of a muskrat moving >70 m during a single observation was 0.0396. Four long movements out of 11 observations ($P = 0.00065$) were made during high water levels (>20 cm deep), and 18 long movements out of 545 observations ($P = 0.81351$) were recorded during low water. Since the probability of long movements occurring 4 out of 11 times during high water is so low, water levels appear to affect the distances muskrats travel between daytime locations.

Errington (1940) and Beer and Meyer (1951) reported high mortality rates among dispersing muskrats. We observed only 1 mortality among the 5 animals that dispersed from the study area; 1 other muskrat seemed to be established in a new home range after emigrating. The fates of the 3 others are unknown.

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