Tools and Technology Article

Determining Observer Reliability in Counts of River Otter Tracks

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ABSTRACT In many research projects, reliability of collected data is dependent on reliability of field observers. However, it is uncommon for observer reliability to be either measured or reported in wildlife research. We tested whether observer skill affected outcomes of a northern river otter (*Lontra canadensis*) track survey conducted by the Texas Parks and Wildlife Department. Observers recorded presence of tracks at bridge sites ($n = 250$) throughout a 27-county region in east Texas, USA. Logistic regression indicated that observers were significantly associated with frequency of reported otter tracks. Because observers were not assigned to bridges at random, we tested and found associations between the bridges surveyed by each observer (SURVEY ROUTE) and habitat variables (WATERSHED, VEGETATION-TYPE, WATER-TYPE, BRIDGE-AREA) that may have influenced otter presence and probability of detection. A standardized tracker evaluation procedure indicated that experienced observers ($n = 7$) misidentified 37% of otter tracks. Additionally, 26% of tracks from species determined to be "otter-like" were misidentified as otter tracks. We recommend that observer skill in identification of animal tracks and other indirect signs be measured to detect and reduce observer errors in wildlife monitoring. (JOURNAL OF WILDLIFE MANAGEMENT 73(3):426–432; 2009)

DOI: 10.2193/2007-514

KEY WORDS behavior, indirect signs, *Lontra canadensis, Lutra,* observer reliability, river otter, Texas, tracks.

Wildlife research often relies upon skilled observers to collect accurate field data (Wilson and Delahay 2001). However, when the skill level of the observers is unknown, the accuracy of collected data is questionable (Anderson 2001). Observer reliability is an important issue to address in wildlife research, yet it has often been overlooked or assumed to be high (Anderson 2003). Measuring observer field skills enables managers to select the most qualified observers, thereby increasing confidence in collected data.

Survey methods involving complex tasks, such as identification of animal tracks, are especially susceptible to observer errors (Wilson and Delahay 2001). Although tracks and other indirect signs (i.e., scat, hair, burrows, and other indicators) can be the most efficient way to detect elusive animals (Beier and Cunningham 1996), several factors (e.g., substrate quality, moisture level, age of track, animal movement) can cause tracks to be highly variable and difficult to identify. Therefore, the chance of observers misidentifying target species may be high (Smallwood and Fitzhugh 1993, Silveira et al. 2003). In surveys using tracks and sign, confidence in observer skills is of fundamental importance to the reliability of collected data.

In presence–absence studies, where target species are either detected or undetected at specified locations, use of indirect signs is prevalent (Stanley and Royle 2005, MacKenzie et al. 2006). Misidentification of indirect signs in these studies, however, can result in both false-negatives (i.e., failure to identify signs of the target species correctly) and false-positives (i.e., misidentification of other signs as those of the target species). Presence–absence data are often used to form an index of relative population size or abundance and false-negatives and false-positives affect an index differently. A small degree of false-negative results may not prove detrimental to an index, provided observers are consistent, because the relative relationship between the index and the actual population should remain unchanged. However, consistent false-positives cause an index to reflect $\geq$2 confounded species populations. When this is the case, the index no longer reflects only the population of interest and may be invalid. We investigated whether these sources of error were problematic in a presence–absence study of the northern river otter (*Lontra canadensis*) in east Texas, USA.

Texas Parks and Wildlife Department (TPWD) biologists in the Piney Woods of East Texas conducted track surveys for otters in east Texas since 1977 (Bartnicki and Boone 1989). Standard methods for surveying otters in other states consisted of searches for indirect signs (usually scats or tracks) along set lengths of riverbanks (600 m), upstream and downstream from bridges (Mason and Macdonald 1987, O'Sullivan 1993). However, because of lack of access on private property along waterways, TPWD personnel could not use standard methods (Ruiz-Olmo et al. 2001, Bifolchi and Lodé 2005). Rather, a survey was developed where only the area directly under bridges was searched for otter tracks. After a number of exploratory surveys between 1977 and 1983, a revised survey design was initiated in 1995 and replicated for 3 years (1995–1997). In 1997, the interval between surveys was extended to every 3 years: 2000, 2003, and 2006. The percentage of bridges with otters reported

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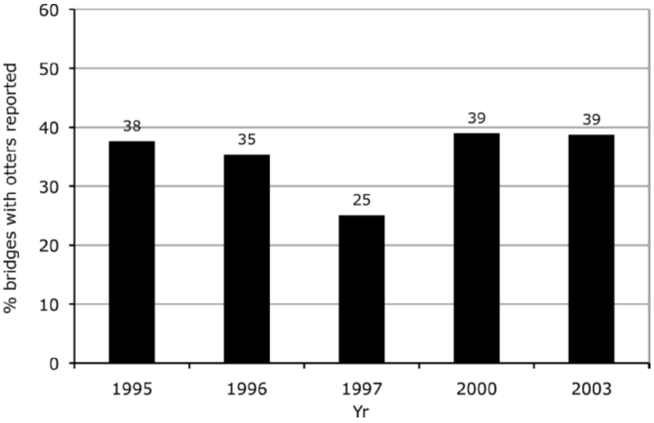

Figure 1. Percentage of bridge sites with river otter tracks reported by Texas Parks and Wildlife, within the 27-county study area in east Texas, USA, 1995–2003.

each year (Fig. 1) was used as an index of relative abundance (McGinty and Young 2003, Young 2003).

Our management goal was to evaluate potential observer variability in the TPWD otter survey technique to aid TPWD in improving the reliability of its survey method. Our study objectives were 1) to determine whether observer bias was a source of error in the existing data set and 2) to determine the proportion of error associated with false-negatives and false-positives in otter track identification.

STUDY AREA

Six major watersheds are found in the Piney Woods ecological region of east Texas: the Cypress Creek, Neches River, Sabine River, San Jacinto River, Trinity River, and the Sulfur River. The elevation ranged from sea level to >150 m, with the highest elevations occurring in the northwest portion of the study area and the lowest elevations in the south. Major vegetation types were classified as pine–hardwood; young forest–grassland; post-oak woods, forest, and grassland mosaic; willow–oak, water oak, and blackgum forest; and other vegetation types (McMahan et al. 1984). Substrates consisted mostly of sandy loams and sands in the uplands and sandy loams and clay loams in the bottomlands (Arbingast 1976). There were large tracts of land owned by corporations and the United States Forest Service, which was used primarily for timber production and other uses.

METHODS

To evaluate observer reliability, our study design included reanalysis of an existing data set from TPWD's river otter survey (1996, 1997, 2000, and 2003). Additionally, we collected and analyzed data from 2 standardized tracker-evaluation procedures held before the winter survey in 2006.

Texas Parks and Wildlife Department Bridge Survey

Data collection.—Surveys between 1995 and 2003 consisted of searches under bridge sites for otter tracks during the winter peak in otter activity (mid Jan to mid Mar; G. Calkins, TPWD, personal communication). Each year, approximately 250 bridge sites were surveyed throughout the 27-county region (Fig. 2). Most counties contained 10 bridge sites selected ad hoc, based on accessibility and suitability of the bridge for reading tracks. If tracking substrate under a bridge became unsuitable (e.g., flooding, scouring, fencing), another bridge was chosen nearby on the same waterway.

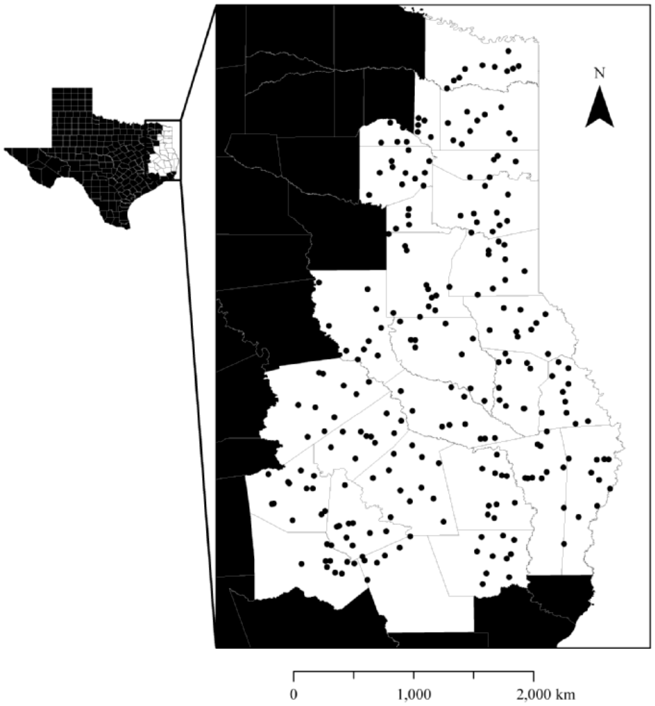

Figure 2. Locations of bridge sites used by Texas Parks and Wildlife for surveying river otters within the 27-county study area in east Texas, USA, 1995–2006.

Only 5 of the 21 observers conducted the survey in all years (1995–2003), with approximately 12 observers surveying each year. Observers were assigned to counties within their areas of responsibility, thus the same observer usually surveyed all selected bridges in a given county. Observers usually worked alone, searching for tracks within the public right-of-way of each bridge (G. Calkins, personal communication). If a bridge site was disturbed by heavy rainfall or flooding <1 week before the survey, it was postponed to a later date.

At each bridge site, observers recorded presence of tracks identified as otters and other furbearers, including beaver (*Castor canadensis*), raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), and mink (*Neovison vison*). In addition, site location, date, a brief substrate description, and observer identity were recorded. Occurrence of otter scats and other signs were not recorded in these surveys. Search duration was as long as necessary for the observer to examine tracks in all suitable areas under the bridge.

Training consisted of a 1-day workshop in 1996, which was facilitated by the most experienced observers and emphasized track identification from slides and practice in the field. Subsequently, as new observers were added, they

Table 1. Description of variables used in analysis of Texas Parks and Wildlife Department's otter bridge survey data, from the 27-county study area in east Texas, USA, 1995–2006.

Variable[a]	Description	Categories
OBSERVER	Observers who surveyed >25 bridges	13 observers
SURVEY ROUTE	The subset of bridges assigned to each observer	13 observers
WATERSHED	Major watersheds in the study area	1) Cypress Creek 2) Neches River 3) Sabine River 4) San Jacinto River 5) Trinity River 6) Sulfur River
WATER TYPE	Major water body categories	1) Intermittent stream 2) Stream–water body 3) Major stream
VEGETATION TYPE	Major vegetation types in the study area	1) Pine hardwood 2) Willow oak–water oak–blackgum forest 3) Young forest–grassland 4) Other
BRIDGE AREA	Surface area of the of the survey bridges	1) <250 m^2 2) 250–499 m^2 3) 500–749 m^2 4) 750–999 m^2 5) 1,000–7,000 m^2

[a] We acquired the existing Geographic Information System layers from the following sources: WATERSHED, Texas Water Development Board (1991); WATER TYPE, Texas Department of Transportation–Texas General Land Office (2000); VEGETATION TYPE, McMahan et al. (1984); and BRIDGE AREA, National Bridge Inventory Database (2004).

were trained in the field by experienced coworkers (G. Calkins, personal communication).

Data analysis.—The first year of the standardized survey (1995) was primarily reconnaissance and bridge-site selection (G. Calkins, personal communication) and was, therefore, deemed unsuitable for inclusion in our analysis. We used data collected during 1996, 1997, 2000, and 2003 to evaluate factors contributing to variation in reported otter tracks.

Otter distributions have been associated with several environmental factors (Macdonald and Mason 1983, Lodé 1993). Therefore, we chose 4 factors as potential explanatory variables for the effect of OBSERVER on reported river otter presence: WATERSHED, WATER TYPE, VEGETATION TYPE, and BRIDGE AREA (Table 1). The WATERSHED variable included 6 major watersheds in the 27-county region. Bridges were located within 3 categories of WATER TYPE variables: intermittent streams, stream–water bodies, and major streams. Bridges were also located within 4 VEGETATION TYPE categories: pine hardwood, willow oak–water oak–blackgum forest, young forest–grassland, and other. We calculated BRIDGE AREA by multiplying length and width data from the National Bridge Inventory Database for each bridge and placed them into 5 size categories. We originally hoped to use substrate type as an explanatory variable. However, most of the study area was of the same sandy substrate type and sample sizes in the other substrates were too small to make statistical analyses possible.

We entered the coordinates for bridge sites into a Geographic Information System (GIS) using Arc View 9.1. We joined the attributes from WATERSHED, WATER TYPE, and VEGETATION TYPE that intersected the coordinates of the bridge midpoints with the river otter data in the GIS database.

From 1996 to 2003, 16 observers participated in the otter survey. However, we only analyzed data for observers who participated in ≥ 2 years of surveys ($n = 13$). Because observers were not assigned to bridges at random, we examined associations between SURVEY ROUTE and possible confounding habitat variables. We defined the variable SURVEY ROUTE as the subset of bridges assigned to each observer. For example, if a given observer exclusively surveyed bridges at a particular water type at which otters were never reported, it would be impossible to determine whether nondetection was a result of 1) bias in detection probability of that water type (e.g., substrate, vegetation), 2) the observer misidentifying otter tracks as another species, or 3) actual absence of otters in that water type.

We evaluated the association of each habitat variable with reported otters using logistic regression. We used a 95% level of confidence to determine significance ($P < 0.05$). We then determined associations between variables through a chi-square test of independence. We evaluated relative predictability of each variable through comparison of the G^2-likelihood ratios (also known as the change in -2 log-likelihood ratio). We conducted all statistical tests with SPSS 11 (SPSS Inc, Chicago, IL).

Evaluation of Observer Skill

Data collection.—We measured the field observers' track identification skills through 2 standardized CyberTracker evaluations. The CyberTracker evaluation system was designed to be an objective and accurate means for measuring tracking skills in the field. The initial evaluator and creator of the system, Louis Liebenberg, authored several tracking books (Liebenberg 1990*a*, *b*, 1992, 2000)

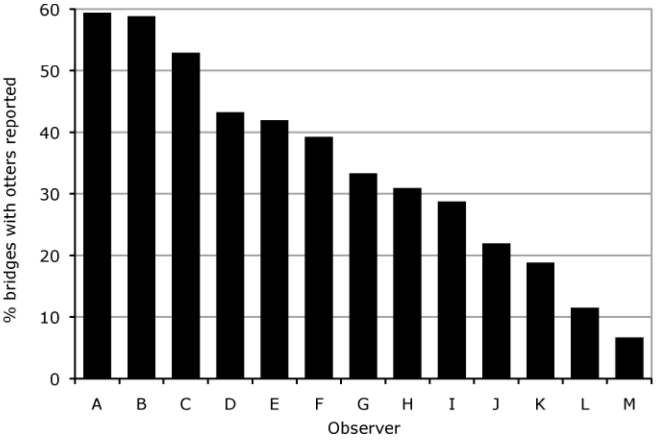

Figure 3. Percentage of bridge sites with otter tracks reported by each Texas Parks and Wildlife observer, east Texas, USA, 1995–2003.

and created the CyberTracker software for handheld computer field data entry. Mark Elbroch, a certified CyberTracker Evaluator and author of tracking field guides (Elbroch 2001, 2003; Murie and Elbroch 2005), conducted evaluations for TPWD.

The evaluation procedure used objective criteria to place questions into 3 categories of difficulty: easy, difficult, and very difficult (L. Liebenberg, CyberTracker Conservation, personal communication). A track was rated easy if it was of a medium to large species, complete, typical in every way (not abnormally large or small), and with no similar species in the area. A difficult track was either a clear print of a small species or a track of a medium to large species that was unclear or incomplete, but typical, with no similar species in the area. A track was rated very difficult if it was obscure, partial, atypical, or there were similar species in the area. Scoring was then weighted, with point values for each question based on the difficulty rating. Correct answers for questions rated as easy improved scores relatively little, whereas mistakes decreased scores considerably. Conversely, correct answers for questions rated as very difficult improved scores considerably, and mistakes decreased scores relatively little (for details see CyberTracker Conservation 2006, Evans 2006). Thus, participants with the same numbers of correct and incorrect questions could receive different scores, depending on the relative weights of missed questions. After 5–10 questions were asked, they were discussed as a group so all participants could learn the field marks for identification. Additionally, if a participant disputed the evaluator's answer to a question and the evaluator could not clearly explain and justify his or her answer to the participant, the question was discarded and not counted. At the end of an evaluation, certificates could be awarded for the following scores: level 1 (70–79 points), level 2 (80–89 points), level 3 (90–99 points), and track and sign specialist (100 points).

The evaluator asked 23 TPWD field staff to identify tracks in the field during 2 evaluations. Of the 13 experienced observers who had participated in ≥ 2 years of river otter surveys, 7 were available to be evaluated. Because questions depended on actual signs encountered in the field, specific track questions differed between the first and second evaluations (59 and 81 questions, respectively). Although the evaluator chose locations where river otter tracks were likely to be found, participants were asked to identify tracks and signs of a variety of species. For example, in addition to otter-sized species, questions included tracks of great-blue heron (*Ardea herodias*), marsh rice rat (*Oryzomys palustris*), house cat, and crayfish (*Cambaridae* sp.).

Data analysis.—We used the answers from all 23 participants to determine which species' tracks were mistakenly identified as river otter tracks at least once. Subsequently, we partitioned the data set into experienced otter observers ($n = 7$) and other participants ($n = 16$). For the experienced observers, we calculated the percent of false-positives and false-negatives. We defined false-positives as the number of otter-like track questions incorrectly called otter, where "otter-like" meant any track made by a species that was misidentified as an otter in >10% of answers during the evaluations of all 23 participants. We defined a false-negative as an actual river otter track misidentified as another species.

RESULTS

Texas Parks and Wildlife Department Bridge Survey

Among observers, the percentage of bridge sites with otters reported from 1996 to 2003 varied from 7% to 59%, with a mean of 34% (Fig. 3). OBSERVER was associated with reported otter presence ($G^2 = 118.620$, $P \leq 0.001$). Two of the 4 habitat variables (Fig. 4), WATERSHED ($G^2 = 14.524$, $P = 0.013$) and BRIDGE AREA ($G^2 = 24.218$, $P \leq 0.001$), were associated with reported otter presence. Variation in reported otter presence was not associated with VEGETATION TYPE ($G^2 = 5.704$, $P = 0.127$) or WATER TYPE ($G^2 = 2.171$, $P = 0.338$). The effect of OBSERVER on reported otter presence was confounded by the effect of WATERSHED and BRIDGE AREA. SURVEY ROUTE was associated with WATERSHED ($\chi^2_{78} = 1{,}775.5$, $P \leq 0.001$) and BRIDGE AREA ($\chi^2_{78} = 269.645$, $P \leq 0.001$), which were both associated with reported otter presence. In addition, SURVEY ROUTE was associated with VEGETATION TYPE ($\chi^2_{52} = 336.6$, $P \leq 0.001$) and WATER TYPE ($\chi^2_{39} = 240.2$, $P \leq 0.001$).

Evaluation of Observer Skill

The 23 evaluation participants misidentified tracks of 12 species as otter (Table 2). Tracks of 3 of these species were misidentified as otter in >10% of answers and were, therefore, considered otter-like. The species whose tracks were considered otter-like were swamp rabbit (*Sylvilagus floridanus*), raccoon, and opossum. Experienced observers ($n = 7$) misidentified 11 of 42 (26%) otter-like species track questions as otter (false-positives). Of actual otter track questions, experienced observers misidentified 14 of 38 (37%; false-negatives).

DISCUSSION

We used 2 methods to determine whether observer error influenced TPWD otter survey results: analysis of the effect

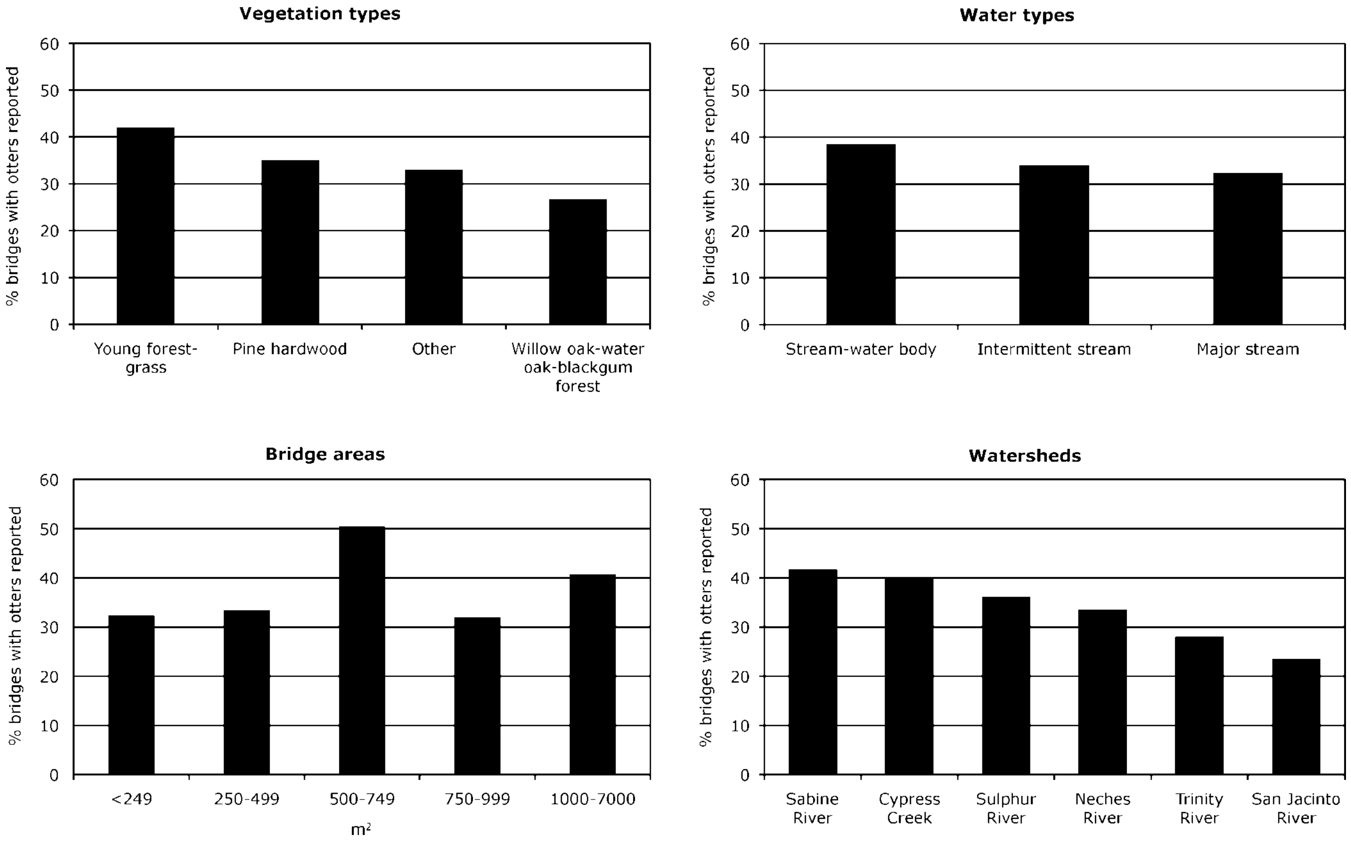

Figure 4. Percentage of bridge sites with river otters reported for each habitat variable examined, east Texas, USA, 1995–2003.

of the observers on a preexisting data set and quantitative evaluation of observer skill. Based on the corresponding results of these investigations, spatial and temporal changes in the east Texas otter population could not be inferred from these data.

Analysis of the past survey data was problematic because observers were assigned to bridge sites by geographical areas (i.e., county boundaries). We found SURVEY ROUTE (the subset of bridges surveyed by each observer) to be associated with all other habitat variables. Therefore, it was not possible to completely separate the effect of observer error from the other variables that also varied across the landscape. We attribute these associations to the spatially distinct placement of the observers.

The only spatial variables we found to be associated with reported otter presence were WATERSHED and BRIDGE AREA. However, it was not possible to know if these associations were a result of different otter abundances or observer error. Although we found associations between SURVEY ROUTE and the other spatial variables, the predictive significance of OBSERVER was much stronger than the other variables, which alone was enough to raise concerns about reliability of the past survey data.

During evaluations of track identification skills, experienced observers misidentified a substantial percentage of otter tracks and frequently misidentified the tracks of otter-like species as otter (false-positives). Therefore, we concluded that more rigorous training in track identification was needed and would greatly decrease errors associated with observer skill.

Although the initial scores of the TPWD observers indicated that more training was needed, rapid improve-

Table 2. Species misidentified as river otter during the 2 evaluations of track-identification skill of 23 Texas Parks and Wildlife biologists, Jasper area, Texas, USA, 31 October 2005 and 23 January 2006.

Confused species			Misidentified as otter	
Common name[a]	Track questions	Completed answers[b]	Frequency	% error
Raccoon[c]	14	193	24	12.4
Opossum[c]	8	109	11	10.1
Dog	7	106	2	1.9
House cat	8	99	2	2
Bobcat	6	87	3	3.4
Armadillo	6	77	2	2.6
Nutria	5	76	1	1.3
Gray fox	4	62	3	4.8
Rice rat	4	55	1	1.8
Turtle	2	31	1	3.2
Swamp rabbit[c]	1	20	9	45
Bullfrog	1	20	1	5

[a] Bobcat, *Lynx rufus*; armadillo, *Dasypus novemcinctus*; nutria, *Myocastor coypus*; gray fox, *Urocyon cinereoargenteus*; and bullfrog, *Rana catesbeiana*. Turtle genus not identified.

[b] Each value represents a count of all questions answered for the tracks of the indicated species, summed over all 23 observers who answered those questions.

[c] Tracks of these species were misidentified as otter in >10% of answers and were considered otter-like.

ment was observed. C. Evans (Texas A&M University, unpublished data) demonstrated the educational utility of the CyberTracker Tracker Evaluation system, showing substantial improvement in the scores of participants who were able to attend both the first evaluation discussed here ($\bar{x} = 61\%$) and an evaluation ($\bar{x} = 79\%$) 3 months later. All returning participants increased their score. With proper training and experience, skilled observers have achieved high levels of accuracy (Stander et al. 1997, Zuercher et al. 2003).

Although identification of river otter tracks can be difficult, they are not a special case. Many species leave tracks that can be difficult to identify. Therefore, issues with observer reliability in use of indirect signs are potentially widespread and not limited to only river otter track surveys in Texas. Nevertheless, in many studies observer skill in identification of tracks and signs is overlooked, unreported, or assumed to be high.

When considering ways to reduce observer error in indirect sign surveys, managers have the following options: 1) adequately train and evaluate all field observers, 2) select preevaluated field observers of an adequate skill level, or 3) use methods to record the signs (such as track plates, plaster casts, or photographs) and verify the species' identities with the aid of an outside track and sign specialist. It is difficult to judge whether studies that relied on indirect signs were reliable, unless the signs of the species were unmistakable even to a novice observer or the observer skill in identification of the signs was measured and reported.

MANAGEMENT IMPLICATIONS

Many wildlife studies would benefit greatly from adopting standardized methods of evaluating skills of field biologists and data collectors. Methods such as the track and sign evaluation we used could be applied to a variety of research fields, both for testing validity of preexisting data and for quantitatively evaluating skills of field observers.

ACKNOWLEDGMENTS

We thank B. A. Collier, L. Liebenberg, K. Rinehart, and J. H. Young for their contributions and review comments. D. Schlitter and J. H. Young of TPWD arranged funding for the track evaluation workshops. We also thank the 23 participants of the tracking evaluation workshops for their willingness to be tested, and we thank those biologists who collected the TPWD otter survey data.

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