Movement Patterns of Muskrats in a Louisiana Coastal Marsh

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Abstract: Diel movement of muskrats (*Ondatra zibethicus*) in a Louisiana brackish, coastal marsh was determined using 37 radio-collared muskrats and a total of 2,046 radio fixes during a 13-month period. Monthly home range averaged 0.48 ha but varied considerably among animals; no differences in home ranges were detected among seasons or sex-age classes of muskrats. Also, no differences in hourly movements were found among sex-age classes during periods of day. During winter and spring, differences were detected among individual muskrats. Comparison of seasonal means for all times of day and for all sex-age classes revealed that hourly movement rates were greater in spring than in summer or winter, but did not differ from fall movements. Fall movements did not differ from summer or winter movements. Temperature and marsh water depth had a minor effect on distances moved; neither factor explained more than 21% of the variation in distances moved.

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The muskrat is the single most important furbearer in North America in terms of both numbers of pelts and total pelt value (Tarver et al. 1987). The Gulf Coast

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muskrat comprised 82% of the total fur catch in Louisiana from 1913 through 1960 (Lowrey 1974:27). However, muskrat numbers declined drastically after that time and in recent years muskrats have comprised only 25% of the state's fur harvest (Tarver et al. 1987). The cause of the decline is not completely understood, because much basic information is unavailable concerning coastal muskrats. Information about muskrat movement and home range in relation to changing environmental conditions would be useful in understanding muskrat ecology.

Several studies of muskrat movement and activity have been conducted in northerly areas such as Illinois (Coon 1965), Wisconsin (Van Horn 1975), and Manitoba (MacArthur 1980). O'Neil (1949) made an indepth study of the muskrat in Louisiana coastal marshes, but his study emphasized habitat ecology and management. Likewise Svhila and Svhila (1931) and Arthur (1931) studied the Gulf Coast muskrat in Louisiana, but neither considered movement patterns.

This study was undertaken to provide a better understanding of the patterns of movement and home range size of Gulf Coast muskrat and to relate these patterns to temperature and water depth.

Methods

The study area was a 34-ha section of marsh on the northern shore of Lake Pontchartrain in southeastern Louisiana. Vegetation was typical of brackish marsh (Chabreck 1972) and consisted mainly of *Spartina patens* and *Scirpus olneyi*. Water salinity in the area averaged 4.7 ppt (range: 1.3–7.5 ppt), and marsh water depth (marsh level = 0.0) ranged from −1.5 cm (July 1982) to 18.9 cm (December 1983). Variation in water level was affected strongly by wind velocity and direction, rainfall in the Bayou Lacombe basin, and tidal action on Lake Pontchartrain (Keyser 1984).

Muskrats were captured in live traps placed in trails used by the animals. They were immobilized by intramuscular injections of ketamine hydrochloride (about 0.1 cc/450 g body weight; Dell 1983). Age was classified as adult or immature based on body size and condition of external genitalia (Baumgartner and Bellrose 1943). Sex was determined as described by Dozier (1942) and Baumgartner and Bellrose (1943).

Radio transmitters mounted on collars (45 g) were placed on muskrats, and the location of the animals was determined with a receiver and directional antenna. Muskrats were selected for radio-collaring based on their size (>700 g) and apparent health.

Hourly locations were obtained for all radio-collared muskrats during diel tracking sessions conducted at 2- to 3-week intervals (22 tracking sessions) between February 1982 and February 1983. Signal azimuths were read each hour with 2 dual-element yagi antennas attached to a 3-m mast mounted to each of 2 permanently aligned compass roses (direction indicators). These 2 tracking points were located approximately 335 m apart along the southern boundary of the study area. Two stationary transmitters were placed at known locations to test the accuracy of receptions. Movement of muskrats was interpreted as the distance between successive points where the animal was located. Air temperature and marsh water depth were determined hourly during the diel tracking sessions.

Home range sizes were computed by the minimum convex polygon method (Mohr 1943) and compared using analysis of variance (SAS Institute 1982) with season and sex-age classes as treatments. Sex-age classes were designated as adult male, adult female, immature male, immature female. The dependent variable was monthly home range size for an individual muskrat and based on all locations obtained from diel-tracking each month for each animal.

Movement patterns also were analyzed by analysis of variance (SAS Instit. 1982), and distances between successive diel locations recorded ≤ 1 hour apart were used as the dependent variable. The model contained time-of-day, sex-age class, a split-plot using individual muskrats within a sex-age class, and an interaction between sex-age class and time-of-day. The mean square for the split-plot analysis was used as the error term in the sex-age class model. Times-of-day were defined as dawn (from 1 hour before to 2 hours after sunrise), dusk (from 1 hour before to 2 hours after sunset), day (the period between dawn and dusk), and night (the period between dusk and dawn). In all tests, the significance level was 0.05.

Results

In 2,300 trap-nights we captured 89 muskrats for a 3.9% trapping success, which was similar to the 2.8% trapping success reported by Robicheaux and Linscombe (1979). During warm weather (April through September), 11 muskrats were captured on 1,027 trap-nights for a 1.1% trapping success. The average daily low temperature for that period was 20.1° C. Between 1 October and 28 February, the low temperature on 1,273 trap-nights averaged 7.5° C, and 78 muskrats were captured for a trapping success of 6.1%. Air temperature apparently affected the movement behavior of muskrats and the greater trapping success on cold nights ($X^2 = 56.59$, df = 2, $P < 0.005$). Of the 89 muskrats captured, 37 were radio-collared. These included 15 adult males, 10 adult females, 6 immature males, and 6 immature females.

The mean monthly home range during all seasons for all muskrats was 0.48 ± 0.12 ha (SE) and no differences in home ranges could be detected among sex-age classes or seasons because of the great variability in monthly home range sizes.

Spring movements by all radio-collared muskrats averaged 30.3 ± 2.2 m/hour, were longer ($P < 0.05$) than winter ($\bar{x} = 22.7 \pm 0.8$ m/hour) or summer ($\bar{x} = 19.2 \pm 2.2$ m/hour) movements, but did not differ from fall movements ($\bar{x} = 24.8 \pm 4.2$ m/hour). Mean hourly movements did not differ among winter, summer, and fall, and no differences in hourly movements were noted among sex-age classes during any season. However, differences were found among individual muskrats within winter and spring (Table 1).

Muskrat movements did not differ among periods of the day within sex-age classes during any season but approached statistical significance during winter ($F = 1.80$; 9, 1,174 df; $P = 0.0642$) (Table 1); data were not available for immature

Table 1. Analysis of variance of mean hourly distance moved (m) by radio-collared muskrats during diel tracking sessions in Louisiana between February 1982 and February 1983. Separate analyses were conducted for each season.

Source of variation	Winter			Spring			Summer			Fall		
	df	*F*	*P*	df	*F*	*P*	df	*F*	*P*	df	*F*	*P*
Sex-age (SA)	3	1.90	0.1598	3	0.38	0.7711	1	1.86	0.2216	1	0.01	0.9279
Muskrat[a]	22	11.84	0.0001	7	6.02	0.0001	6	2.06	0.0605	9	1.58	0.1199
Time of day (TD)	3	2.00	0.1106	3	2.28	0.0782	3	0.09	0.9619	3	0.60	0.6196
SA X TD	9	1.80	0.0642	9	0.88	0.5480	3	0.31	0.8177	3	0.07	0.9694
Model	37	8.40	0.0001	22	3.02	0.0001	13	1.48	0.1281	16	1.20	0.2671
Error	1,174			298			174			273		

[a]Signifies split-plot analysis.

muskrats during summer and fall. Winter movement of adult males and females was similar and averaged 21.5 m/hour with only slight variation throughout the diel period; extremes of movement were at dusk and dawn and averaged 25.7 and 18.7 m/hour, respectively. Dawn movement of immature males and females averaged 39.2 and 43.8 m/hour. Throughout the remainder of the diel period, movement of immature males declined and was similar to movement of adults. However, immature females remained fairly active throughout the diel period.

During spring, no differences in mean hourly movements were found among sex-age classes. Variability among individual muskrats within a sex-age class, however, remained very high ($F = 6.02$; 7, 298 df; $P = 0.0001$). No interaction was observed between time-of-day and sex-age class during spring.

Variation in water depth on the marsh accounted for 19.8% of the variation in distance moved during dawn ($P = 0.0003$) and 8.2% of the variation at night ($P = 0.0362$), but was not related to movement during the day or at dusk. Similarly, temperature variation accounted for 20.7% of the variation in distance moved from sunset to sunrise ($P = 0.0001$), and 8.6% ($P = 0.0064$) from sunrise to sunset.

Discussion

Muskrat home ranges on our study area were apparently greater than those reported by Coon (1965) and MacArthur (1978), who found that most muskrats remained within 15 m of a lodge or burrow. Our finding that muskrat movements were not greatly associated with temperature and water depth agrees with results of Van Horn (1975) and MacArthur (1980), who reported that environmental factors accounted for only a small portion of the variation in activity levels. Dozier (1948) reported that muskrats in a Maryland marsh were most active from dusk to about 2300 hours and during early morning. He noted that muskrats could always be found in lodges during early afternoon. Smith (1938), however, believed that activity levels were low in the morning, increased during the afternoon, and reached a peak at dusk. Van Horn (1975) used trip wires to monitor activity along runways to study muskrat movements and activity. He reported that most activity was crepuscular in summer and diurnal activity increased during winter with a peak from late afternoon through dusk.

Other workers have studied muskrat movement using radiotelemetry. Sokolov et al. (1979) found that the greatest activity during summer occurred from 1 to 2 hours before sunset to about midnight and at dawn. Diurnal activity was greatest during mid-morning and mid-afternoon. MacArthur (1980) found a bimodal activity pattern during summer, but during winter this pattern was less distinct, and activity tended to be more diurnal with a peak in late afternoon and the early part of the night (1500–2000 hours). He further noted that nocturnal activity was most pronounced in summer, although periodic activity occurred throughout the day during both summer and winter. This periodic activity seemed to follow a cyclic pattern with periods of activity and rest lasting about 6 hours. Considerable variation was noted among individuals and days.

All of the more recent studies were conducted at more northerly latitudes; consequently, movement and activity patterns may reflect climatological or photoperiod differences between those areas and Louisiana. The most obvious difference in daily movements between muskrats in Louisiana and those studied elsewhere is the lack of a clear bimodal crepuscular activity pattern in Louisiana. Other than the vaguely bimodal pattern of movement in juvenile males during winter, we observed no other instances of longer movements at dawn. On the other hand, there was some indication that diurnal activity was greater in winter than spring. Moreover, spring movements were longest at dusk and at night. Van Horn (1975), Sokolov et al. (1979), and MacArthur (1980) considered only winter and summer activity. Winter movements of muskrats in Louisiana were similar to those in more northerly latitudes; spring movements in Louisiana were similar to summer movements in more northerly latitudes. Daily movements in Louisiana during summer, however, differed from those in Wisconsin (Van Horn 1975), Russia (Sokolov et al. 1979), and Manitoba (MacArthur 1980), and seemed to be characterized by relatively uniform, short movements with no apparent peak or lull. Similarities between our study and others are the frequent diurnal activity and the high variability among muskrats.

No severe drawdowns as discussed by McDonnell and Gilbert (1981) occurred during our study. Floodtides, however, were relatively common, and during 1 diel tracking session (February 1983) a floodtide covered the marsh with >60 cm of water. Movements during this period ($\bar{x}$ = 13.6 m/hour) were less (P = 0.05) than were observed under lower water conditions ($\bar{x}$ = 38.9 m/hour) on the same date in 1982. McDonnell and Gilbert (1981) noted that floodtides did not result in abandonment of home ranges, but instead seemed to reduce movements and increase activity associated with lodge repair (Dozier 1948). Although high water may facilitate dispersal by muskrats (Sprugel 1951), lodge maintenance to prevent a washout (Danell 1978) apparently is the primary activity of most animals during floods, particularly during winter.

We were unable to detect a difference in the distance moved per hour by muskrats during winter and summer. In contrast to this finding, however, was the increased trapping success on cold winter nights during our study and also reported by others in Louisiana (Arthur 1931, Svihla and Svihla 1931). This difference may be explained by MacArthur's (1979) finding that during winter muskrats avoid prolonged exposure to water an thus reduce heat loss. Louisiana muskrats, therefore, may move less in tunnels below the marsh and more above the marsh surface during winter, and thus increase their exposure to traps. Moreover, MacArthur (1979) also reported that muskrats use immersion in water during summer as a means of preventing hyperthermia. This may explain our poor trapping success during warm weather, even though we failed to detect a significantly reduced level of movement during summer. Muskrats probably used tunnels beneath the marsh for most of their movements during summer rather than marsh surface runways and thus reduced their vulnerability to traps.

Breeding activity may have had a larger influence on movement patterns than did environmental variables during winter. O'Neil (1949:58) and Freeman (1945) reported that litters were mostly present along the Gulf Coast in November, late winter, and early spring; and the highly variable fall movements may be explained by the increased breeding activity at that time after a lull during the warm summer months. Such variable activity may be a result of not only mating but also establishment of new territories and lodge construction by certain individuals (O'Neil 1949). Unmated subadults may become more unsettled as established adults prepare for renewed mating and new litters (Errington 1963). Also heightened aggression may be associated with increased breeding activity (Errington 1943, Beer and Meyer 1951). Summer and winter behavior may reflect less population interaction and more settled patterns of movement.

In general, this research showed that individual muskrats had very different movement patterns, and that sex, age, and time of day were not factors of importance except during winter when the interaction of these factors neared statistical significance. We were unable to detect any muskrat movement pattern that might be linked to declines in the muskrat population.

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