From The Field

A Comparison of Three Methods to Evaluate Otter Latrine Activity

NELDA A. RIVERA, *Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign, 1816S Oak Street, Champaign, IL 61820, USA*

SAMANTHA TOTONI, *Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign, 1816S Oak Street, Champaign, IL 61820, USA*

KATHRYN MONICK, *Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign, 1816S Oak Street, Champaign, IL 61820, USA*

TING TIAN,[1] *Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign, 1816S Oak Street, Champaign, IL 61820, USA*

MICHELLE L. GREEN,[2] *Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign, 1816S Oak Street, Champaign, IL 61820, USA*

JAN NOVAKOFSKI, *Department of Animal Sciences, University of Illinois Urbana-Champaign, 205 Meat Science Lab 1503S, Maryland Drive M/C 010 Urbana, IL 61801, USA*

NOHRA E. MATEUS-PINILLA,[3] *Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign, 1816S Oak Street, Champaign, IL 61820, USA*

ABSTRACT We compared methods commonly used in the field of river otter (*Lontra canadensis*) ecology to estimate visitation rates. We evaluated visitation rates estimated from 2 survey protocols based on video detection—individual visitation rate (IVR) and recording visitation rate (RVR)—and one indirect method based on scat detection—scat visitation rate (SVR). From August 2011 through August 2012, overall scat detection and cumulative video data from 403 camera-days in 2 latrine sites (River and Pond, at a study site adjacent to the Salt Fork of the Vermilion River near Fairmount, Illinois, USA) located <50 m apart did not reveal monthly or seasonal differences between SVR and video detection methods. We identified positive correlations among the 3 visitation rates and differences between overall IVR and RVR. All 3 methods resulted in peak visitation rates during winter. However, when these data were stratified by latrine site, we found both positive and negative correlations at the River latrine. Our work supports that SVR, IVR, and RVR are valuable methods to estimate otter visitation rates at latrine sites. However, it is clear that even within such a short distance between these 2 latrines, these methods detected differences in site utilization. The significant positive correlation observed between IVR and RVR (overall and by latrine site) suggests these methods can be used interchangeably. Otter detection using SVR may serve as a complementary assessment tool for IVR and RVR. To optimize cross-study comparisons and interpretation of results, future studies should detail the type of otter detection and visitation rate used, how variables are measured, formulas used in the calculation of the visitation rates, and detailed descriptions of scat counting efforts when using scat as a tool to evaluate otter visitation rates.   2019 The Authors. *Wildlife Society Bulletin* Published by Wiley Periodicals, Inc.

KEY WORDS consistency, *Lontra canadensis*, repeatability, scat detection, spraint detection, visitation rate.

Direct and indirect survey methods of animal detection are widely used to measure species abundance, distribution,

[1]*Present Address: School of Mathematics, Sun Yat–Sen University, 135, Xingang Xi Road, Guangzhou, Guangdong 510275, P.R. China.*
[2]*Present Address: Department of Biological Sciences, University of South Florida St. Petersburg, 140 7th Ave S, St. Petersburg, FL 33701, USA.*
[3]*E-mail: nohram@illinois.edu*

habitat use, activity patterns, and related ecological characteristics in wildlife research (Wilson and Delahay 2001). Given the secretive and nocturnal behavior of river otters (*Lontra canadensis*), methods to study otters and their activity patterns have centered on latrines—terrestrial sites where otters repeatedly scent-mark and deposit feces (Ben-David et al. 1998). The traditional approach to evaluate otter activity patterns is through the measurement of visitation rates ("a measure of the frequency with which animals visit specific locations or objects of interest" [Gruber et al. 2008, p. 728]). Visitation rates could be measured by methods based on direct observation such as video surveillance, or by indirect methods such as the detection of glandular secretions and

feces (also referred to as scats or sprints) at these sites (Mason and Macdonald 1987, Olson et al. 2008).

Visitation rates are commonly used to understand complexities of otter activity. For instance, Stevens and Serfass (2008) reported the largest peak in latrine visitation rates was associated with the breeding season of the river otter. Field studies that estimate otter visitation rate based on video detection may measure different biological information, yet the described methods and results using the same terminology may affect potential for comparison. For example, studies that used trail cameras in latrine sites defined an otter visit in 1 of 2 ways: 1) one visit = one recording, regardless of the number of otters present (Stevens and Serfass 2008, Green et al. 2015), which from here on we will refer to as recording visitation rate (RVR), or 2) one visit = the detection of ≥1 otter by a camera and counts the number of otters present in the visiting group (Guter et al. 2008, Day et al. 2016), which from here on, we refer to as individual visitation rate (IVR). The literature reports both approaches with the same terminology as "visitation rate" even though calculations differ.

Scat density has served as a broad indicator of population status and habitat utilization (Mason and Macdonald 1987); seasonal changes in scat quantity have informed population-monitoring protocols (Olson et al. 2008). Quantifying otter scat is also a crucial aspect of many diet studies (e.g., Day et al. 2015). However, evaluation of otter scat as a research tool offers challenges that could affect potential for extrapolation and comparison of results across studies. Unlike Kruuk et al. (1986), who defined one sprint from a Eurasian otter (*Lutra lutra*) as "one bowel evacuation," it is often unclear how authors define one otter scat (Table 1). As Greer (1955:8) pointed out, North American otter scat is "characteristically in 2, 3, or 4 curved segments" (Fig. 1A). Detailed methodological descriptions make it possible for subsequent efforts to repeat the same method for counting feces.

Scat counts has been positively correlated with video detection at latrine sites, and suggested a comparable method

Table 1. Examples of published methodological descriptions from studies that quantified scats of river otters.

Methodological description	Reference
"Otter scats are readily recognized with experience. The average is approximately 3/4 inch in diameter and characteristically in 2, 3, or 4 curved segments each about $1^{1/2}$-3 inches long making a total length of 4-7 inches."	Greer (1955:8)
"…we collected otter feces ($n = 18$)…"	Ben-David et al. (1998:2568)
"From early May until mid July 1999 and from early May through early August 2002, scats ($N = 53$) were collected from river otter latrine sites in the study area."	Taylor et al. (2003:337)
"Fresh scats were collected and individually bagged…"	Cote et al. (2008:1002)
"In 2006, five otter scats with a distinct anal jelly portion disassociated from the fecal material were collected from Victoria Harbour latrines. We assumed that each sample was derived from an individual animal based on its location from other excrements in the field."	Elliott et al. (2008:59)
"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…"	Olson et al. (2008:111)
"During the next two visits, all otter scats found in the segments were collected and individually stored in plastic bags for later analysis."	Roberts et al. (2008:304)
"…we recorded the number of scats at each site to provide a coarse estimate of relative abundance of river otters."	Crimmins et al. (2009:995)
"A layer of sand was placed on 10 latrines and adjacent slides to determine visitation by recording fresh tracks, scat, scat-jellies, and urine (identified by a wet mark)."	Oldham and Black (2009:207)
"All scat discernable as individual deposits were collected at least once per month from each site from 19 July 2005 through 27 July 2006."	Penland and Black (2009:233)
"Fecal matter was collected and stored at $-30°$ C prior to analysis in the laboratory."	Dekar et al. (2010:1441)
"We collected 203 otter feces between the summers of 1999 and 2000…"	Wengeler et al. (2010:1145)
"Locations of all tracks (≥1 foot track) and scat (≥1 piece of scat) and their descriptions (e.g., type, size) were recorded."	Jeffress et al. (2011:146)
"We then collected each scat sample in a separate sealable plastic bag."	Mowry et al. (2011:1627)
"Scats were collected in individual plastic bags, which subsequently were labeled with identifying information (i.e., date, river and site) and frozen until analysis."	Stearns and Serfass (2011:171)
"After latrine sites were identified, we surveyed each site every 2 weeks to collect scats and record the number of scats deposited."	Crowley et al. (2012:172)
"We ranked all scat and jelly samples with freshness scores determined visually by moistness and odor: new (<24 hr), old (>24 hr), and recorded the primary diet content of each scat at time of collection."	Brzeski et al. (2013:1524)
"We surveyed latrine sites every 2 weeks to collect scats and record the frequency of use."	Crowley et al. (2013:30)
"At each latrine site, we counted old (deposited >24 hr before the survey) and fresh scats (distinguished by distinct odor and appearance)."	Crait et al. (2015:598)
"When we discovered a latrine site, we counted the number of fresh (i.e., wet, soft, pungent) otter scats."	Day et al. (2016:231)
"The number of scat samples collected at each latrine site during every survey date was also recorded."	Fretueg et al. (2015:296)
"At each site, we only collected fresh otter feces (<24 hr old)."	Godwin et al. (2015:782)
"Otter scats were collected opportunistically along 400 m and 800 m stream transects, which began at road bridges, during January−April 2013 and 2014."	Feltrop et al. (2016:299)
"Scats were collected from both latrine sites and marking sites, stored in Whirl-pakE bags, and frozen for later processing."	Scordino et al. (2016:37)
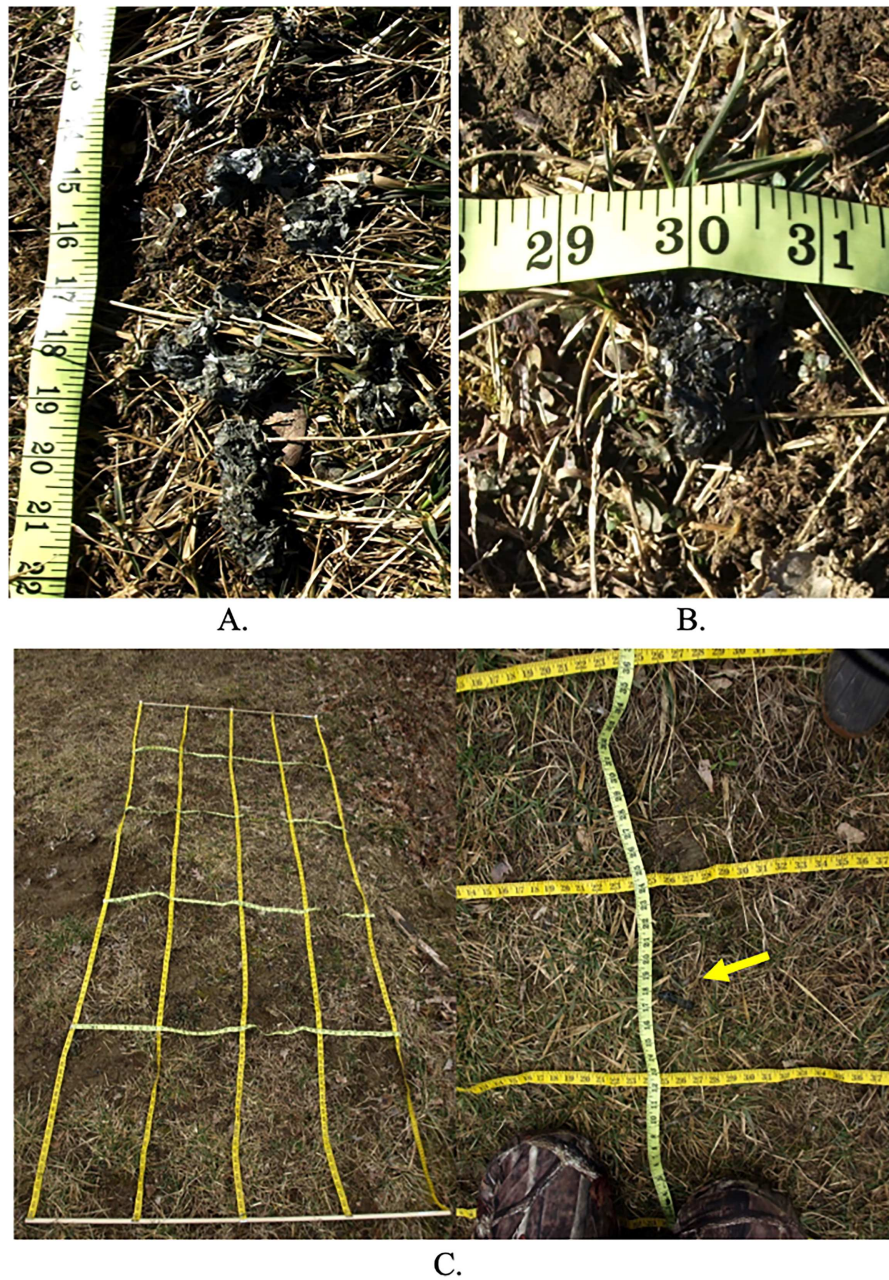
Figure 1. Grid system used to reference river otter scat location during scat surveys from 1 August 2011 to 31 August 2012, Illinois, USA. Given the variation in scat, different research teams may define "one scat" differently than another: (A) Multiple pieces of scat that likely represent one bowel evacuation. (B) One piece of scat that likely represents one bowel evacuation. (C) Portable grid system used to reference scat location. Arrow indicates new scat.

to camera-trapping "in determining intensity of site use" (Guter et al. 2008, Day et al. 2016). Scat visitation rate (SVR)—as defined in this paper—is a binary detection rate of otter activity that can complement or serve as an alternative to counting otter scat. However, methods such as SVR do not allow us to extrapolate from presence of feces to presence of individuals because several otters can use a single latrine. Researchers may choose to use a direct method to determine otter presence, such as video detection rates, that does not hinge on scat or scent marking. However, without taking into consideration differences in survey techniques and research protocols, it is unclear whether otter detection rates based on scat detection and video detection provide comparable information.

The study of site-specific visitation rates (the probability of visitation to a particular location) and evaluation of different survey techniques and data collection protocols on visitation rate results will contribute to better understanding of potential difficulties and similarities in comparing study results. Therefore, our objectives were to use the same data set from 2 latrines located at 50 m from each other to 1) compare visitation rate results between 2 direct observation methods of video detection (IVR vs. RVR), and 2) compare an indirect method of otter detection—SVR—with the direct video detection methods. We explored whether seasonality and location of the latrine (pond or river) influenced visitation rates. We hypothesized that visitation rates based on video detection would provide more reliable

and consistent data to estimate visitation rates trough time than scat detection. We predicted that RVR and IVR would differ from each other, and that SVR would reveal similar otter detection patterns at latrine sites as RVR.

STUDY AREA

The Salt Fork Vermilion River was approximately 70 miles long and a major tributary of the Vermilion River (Wabash Basin) located in an eastern Illinois county bordering Indiana, USA (IDNR 2017). The Illinois portion of the Vermilion (Wabash Basin) watershed included drainage from 5 Illinois counties. The river originated at Ford County, and included Champaign and Vermilion counties (Fig. 2). The watershed drainage encompassed terrestrial habitat areas such as savanna, tallgrass prairie, wet meadows, and river corridor. As a result of the glacial legacy in this region, soils were mostly flat, wet, and fertile (Illinois CBMP 2017). Our study site was within the Vermilion River Conservation Opportunity Area in Fairmount, Illinois, USA. We conducted our study from 1 August 2011 to 31 August 2012. In the Midwest long-term daily mean temperatures vary between $\pm 15°$ C (McIsaac and Edwards 1994). Average temperature during our study for the 4 seasons were $15°$ C in autumn and spring, $<10°$ C in winter, and $>20°$ C in summer (Green et al. 2015). The long-term weather data were calculated on an average of daily temperatures (lows and highs) and snowfalls, and a 7-day moving average from August 2011 to August 2012 (Green et al. 2015).

METHODS

Field Work

The study site was adjacent to the Salt Fork of the Vermilion River near Fairmount, Illinois. To avoid large-scale differences in habitat that could influence visitation rates, we chose 2 latrines, <50 m apart and connected by an animal-made trail, for study. We identified these latrines as part of a previous study, and selected them on the basis of detection of river otter scat in undisturbed natural areas and proximity to a river and a fishpond (Green et al. 2015). We did not consider other places (e.g., man-made structures) within a 100-m radius that were used by otters to deposit scats as latrines and did not include them in our analyses. Latrine 1 (2.0×5.0 m^2) was located on a dam near a 4,046.86-m^2 fish pond (hereafter, we refer to Latrine 1 as Pond); Latrine 2 (2.5×6.5 m^2) was located on the south bank of the Salt Fork of the Vermilion River (hereafter, we refer to Latrine 2 as River; Fig. 2). Choosing 2 latrines close to each other provided the opportunity to evaluate visitation data for both latrines combined and stratified by latrine site. To record river otter activity, we used SPYPOINT^{TM} (Des Moines, IA, USA) PRO-X infrared digital game-cameras set to record video data for 30–90 s, with a delay of 10 s between recordings (Green et al. 2015). We conducted replacement of memory cards, batteries, and equipment evaluation on a weekly basis. We conducted surveys of scat and glandular secretions twice each week.

Visitation Rates

Recording visitation rates (RVR) and individual visitation rates (IVR).—Over the study period (1 Aug 2011 to 31 Aug 2012), we monitored and analyzed data recorded by digital game cameras placed at 2 latrine sites. We considered video recordings independent of the next recording if ≥ 1 min passed between recordings. For RVR, we defined a visit as a single recording, regardless of the group size in the recording (i.e., one video recording was considered as one visit; Green et al. 2015). For IVR, we evaluated all recordings and counted the number of otters observed in a single video (i.e., we considered a video recording with 4 otters as 4 visits; Day et al. 2016). We considered a visit on either camera as detection at the corresponding latrine site. To obtain both RVR and IVR, we divided the number of visits per month by the number of working camera-days—days the cameras were
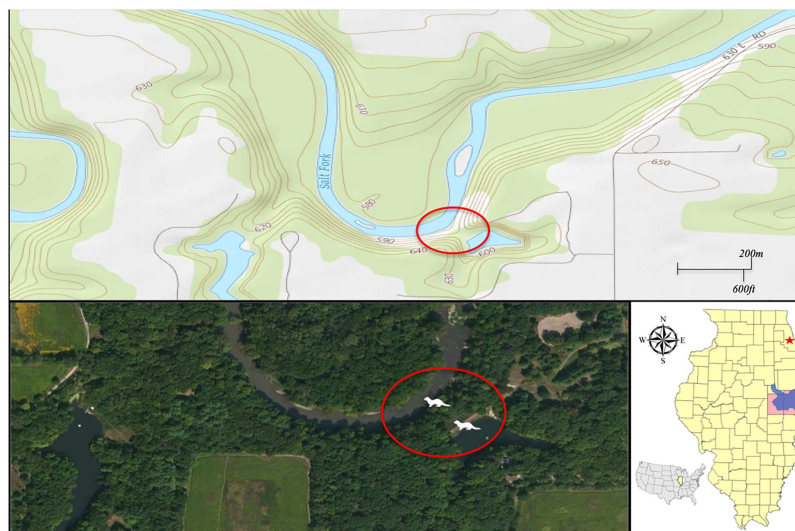
Figure 2. Latrine sites (river otter symbol) are connected by an animal-made trail and located near a fish pond adjacent to the Salt Fork of the Vermilion River (Wabash basin) watershed, Illinois, USA. We conducted scat surveys and video detection from 1 August 2011 to 31 August 2012. Illinois map shows Vermillion River watershed (in blue) and Chicago area (red star). Pink color denotes Champaign and Vermillion counties.

able to record data—for that month.

$$RVR = \frac{\text{No. recordings per month}}{\text{No. working camera} - \text{days per month}}$$

$$IVR = \frac{\text{No. individual visit per month}}{\text{No. working camera} - \text{days per month}}$$

Scat visitation rate (SVR).—Twice each week, we surveyed and recorded presence of new feces and new glandular secretions observed at otter latrines. We did not remove scat from latrine sites. We photographed new scat for comparison with the subsequent survey. We used a portable grid system constructed from measuring tapes and consisting of 20 (30 × 61 cm) quadrants. We placed the portable grid system in the same location at the beginning of each survey and moved it in a consistent pattern until the entire latrine was surveyed. We did not record any scat outside the defined boundaries of each latrine. For each survey we recorded 1) location of scat within a quadrant in a portable grid system placed in the same location in each latrine per survey (Fig. 1C), 2) length of scat, 3) color of scat, and 4) prey items visible in the scat (e.g., fish scales, crayfish carapace, amphibian vertebrae). In the subsequent survey, we checked for scat recorded at the latrine during the previous survey. We recorded scat that matched the location, length, number of pieces, and visible prey items from the previous survey as old scat. We recorded previously undocumented scat in new locations within the latrine as new scat. Newly deposited scat became visibly desiccated after 2–4 days, depending on weather events. Rain events that occurred between scat surveys modified the length, number of pieces, and color of scat in the latrines. However, the location and visible prey items remained consistent even after rain events, making those characteristics useful for the distinction of old and new scat at each survey. We defined a visit if we detected ≥1 new scat/survey. We calculated monthly scat visitation rates (SVR) by dividing the number of surveys with new scat detected by the total number of surveys per month.

$$SVR = \frac{\text{No. surveys with new scats per month}}{\text{No. surveys per month}}$$

Statistical Analysis

We analyzed data from scat and video surveys collected at 2 latrine sites (Pond and River). We calculated monthly and seasonal visitation rates (overall and by latrine), and calculated the correlation coefficients between visitation rates (IVR, RVR, and SVR) using Pearson's correlation coefficients. We analyzed seasonal differences in visitation rates based on the definition of ecological seasons by Green et al. (2015). Seasons were defined based on temperature and snowfall data collected in 2011 and 2012, as follows: "fall occurred from September 6, 2011 through November 29, 2011; winter occurred from November 30, 2011 through March 5, 2012; spring occurred from March 6, 2012 through June 7, 2012; summer occurred from June 8, 2012 through August 31, 2012" (Green et al. 2015, p. 229). We applied a *t*-test to examine differences in visitation rates between the indirect method of otter detection and the direct video detection methods (SVR vs. IVR and SVR vs. RVR). We used Program R version 3.5.1 to carry out all statistical analyses. We considered as significant a *P*-value <0.05.

RESULTS

Latrine sites were monitored for 57 weeks, from August 2011 through August 2012. Cameras operated for 403 camera-days (Pond = 215 camera-days; River = 188 camera-days; Table 2). We recorded 182 individual otter visits (average IVR = 0.373 ± 0.114 [SE] visitation rate/month) and 123 video recordings (average RVR = 0.251 ± 0.071 [SE] visitation rate/month). Overall visitation rates (combined data for both latrine sites) were significantly different between direct methods of detection (IVR vs. RVR t_{12} = 2.537, P = 0.026; Figs. 3C and 4C). Furthermore, overall IVR and RVR were positively correlated by month and by season (r = 0.969, P < 0.001 and r = 0.988, P = 0.002, respectively; Table 3). In

Table 2. Summary of the overall visitation rates based on river otter scat surveys and video surveys conducted at 2 latrine sites located near a fish pond and adjacent to the Salt Fork of the Vermilion River near Fairmount, Illinois, USA. Surveys were conducted from August 2011 to August 2012.

Year	Month	Scat surveys		Video surveys			Detection rates		
		Total surveys	Positive surveys	Camera-days	Positive recordings	Individual otters per recording	SVR[a]	IVR[b]	RVR[c]
2011	Aug	14	0	33	3	6	0.000	0.182	0.091
	Sep	16	1	35	12	17	0.063	0.486	0.343
	Oct	16	4	34	5	7	0.250	0.206	0.147
	Nov	12	7	42	11	23	0.583	0.548	0.262
	Dec	12	8	37	34	57	0.667	1.541	0.919
2012	Jan	12	7	58	27	36	0.583	0.621	0.466
	Feb	12	8	36	14	15	0.667	0.417	0.389
	Mar	12	5	30	11	11	0.417	0.367	0.367
	Apr	12	2	19	4	7	0.167	0.368	0.211
	May	8	2	24	1	2	0.250	0.083	0.042
	Jun	8	4	14	0	0	0.500	0.000	0.000
	Jul	8	1	10	0	0	0.125	0.000	0.000
	Aug	10	6	31	1	1	0.600	0.032	0.032

[a] SVR = Scat visitation rate.
[b] IVR = Individual visitation rate.
[c] RVR = Recording visitation rate.
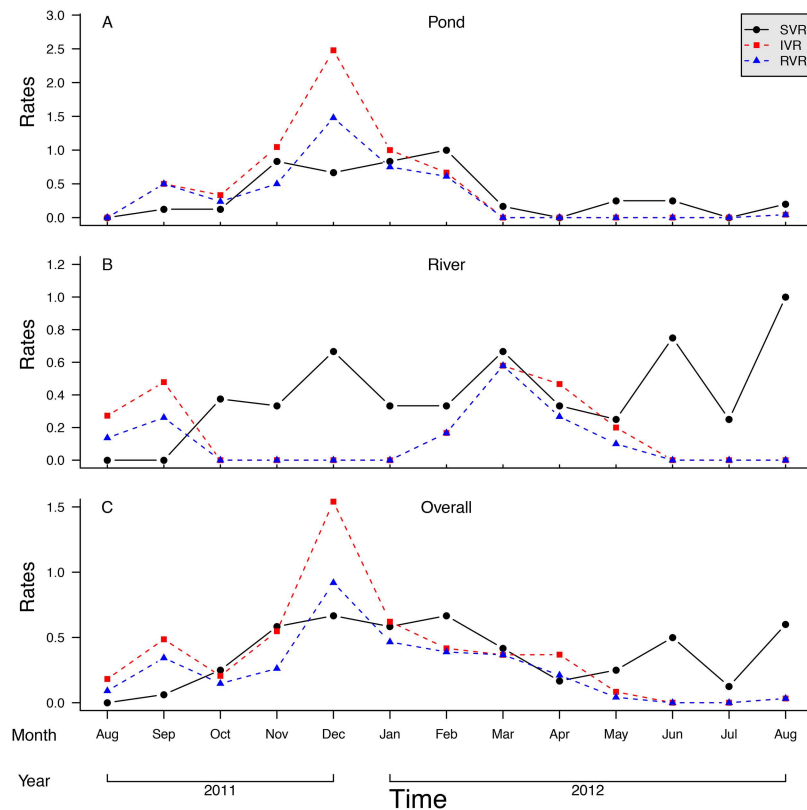
Figure 3. Monthly visitation rates by latrine sites—Pond (A) and River (B)—and Overall (C). Individual visitation rate (IVR) calculated as the number of individual otters recorded per month/number of working camera-days per month. Recording visitation rate (RVR) calculated as the number of recordings per month/number of working camera-days per month. Scat visitation rate (SVR) calculated as the number of surveys per month with new scat detected/total number of weeks surveyed that month. We conducted scat and video detection surveys of river otters at latrine sites from 1 August 2011 to 31 August 2012, Illinois, USA.

addition, for the overall visitation rates, there were seasonal differences ($t_4 = 2.981$, $P = 0.041$) between average RVR (0.244 ± 0.122 [SE] visitation rate/season) and average IVR (0.338 ± 0.146 [SE] visitation rate/season).

We calculated monthly and seasonal visitation rates by latrine site for both video detection methods. The average visitation rates/month at the River latrine were 0.116 ± 0.048 (SE) for RVR and 0.166 ± 0.060 (SE) for IVR. The average visitation rates/month at the Pond latrine were 0.317 ± 0.123 (SE) for RVR and 0.467 ± 0.200 (SE) for IVR. We found significant differences between video detection methods (RVR vs. IVR) at the River latrine ($t_{12} = 2.181$, $P = 0.049$), but no differences at the Pond latrine ($t_{12} = 1.799$, $P = 0.097$). Both IVR and RVR were positively correlated when analyzed by month (Fig. 3A,B and Table 3), and season (Fig. 4A,B and Table 3). Both IVR and

Table 3. Monthly and seasonal correlation matrix (Pearson's correlation coefficient) for river otter visitation rates overall and by latrine sites (River and Pond), at study site adjacent to the Salt Fork of the Vermilion River near Fairmount, Illinois, USA. Surveys were conducted from August 2011 to August 2012.

Latrine	Visitation rate	Monthly			Seasonal		
		SVR[a]	IVR[b]	RVR[c]	SVR[a]	IVR[b]	RVR[c]
Overall	SVR	1.000			1.000		
	IVR	0.426	1.000		0.458	1.000	
	RVR	0.468	0.969	1.000	0.582	0.988	1.000
River	SVR	1.000			1.000		
	IVR	−0.310	1.000		−0.573	1.000	
	RVR	−0.099	0.934	1.000	−0.254	0.911	1.000
Pond	SVR	1.000			1.000		
	IVR	0.667	1.000		0.901	1.000	
	RVR	0.696	0.977	1.000	0.920	0.999	1.000

[a] SVR = Scat visitation rate.
[b] IVR = Individual visitation rate.
[c] RVR = Recording visitation rate.
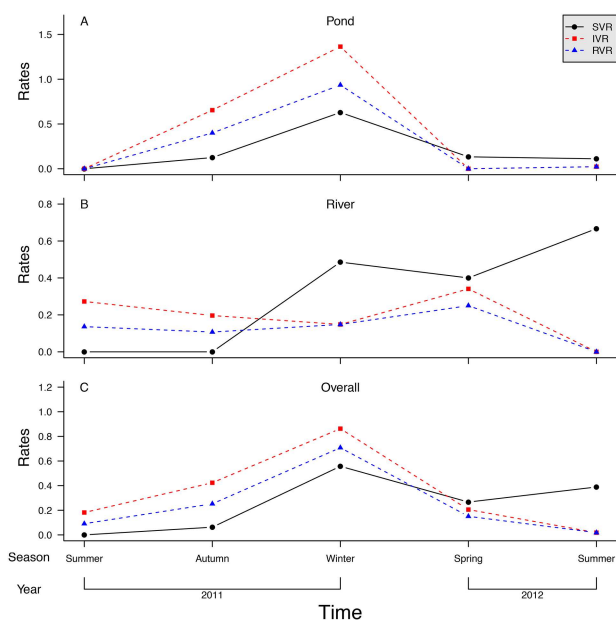
Figure 4. Seasonal visitation rates by latrine sites—Pond (A) and River (B) —and Overall (C). Individual visitation rate (IVR) calculated as the number of individual otters recorded per month/number of working camera-days per month. Recording visitation rate (RVR) calculated as the number of recordings per month/number of working camera-days per month. Scat visitation rate (SVR) calculated as the number of surveys per month with new scat detected/total number of weeks surveyed that month. We conducted scat and video detection surveys of river otters from 1 August 2011 to 31 August 2012, Illinois, USA.

RVR peaked in December 2011, followed by November 2011 and January 2012; and were lowest in June and July 2012 (Figs. 3 and 4).

During the same sampling period, we conducted 152 scat surveys and recorded 55 surveys with ≥ 1 new scat (average SVR $= 0.375 \pm 0.067$ [SE] visitation rate/month; Table 2). We did not find differences ($P > 0.05$) between overall SVR and either overall IVR ($t_{12} = 0.016$, $P = 0.988$) or overall RVR ($t_{12} = 1.730$, $P = 0.109$). However, the correlation coefficients between visitation rates based on indirect and direct methods of detection were smaller than between video detection methods (SVR vs. IVR $r = 0.426$, $P = 0.147$; SVR vs. RVR $r = 0.468$, $P = 0.107$; Table 3).

Further analysis by latrine site showed monthly differences in the correlation coefficient at the River latrine with negative correlation between SVR and IVR ($r = -0.31$, $P = 0.303$) and negative correlation between SVR and RVR ($r = -0.099$, $P = 0.749$; Table 3). Negative correlations were also found by season (Table 3). We did not find differences in visitation rates ($P > 0.05$) between SVR and the video detection methods at the River latrine (SVR vs. IVR [$t_4 = 0.684$, $P = 0.532$]; SVR vs. RVR [$t_4 = 1.221$, $P = 0.289$]) and the Pond latrine (SVR vs. IVR [$t_4 = -1.177$, $P = 0.304$], SVR vs. RVR [$t_4 = -0.784$, $P = 0.477$]). On average, seasonal SVR at River and Pond latrines were 0.310 ± 0.134 (SE) visitation rate/season and 0.200 ± 0.110 (SE) visitation rate/season, respectively. Scat visitation rates peaked in December 2011 and February 2012, followed by August 2012.

DISCUSSION

Numerous studies have evaluated the influence of habitat characteristics and seasons in river otter visitation rates. We used the same 2 sites to examine differences and similarities among visitation rates using 2 direct observation protocols of video surveillance (group counts and individual counts) and visitation rates based on indirect signs (otter scat detection), allowing us to recognize and highlight differences between detection methods that have been previously referred to simply as "visitation rate." Our results support the value of using individual visitation rate (IVR), recording visitation rate (RVR), and scat visitation rate (SVR) to provide information about activity patterns by otters at latrine sites. Our results corroborate seasonal differences in latrine patterns, especially during winter, and demonstrate changes in the strength of correlations between direct and indirect methods associated with latrine sites (Crowley et al. 2017).

Some might argue that because RVR and IVR are 2 aspects of the same data, these approaches may be used interchangeably, with values derived from each compared across studies. Values for IVR will be the same or greater as values for RVR using the same data in a given period of time. We found a positive correlation between IVR and RVR, indicating that these methods provide similar information to reveal activity at a latrine site and demonstrating that these 2 methods can be used interchangeably. However, we also note that both methods provide different information on the basis of the number of individual animals visiting the latrine. In our study, both IVR and RVR demonstrated peak visitation from November 2011 to January 2012, with lowest visitation in June and July 2012. However, the increase in IVR was greater than RVR during November 2011, December 2011, and April 2012, indicating that groups of otters were visiting most intensely during those months. This fluctuation may be influenced by the information that scent-marking otters are communicating in a latrine, such as signaling the use of resources or signaling reproductive status (Kruuk 1992, Kean et al. 2011).

Although we found positive correlations among SVR, IVR, and RVR (overall), negative correlations between SVR and both IVR and RVR were found when analyzed separately by latrine site. We found monthly and seasonal negative correlations between visitation rates based on scat detection (SVR) and both video detection protocols (IVR and RVR) at the latrine located near the river. Our results agree with previous findings that showed river otters may choose different latrine sites during different seasons depending on multiple factors, such as food availability, stream depth, and ice-cover, among others (Swimley et al. 1998, Crowley et al. 2017). These factors may contribute to changes in the typical river otter latrine-patterns behavior. For example, shallow waters may facilitate food availability for river otters during winter, and could explain differences in visitation rates between latrine sites found in our study (Crowley et al. 2017). Other important factors, such as snow or ice-cover, should be taken into account at the moment of selecting survey methods because these factors not only may change

otter behavior, but also may affect the performance of equipment such as video cameras. The small number of latrines sampled in this study prevented us from making inferences related to the factors that could influence changes in latrine utilization. However, it is clear that even within such a short distance between these 2 latrines, these methods detected differences in site utilization. Future studies should focus on increasing latrine-sampling sites, as well as in identifying factors that could affect latrine preference by site and according to seasons.

It is useful to compare SVR with RVR and IVR to determine whether detection of river otters in latrines can be reliably assessed without the use of equipment such as trail cameras, especially because SVR reveals when latrines are actively being used for scent marking via scat deposition. In contrast, RVR and IVR have the capacity to reveal otter presence in latrines regardless of presence or absence of scats (e.g., when sniffing and traveling through). Of the 13 months of survey, we found 1 month with otters in videos, but not scats in the latrine. However, we recorded 2 months with scats but not videos. Additionally, during March and August 2012 we found IVR and RVR to be identical, but scat detection for the same months were lower (Mar 2012) and greater (Aug 2012) than video detection of the respectively months. Day et al. (2016) also found differences between presence of scats and detection of otters by cameras, with monthly detections recorded by one method, but not the other (photos vs. scat counts). Our results show no differences between visitation rates based on direct and indirect detection methods, supporting that in some cases depending on the study and researcher–managers goals, scat detection may be more appropriate and used as an alternative to video detection for estimating visitation rates at latrine sites.

We did not find differences between SVR and RVR or IVR during the course of our study, although there were 5 months during which scat-detection rates exceeded video detection rates, indicating periods of time when cameras did not record otter activity. This is in contrast to Day et al. (2016), who found the direct method of video detection produced a greater monthly detection probability than the indirect method of scat detection. The discrepancy between the 2 studies may be attributed to differences in field methodology (such as camera functionality or number of latrines sampled) or biology, including varying otter social systems (Ben-David et al. 2005) or prey availability (Crait and Ben-David 2006). However, we recognize the limitations in video recording capabilities due to our use of 8GB memory cards, which occasionally reached maximum capacity between the weekly latrine surveys. Full memory cards appeared to be the result of strong wind events that caused movement in vegetation, triggering continuous camera operation. We suggest future studies utilize memory cards with greater capacity than 8GB, and to use at least an additional camera at a latrine site to ensure that the whole latrine-area is fully covered in the recording frame. Based on our results, SVR and RVR–IVR represent straightforward, repeatable methods that facilitate cross-study comparison. Furthermore, the video-capability

required to accurately ascertain group size also facilitates behavior assessment of otters in the latrine.

Previous studies conducted in Pennsylvania and Maryland, USA, report peaks in the total number of scat pieces for the months of September 2004 and March 2005, with the least amount of recorded scat during December and January (Olson et al. 2008). However, December and January were months of high scat detection in our study. This discrepancy may be attributable to differences in geographical regions, characteristics of the field sites, differences in the weather patterns between Pennsylvania and Illinois, or differences in field methodology between the scat counting approach by Olson et al. (2008) and our dichotomous presence or absence approach to scat detection. By specifying the visitation rate as reported in this study, we made it easier to record the information and decrease opportunities for underlying inconsistency in data collection to produce the observed differences.

We are not aware of other studies that report month-by-month SVR for specific latrines that were monitored on a weekly basis. Day et al. (2016) reported a scat detection rate for 10 latrines based on the number of months during the course of a year in which ≥ 1 scat was recorded. Crowley et al. (2013) report 2-week time periods of seasonal changes in otter activity; whereas Crimmins et al. (2009) reported winter and summer detection rates of otter scat at bridge and randomized sites using data pooled across 2 years. Olson et al. (2008) did not report otter detection rates, but rather counted scats in 8 otter latrine sites in Pennsylvania and Maryland from 2004 to 2005. Difference in sampling protocols and vagueness among the literature regarding how individual scats are determined and counted at a site make it difficult to do cross-comparison of otter visitation rates and extrapolate results to other types of scat-based visitation rates, suggesting the necessity of standardized and defined methodology. Furthermore, for surveys that use presence or absence of scats to estimate visitation rates (SVR), if scats have not been removed, we recommend the use of a portable grid system to specifically record scat locations within latrines in order to enable accurate comparisons of scat during the next survey.

Generating RVR can unveil valuable results regarding monthly or seasonal changes in the presence or absence of otters in latrine sites, without the influence of group activity. In addition, use of RVR enables comparison with historical studies that also used RVR. On the other hand, one benefit of IVR is its ability to provide information that may help researchers optimize the timing of scat collection. This can be important when attempting to maximize the likelihood of sampling feces during periods of time when groups of otters visit latrines more intensively. Such information can be valuable when conducting genetic evaluations of population structure and movement. Individual visitation rate is inclusive of group size; decision-making processes to monitor otter populations should take this into account.

Conveying months when new scat is present in a latrine site (SVR) may be valuable for riparian monitoring protocols and could have applications to genetic population studies

(Mowry et al. 2011). Furthermore, because river otters serve as a biomonitor for banned organochlorine pesticides in Illinois, a tool such as SVR used to inform researchers about optimal months for scat collection may facilitate the use of scat for chemical analysis and potential identification of individual otters via genetic profiles from scats (Carpenter et al. 2014). Regardless of the method used for scat assessment or direct observation of river otters, it is important for published studies to include sufficient detail for the described methods to be replicated (Cassey and Blackburn 2006).

Repeatability and reproducibility are important aspects of ecological research with implications for the management of top-trophic predators such as river otters (Cassey and Blackburn 2006). Failure to provide detailed descriptions of survey methods facilitate errors in the extrapolation of resulting data, undermining our ability to evaluate and understand variables that influence otter activity and ways in which otter activity patterns influence ecosystem dynamics (Estes et al. 2011, Santos et al. 2011, Crowley et al. 2012). For example, lack of methodological clarity may contribute to the variability in published results of fecal counts (Gallant et al. 2008). However, defining the "what was measured and how it was measured" is not enough. This should be complemented with reporting the actual equations used with the data to achieve a visitation rate result. This may help the research community with the interpretation of data relevant to the study of biological factors influencing changes of otter activity across the landscape.

In summary, our results support the value of using individual visitation rate, recording visitation rate, and scat visitation rate to provide information about otter activity patterns at latrine sites. Monthly visitation rates based on scat detection and video detection rates were similar. However, scat detection rates may represent a more cost-effective tool to inform monitoring protocols than video detection rates. Scat detection rates also represent an alternative or complimentary scat assessment tool. The field of river otter ecology would benefit from a standardized method for scat assessment; current lack of clarity in methodological descriptions may be contributing to high variability in fecal counts. In the case of visitation rates based on video recordings, we did not have a way to determine if one observation was independent of another. An individual or a group of otters moving around the latrine site for long periods of time could have serious effects on visitation rate calculations, especially when all video recordings are considered a new visit. Thus, it is important for studies using video cameras to determine visitation rates to clearly define independent visits to facilitate cross-comparison among studies. Our results indicated a baseline level of agreement among IVR, RVR, and SVR during November through February, which are months of greatest latrine use according to all 3 methods. Identifying peaks in latrine use is essential to identify the most appropriate months for conducting latrine surveys. The current protocol for large-scale monitoring of river otters in Illinois recommends monitoring riparian sites from August to October for river otter sign (Lesmeister and Nielsen 2011); this monitoring protocol may benefit from future studies incorporating any of the 4 methods.

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