A R T I C L E

SEASONAL VARIATION IN LATRINE SITE VISITATION AND SCENT MARKING BY NEARCTIC RIVER OTTERS (*Lontra canadensis*)

Zachary H. OLSON[*1], Thomas L. SERFASS[1], Olin E. RHODES, Jr.[2]
[1]*Department of Biology, Frostburg State University, 101 Braddock Rd., Frostburg, Maryland 21532, USA. e-mail: zolson@purdue.edu*
[2]*Department of Forestry and Natural Resources, 195 Marstellar St., Purdue University, West Lafayette, Indiana 47907, USA*

(received 17th January 2009, accepted 13th February 2009)

Abstract: We combined analyses of visitation (using remote cameras) and scent marking (using traditional sign surveys) to provide a comprehensive assessment of the mechanisms underlying variation in river otter scent marking at latrine sites and to verify that river otter scent marking varies seasonally in Pennsylvania and Maryland. We observed seasonal peaks in total scent marking in the fall (September) and in the spring (March) similar to those previously reported. Group sizes of river otters visiting latrines were higher in the fall than any other season and anal sac secretions were documented only from February through mid-June. We attribute the fall peak in scent marking to family groups traveling together to latrine sites and the spring peak in scent marking to communication during the breeding season. Based on seasonal variation in the periodicity of river otter visits and seasonal variation in the intensity of scent marking, we suggest spring and fall as the most efficient seasons during which river otters could be detected using their scent marks.
Keywords: latrine, *Lontra canadensis*, remote cameras, scent marking, seasonal variation, sign surveys.
Citation: Olson, Z.H., Serfass, T.L. and Rhodes, O.E. (2008). Seasonal Variation in Latrine Site Visitation and Scent Marking by Nearctic River Otters (*Lontra canadensis*) . *IUCN Otter Spec. Group Bull.* **25** (2): 108 - 120

INTRODUCTION

Nearctic river otters (*Lontra canadensis*) were extirpated from much of their native range through unregulated harvest and habitat degradation by the early 1900s (Melquist and Dronkert, 1987; Lariviere and Walton, 1998). Efforts to restore river otter populations have included reintroduction or supplementation efforts in 21 states and Alberta, Canada (Melquist et al., 2003). The resulting populations are now established or expanding into much of the area from which river otters were extirpated

(Melquist et al., 2003), creating the need for effective methods of monitoring these populations.

The secretive nature of river otters combined with ethical (Bekoff and Jamieson, 1996) and logistical considerations (i.e. relatively high cost) often limits monitoring efforts to indirect detection methods (Swimley et al., 1998). Sign surveys (i.e. visually scanning riparian areas for otter sign) have been a common method of detecting otters in North America (river otter; Mowbray et al., 1976; Melquist and Hornocker, 1979; Dubuc et al., 1990; Swimley et al., 1998; Mills, 2004) and Europe (Eurasian otter *Lutra lutra*; Jenkins and Burrows, 1980; Conroy and French, 1987; Macdonald and Mason, 1987; Kruuk et al., 1989; Delibes et al., 1991; Ruiz-Olmo and Gosálbez, 1997). River otters scent mark by depositing scat, urine, and glandular secretions at conspicuous riparian locations called latrine sites (Melquist and Hornocker, 1983; Newman and Griffin, 1994; Swimley, 1996; Swimley et al., 1998), which are thought to focus opportunities for intraspecific communication through olfaction (Melquist and Hornocker, 1983). Latrine sites, areas where river otters scent mark, are the most common and easily identified field sign of river otters and are characterized by the presence of scats, anal sac secretions, and a diagnostic, fishy odor (Mowbray et al., 1976; Swimley et al., 1998).

Seasonal variation in scent marking intensity has been reported previously for river otters, with peaks in spring (March-April) and fall (September-November) in Pennsylvania (Serfass, 1994; Mills, 2004; Stevens, 2005). Although the function of scent marking may not be the same in other species, seasonality also has been documented in the scent marking of Eurasian otters generally with a peak in winter and a low in summer (Gorman et al., 1978; Mason and Macdonald, 1986; Macdonald and Mason, 1987; Kruuk, 1992; Jahrl, 1995; Ruiz-Olmo and Gosálbez, 1997). Identifying seasons during which otters are more likely to scent mark may help improve the efficiency of monitoring efforts. Peaks in scent marking intensity have been attributed to communication of breeding condition (Eurasian otter - Gorman et al., 1978; river otter - Mills, 2004; Stevens, 2005), emergence of cubs (Eurasian otter - Macdonald and Mason, 1987; Conroy and French, 1987; Jahrl, 1995; river otter - Olson et al., 2005), signaling the use of resources (Kruuk, 1992), intra-group male communication (Eurasian otter - Durbin, 1989; river otter - Rostain et al., 2004; Ben-David et al., 2005), and male-female communication relating to reproductive condition (Eurasian otter - Gorman et al., 1978; river otter - Mills, 2004). However, the parameters underlying seasonal variation in river otter scent marking behavior are still poorly understood complicating efforts to develop efficient population monitoring techniques that use latrine sites.

Our objective was to quantify parameters associated with river otter visits to latrine sites. We were particularly interested in using remote cameras to assess variation in group sizes, times of visitation within and among seasons and temporal variation of visitation concurrently with an assessment of scent marking variation at individual latrine sites. By combining the analysis of visitation and scent marking at individual latrine sites, we provide a more comprehensive assessment of river otter scent marking behavior than has been attempted previously for wild populations.

STUDY AREA

Our study areas were located in 2 drainages, Tionesta Creek and the Youghiogheny River, both of which support populations of river otters established through reintroductions (Mills, 2004). Tionesta Creek is located in northwestern

Pennsylvania and flows generally west through the Allegheny National Forest. Tionesta Creek enters the Allegheny River at the borough of Tionesta, Forest County, approximately 85 km from its headwaters in Elk (South Branch) and McKean Counties (East Branch; Swimley, 1996). We monitored 3 latrine sites within a 13-km section along the southern bank of Tionesta Creek (41º35'N, 78º15'W), between the bridge at Kelletville and 2 km upstream of the bridge at Mayburg.

The Youghiogheny River originates in West Virginia, flows north through Garrett County, Maryland, and converges with the Monongahela River south of Pittsburgh, Pennsylvania. In Maryland, we monitored 1 latrine site along the western bank of the Youghiogheny River, situated about 1 km upstream from the bridge at the town of Sang Run (39º34'N, 79º25'W). In Pennsylvania, we monitored 4 latrine sites in a 13-km section along the southwestern bank of the Youghiogheny River in Ohiopyle State Park (39º50'N, 79º26'W), Fayette County, between the town of Ohiopyle and the mouth of Ramcat Run. The study areas are proximate to roads and accessible to humans, and, as such, could be considered typical of rural Pennsylvania and Maryland (Fig. 1).

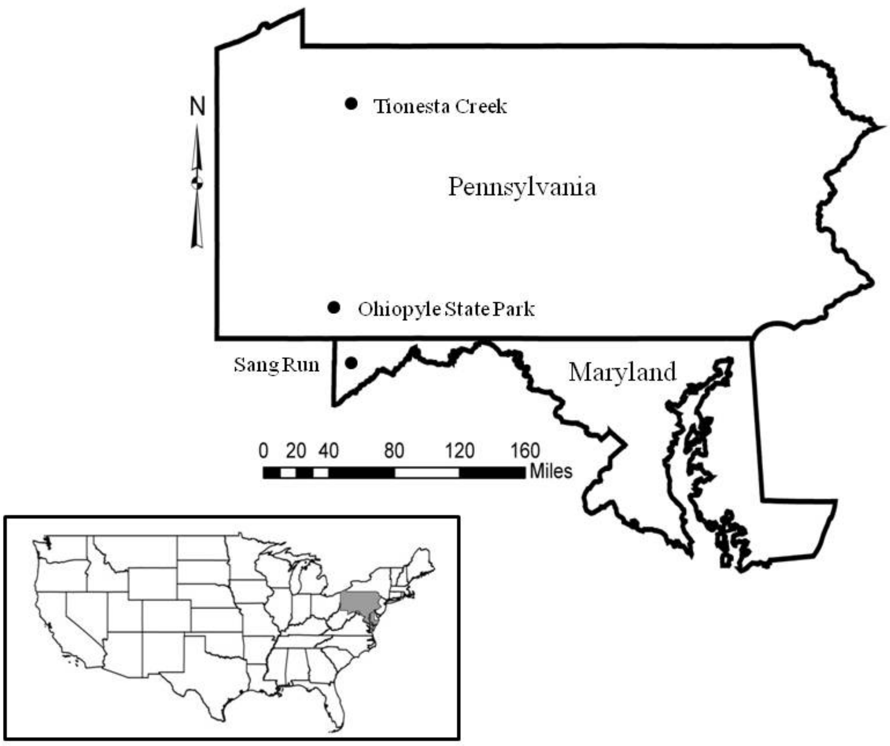

Figure 1. Location of the 3 study areas in Pennsylvania and Maryland, USA

METHODS

From 1 August 2004 through 31 August 2005, we used TrailMaster® video (TM-700V) and still (TM-500 and 550) cameras (Goodson and Associates, Lenexa, Kansas, U.S.A.) and Reconyx Silent Image™ digital cameras (Reconyx, La Crosse, Wisconsin, U.S.A.) to detect river otters visiting latrines. The cameras took a picture or recorded video when infrared sensors were "triggered" by an animal's heat and motion. An animal would continue to trigger a camera as long as it moved in front of the sensor. Therefore, we programmed the delay and sensitivity settings of each camera system to conserve film, tape, or memory, but also to remain sensitive enough to enhance the likelihood that each river otter visit was recorded. When triggered, TrailMaster® still cameras were programmed to take a picture at a maximum rate of once per minute; Reconyx Silent Image™ cameras were programmed to record an image at a maximum rate of once every 10 sec; and TrailMaster® video cameras were set to record for 3 min, and to continue recording as long as the animal continued to re-trigger the sensor. We adopted sensitivity and delay settings for the TrailMaster® systems from Stevens (2005). We assumed that the detection of river otters was equally efficient among camera systems.

Active latrine sites were selected for monitoring during sign surveys for river otters conducted in the study areas immediately before our investigation (see Mills, 2004; Stevens, 2005). Remote cameras were checked at least bi-weekly to monitor performance, download events (TrailMaster®) or images (Reconyx™) and, if necessary, replace film or digital videotape (TrailMaster®). The latrine site, date, time, and group size of each river-otter-detection was recorded during our review of the images and videos. River otter scent marks—categorized as scats, anal sac secretions, and scats with associated anal sac secretions (secretions exuded with scat) were counted at the latrine site each time cameras were checked and were crushed by foot to eliminate recounting. Although all scent marks potentially facilitate communication among river otters, we restricted our definition to those scent marks readily detectable by the researcher in all seasons: scats and anal sac secretions.

Camera systems were in constant deployment throughout the study period. However, mechanical or human errors (see Stevens, 2005) often resulted in camera malfunctions. Therefore, we quantified functional latrine-nights (i.e. at least 1 camera was operating properly) at each latrine site by month to facilitate comparisons among latrine sites. The term "latrine-night" was used instead of camera-night because some latrines were monitored with 2 cameras. We used 2 temporal categories for comparisons: months and seasons. Seasons were defined as: spring (March, April, and May), summer (June, July, and August), fall (September, October, and November), and winter (December, January, and February). To define a "visit" by an otter or group of otters to a latrine site, we assigned 30 min as the time period after which camera detection was independent based on our observations of the average time river otters spent at latrines and to follow previous work by Stevens (2005). Thus, all detections separated by ≤30 min at a latrine site were classified as 1 visit. The largest number of individuals observed during a visit was assigned as that visit's group size.

Scent marking. Variation in intensity of river otter scent marking was analyzed by tabulating the numbers of scats, anal sac secretions, and scats with associated anal sac secretions by month. We used Wiens' Heterogeneity Index (Wiens, 1974) to evaluate the relative contributions of each latrine site in comparison with the total scent marks in each month and season. Higher index numbers denoted greater variation in the number of scent marks among latrine sites. Also, the number of scent marks per latrine visit was calculated by month as the sum of scent marks divided by the sum of visits in each month.

Visitation and group size. We evaluated monthly variation in the number of visits, weighted by the proportion of functional latrine-nights, using a Friedman ANOVA (Zar, 1999; STATISTICA 2004). We used Kruskal-Wallis ANOVA to determine if the median group size of river otters visiting latrine sites differed among months (Zar, 1999; STATISTICA 2004). Multiple comparisons were conducted post-hoc to evaluate pairwise differences in the ranks between months. Also, we calculated the relative frequency of visits by each group size (1, 2, and ≥3) within seasons.

We categorized time of visit as nocturnal, diurnal, or crepuscular. The crepuscular period was defined in all seasons as 30 min before to 30 min after both sunrise and sunset. The average daylight internal for each season was used to define the boundaries of each time category within seasons and was calculated as the average lengths of the daylight periods from the 15th day of each month in that season (http://aom.giss.nasa.gov/). We calculated the length of the nocturnal period by subtracting the average daylight hours and the 2 crepuscular hours from 24. We tabulated visits occurring in nocturnal, diurnal, and crepuscular periods by group size (1, 2, and ≥3) and season (spring, summer, fall, and winter) across the study period. We then evaluated proportional differences in the frequencies of visitation among time categories, group sizes, seasons, and the interactions of these variables using log-linear analyses (STATISTICA, 2004). Separately, we constructed a forage model (Williams and Marshall, 1938), based on selection indices (Krebs, 1998), using the proportion of 24 hr each time category comprised to determine if river otters selected nocturnal, diurnal, or crepuscular periods to visit latrine sites in each season. Data from time categories were pooled across study areas for this analysis.

Periodicity. We counted the number of daylight periods between consecutive visits to each latrine site to construct a metric called periodicity of visits; and defined it as 0 (i.e. 3 visits on the same night was 2 zeros), 1, 2, 3, etc., within seasons. The number of days from the first day in the season to the first visit as well as the number of days from the last visit to the last day of the season were included in the calculations. To characterize seasonal variation in the periodicity of visits, we calculated the average number of days between visits within each season. To assess if the frequency distribution of periodicity differed among seasons, the number of days between visits was categorized as 0, 1, 2, 3, 4, 5, 6, and ≥7 days and the resulting frequency distributions were evaluated for independence among seasons using chi-square analyses. To assess the intensity of visitation within 24 hr periods, we calculated the average number of visits for days with ≥1 visit within seasons.

RESULTS

Latrine sites were monitored for 3,127 latrine-nights. The cameras yielded 2,698 functional latrine-nights, with 429 latrine-nights lost due to camera malfunction or human error. One or more river otters were detected 500 times in 327 observed visits to latrine sites. The number of river otter detections per functional latrine-night across the study period was 0.185.

Scent marking. We documented 561 scats, 28 anal sac secretions, and 21 scats with anal sac secretions over the study period. Two peaks were observed in the number of scent marks at latrine sites: September 2004 and March 2005 (Fig. 2). Total scent marking during the March 2005 peak (n=106) was approximately 7 and 15 times greater, respectively, than during the 2 periods with the lowest levels of marking [December 2004 (n=16) and August 2005 (n=7)]. Anal sac secretions (separately or with scat) were detected only during the period February through mid-June 2005 (Fig. 2). Wiens' Heterogeneity Index ranged from 1.21 to 5.71 across months and was negatively correlated with the total number of scent marks per month, although this relationship was not significant (r=-.282, P>0.05). Seasonally, heterogeneity was higher in summer (4.23) than in fall (2.62), winter (2.71), and spring (2.21). Peaks in the total number of scent marks per visit occurred in August 2004 and July 2005 (Fig. 3).

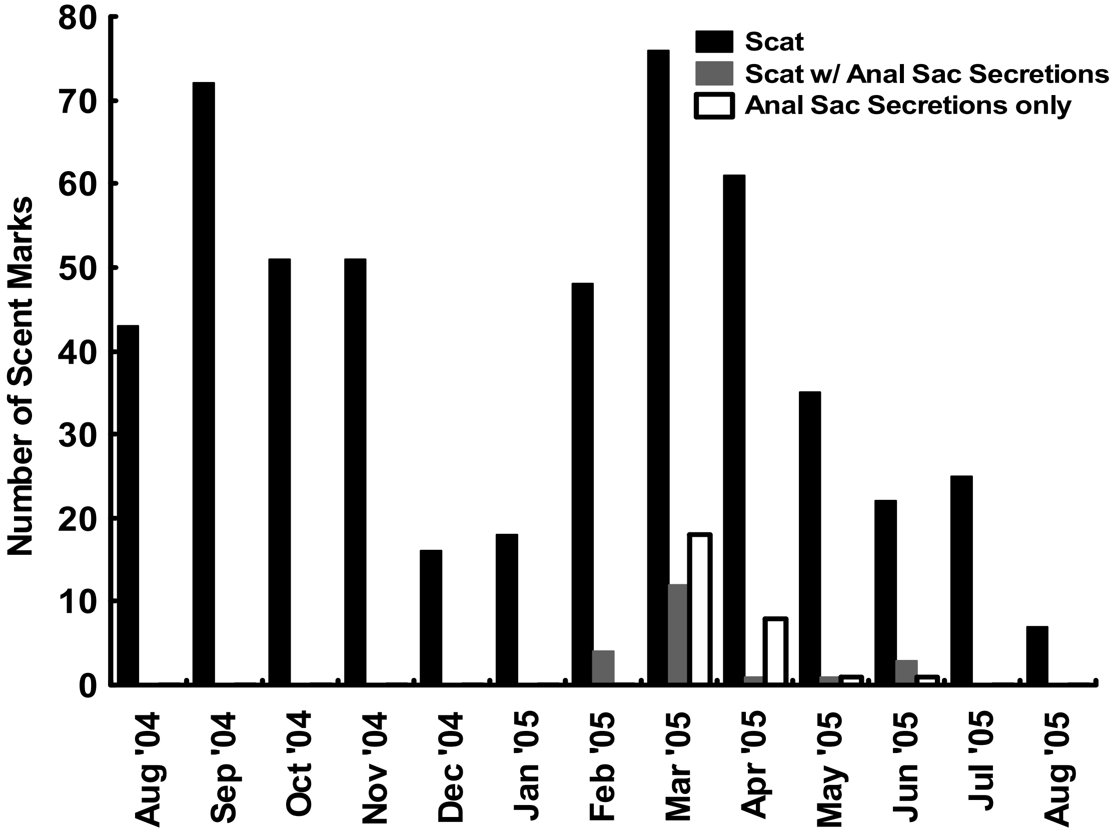

Figure 2. The total number of scent marks (categorized as scat, anal sac secretions, and scat with associated anal sac secretion) at 8 latrine sites monitored in Pennsylvania and Maryland from August 2004 through August 2005.

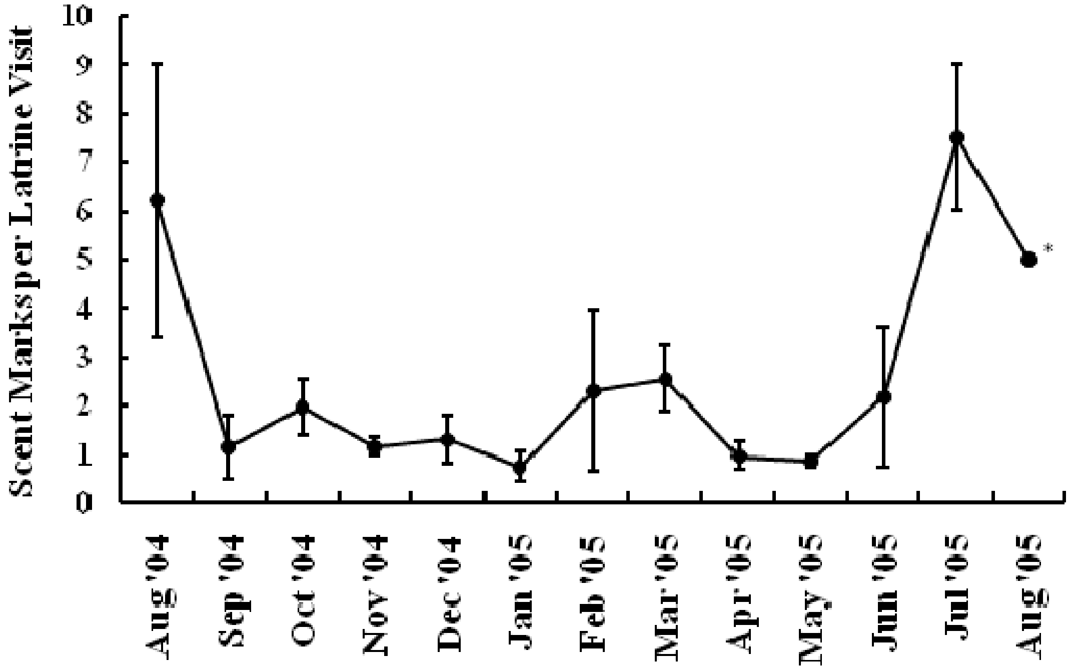

Figure 3. Mean (± SE) scent marks per latrine site visit by month pooled for 8 latrine sites in Pennsylvania and Maryland monitored with remote cameras and traditional sign surveys from August 2004 through August 2005. Lines connecting the months are provided only to aid in interpretation. Only one visit was recorded in August 2005 (*).

Visitation and group size. The number of visits based on functional latrine-nights differed by month ($P<0.001$), with a peak evident in March and April 2005. However, there was no fall peak in the number of visits to correspond with the documented fall peak in scent marking (Fig. 4). River otter group size ranged from 1 to 7 and the median group size varied by month ($P<0.001$, Fig. 5). Median group size in November 2004 was significantly higher than that of January 2005 ($P<0.05$), February 2005 ($P<0.001$), March 2005 ($P<0.001$), and April 2005 ($P<0.05$) and median group size in December 2004 was higher than that of March 2005 ($P<0.05$, Fig. 4). Groups of 2 river otters visited latrines most frequently in spring (17%, 26/154), despite most spring visits being by singles (71%, 110/154). Most latrine visits in the fall were by groups of ≥3 river otters (54%, 29/54) whereas most visits in the winter were by single otters (73%, 74/101), although groups of ≥3 also were prevalent (21%, 21/101).

River otters visited latrine sites at night (n=231, 70.64%) 4 times more often than during the day (n=54, 16.51%) and 5 times more often than during crepuscular periods (n=42, 12.85%). The highest seasonal frequency of diurnal visits occurred in winter (n=21, 20.79%). Over 45% of all recorded latrine visits were single otters at night (n=148).

The most parsimonious log-linear model included the term "time of visit" and the interaction term "season × group size" (maximum likelihood χ^2 = 19.830, df = 19, P=0.405). This model indicates that time of visit did not differ among seasons or group sizes and that group size varied proportionally among seasons. Based on our forage model analysis, river otters selectively visited during nocturnal periods in spring and selectively visited during nocturnal and crepuscular periods in summer, fall, and winter (Table 1). Diurnal periods were never selected (Table 1).

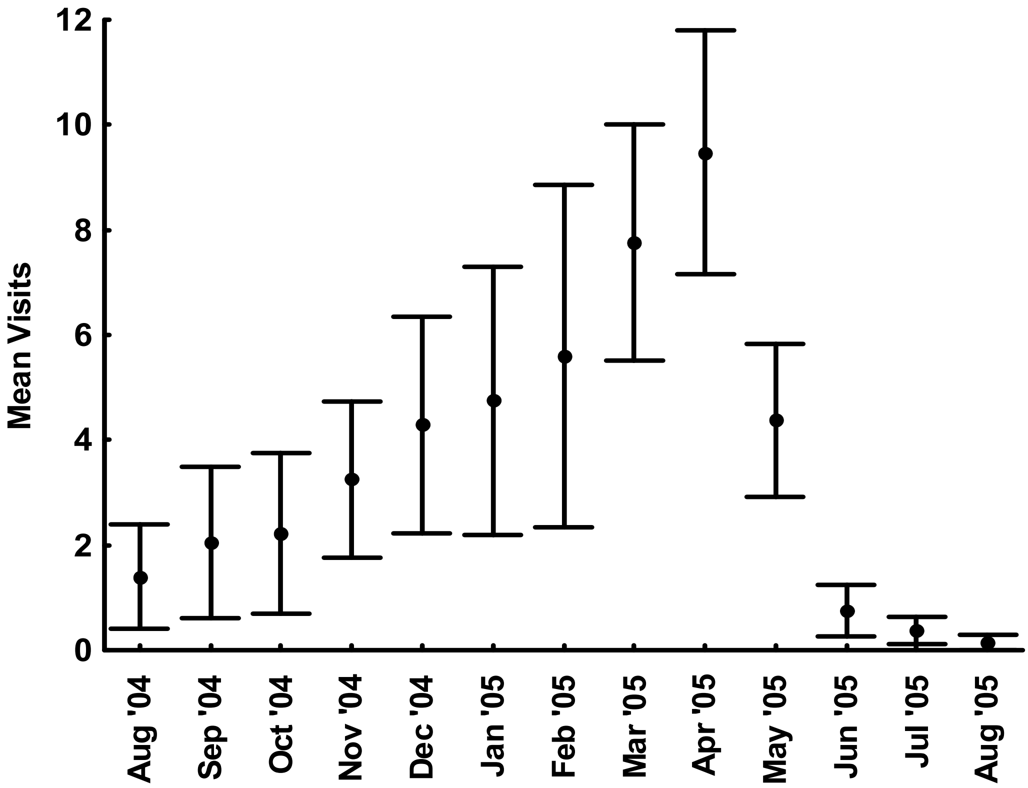

Figure 4. The monthly mean (± SE) number of river otter visits weighted by functional latrine-nights at 8 latrine sites monitored with remote cameras in Pennsylvania and Maryland. Latrine sites were monitored from August 2004 through August 2005.

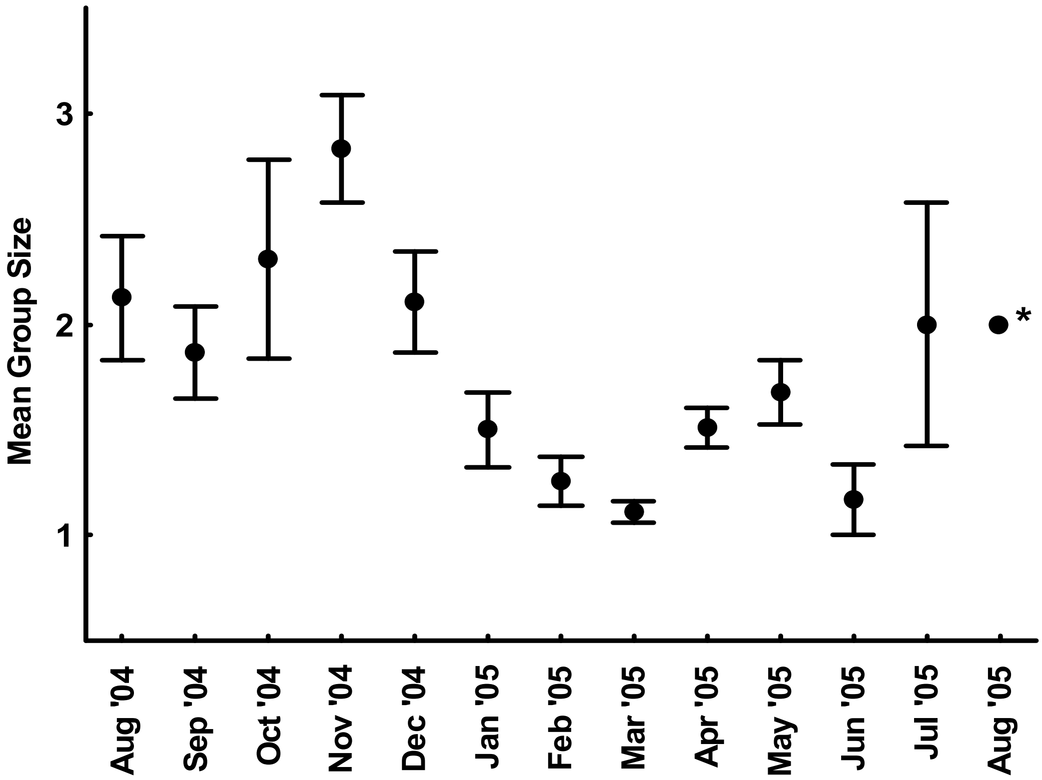

Figure 5. Mean (± SE) monthly group size of river otters visiting 8 latrine sites monitored with remote cameras in Pennsylvania and Maryland from August 2004 through August 2005. Only one visit was recorded in August 2005 (*).

Table 1. Time of visit selection indices for spring, summer, fall, and winter for river otters visiting 8 latrine sites monitored with remote cameras from August 2004 through August 2005 in Pennsylvania and Maryland. Significant selection indices are denoted by (*). Standardized selection indices indicated selection when $B_i >$ (1/number of categories), or 0.333 in this case (bolded)

Season	Time Category	Proportion Available (p_i)	No. of river otter visits (u_i)	Proportion of visits in category (o_i)	Selection Index (w_i)	Standardized selection index[a] (B_i)
Spring	Night	0.3542	114	0.740	2.090*	**0.600**
	Day	0.5625	26	0.169	0.300	0.086
	Crepuscular	0.0833	14	0.091	1.091	0.313
	Total	1.00	154	1.00	3.48	1.00
Summer	Night	0.4921	12	0.667	1.355	**0.361**
	Day	0.4246	3	0.167	0.393	0.105
	Crepuscular	0.0833	3	0.167	2.001	**0.534**
	Total	1.00	18	1.00	3.75	1.00
Fall	Night	0.5454	41	0.759	1.392*	**0.388**
	Day	0.3713	4	0.074	0.199	0.056
	Crepuscular	0.0833	9	0.167	2.001*	**0.557**
	Total	1.00	54	1.00	3.59	1.00
Winter	Night	0.4238	64	0.634	1.495*	**0.392**
	Day	0.4929	21	0.208	0.422	0.110
	Crepuscular	0.0833	16	0.158	1.902*	**0.498**
	Total	1.00	101	1.00	3.82	1.00

Periodicity. The average number of days between visits during spring (mean±SE; 4.571±0.702) was lower than that observed during winter (6.60±1.367), fall (11.65±3.173), and summer (31.28±6.852). The frequency distributions of periodicity did not differ among seasons ($\chi^2_{0.05,\ 14}$=19.882, P>0.05), although summer could not be included in the analysis because of low sample size. The average number of visits for days with ≥1 visit was higher in fall (1.54 ± 0.16) than in spring (1.34±0.05), summer (1.27±0.15), and winter (1.48±0.12).

DISCUSSION

We are aware of no other study concomitantly examining aspects of latrine site visitation and scent marking by river otters. Rostain et al. (2004) and Mills (2004) examined scent marking whereas Stevens and Serfass (2008) and Ben-David et al. (2005) analyzed visitation to latrines. Although the number of latrine sites we monitored was small, our study supports previous work suggesting that river otter scent marking varies seasonally in Pennsylvania and Maryland. We observed seasonal peaks in total scent marking in fall (September) and spring (March) similar to those previously reported in Pennsylvania and Maryland (Serfass, 1994; Mills, 2004; Stevens, 2005; Stevens and Serfass, 2008).

The fall and spring peaks in scent marking correspond with 2 distinct periods in the natural history of river otters: mobility of young-of-the-year juveniles and the breeding season, respectively. The fall peak in scent marking has been hypothesized to result from the highest seasonal density of marking individuals as juvenile river otters begin traveling to latrine sites with their mothers (Mills, 2004). Olson et al. (2005) supported this "traveling family" hypothesis with photographs of juveniles and an adult visiting latrine sites in the late summer and fall. A positive feedback loop (i.e. scent marking by an individual triggering scent marking by other individuals) was cited as a possible mechanism by which larger group sizes consequently resulted in more scent marks at a latrine site (Melquist and Hornocker, 1983; Olson et al., 2005). The presence of cubs also has been cited as a possible mechanism for increased scent marking observed in Europe (Macdonald and Mason, 1987; Conroy and French, 1987; Jahrl, 1995). Our results are consistent with the "traveling family" hypothesis for the fall peak in scent marking. Average group size visiting latrine sites was higher in the fall than at any other time of the year, and, despite relatively low visitation rates, the number of scent marks per month in the fall was nearly that occurring in the spring. Therefore, family groups traveling to latrine sites likely deposited more scent marks per visit resulting in the observed fall peak in scent marking.

The spring peak in scent marking, and the only period in which we encountered anal sac secretions (February–mid-June), slightly precedes and overlaps what is thought to be the breeding season for river otters in Pennsylvania and Maryland (Hamilton and Eadie, 1964; Mowbray et al., 1979; Melquist et al., 2003). Mills (2004) hypothesized that the spring peak in scent marking, and particularly anal sac secretions, serve some purpose during the breeding season. However, the actual function of anal sac secretions is unknown. The difficulty in ascribing a function to the secretions is two-fold. First, few authors have documented the occurrence or frequency of anal sac secretions during scent mark surveys. The only detailed information on this topic comes from a comprehensive study of 2 captive Eurasian otters where both sexes marked with anal sac secretions in apparent synchrony with the female's estrus cycle (Gorman et al., 1978). There have been descriptions of anal sac secretions occurring in the context of anger or fright (see Liers, 1951; Melquist and Hornocker, 1983) and starvation (Carss and Parkinson, 1996) but nothing comparable to the Eurasian otter study has been published for river otters. Second, identifying the gender or age of the individual depositing a secretion was not possible with remote cameras. River otters were not sufficiently sexually dimorphic to differentiate genders from photographs and any disparity in length between adults and juveniles was distinguishable only from late summer through early fall. Even if individual identities could be determined from photographs, images of river otters depositing anal sac secretions were rarely obtained during our study.

Reports from radiotelemetry studies describe the generally nocturnal habits of river otters (Larson, 1983; Melquist and Hornocker, 1983; Melquist et al., 2003). Diurnal activity has been reported to increase during winter (Melquist and Hornocker, 1983; Melquist et al., 2003), in areas with little human disturbance (Melquist and Hornocker, 1983), or in restricted areas around resting sites (Larson, 1983; Woolington, 1984; Melquist et al., 2003). Our study confirms that river otters visit latrine sites most often at night; diurnal visits, although uncommon, were proportionally most frequent during winter. However, based on our forage model analysis, river otters also selectively visited during crepuscular periods in fall, winter, and spring. Crepuscular activity recently has been revealed for Eurasian otters by means of novel, in-stream infrared sensors (Garcia de Leaniz et al., 2006).

CONCLUSIONS

Identifying patterns of temporal and spatial variability in scent marking should allow researchers and managers to more efficiently conduct surveys for river otter scent marks (Kranz, 1996). Much of the research in this area has been conducted on Eurasian otter populations (see Hutchings and White, 2000; Ruiz-Olmo et al., 2001), whereas little work on the variability of scent marking in river otter populations has been reported previously. We documented substantial seasonal differences in the average number of days between visits suggesting that the effectiveness of scent mark surveys also might vary by season. Intuitively, detecting river otter presence using latrine sites would be more efficient as the intensity of visitation increases. Stevens (2005) advocated spring scent mark surveys as the most effective because visitation was highest during that season. We also documented the highest rates of visitation in the spring along with the lowest heterogeneity in scent marking among latrine sites in the spring. Although river otters visited less often and exhibited greater heterogeneity in scent marking among latrine sites in the fall than in the spring, they visited in larger groups that deposited more scent marks per visit in the fall than in the spring. Also, when river otters visited, the intensity of visitation within 24 hr was higher in the fall than during any other season. Thus, as Mills (2004) suggested, fall scent mark surveys also may be an effective means of detecting river otter presence.

Our results are ambiguous as to the efficacy of winter scent mark surveys. Both visitation and heterogeneity of scent marking in winter were intermediate to spring and fall values. However, the frequency of scent marks during winter was lower than in spring and fall. Although we did not include other forms of sign (i.e. tracks or slides in snow) in our study, aerial surveys after snowfalls have been used to efficiently document the distribution of river otters in southern Minnesota, U.S.A. (Erb and Deperno, 2001). However, Gallant et al. (2007) discovered a poor relationship between the number of latrine sites used and the number of river otters detected using winter sign surveys in New Brunswick, Canada. Alternatively, snow-tracking surveys have proven successful in Finland (Sulkava and Liukko, 2007).

Regardless, these methods require reliable snowfall and consistent snow cover (Erb and Deperno, 2001), conditions not occurring throughout the range of river otters. Finally, because of the high average number of days between visits and high heterogeneity in scent marking among latrine sites, our data suggests that scent mark surveys during the summer should be avoided.

ACKNOWLEDGEMENTS - A United States Fish and Wildlife Service State Wildlife Grant [administered by the Pennsylvania Game Commission (PGC)], the Pennsylvania Wild Resource Conservation Fund (WRCF; nongame tax-checkoff), and logistical support by the United States Department of Agriculture Allegheny National Forest (ANF) provided primary funding and support for this project. We are grateful to A. Hayden (deceased) and J. Hassinger of the PGC, F. Felbaum and R. Stanley of the WRCF and B. Nelson of the ANF for their cooperation and support of river otter research in Pennsylvania. J. E. Gates provided helpful comments on an earlier draft of this manuscript.

REFERENCES

Bekoff, M., Jamieson, D. (1996). Ethics and the study of carnivores: doing science while respecting animals. In: **Gittleman, J. L.** (Ed.). Carnivore behavior, ecology, and evolution. Second volume. Cornell University Press, Ithaca, New York, USA., pp. 15-45.

Ben-David, M., Blundell, G.M., Kern, J.W., Maier, J.A.K., Brown, E.D., Jewett, S.C. (2005). Communication in river otters: creation of variable resource sheds for terrestrial communities. Ecology **86**: 1331-1345.

Carss, D.N., Parkinson, S.G. (1996). Errors associated with otter *Lutra lutra* faecal analysis. I. Assessing general diet from spraints. J. Zool. **238**: 301-317.

Conroy, J.W.H., French, D.D. (1987). The use of spraints to monitor populations of otters (*Lutra lutra* L.). Symp. Zool. Soc. Lond. **58**: 247-262.

Delibes, M., Macdonald, S.M., Mason, C.F. (1991). Seasonal marking, habitat and organochlorine contamination in otters (*Lutra lutra*): a comparison between catchments in Andalucia and Wales. Mammalia **55**: 567-578.

Dubuc, L.J., Krohn, W.B., Owens, R.B., Jr. (1990). Predicting occurrence of river otters by habitat on Mount Desert Island, Maine. J. Wildlife Manage. **54**: 594-599.

Durbin, L. (1989). Some responses of otters *Lutra lutra* to strange and familiar spraints. Lutra **32**: 132-138.

Erb, J.D., DePerno, C.S. (2001). Distribution and relative abundance of river otters in southern Minnesota. In: **DonCarlos, M.W.** (Ed.). Summaries of Wildlife Research Findings, 2000. Minnesota Department of Natural Resources, Division of Wildlife, St. Paul, USA., pp. 19-26.

Gallant, D., Vasseur, L., Bérubé, C.H. (2007). Unveiling the limitations of scat surveys to monitor social species: a case study in river otters. J. Wildlife Manage. **71**: 258-265.

Garcia de Leaniz, C., Forman, D.W., Davies, S., Thomson, A. (2006). Non-intrusive monitoring of otters (*Lutra lutra*) using infrared technology. J. Zool. **270**: 577-584.

Gorman, M.L., Jenkins, D., Harper, R.J. (1978). The anal scent sacs of otter (*Lutra lutra*). J. Zool. **186**: 463-474.

Hamilton, W.J., Jr., Eadie, W.R. (1964). Reproduction in the otter, *Lutra canadensis*. J. Mammal. **45**: 242-252.

Hutchings, M.R., White, P.C.L. (2000). Mustelid scent-marking in managed ecosystems: implications for population management. Mammal Rev. **30**: 157-169.

Jahrl, J. (1995). Marking behavior of *Lutra lutra*. Habitat **11**:131-134.

Jenkins, D.J., Burrows, G.O. (1980). Ecology of otters in northern Scotland. III. The use of faeces as indicators of otter (*Lutra lutra*) density and distribution. J. Anim. Ecol. **49**: 755-774.

Kranz, A. (1996). Variability and seasonality in sprainting behavior of otters *Lutra lutra* on a highland river in central Europe. Lutra **39**: 33-43.

Krebs, C.J. (1998). Ecological Methodology. Second edition. Addison Wesley Longman Inc., New York, New York, USA.

Kruuk, H. (1992). Scent marking by otters (*Lutra lutra*): signaling the use of resources. Behav. Ecol. **3**: 133-140.

Kruuk, H., Moorhouse, A., Conroy, J.W.H., Durbin, L., Frears, S. (1989). An estimate of numbers and habitat preferences of otters *Lutra lutra* in Shetland, UK. Biol. Conserv. **49**: 241-254.

Lariviere, S., Walton, L.R. (1998). *Lontra canadensis*. Mammal. Spec. **587**: 1-8.

Larson, D.N. (1983). Habitats, movements, and foods of river otters in coastal southeastern Alaska. Thesis, University of Alaska, Fairbanks, USA.

Liers, E.E. (1951). Notes on the river otter (*Lutra canadensis*). J. Mammal. **32**: 1-9.
Macdonald, S.M., Mason, C.F. (1987). Seasonal marking in an otter population. Acta Theriol. **32**: 449-462.
Mason, C.F., Macdonald, S.M. (1986). Otters: ecology and conservation. Cambridge University Press, Cambridge, United Kingdom.
Melquist, W.E., Dronkert, A.E. (1987). River otters. In: **Novak, M., Baker, J.A., Obbard, M.E., Malloch, B.** (Eds). Wild furbearer management and conservation in North America. Ontario Ministry of Natural Resources, Peterborough, Canada, pp. 627-641.
Melquist, W.E., Hornocker, M.G. (1979). Methods and techniques for studying and censusing river otter populations. Technical Report 8. Forest, Wildlife, and Range Experiment Station, University of Idaho, Moscow, USA.
Melquist, W.E., Hornocker, M.G. (1983). Ecology of river otters in west central Idaho. Wildlife Monogr. **83**: 1-60.
Melquist, W.E., Polechla, P.J., Jr., Toweill, D. (2003). River otter *Lontra canadensis*. In: **Feldhamer, G.A., Thompson, B.C., Chapman, J.A.** (Eds.). Wild mammals of North America: biology, management, and conservation. Second edition. Johns Hopkins University Press, Baltimore, Maryland, USA, pp. 708-734.
Mills, M.A. (2004). Scat-marking by river otters in Pennsylvania and Maryland. Thesis, Frostburg State University, Frostburg, Maryland, USA.
Mowbray, E.E., Chapman, J.A., Goldsbury, J.R. (1976). Preliminary observations on otter distribution and habitat preferences in Maryland with descriptions of otter field sign. Proc. 33rd Northeast Fish and Wildl. Conf. **33**: 125-131.
Mowbray, E.E., Pursley, D., Chapman, J.A. (1979). The status, population characteristics and harvest of the river otter in Maryland. Maryland Wildlife Administration, Publications in Wildlife Ecology No. 2.
Newman, D.G., Griffin, C.R. (1994). Wetland use by river otters in Massachusetts. J. Wildlife Manage. **58**: 18-23.
Olson, Z.H., Stevens, S.S., Serfass, T.L. (2005). Do juvenile Nearctic river otters (*Lontra canadensis*) contribute to fall scent marking? Can. Field Nat. **119**: 457-459.
Rostain, R.R., Ben-David, M., Groves, P., Randall, J.A. (2004). Why do river otters scent-mark? An experimental test of several hypotheses. Anim. Behav. **68**: 703-711.
Ruiz-Olmo, J., Gosálbez, J. (1997). Observations on the sprainting behaviour of the otter *Lutra lutra* in the NE Spain. Acta Theriol. **42**: 259-270.
Ruiz-Olmo, J., Saavedra, D., Jiménez, J. (2001). Testing the surveys and visual and track censuses of Eurasian otters (*Lutra lutra*). J. Zool. **253**: 359-369.
Serfass, T.L. (1994). Conservation genetics and reintroduction strategies for river otters. Dissertation, Pennsylvania State University, University Park, USA.
STATISTICA (2004). Data analysis software system, version 7. StatSoft Inc., Tulsa, Oklahoma, USA.
Stevens, S.S. (2005). Visitation patterns and behavior of river otters at latrine sites in Pennsylvania and Maryland. Thesis, Frostburg State University, Frostburg, Maryland, USA.
Stevens, S.S., Serfass, T.L. (2008). Visitation patterns and behavior of Nearctic river otters (*Lontra canadensis*) at latrines. Northeastern Nat. **15**: 1-12.
Sulkava, R.T., Liukko, U. (2007). Use of snow-tracking methods to estimate the abundance of otter (*Lutra lutra*) in Finland with evaluation of one-visit census for monitoring purposes. Ann. Zool. Fenn. **44**: 179-188.
Swimley, T.J. (1996). Predicting river otter marking sites in Pennsylvania. Thesis, Pennsylvania State University, University Park, U.S.A.
Swimley, T.J., Serfass, T.L., Brooks, R.P., Tzilkowski, W.M. (1998). Predicting river otter latrine sites in Pennsylvania. Wildlife Soc. B. **26**: 836-845.
Wiens, J.A. (1974). Habitat heterogeneity and avian community structure in North American grasslands. Am. Midl. Nat. **91**: 195-213.
Williams, C.S., Marshall, W.H. (1938). Duck nesting studies, Bear River Migratory Bird Refuge, Utah, 1937. J. Wildlife Manage. **2**: 29-48.
Woolington, J.D. (1984). Habitat use and movements of river otters at Kelp Bay, Baranof Island, Alaska. Thesis, University of Alaska, Fairbanks, USA.
Zar, J.H. (1999). Biostatistical analysis. Fourth edition. Prentice Hall, Upper Saddle River, New Jersey, USA.

RESUME

Variation Saisonnière Dans L'utilisation Des Latrines Et Du Marquage Par Les Loutres De Rivière (*Lontra canadensis*)

Nous avons combiné l'étude de l'utilisation des sites (à l'aide de caméras à distance) et du marquage (à l'aide des indices habituels) pour mettre en évidence de manière claire les mécanismes qui sont à la base de la variation du marquage dans les latrines de la loutre de rivière et pour vérifier que le marquage chez cette loutre varie de manière saisonnière en Pennsylvanie et dans le Maryland. Nous avons observé des pics saisonniers de marquage en automne (septembre) et au printemps (mars) identiques à ceux déjà rapportés. La taille des groupes de loutres de rivière utilisant les latrines étaient plus importante en automne qu'en toute autre saison et les sécrétions des glandes anales n'ont été mises en évidence que de février à la mi-juin. Nous pensons que le pic automnal de marquage est le fait de groupes familiaux se déplaçant ensemble vers les latrines et que le pic de marquage printanier est dû à la communication au cours de la période de reproduction. Partant de la variation saisonnière dans la périodicité de l'utilisation des sites et de la variation saisonnière dans l'intensité du marquage, nous suggérons que le printemps et l'automne sont les deux saisons au cours desquelles les loutres de rivière peuvent être repérées par le biais de leur marquage.

RESUMEN

VARIACIÓN ESTACIONAL EN VISITAS A SITIOS DE DEPOSICIÓN Y MARCAS DE OLOR EN NUTRIAS (*Lontra canadensis*) DE RIO CERCANAS AL ARTICO

Con el objeto de proveer una explicación de los mecanismos que articulan la variación en las marcas de olor hechas por las nutrias de rio en los lugares de deposición, se utilizó el análisis de visitas (utilizando camaras remotas), así como el análisis de las marcas de olor (utilizando analizadores de rastro tradicionales). Igualmente se pretendía verificar que las marcas de olor tienen variación estacional en Pennsylvania y Maryland.

Picos estacionales fueron observados en el otoño (septiembre) y en primavera (marzo) lo cual concuerda con lo reportado previamente. El tamaño de los grupos de nutrias de rio fue mayor en el otoño comparado con cualquier otra estación; sin embargo, secreciones de los sacos anales fueron documentadas solamente entre Febrero y la mitad de Junio. Se le atribuye el pico de otoño a grupos familiares de nutrias viajando juntos a los lugares de deposición, mientras que el pico de primavera se le atribuye a la comunicación durante el período de apareamiento. Basados en la variación estacional de la periodicidad de las visitas de las nutrias de rio, así como la variación estacional en la intensidad de las marcas de olor, se sugieren las estacones de primavera y otoño como las más eficientes para la detección por sus marcas de olor de las nutrias de río.