Unveiling the Limitations of Scat Surveys to Monitor Social Species: A Case Study on River Otters

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ABSTRACT We examined the relationship between the production of sites with feces (i.e., latrines) and river otter (*Lontra canadensis*) abundance to determine whether scat surveys were adequate for monitoring relative population size for species leaving activity signs in a clumped distribution on the landscape. We conducted winter riparian transects to simultaneously monitor otter abundance via snow tracks and latrine sites along the rivers of Kouchibouguac National Park and surrounding area in New Brunswick, Canada. Our data showed that latrine abundance poorly reflected otter abundance for given stretches of rivers because the relationship was nonlinear and reached a plateau. The number of latrine sites was not related to the time period since last snowfall, which indicated that otters repetitively defecated at the same sites. Individual otters and groups did not produce activity signs over larger distances as a function of time, which indicated that they tend to stay in their home ranges in winter. We discuss why scat survey protocols based on determining presence–absence of a species at predetermined search sites may poorly reflect population size, as well as population fluctuations in time. Caution is advised when interpreting data from such surveys for species for which feces or other activity signs surveyed play a role in intraspecific communication and tend to be in a clumped distribution on the landscape. (JOURNAL OF WILDLIFE MANAGEMENT 71(1):258–265; 2007)

DOI: 10.2193.2005-697

KEY WORDS evaluation studies, *Lontra canadensis*, population monitoring, river otter, scat survey, social species.

The use of scat surveys to study habitat selection by animal species or to determine the relative size of populations is common practice. These types of surveys are popular because they are inexpensive to conduct and constitute noninvasive methods for studying animal activity. Scat surveys often prove useful when studying species that are hard to detect because of their elusive behavior (e.g., Sharp et al. 2001), their rarity (e.g., Lozano et al. 2003), or the type of habitat where they occur (e.g., Lunney et al. 1998). Some scat surveys are known to produce results that are similar to other techniques used for monitoring population size. Eggert et al. (2003) found similar results between their multilocus genotyping of DNA extracted from fecal material and fecal enumerations for the forest elephant (*Loxodonta cyclotis*) population of Kakum National Park in Ghana. Sharp et al. (2001) also found correlated results with red fox (*Vulpes vulpes*) when counting feces along a bait line perpendicular to transects of a nocturnal survey. However, the extent to which various types of scat surveys can be expected to reflect population trends is uncertain for a wide diversity of species.

It is difficult to observe freshwater otter species (e.g., *Lutra* spp., *Lontra* spp.) in nature, so researchers often use scat surveys to monitor their relative abundance and distribution. Researchers conducted many surveys on the Eurasian otter (*Lutra lutra*) in Europe and North Africa in the 1980s while the species was in sharp decline (resumed in Mason and Macdonald 1987). A discord formed between studies favoring the use of scat surveys to monitor population size (Macdonald and Mason 1987, Mason and Macdonald 1987) and those expressing reserve or opposition to them (Kruuk et al. 1986, Conroy and French 1987, Kruuk and Conroy 1987). Some of these studies had difficulty finding correlations between otter abundance and fecal counts (Kruuk et al. 1986, Conroy and French 1987). Several studies from that region and time period had shown that fecal counts could vary greatly within (Jenkins and Burrows 1980) and among seasons (Conroy and French 1987, Macdonald and Mason 1987). They also varied according to coastline or bank characteristics (Bas et al. 1984, Conroy and French 1987), and possibly several other factors (Kruuk and Conroy 1987). In Scotland for instance, from November 1977 to March 1978, sustained snow-tracking by Jenkins (1980) indicated no changes in otter numbers, but monthly fecal counts during that winter period fluctuated wildly from 10 feces to 240 feces detected (Jenkins and Burrows 1980). Conroy and French (1987) found fecal counts at defecation sites to be extremely variable, reaching ±200% in some cases. For a seemingly unchanged population in terms of otter abundance, they also detected twice as many feces in one winter compared with the following winter (Conroy and French 1987).

High variability in fecal counts rendered unreasonable the enumeration of individual feces as a direct index of otter abundance. There are scat survey methods that avoid using fecal counts directly. Some researchers determine the presence or absence of otter activity at selected sites where they search standardized lengths of shores for activity signs, chiefly feces. They then use the distribution and proportion of sites with otter detection to show population distribution and relative population abundance over the geographical area of interest. This type of survey protocol based on presence–absence data became popular and researchers have used it in almost every country of Europe and northern

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Africa to survey the Eurasian otter (e.g., Macdonald and Mason 1983*a*, 1984; Prigioni et al. 1986; Lodé 1993). Subsequently, researchers also used it on other continents hosting freshwater otter species (e.g., Chehébar 1985, Lee 1996, Shackelford and Whitaker 1997).

The results of such scat surveys, for which researchers classify search sites as having or lacking a particular species' presence, are directly influenced by the occurrence of locations where feces are to be found. They are not influenced by the total number of feces in a surveyed area, but by the number of locations with feces in that area because this is what directly influences the odds of detecting otter activity at search sites. Otters tend to repeatedly defecate at particular sites called latrines (Macdonald and Mason 1987, Swimley et al. 1998). They are representative of species that leave activity signs in a clumped distribution on the landscape. Contrary to the number of feces, researchers have virtually failed to make a research effort to establish an understanding of the relationship between the number of otters detected within a sampled region and the number of sites with feces (i.e., latrines) they produce. For wildlife management, this relationship is important to study because these presence–absence scat surveys currently rely on the untested presumption that more otters in a surveyed area will translate into more search sites turning out positive (i.e., otter detection).

The objective of this study was to investigate and ascertain what kind of relationship exists between the numbers of North American river otters (*Lontra canadensis*, formerly *Lutra canadensis*) detected on given portions of rivers and the number of latrine sites (i.e., sites with feces) they produced in a measured period of time. We then discuss the consequences this relationship has for presence–absence scat surveys. We used the logistic advantage of conducting winter riparian transects to simultaneously record otter abundance via snow tracks and the number of latrine sites associated with those tracks.

STUDY AREA

The study area included Kouchibouguac National Park of Canada and the surrounding area (Fig. 1). The park covered an area of 238.8 km^2, was part of the province of New Brunswick's lowlands, and was representative of the Maritime Coastal Plains (Desloges 1980). The topography was rather flat and contained 8 major watercourses with numerous bogs and swamps: Portage River, Carrigan Brook, Fontaine River, Black River, Rankin Brook, Kouchibouguac River, Major Brook, and Kouchibouguacis River (Desloges 1980). The 2 main rivers, Kouchibouguac and Kouchibouguacis, had tidal components that reached beyond the park's border. The climate was humid continental with important maritime influences near the shore (Graillon et al. 2000). Average annual temperature was 4.8° C, average freeze-free period was 177 days, and annual precipitation averaged 979 mm (Desloges 1980). The majority of forested areas were mixed, dominated by balsam fir (*Abies balsamea*) and birch (*Betula* spp.), or were coniferous, dominated by black spruce (*Picea mariana*; Graillon et al. 2000). Speckled alder (*Alnus incana rugosa*) dominated the banks of smaller streams in the area. The study area also extended outside the park along the Portage, Kouchibouguac, Kouchibouguacis, and St-Charles rivers (Fig. 1). We also included the portion of Black River outside the park, located in the adjacent Black River Provincially Protected Zone of New Brunswick (Fig. 1). Areas outside the park and the protected zone were at various stages of succession, with light residential areas, pasture, and agricultural fields.

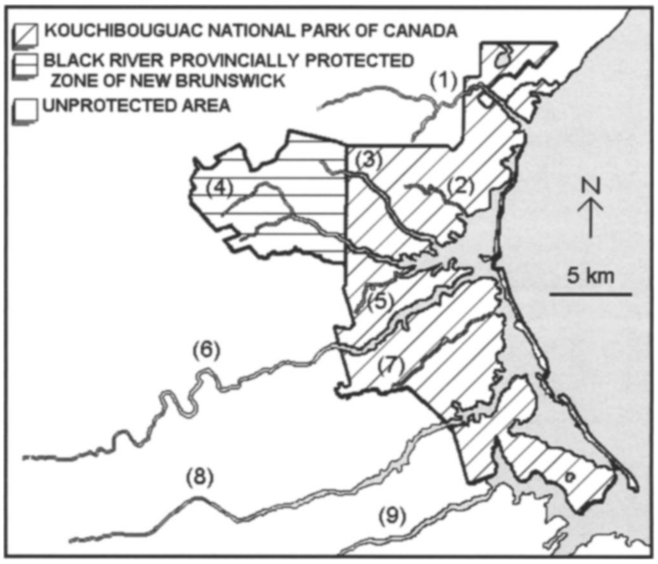

Figure 1. Stretches of watercourses sampled in search of river otter activity signs in the study area in New Brunswick, Canada, which comprises of Kouchibouguac National Park of Canada, the Black River Provincially Protected Zone of New Brunswick, and unprotected areas in the vicinity. Rivers and streams sampled during the winters of 2000, 2001, 2003, and 2004 are: 1) Portage, 2) Carrigan, 3) Fontaine, 4) Black, 5) Rankin, 6) Kouchibouguac, 7) Major, 8) Kouchibouguacis, and 9) St-Charles.

Watercourses in our study area completely froze over during winter. However, spots of unfrozen or thin ice regularly occurred at the junction of tributary streams and rivers, as well as at locations with springs along riverbanks. Further inland, shallower waters created some spots that also remained unfrozen or had thin ice due to occasional boulders with water cascading over them. River otters appeared to be able to access water anywhere in our study area because of the regular occurrence of such spots.

METHODS

To monitor the movement of individual otters or groups, we conducted wintertime transects along the shores of the 9 main rivers and streams of the study area (Fig. 1), as well as minor streams associated with them. In winter, detection rates are high because of the conspicuous tracks they leave in the snow, and all other activity signs are linked to these tracks. The homogeneous substrate created by snowfalls also safeguards against biases in detection rates that can occur during other seasons because of the heterogeneous substrate of riverbanks (Conroy and French 1987, Romanowski et al. 1996). We documented all river otter activity signs detected within these transects: snow tracks, feces, burrows, water access holes, and direct sightings. We collected data from early January until the end of April for the winters of 2000, 2001, 2003, and 2004. River otters are usually nocturnal or crepuscular, but can tend to be more diurnal in winter (Melquist and Hornocker 1983). Before conducting the first transect after a snowfall, we respected a minimum waiting period of 12 hours after each snowfall to ensure enough time for the otters to manifest their presence and produce activity signs on the fresh snow. We conducted transect searches with light snowmobiles (Bombardier's Tundra models; Montreal, Quebec, Canada) when river width and ice thickness allowed, and we used snowshoes otherwise. Two riders searched banks on separate machines, riding single file at slow speeds along the shore on the given river, and stopping at will to inspect all potential otter signs detected. We sampled rivers after each snowfall in random order and alternated the order for ensuing snowfalls. Transects were continuous, meaning that regardless of means of transport, we invested a whole day or 2 to scrutinize the chosen river, hence maximizing our ability to document river otter movements along the shores of the major watersheds in the study area.

We recorded coordinates (Universal Transverse Mercator, Grid no. 20, in m, recorded with a Garmin12 XL Global Positioning System) and date and time for the beginning and end of each transect, as well as for all encountered signs of otter activity. We calculated time (hr) elapsed since last snowfall each time we began a new transect, as well as for every otter activity sign we detected. We counted latrines for each transect and also included lone scats in these counts because we aimed to quantify the production of sites with feces by otters, regardless of the number of feces at each site. We defined latrine as a site with $\geq$1 fece. We determined the number of otters active within each transect by inspecting the easily recognizable corridor-like tracks they leave in snow. Because river otter home ranges tend to be unidimensionally established along shores at the water–land interface (Bowyer et al. 1995, Sauer et al. 1999), it was possible for us to follow particular groups of otters from several hundred meters to over a kilometer along sampled rivers. This provided enough opportunities to establish the number of animals in groups and in transects with good confidence by counting fresh tracks consistently oriented in the same direction and by comparing their width relative to each other.

Data Analysis

To control for variability caused by how far otters traveled and how much time they had to produce activity signs, we divided the latrine counts within each transect by both the flight distance (straight-line measurement of distance in km) over which otters produced activity signs within each transect and the time (d) elapsed since the last snowfall at the beginning of each transect. Thus, we analyzed the dependent variable number of latrines per km per day (latrines/km/d). For the number of sites with feces (i.e., latrines) to adequately reflect otter abundance, the statistically ideal relationship between the two would be linear, and most preferably for management purposes, a 1:1 relationship (Elzinga et al. 2001). To determine the relationship between production of latrine sites and otter abundance groups (i.e., 1, 2, 3, 4, 5, and 6 otters), we favored a descriptive approach and employed regression analysis to elucidate tendencies in our data. We used the regression curve estimation program in SPSS (version 8.0 for Windows) to determine the polynomial model that best described the data, based on the coefficient of determination (r^2) and the mean of squared residuals for regression curves obtained. To prevent loss of information with regard to the dependent variable, we used the individual value obtained in each transect for regression analyses and not a calculated mean for each otter abundance group (Freund 1971). Because the absence of otter detections for a sampled stretch of river will inevitably be associated with absence of snow tracks and scats, we applied regression models without constants (intercepts).

We also assessed the relationship between latrine abundance and the time since last snowfall. We used the number of latrines per km per otter (latrines/km/otter) as the dependent variable, which controlled for variability in otter movement and abundance among the riparian transects. We again used the regression curve estimation program in SPSS to determine the polynomial model (without intercept) that best described this relationship. To determine if the flight distance traveled by river otters grew in relation to the time elapsed from the last snowfall to the time of documentation when conducting transects, we conducted linear regressions on the values of flight distances (km) of activity signs in relation to the time elapsed (d) since last snowfall for transects within each otter abundance group. Here, we did not force the regression model to pass through the origin because it would have biased the results by automatically producing statistically significant positive slopes.

RESULTS

We conducted 92 transects during the 4 winters of surveys, totalling 1,557 km of shoreline inspections. We discarded 7 of these transects from the database as outliers (conducted in May) and did not consider 3 others because it was impossible to estimate otter numbers from track counts, leaving 82 transects for analyses. Sampling effort varied according to year depending on the incidences of snowfalls, with 168 km, 381 km, 769 km, and 239 km of shoreline searches for the winters of 2000, 2001, 2003, and 2004, respectively. The highest sampling effort was in 2003, when regular snowfalls and thick ice allowed for frequent, long-distance transects. Average transect length with standard error was 6.18 ± 0.63 km and varied as a function of means of transport, ease of progress along shoreline trajectories, and the number of times we stopped and documented otter activity signs. The mean flight distance over which individual otters or groups produced detectable signs was 1.69 ± 0.20 km, with 4.9% of transects having otters that could be followed for more than 5 km along a given river. The number of otters detected per transect via snow tracks

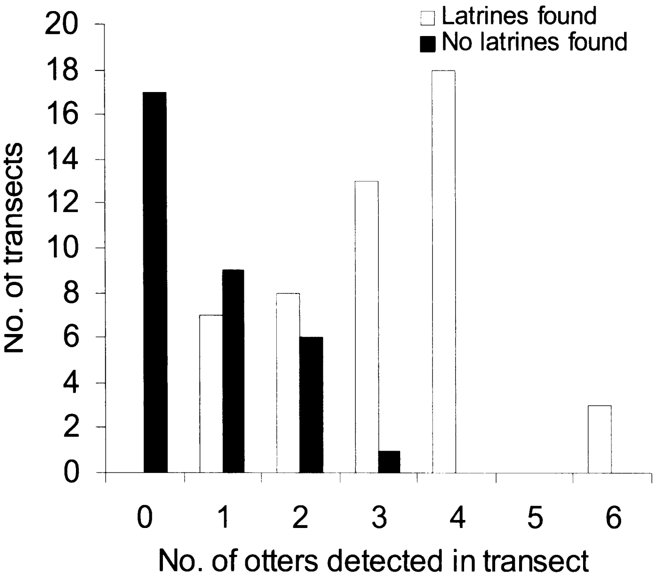

Figure 2. Frequency distribution of transects with and without latrines detected as a function of the number of river otters detected by snow tracks for 82 riparian transects conducted in Kouchibouguac National Park of Canada and surrounding area during the winters of 2000, 2001, 2003, and 2004.

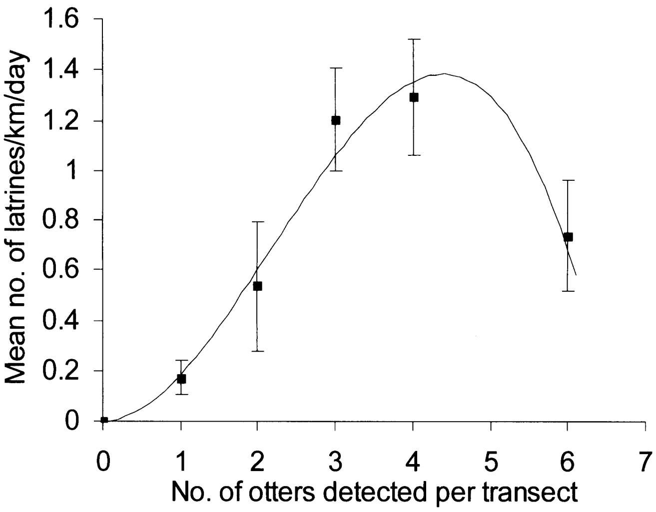

Figure 3. Relationship between the number of latrines/km/day and the number of river otters detected for 82 riparian transects conducted in Kouchibouguac National Park of Canada and surrounding area during the winters of 2000, 2001, 2003, and 2004. Shown is the mean and standard error for each otter abundance group and equation for the curve is latrines/km/day = 8.2E–05x + 0.216x^2 – 0.033x^3.

had even distribution among the abundance groups. We did not detect any otters in 17 transects, we detected one otter in 16 transects, we detected 2 otters in 14 transects, we detected 3 otters in 14 transects, we detected 4 otters in 18 transects, and we detected 6 otters in 3 transects. Sixteen transects contained river otter tracks but did not contain any detectable feces associated with them: 9 of these transects had one otter, 6 had 2 otters, and one had 3 otters detected (Fig. 2). We did not detect any otters in the developed areas along the Kouchibouguac, Kouchibouguacis, and St-Charles rivers, which infers that otter activity was mostly confined to relatively undisturbed habitats such as portions of rivers within Kouchibouguac National Park of Canada, the Black River Provincially Protected Zone of New Brunswick, and along the Portage River outside the park, which is a region free from anthropogenic disturbances.

Our regression results (Table 1) showed that a third-order polynomial (latrines/km/d = 8.2E–05x + 0.216x^2 – 0.033x^3, $P < 0.001$, $r^2 = 0.597$) best described the relationship between latrine site production and the number of otters detected in transects (x). The relationship was nonlinear and reached a plateau at the 3-otters group and beyond (Fig. 3). The fit of the third-order polynomial was better than would be expected if the relationship was linear, with r^2 8.38% larger, the mean of squared residuals 10.98% smaller, and the uncertainty about this mean 8.79% smaller than that of the linear function (Table 1). Conducting the regression analyses without the 3 values of the 6-otters abundance group did not change the fit of the regression ($r^2 = 0.594$), nor did it result in the best fit of another type of polynomial. Even with log-transformed data [log ($x + 1$)], a third-order polynomial ($r^2 = 0.740$) still best described the relationship rather than a linear function ($r^2 = 0.693$).

The relationship between the numbers of latrines/km/otter and time (d) since last snowfall (x) was also best described by a third-order polynomial (latrines/km/otter = 0.476x – 0.090x^2 + 0.005x^3, $P < 0.001$, $r^2 = 0.521$). Latrine abundance as a function of time since last snowfall reached a plateau, as otters did not produce more latrines/km/otter beyond 3 days after snowfall (Fig. 4). The flight distance over which otters produced activity signs within transects did not augment as time since the last snowfall increased. Linear regressions of the flight distance (km) of activity signs within respective transects on time (d) since last snowfall (x) had negative slopes (Fig. 5) that were not statistically significant for the 1-otter abundance group (flight distance = 1.637 – 0.116x, $F_{[1,14]} = 0.150$, $P = 0.700$, $r^2 = 0.011$), the 2-otters abundance group (flight distance = 1.929 – 0.057x, $F_{[1,12]} = 0.090$, $P = 0.773$, $r^2 = 0.007$),

Table 1. Regression statistics for 3 feasible polynomial models describing the relationship between latrines per km per day values (dependant variable) and the number of otters detected for 82 riparian transects conducted in Kouchibouguac National Park of Canada and surrounding area during the winters of 2000, 2001, 2003, and 2004.

					Regression coefficients			Squared residuals	
Model curve	r^2	df	F	p	b^1	b^2	b^3	$\bar{x}$	SE
Linear	0.547	81	97.70	<0.001	0.294			0.519	0.182
Quadratic	0.567	80	52.34	<0.001	0.470	−0.045		0.496	0.174
Cubic	0.597	79	38.96	<0.001	8.2E−05	0.216	−0.033	0.462	0.166

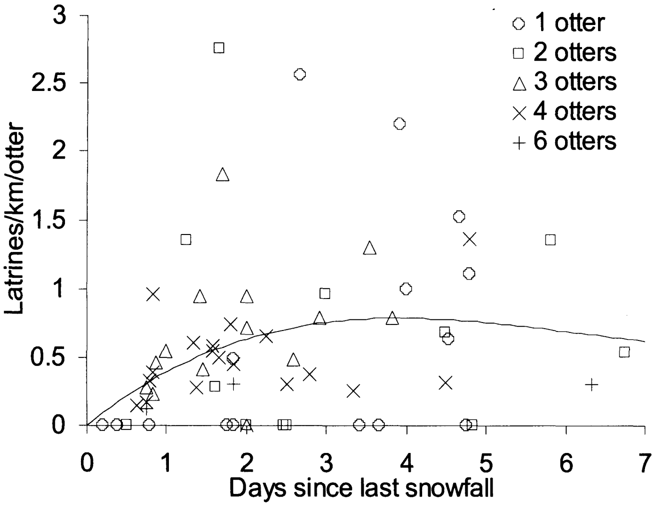

Figure 4. Relationship between the number of latrines/km/otter and the number of days since last snowfall for 65 riparian transects conducted in Kouchibouguac National Park of Canada and surrounding area during the winters of 2000, 2001, 2003, and 2004. Equation for the curve is latrines/km/otter $= 0.476x - 0.090x^2 + 0.005x^3$.

the 3-otters abundance group (flight distance $= 3.986 - 0.508x$, $F_{[1,12]} = 0.930$, $P = 0.355$, $r^2 = 0.072$), and the 4-otters abundance group (flight distance $= 2.684 - 0.079x$, $F_{[1,16]} = 0.060$, $P = 0.816$, $r^2 = 0.003$).

DISCUSSION

Presence–absence scat surveys have been deemed highly accurate for otters because their activity signs are concentrated along rivers (Chehébar 1985) but, given our results, we disagree with this assertion. Our results show that at the scale of individual rivers, more otters do not translate into ever more sites with feces (Fig. 3) and so, the probability of detecting otter presence via feces along portions of rivers searched will not increase appreciably with otter abundance in them because feces are clumped at latrine sites. The major consequence of this finding is that more otters in a particular area will usually not translate into more positive searches when conducting scats surveys that operate by classifying searched sites as having or lacking the presence of otters. With Eurasian otters, Ruiz-Olmo et al. (2001) also found that there was no linear relationship between otter abundance and the number of positive search sites in their track and visual censuses. They observed that there was rapid saturation of feces and latrine sites without linearity as otter numbers rose. Elzinga et al. (2001) noted that this is a common problem with indices of population size based on presence–absence surveys. The index value becomes saturated when population density is high, and hence the given index reflects population size in low-density situations only. Our results, and those of Ruiz-Olmo et al. (2001), show that otter species quickly reach such saturation.

The logic of our results can be explained by the river otter's basic ecology. North American river otters are highly social mustelids and the basic social unit of the species is the family, composed of an adult female and her unweaned offspring (Melquist and Hornocker 1983). Unrelated adults, yearlings, or juveniles are also known to be included in some family groups by acting as helpers (Melquist and Hornocker 1983, Reid et al. 1994, Rock et al. 1994). Reid et al. (1994) found adult males to be generally solitary but observed that they form temporary groupings, whereas Blundell et al. (2002) in a marine environment found adult males to be very social and present in both all-male and mixed-gender groups. Researchers have also observed groups of unrelated juveniles (Melquist and Hornocker 1983). Families and other groups hunt, travel, rest together, and will use the same dens and latrines (Beckel 1990, Reid et al. 1994). The cohesiveness of these groups while in existence seems to partly explain why the presence of more otters in a given region need not result in more sites with feces (i.e., latrines) being detected. If all otters in a group tend to defecate at the same latrine sites, as we observed, it is then understandable that a family of 3, for example, may not produce more sites with feces than a family of 4, 5, 6, or more. Researchers have observed group size for river otters to vary from 1 to 6 (Beckel 1990), 1 to 8 (Bischof 2003), 1–9 (Blundell et al. 2002), and 2 to 13 animals (Rock et al. 1994). Considering this social aspect of their ecology and the nonlinear relationship we obtained between latrine site production and otter abundance (Fig. 3), it is apparent that more otters in an area risk not producing more sites with feces that would have potentially resulted in more sites with otter detection during presence–absence scat surveys.

Usually river otters do not actively defend territories and will instead mutually avoid each other (Melquist and Hornocker 1983). Individual animals and family groups, however, will establish home ranges for themselves (Reid et al. 1994, Bowyer et al. 1995). This was reflected in our data, as the flight distance traveled by individual river otters or groups did not increase with time (Fig. 5). Our data suggest that river otters quickly cover the distance of their home ranges, which is most likely because they are known to travel great distances in short periods of time (e.g., Melquist and Hornocker 1983, Reid et al. 1994). Otters in our study did not produce ever-increasing numbers of sites with feces (i.e., latrines) as the time after snowfall increased (Fig. 4). Otters defecate repetitively at the same sites and visitation rates to these latrines are high (Bowyer et al. 1995, Ben-David et al. 2005). Melquist and Hornocker (1983) observed that otters often repetitively defecate at conspicuous sites such as exposed logs, logjams, sand bars, large boulders, and elevated banks. Otters consistently mark some latrine sites for generations; some authors refer to these as traditional latrines (Melquist and Hornocker 1983, Macdonald and Mason 1987, Swimley et al. 1998). Considering this, occurrence of sites with feces might be too stable temporally to fluctuate reliably with otter abundance in a region and accordingly change the odds of detecting otter presence at search sites.

Faeces, urine, and anal secretions play a role in olfactory intraspecific communication for river otters (Melquist and Hornocker 1983, Rostain et al. 2004). Kruuk (1992) suggested that scent-marking by Eurasian otters is used to

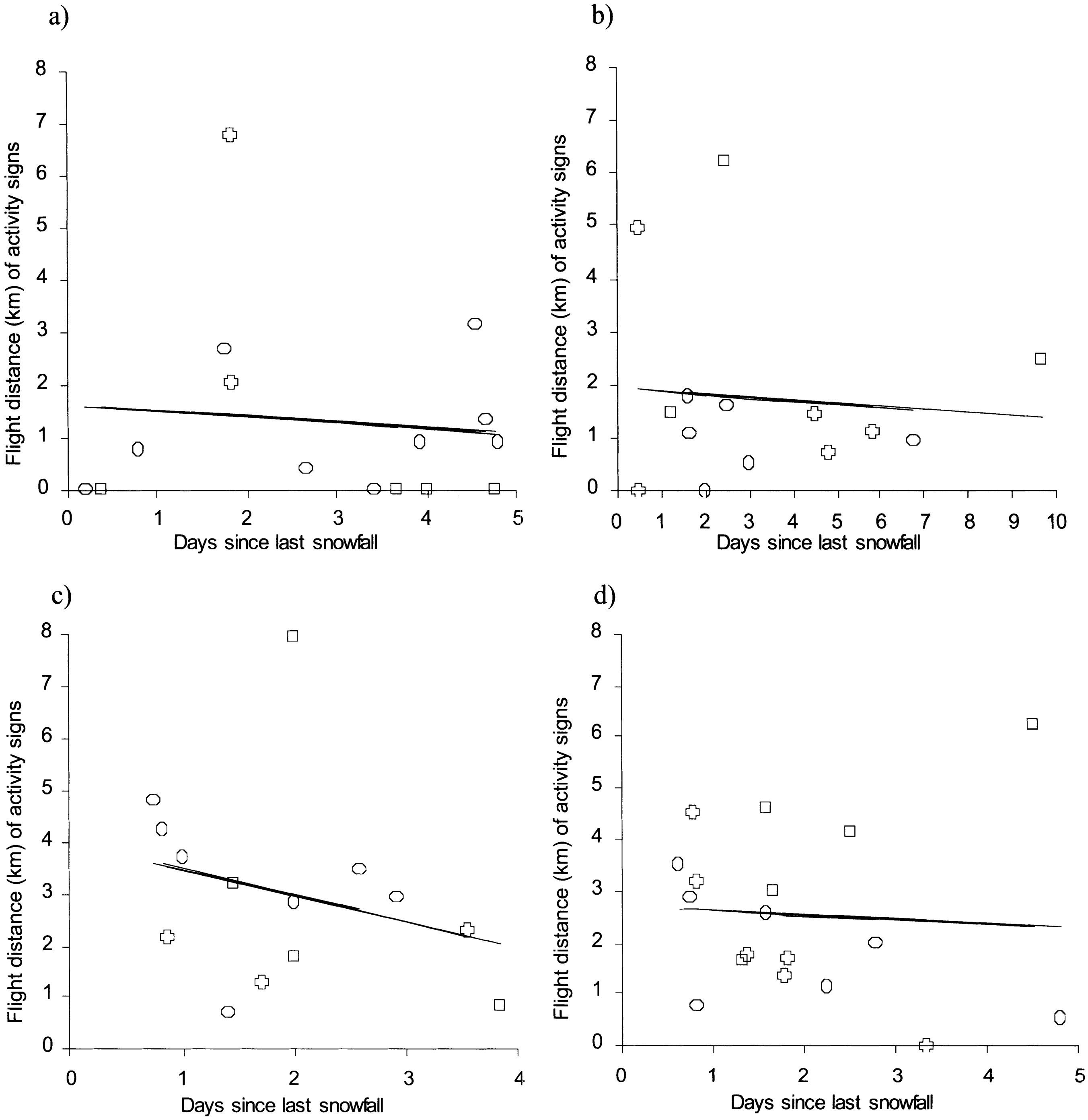

Figure 5. Relationship between the flight distance (km) over which river otters produced activity signs and the time (d) elapsed since last snowfall according to otter abundance within 65 riparian transects conducted in Kouchibouguac National Park of Canada and surrounding area during the winters of 2000, 2001, 2003, and 2004. Shown are scatter plots and linear-regression plots expressing nonsignificant slopes for the a) 1-otter (flight distance = 1.637 – 0.116*x*), b) 2-otters (flight distance = 1.929 – 0.057*x*), c) 3-otters (flight distance = 3.986 – 0.508*x*), and d) 4-otters (flight distance = 2.684 – 0.079*x*) abundance groups.

signal the use of resources, whereas recent results by Ben-David et al. (2005) suggest that social river otters use latrines for intragroup communication, solitary individuals for signalling mutual avoidance, and females for territorial defense. Much remains to be discovered about the various roles of this mode of communication for the different sex and age classes of river otters (e.g., Rostain et al. 2004, Ben-David et al. 2005). An important consequence of the social function of latrines is that not only will members of the same group defecate at the same sites, but otters venturing into the home ranges of other otters tend to defecate at pre-existing latrine sites on the landscape. Melquist and Hornocker (1983) observed that traveling otters generally marked at traditional landings when encountered. Several captive Eurasian otters were also observed sniffing an established latrine site and then urinated and defecated before ejecting contents of their anal sacs directly on top or alongside the excrements constituting the latrine (Gorman et al. 1978). The communication function of their defecation behavior can further contribute to the phenomenon that more otters in a region will not necessarily translate into a meaningful increase in the number of sites with feces for that region.

Because our data represented otters using mostly undisturbed riverbanks, it is unlikely that anthropogenic disturbances had any considerable influence on our results. In our study area, at the scale of individual rivers, we did not detect very large numbers of otters within individual transect searches. For example, in 4 years of survey, we only detected as many as 6 otters within a given transect on 3 occasions. Still, it is clear from our data that a saturation plateau occurs at the 3-otters abundance group and beyond (Fig. 3). Had there been more data available for the abundance groups of >4 otters, the difference of fit between curvilinear and linear functions could have been much greater. Lone river otters or groups are known to have home ranges that can partially overlap those of neighboring otters in a region (Melquist and Hornocker 1983, Reid et al. 1994). We could occasionally observe this in some transects when documenting snow tracks and we could often distinguish between 2 neighboring otter groups because of locations where they interacted together or where both sets of tracks would overlap. Following otter movements along riverbanks can be difficult at times because they often alternate travel on snow and under ice. We could have made occasional errors by interpreting the snow tracks of 2 neighboring groups of otters as if it were those of one group. As an extreme scenario, consider a sampled stretch of river where we erroneously recorded 2 neighboring groups of 4 otters as one group of 4 otters. We should have put the count of latrine sites obtained for that transect in the 8-otters and not the 4-otters abundance group. Such errors, if they occurred, would have undermined our ability to obtain the relationship we described in this study (Fig. 3). We obtained a relationship that reaches a plateau despite the possibility of such errors, which attests to the strength of the relationship we describe in this study.

Our results also showed that river otters could be present on a stretch of river without depositing feces on riverbanks. This means that presence–absence scat surveys are prone to produce some false negatives (i.e., erroneously concluding that otters are absent at a searched location while actually present). The proportion of transects without feces documented was quite high when we detected only one and 2 otters by snow tracks, respectively (Fig. 2). This reflects Macdonald and Mason's (1983*b*) observations and Kruuk et al.'s (1986) warning that otters, when at low density, may mark their range substantially less than when at higher density. Ben-David et al. (2005), studying river otters in a marine environment, found that solitary otters were located near more latrine sites than social otters, suggesting that solitary otters scent-mark at more latrine sites than social otters. However, they found that social otters visited the latrine sites they used more frequently than solitary otters. Our winter study reflected this finding, implicating periodic snowfalls in the covering of latrine sites because the 1-otter abundance group was associated with very low latrines/km/day values (Fig. 3). Furthermore, the proportion of scats deposited in the water as opposed to deposited on land is not well-known and could be considerable (Kruuk and Conroy 1987). Researchers using various scat-survey methods to study some component of freshwater otter populations should acknowledge these inherent sources of bias and their implications.

MANAGEMENT IMPLICATIONS

We conclude that scat surveys that work by determining presence–absence of animals at searched sites are inadequate as an index of relative population size for this species. We advise extreme caution when interpreting data from such surveys to monitor relative population size for species for which feces or other surveyed signs play a role in social communication and tend to be in a clumped distribution on the landscape.

ACKNOWLEDGMENTS

We are thankful to E. Tremblay and park staff at Kouchibouguac National Park of Canada for significant and sustained logistical and financial support for the duration of the study. We are indebted to M. Dumond and S. Martinez for collecting data in 2000 and 2001, as well as B. Peters, P. Roguet, G. Daigle, S. Pouzet, and M. Gallant for their assistance in 2003 and 2004. The New Brunswick Wildlife Trust Fund (C. Bérubé), the Faculté des Études Supérieures et de la Recherche, Université de Moncton, with Canadian Heritage Scholarships (D. Gallant), and the K. C. Irving Chair in Sustainable Development (L. Vasseur) funded this study.

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Associate Editor: Ransom.