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Original Research

Monthly Variation in Scat Marking by River Otters along Tionesta Creek in Northwestern Pennsylvania

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Abstract

We examined monthly variation in scat marking by river otters (*Lontra canadensis*) by surveying both shorelines of a 17.3 km section of Tionesta Creek in northwestern Pennsylvania once a month from 4 March 2000 to 24 March 2001 to count the number of scats and latrines (sites where river otters deposit scats). Overall, we counted 7,586 scats at 170 latrines. Most of the section of Tionesta Creek where surveys were conducted was bordered to the north with a 2-lane, secondary road. Significantly more scats and latrines were detected along the non-roadside (6,642 scats, 113 latrines) than the roadside (944 scats, 57 latrines) of the stream. Measures of scat marking fluctuated among months, with peaks during March and April and September through November, and lows during May through August. The peaks in scat deposition coincided with the breeding season in March and April, and increased traveling by family groups (mother and her cubs) during September through November. Efficiency of detecting evidence of river otter through scat surveys would be enhanced by conducting riparian surveys during spring (March-April) and fall (September-November) peaks in scat marking.

Key Words: *Lontra canadensis*, Pennsylvania, River Otter, Scat Marking, Seasonality, Surveys.

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INTRODUCTION

Rhoads (1903) reported that North American river otters (hereafter, river otters or otters; *Lontra canadensis*) once inhabited every major watershed in Pennsylvania, USA. Water pollution, disturbance to riparian habitats, and unregulated trapping contributed to the extirpation of river otters throughout most of the state by the 1950s (Eveland 1978). Consequently, in 1952 the Pennsylvania Game Commission provided complete legal protection to river otters (Eveland 1978). In 1982, the Pennsylvania River Otter Reintroduction Project (PRORP) was initiated, and succeeded in the restoration of river otter populations through the release of 153 river otters among 7 discrete riverine systems in central and western Pennsylvania (Serfass *et al.* 1986; Serfass *et al.* 1993; Serfass *et al.* 2003). In addition to the release, and initial radio-telemetry monitoring of some reintroduced river otters, PRORP's mission was to develop methodologies to enhance long-term monitoring of the reintroduced populations (e.g., Swimley *et al.* 1998; Hubbard and Serfass 2005).

River otters are elusive and relatively difficult to observe on a consistent basis. Therefore, field surveys to detect otter signs, such as tracks, scats, and latrines (areas where otters deposit scats, otherwise scent mark, and congregate [Olson *et al.* 2008; Stevens and Serfass 2008]) have been used frequently in Europe (e.g., Bas *et al.* 1984; Kruuk *et al.* 1986; Macdonald and Mason 1985; Taylor *et al.* 1988) and North America (e.g., Mowbray *et al.* 1976; Clark *et al.* 1987; Dubuc *et al.* 1990,) to determine if otters occupy an area. Scat-marking sites are the most frequent signs detected during surveys and the focus of many survey efforts, except during winter when tracks and slides in the snow can be evident (e.g., Gallant *et al.* 2008).

Conducting field surveys to detect evidence of river otters typically involves walking shorelines adjacent to aquatic systems and visually searching for river otter scat-marking sites or other signs (e.g., Swimley *et al.* 1998; DePue and Ben-David 2010). Although time consuming, field sign surveys to detect scats are generally considered reliable in determining the presence of river otters. However, failure to detect otter scats during surveys may reflect the quality of riparian conditions for scat marking or seasonal variation in marking intensity, not necessarily the absence of otters in an area. In Pennsylvania and Colorado, models developed by Swimley *et al.* (1998) and DePue and Ben-David (2010) were effective in predicting riparian habitat conditions (e.g., vertical banks, rock formations, and areas with American beaver [*Castor canadensis*] activity) where river otters were most likely to deposit scats along riverine systems.

Stevens *et al.* (2011) and Just *et al.* (2012) demonstrated the utility of applying elements of Swimley *et al.*'s (1998) models to enhance the likelihood of detecting river otter latrines when conducting surveys near bridges. Crowley *et al.* (2012) appropriately established concern that habitat conditions at latrines may not reflect overall otter-habitat use by demonstrating seasonal flux in areas occupied by river otters. However, Swimley *et al.* (1998), Stevens *et al.* (2011), and Just *et al.* (2012) intended to determine if riparian habitat conditions could be useful in predicting the location of latrines as a basis for enhancing survey efficiency in areas occupied by otters. These studies demonstrated that selecting specific habitat conditions prior to a survey effort can enhance detection rates of scat-marking areas, but did not consider in detail the potential for seasonal shifts in river otter scat marking behaviour when selecting times of years to conduct surveys. Olson *et al.* (2008) and Stevens and Serfass (2008) demonstrated fluctuations in river otter visitations to latrines, with peaks during spring and fall months through use of remote-camera surveys. Although yielding useful and insightful information about river otter activity at latrines, fluctuations in seasonal visitation rates at latrines monitored with remote cameras plausibly could only reflect seasonal shifts in use of specific latrines and general areas associated with those latrines, not an overall indication of seasonal variation of scat marking. Accounting for the potential of river otters alternating use of latrines in an area would require monitoring entire sections of shoreline instead of specific latrines. Studies designed to assess potential seasonal variation in scat deposition by river otters are fundamental in determining if time of year should be among factors considered in survey design.

The goal of our study was to determine if scat-marking habits of river otters differed throughout the year along a substantial, continuous section of shoreline, not only at known latrines. Specifically, we designed our study to investigate if: 1) the number of scats differed among months, 2) the number of marked latrines differed among months, 3) the number of scats per marked latrines differed among months, and 4) the same latrines were being marked each month. We hypothesised that peaks in scat-marking activity would occur during spring and fall, coinciding with advertising for potential mates during the breeding season (March or April in New York - Hamilton and Eadie 1964) and the increased movement of family groups (mother and her pups) after the weaning of pups (Olson *et al.* 2005), respectively.

STUDY AREA

Our study occurred along Tionesta Creek, which flows approximately 70 km through the Allegheny National Forest, Forest County, northwestern Pennsylvania. The West Branch of Tionesta Creek begins at Chapman Dam State Park, Warren County, and the South Branch begins near Kane, McKean County. Tionesta Creek flows into Tionesta Lake, which is impounded by Tionesta Dam, a U. S. Army Corps of Engineers flood control dam. Tionesta Creek is a 6th order stream, which enters the Allegheny River approximately 2 km below Tionesta Dam. The study area is dominated by public lands, but there are a few private inholdings (mostly secondary residential areas used seasonally by the owners for outdoor recreational activities on adjacent public lands), with housing seldom adjacent to the portion of Tionesta Creek represented in the study area (<5% of riparian area in the study area is represented as private, residential areas).

The study area included stream banks along both sides of a 17.3 km section of Tionesta Creek (34.6 km of shoreline), starting 5.2 km downstream from the bridge at Kellettville (41° 32' 42.8748" N, 79° 15' 22.6332" W) and ending 5.2 km upstream from the bridge at Mayburg (41° 35' 38.2416" N, 79° 12' 55.2492" W) (Figure 1). The north side of the stream was paralleled by a paved, 2-lane, secondary road, which typically was <100 m from Tionesta Creek. The landscape surrounding the portion of Tionesta Creek in our study area was predominantely forested. The riparian forest was mostly comprised of hardwood species such as American sycamore (*Platanus occidentalis*), northern red oak (*Quercus rubra*), basswood (*Tilia americana*), red maple (*Acer rubrum*), American hornbeam (*Carpinus caroliniana*), American beech (*Fagus grandifolia*), and black cherry (*Prunus serotina*). However, conifers (predominantly eastern hemlock (*Tsuga canadensis*) and eastern white pine (*Pinus strobus*)) also occupied sections of the shoreline.

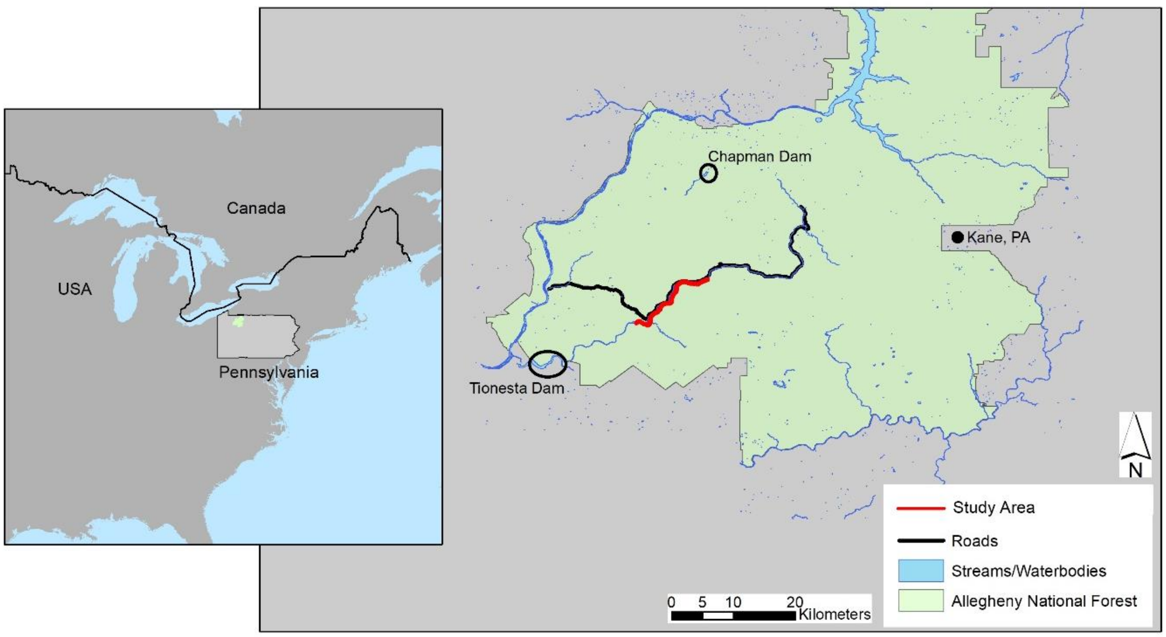

Figure 1. Location of the Tionesta Creek study area in the Allegheny National Forest, northwestern Pennsylvania. Surveys to detect river otter scats and latrines were conducted along both shorelines of a 17.3 km section (shown in red) of Tionesta Creek from 4 March 2000 to 24 March 2001. Most of the section of Tionesta Creek where surveys were conducted is bordered to the north with a 2-lane, secondary road.

MATERIAL AND METHODS

Sampling procedure

We verified that river otters were using the study area by conducting preliminary surveys during fall 1999, and monitoring snow and ice cover throughout the winter. Surveys to document river otter scat-marking activities were initiated 4 March 2000, after all ice on the stream disappeared during a period of rainfall and warming temperatures that induced high water and ice flow at the end of February, which effectively cleansed the shoreline of scats. Final surveys were completed 24 March 2001. Our goal was to conduct surveys along both shorelines of Tionesta Creek on a monthly basis, and to complete each monthly survey in 1 or 2 d. Because of logistics associated with weather conditions and travel, the length of time between successive survey ranged from 18.7 d to 44.3 d ($\bar{x}$ = 30.2, SE = 1.04). Because of weather conditions (snowfalls or flooding), only portions of the shoreline within the study area were surveyed during December, February, and March 2001 (14 km, 29 km, and 29 km, respectively).

We conducted surveys by walking along the banks of the stream and visually searching for river otter scat-marking sites (latrine sites). We were interested in the number of sites where river otters deposited scats, and defined any marking location with >1 scat as a latrine. During each monthly survey, we counted the number of scats at each latrine and number of marked latrines. After completing a count at a latrine, we used our boots to break up the scats and push them into the soil to prevent recounting them the following month. We defined a scat as a single, connected strand (or pile if the scat had deteriorated) of excrement. In some cases, river otters deposited scats over several meters of shoreline. A latrine was defined as separate if >10 m from other scats. When first located, a latrine was assigned an unique, alpha-numeric code, and a nearby tree was marked with yellow surveyor's ribbon and fluorescent orange spray paint to aid in locating the site during subsequent surveys.

Statistical analyses

Data were analyzed using SAS version 6.0 (SAS Institute, Inc., Box 8000, Cary, North Carolina 27511). Each shoreline was partitioned into 1-km units to facilitate statistical comparisons. We used means, standard errors, and frequencies to describe counts of scats and latrines per km of study area. We used PROC MIXED (SAS Institute, Incorporated1989) as a basis for repeated measures analysis of variance, with missing data, to determine if means for the indices used to assess marking intensity (number of scats and latrines per km) differed among months, and by roadside and non-roadside of Tionesta Creek. Although the data analyzed were counts, we considered interpretation of outcomes to be more intuitive when portrayed and analyzed as means and variation around means, thus our decision to use analysis of variance. Analysis of variance has been demonstrated to yield valid results for count and ordinal data (e.g., Harwell and Gatti 2001; Norman 2010), and are robust to deviation from normality (Khan and Rayner 2003). Data in our study did not deviate substantively from normality. Pearson correlations (Zar 1999) were used to determine if mean number of scats per km and mean number of latrines per km were correlated (i.e., yielded a comparable indication of scat marking intensity) by month.

To assess repeated use of a latrine among months, we categorised each latrine as being marked during 1-3, 4-6, 7-9, or 10-13 of the months sampled. We used the Coefficient of Jaccard (Krebs 1998) to assess similarity in latrine use between pairs of months. The Coefficient is calculated as:

$$J = C/(A+B+C)$$

where C is the number of latrines used in both months and A and B are the numbers of latrines used in only 1 of the 2-month pairs. We did not include December in calculations of the Coefficient of Jaccard because a substantial portion of the shoreline was not surveyed.

RESULTS

Overall, we detected 7,586 scats at 170 latrines. The mean number of scats per km and mean number of marked latrines per km differed among months ($F_{12, 360}$ = 6.86, P<0.001, and $F_{12, 372}$ = 6.74, P<0.001, respectively) (Figure 2A, B). These measures of marking intensity were highly correlated among months (r = 0.93, P<0.001), with peaks for each occurring during portions of spring (March and April) and fall (September, October, and November). Both mean number of scats per km and mean number of marked latrines had maximum values in March 2000 (68.40 ± 13.20 and 3.03 ± 0.49, respectively) and minimum values in January (4.15 ± 2.10 and 0.32 ± 0.13, respectively).

The mean number of scats per marked latrine differed among months ($F_{12, 436}$=2.96, P<0.001), with the highest occurring during November (26.7 ± 5.0) and the lowest during August 2000 (7.2 ± 1.2) (Figure 2C). Most latrines were not marked consistently among months, with 127 (74.7%) of latrines marked 1-3 months and only 5 latrines (2.9%) marked 10-13 months. The greatest similarity in use of latrines occurred between August and September and September and November (40% and 42%, respectively; Table 1). The least similarity occurred between September and January, when 8% of the same latrines were marked. There was only a 15% similarity in marked latrines between March 2000 and March 2001.

Otters deposited scats much more frequently along the non-roadside than the roadside of the stream. The non-roadside had an average number of latrines per km almost 4 times higher than the roadside (1.76 ± 0.17 versus 0.45 ± 0.67; $F_{1, 372}$=48.88, P<0.001) and an average number of scats per km almost 7 times higher than the roadside (32.46 ± 4.42 versus 4.76 ± 1.00; $F_{1, 360}$ = 23.26, P<0.001). Also, the mean number of scats per marked latrine was higher along the non-roadside than the roadside ($F_{1, 436}$=7.13, P=0.008) (Figure 2).

DISCUSSION

Our study revealed seasonal difference in the intensity of river otter scat marking, with peaks in the number of scats and marked latrines during spring (March-April 2000) and fall (September-November 2000). River otters are generally solitary, although after parturition in spring pups remain with the mother until dispersing during the ensuing late winter/early spring (Hamilton and Eadie 1964; Melquist and Hornocker 1983; Melquist *et al.* 2003). The role of scent marking for communication has been investigated for coastal river otters in Alaska (Ben-David *et al.* 2005), but is a relatively understudied aspect of the natural history of this species. Scent marking has been demonstrated to increase during the breeding season of various solitary carnivores (e.g., Eurasian lynx [*Lynx lynx*; Vogt *et al.* 2014]; American black bear [*Ursus americanus*; Taylor *et al.* 2015]; apparently serving a role in locating prospective mates

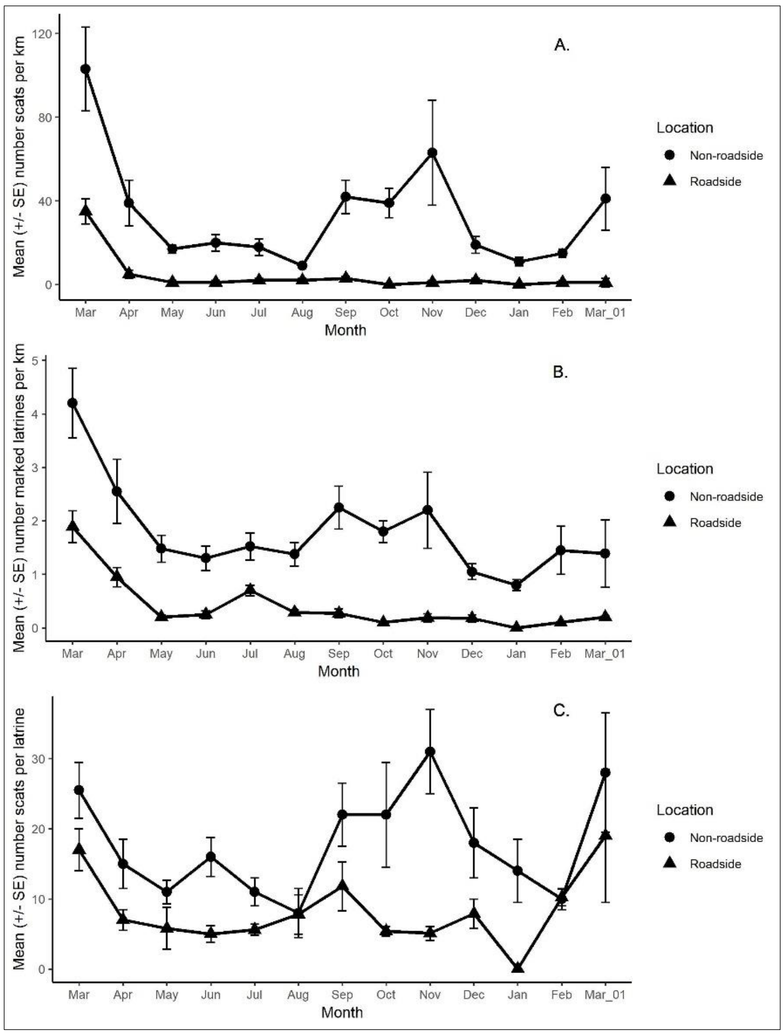

Figure 2. Mean number of river otter scats (A) and marked latrines (B) per km (± SE), and mean number of scats per marked latrine (± SE) (C) detected during monthly surveys along both shorelines of a 17.3 km section of Tionesta Creek in the Allegheny National Forest, northwestern Pennsylvania, from 4 March 2000 to 24 March 2001. One shoreline of the Tionesta Creek in the survey area was paralleled for most of the survey area by a 2-lane, secondary road. This side of the stream is referred to as roadside, and the other shoreline as non-roadside. Surveys encompassed only 14 km of shoreline during December 2000 and 29 km during February and March 2001.

Month	Mar[a]	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar[b]
Mar[a]		33.6	18.8	14.0	15.1	15.7	22.4	16.8	24.0		5.6	13.8	15.3
Apr			29.4	21.4	19.5	20.6	28.8	24.6	33.8		12.5	0.0	21.7
May				22.2	25.5	25.0	24.6	21.7	23.2		7.9	20.5	15.0
Jun					25.0	27.9	25.0	20.0	19.6		11.8	17.5	21.1
Jul						28.6	25.8	16.7	17.5		4.4	15.6	8.2
Aug							40.4	29.6	27.3		18.8	25.0	20.0
Sep								28.6	41.7		8.0	12.8	16.0
Oct									30.2		17.7	24.2	29.4
Nov											19.1	25.6	26.7
Dec													
Jan												31.8	12.0
Feb													21.9

[a]March 2000, [b]March 2001

Table 1. Percent of active river otter latrines (i.e., latrines where river otters deposited scats during a month) that were similarly marked among pairs of months as expressed by the Coefficient of Jaccard (Krebs 1998). Active latrines were located during monthly surveys conducted from 4 March 2000 to 24 March 2001 along both shorelines of a 17.3 km section of Tionesta Creek in northwestern Pennsylvania. We did not include December in the assessments of similarity because only a small portion of the study area was surveyed during this month (14 of 34.6 km).

(Allen *et al.* 2016). The spring peak in scat marking observed in our study coincides with what is considered the breeding period for river otters in the northeastern United States (Hamilton and Eadie 1964), suggesting a relationship between marking and locating mates. However, female river otters become receptive to breeding soon after parturition (Melquist *et al.* 2003), and increased marking by females could have detrimental consequences, including detracting from pup-rearing responsibilities, increased vulnerability to predation by frequenting latrines, and serving to advertise the location of natal dens to potential predators. Stevens and Serfass (2008) and Olson *et al.* (2005) demonstrated that visitations by river otters to latrines during the presumed breeding period in Pennsylvania were more likely to comprise single individuals visiting latrines more frequently, in comparison to less frequent visitations by a larger average number of individuals per visit during other periods of the year. Because of the aforementioned potential liabilities of females contributing extensively to spring marking, we speculate that the increased marking intensity largely is attributable to single males advertising their presence to females, and to other males competing for breeding opportunities.

River otter marking activity was lowest between May and August, a period when females with pups were unlikely to be traveling long distances (Melquist and Hornocker 1983). As with the breeding season, infrequent marking during ongoing pup rearing would serve to avoid advertising the location of dens. Also, following the mating period, males no longer need to mark as part of breeding-related behaviours. The peak in fall marking coincides with the highest annual density of river otters actively traveling together along a section of waterway (after pups have been weaned and prior to their dispersal). We suspect territorial marking by females and along with pups contributing to the marking resulted in the peaks in numbers of scats and marked latrines observed during fall, a supposition supported by Olson *et al.* (2005). The decline in number of scats and marked latrines per km may be at least partially attributable to river otters being physically excluded from the shoreline by ice cover on the stream, not necessarily a behavioural change in marking activity. The number of scats and marked latrines per km were lower in March 2001 than March 2000. Although there was no sustained ice cover of the stream during March 2001, periods of freezing and thawing resulted in flooding and the deposition of 1-2 m of ice along large portions of the shoreline, limiting access to river otters for marking. In contrast, the shoreline was largely free of ice during March 2000. The mean number of scats per marked latrine was higher in March 2001 than in March 2000, suggesting that overall scat marking might have been similar if ice had not limited access to the shoreline in 2001.

The road along Tionesta Creek seemed to have a substantial impact on river otter marking. The non-roadside of the stream was marked more consistently and intensely than the roadside of the stream, which was most evident during seasonal peaks in marking. Disturbances related to vehicular traffic and easier access to anglers and boaters on the roadside likely contributed to decreased marking activity on the roadside of the stream.

MANAGEMENT IMPLICATIONS

Surveys to detect river otter scats at latrines is the primary method used to determine if the river otters are occupying an area (e.g., Mowbray *et al.* 1976; Clark *et al.* 1987; Dubuc *et al.* 1990, Stevens *et al.* 2011; Just *et al.* 2012). Budget and time constraints encountered by personnel of wildlife conservation agencies, or other conservation groups, necessitate that wildlife surveys be conducted efficiently. Inherent to improving the efficiency of surveys for river otter scat is understanding if river otters deposit scats more frequently in riparian areas associated with certain habitat conditions and during certain periods of the year. Swimley *et al.* (1998), DePue and Ben-David (2010), Stevens *et al.* (2011), and Just *et al.* (2012) demonstrated that the likelihood of detecting otter scats can be enhanced by surveying riparian areas with specific habitat conditions. Our study demonstrates efficiency of surveys also are likely to be enhanced by searching for river otter scats during peak periods of marking in spring and fall. However, there are various advantages and disadvantages uniquely associated with various periods of the year that should be considered in the design of surveys, some of which were encountered during this study.

In Pennsylvania, seasonal differences in factors such as density of herbaceous vegetation, precipitation, temperature, and leaf fall have implication for conducting surveys. Low marking intensity, combined with dense herbaceous vegetation along shorelines, warm temperatures, and biting insects (contributing to discomfort of investigators) make summer the least desirable period to survey for otter scats. In contrast, peaks in scat marking during portions of spring and fall, and more comfortable survey conditions contribute to these seasons being preferred for conducting surveys. Limitations during these seasons are related to higher water levels in spring (from snowmelt and higher rainfall) and leaf fall during fall. Higher water levels may wash scats from the shoreline and make stream crossing difficult for investigators, whereas leaf fall may obscure scats. Surveys during winter can be effective in detecting the presence of otters if conducted during appropriate snow conditions (Gallant *et al.* 2008), when river otter signs (scats and tracks) often can easily be detected. However, ice cover during the winter may limit areas where river otters can access riparian areas or otherwise leave the water, and scats may be obscured by snow.

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