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*Tools and Technology Article*

# Detectability of American Mink Using Rafts to Solicit Field Signs in a Population Control Context

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**ABSTRACT** American mink (*Neovison vison*) are an ecologically damaging invasive species where they have been introduced in Europe. Effectiveness of mink population control by trapping has been difficult to assess, without knowing how efficiently mink are caught by traps or detected by other methods. Use of track-recording rafts to detect mink and guide trapping effort has proved efficient and leads to a supposition that no detection indicates absence of mink. To draw this conclusion with any confidence requires a measure of detectability. We applied occupancy models to data from an earlier study to estimate detectability of individual American mink on track-recording rafts. Estimated detectability of individual mink, per raft, and 2-week check period varied between 0.4 in late summer and 0.6 in late autumn. By inference, risk of failing to detect a mink that was present would be <5% given 4–6 independent opportunities to detect it. These opportunities could be created either by using a raft spacing that ensured multiple detections of each mink or by monitoring rafts through a succession of check intervals. Within certain simple constraints, raft location did not contribute substantially to detection probability. These findings will allow field operators, strategists, and funders to assess with confidence the success of efforts to control mink density. We expect the estimation of individual detectability to be similarly valuable in population control or eradication of other species.

**KEY WORDS** American mink, British Isles, detectability, mink raft, *Neovison vison*, occupancy model, passive detector.

In Britain and elsewhere in Europe, the American mink (*Neovison* [formerly *Mustela*] *vison*) became established and widespread during the 20th century as a result of accidental and deliberate releases from fur farms (Dunstone 1993, Sheail 2004). As an invasive alien predator the American mink has proved damaging to native bird and mammal prey species (Macdonald and Harrington 2003, Bonesi and Palazon 2007). For this reason attempts are made locally to control mink numbers. It is difficult to evaluate efficacy of such attempts, due to the lack of independent methods to estimate mink density. As in all trapping, capture rate is an unreliable indicator of the number of mink remaining uncaught. Although mink are not particularly shy, they are not commonly seen even when present and detection by field signs is heavily dependent on substrates and other field conditions (Reynolds et al. 2004).

Much literature concerns use of presence–absence data where probability of detection given that a species is present is <1 (MacKenzie et al. 2002, 2003, 2006; Royle and Nichols 2003; Royle et al. 2005). Within this literature, species detection probability itself is usually of passing interest in that it leads to improved assessments of site occupancy, dispersion in relation to habitat and other correlates, or population size. Species detection probability is also used to improve the design of further occupancy studies (Mackenzie et al. 2006). Little attention has been given to estimating detectability of individuals as a means to improve management. Individual detectability is an important parameter both in targeting population or disease control measures and in establishing absence of a species with acceptable confidence (e.g., Reynolds and Short 2003).

Many mammal species are difficult to detect, and detection often relies on accumulated field signs rather than live sightings. Use of field signs introduces a further layer of uncertainty because detectability of field signs may also vary with environmental conditions. For instance, persistence of feces varies with diet, weather, invertebrate scavengers, or river conditions (Reynolds and Aebischer 1991, Cavallini 1994, Harrington et al. 2008). Feces are used by many mammalian species as territorial markers, and detection may, therefore, vary seasonally and be biased toward territorial individuals. Habitat can affect probability of detecting feces (Baker and Harris 2005), and seasonal changes in habitat structure must compound this difficulty. For footprints, availability and type of receptive substrates clearly affects detection.

The Game & Wildlife Conservation Trust (GWCT) Mink Raft (Reynolds et al. 2004) was developed to standardize detection, escaping dependency on the natural occurrence of field signs and suitable substrates for them. The mink raft solicits field signs by providing a structure likely to be visited by American mink and a substrate that reliably accumulates records of those visits between checks spaced 1–2 weeks apart. Reynolds et al. (2004) showed that use of these rafts was more efficient than chance encounters, field sign surveys, or speculative trapping to detect presence of mink. Operating rules for using the raft were developed empirically through mink removal studies, culminating in a recommendation of 1 raft/km of river so that each mink present would be detected by visits to several rafts (Reynolds

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2003*a*, *b*, 2004). Long-term reduction of mink detections in response to continual removal of detected mink suggests few if any mink using the riparian habitat remain undetected (Reynolds et al. 2004; Reynolds 2007; J. C. Reynolds, GWCT, unpublished data).

Mink rafts are valuable both as a survey tool and to guide control of American mink where it occurs as a damaging alien species outside its native range. In both contexts it is valuable to have an estimate of detectability per mink and check occasion to define confidence in the inference that no detection indicates absence of mink. We applied occupancy models to data from an earlier study to estimate detectability of mink when using mink rafts in monitoring mode. A fundamental assumption of occupancy models is that among sample sites detections are independent. A study design (in our case, raft spacing) that ensures multiple detections of each animal violates that assumption. Furthermore, in most applications of mink rafts for mink population control, continual removal of mink as they are detected creates a fast-changing occupancy scenario. However, Reynolds et al. (2004) provides a suitable data set because raft spacing was chosen using knowledge of typical mink home-range size to promote spatial independence and because mink were not removed during this study.

## STUDY AREA

Our study took place in central southern England on the upper part of the River Avon and its tributaries, the River Nadder, River Wylye, River Ebble, and River Bourne. For a detailed description of the study area see Reynolds et al. (2004). The system comprised approximately 144 km of river channels and drained an area of approximately 1,700 km$^2$ (Environment Agency 2006). This was a stable chalk-stream river system, chiefly fed by an aquifer held within the chalk bedrock, although one tributary (the River Nadder) arose in less permeable Green Sandstone and was prone to rapid changes in water level. Specialized woody and nonwoody riverside vegetation occupied a margin of variable width, depending on encroachment by agricultural activity and presence or absence of fencing to exclude livestock and humans. Emergent semi-aquatic plants were generally present at the river edge.

## METHODS

We used GWCT Mink Rafts to detect presence of mink along the rivers of the upper Avon catchment during 2002. These rafts used a clay and sand medium to accumulate tracks of visiting animals between check occasions. Rafts had a buoyant base with a central hole in which sat a plastic basket filled with flower-arranging foam (OASIS® floral foam; Smithers-Oasis, Cuyahoga Falls, OH). The foam raised water to its upper surface by capillary action from below the raft, thus irrigating a 1-cm-thick layer of the recording medium, which we smeared on top. A short tunnel protected the recording medium and excluded large animals and birds. For a detailed description of rafts, see Reynolds et al. (2004) and Reynolds (2003*b*).

We deployed one mink raft/4-km section of river, but precise locations were chosen for ease of access by the operator so that average spacing was 4.3 km (SE = 0.23 km, range = 2.0–7.3 km). For comparison, average adult mink home ranges in 4 studies in river habitat (reviewed Dunstone 1993) were 1.85 km to 2.64 km in length (range = 1.0–5.0 km). At each site, we tethered rafts adjacent to the bank, among emergent vegetation if present, and avoiding fast water. Apart from this, we did not use any subjective assessment of the likelihood of a mink visit when choosing raft locations. For logistical reasons, we established the 32 sites in a sequential fashion and then checked them in the same sequence every 2 weeks. We checked each raft on 6 occasions within 2 distinct periods: 3 checks between 28 June and 30 August 2002 and 3 checks between 8 October and 19 December 2002. In view of seasonal biology of mink we expected mink density and detectability to differ between these 2 periods; hence, we modeled each period separately (Dunstone 1993). At each check we identified and recorded all tracks accumulated since the previous check (i.e., during 2 weeks); thus, detection probability meant probability of recording $\geq 1$ visit by mink to a raft within 2 weeks, if the raft was within the home range of $\geq 1$ mink (i.e., if the site was occupied). We defined detectability as probability of detecting each individual mink per raft and 2-week check period (Mackenzie et al. 2006).

We analyzed detection data using the package PRESENCE (version 2.2, <http://www.mbr-pwrc.usgs.gov/software/presence.html>, accessed 6 Aug 2008). We applied 3 occupancy models of increasing complexity to the River Avon data. We applied 1) a spatially homogeneous single-season model with constant detection probability within each period, and 2) a spatially homogeneous single-season model with survey-specific detection probability. Models 1 and 2 assumed that the system was demographically closed so that occupancy status of each site remained constant during the period modeled; that mink were not falsely detected (we could not test this assumption in our study, but see Discussion); and that detection at a site was independent of detection at other sites and on previous occasions. Finally, we applied 3) an abundance-induced spatially heterogeneous single-season model (Royle and Nichols 2003). Model 3 parameterized detection probability (per site and sample occasion) as the product of detectability (probability of detection per individual mink) and population size at each site. Model 3 assumed that spatial distribution of animals followed a Poisson distribution, that population size was constant within the modeled period (i.e., within each of the 2 periods), that mink were not falsely detected, and that detections of individuals were independent.

We required an estimate of detectability per individual mink, raft, and check occasion. Although only the Royle–Nichols model splits species detection probability into site-specific abundance estimates and individual detectability, we compared fit of all 3 models to determine whether use of this more complex model was justified. We based model selection on Akaike's Information Criterion (AIC) values and associated measures. Note that although it is conceptually more complex, the Royle–Nichols model involves estimation of only 2 parameters, occupancy itself being a derived parameter.

Normally mink rafts are deployed singly at each site (Reynolds 2004), but because this study was developmental it incorporated 2 sequentially run experiments requiring that rafts were deployed in pairs spaced <50 m apart. This paired deployment gave the opportunity for (randomly allocated) treatment and control rafts at each site but also complicated analysis of occupancy. In June–August, the experiment concerned the effect of a scent lure on mink visit rates (Reynolds et al. 2004). In October–December, the experiment concerned the effect of a physical otter (*Lutra lutra*) excluder on mink visit rates (J. C. Reynolds, unpublished data). Neither experimental treatment had any demonstrable impact on mink visit rates (binomial regression with site, check no., and treatment as explanatory factors; trial 1: $\chi^2_{1,128} = 0.11$, $P = 0.736$; trial 2: $\chi^2_{2,143} = 0.24$, $P = 0.786$) and, therefore, the 2 rafts at each site were functionally equivalent. We assumed the same mink had access to both rafts at a given site. To determine whether the 2 rafts recorded independently (i.e., detection at one did not affect detection at the other), we selected data for 22 sites where we recorded mink on ≥1 of the 6 check occasions. We used the observed detection rate p among these 264 raft checks to compute expected frequencies of double, single, and null records in the raft pairs, assuming within-pair independence, as $p^2$, $2p(1 - p)$, and $(1 - p)^2$, respectively. We compared observed and expected frequencies using chi-square.

We also prepared the raft data for occupancy analysis in 2 alternative ways. First we determined presence or absence at each site as indicated by 1 raft/site. Two data sets were conveniently generated by the random allocation of rafts to treatment or control in each experiment. We expected these to produce similar estimates of detection probability and population size. Because we allocated treatments afresh at the start of the second period, the 2 assortments of rafts (a and b in Jun–Aug, and a′ and b′ in Oct–Dec) were not the same in the 2 periods. Secondly, we determined presence or absence at each site as indicated by consolidating the data from the 2 rafts at each site. To illustrate the best and worst consequences of raft placement choices, we created 2 further alternative data sets by selecting the higher scoring and lower scoring rafts of each pair, assessed across both periods.

# RESULTS

## Model Assumptions

Occupancy status of sites was largely constant both within and between the 2 survey periods. In June, July, and August, number of positive rafts was 10, 10, 11 and 10, 8, 10 for data sets a and b, respectively. In October, November, and December, number of positive rafts was 14, 12, 11 and 12, 12, 13 for data sets a and b, respectively. Within each period, detection histories occurred with expected frequency in 5 of 6 cases (2 single-raft data sets, 2 periods: $\chi^2_1$ test, $P = 0.510, 0.018, 0.153, 0.635$, respectively; data consolidated by site, 2 periods: $P = 0.287, 0.331$). Between the 2 survey periods, fewer sites changed occupancy status than would be expected by random assortment (2 × 2 contingency table, $\chi^2_1$ test; data set a: $P = 0.001$; data set b: $P = 0.070$; consolidated by site: $P = 0.002$). Using data consolidated by site, 19 sites (59%) were positive for mink in each period. Six sites changed status between the 2 periods, 3 from absent to present and 3 vice versa. Twenty-six sites (81%) retained their original status. We conclude that assumptions of constant occupancy status and independent occupancy of sites >2 km apart were upheld.

**Table 1.** Test of independence between mink detection rafts deployed <50 m apart. Data are from 44 rafts deployed in pairs at 22 sites occupied by mink in southern England. We collected data for 6 2-week periods between June and December 2002. Each detection was the result of ≥1 visit by a mink to the raft within a 2-week period. We excluded from this test sites at which we did not detect mink in any of the 6 periods. For the 132 cases (22 raft pairs and 6 check periods) we computed expected frequencies of mink detections at 0, 1, or 2 rafts from the observed overall frequency of detection (0.50).

| | Frequency of occurrence | |
|---|---|---|
| **No. detections per site** | **Observed** | **Expected** |
| Both rafts | 48 | 34 |
| One raft | 37 | 66 |
| Neither raft | 47 | 33 |
| | $\chi^2_2 = 25.5$, $P < 0.001$ | |

Conversely, rafts <50 m apart were not independent. For sites recording mink at ≥1 of the 6 check periods, detections at both rafts of a pair were more common than would have been expected if the 2 rafts recorded independently ($\chi^2_2 = 25.5$, $P < 0.001$; Table 1). Observed frequency of no detection at either raft (0.36) was intermediate between that observed per single raft (0.50) and that expected if the 2 rafts gave 2 independent opportunities to detect (0.50 × 0.50 = 0.25).

## Model Selection and Estimates of Detectability and Occupancy

In all 6 cases (2 periods, 2 single-raft data sets plus consolidated data set), Model 3 (the Royle–Nichols model) was selected, because it resulted in the lowest AIC (Table 2). We estimated detectability of individual mink (*r*; Table 3) per raft and 2-week check interval (given the study design) to be around 0.5. Estimates of *r* did not differ whether we used data from one raft or the other of each pair or from both. Estimates of *r* for June–August were consistently lower (around 0.4) than for October–December (around 0.6; 1 raft/site, data sets a, a′: $Z_{62} = 1.013$, $P = 0.311$; data sets b, b′: $Z_{62} = 1.776$, $P = 0.076$; data consolidated by site: $Z_{62} = 1.991$, $P = 0.046$). Average of estimates of occupancy ($\psi$; Table 3) did not differ between June–August (61%) and October–December (59%; 1 raft/site, data sets a, a′: $Z_{62} = 0.002$, $P = 0.999$; 1 raft/site, data sets b, b′: $Z_{62} = 0.310$, $P = 0.757$; data consolidated by site: $Z_{62} = 0.147$, $P = 0.883$).

Estimates of occupancy and detectability did not differ between high-scoring and low-scoring rafts of each pair (Table 3; occupancy, 2 periods: $Z_{62} = 1.177$, $P = 0.239$; $Z_{62} = 1.062$, $P = 0.288$; detectability, 2 periods: $Z_{62} = 0.444$, $P$

**Table 2.** Comparison of fit for 3 occupancy model types (numbered 1 to 3 in order of increasing complexity) applied to mink detection data for 32 survey sites on the River Avon catchment in southern England ($p$ = probability of detection of the species). There were 3 consecutive 2-week detection periods in each of 2 survey periods in 2002. We applied each model type to alternative data sets in each of 2 survey periods. Data sets a and b are complementary data sets for the first survey period, each containing data from one track-recording raft out of the pair present at each survey site, randomly selected at the start of the period. Data sets a′ and b′ are equivalent selections from the same population of rafts for the second survey period, freshly randomized at the start of the period. We compared model fit using Akaike's Information Criterion (AIC).

| Period | Data set | Model | AIC | Parameters estimated |
|---|---|---|---|---|
| 28 Jun–30 Aug | Random a | 2 = spatially homogeneous, survey-specific $p$ | 115.33 | 4 |
| 28 Jun–30 Aug | Random a | 1 = spatially homogeneous, constant $p$ | 111.84 | 2 |
| 28 Jun–30 Aug | Random a | 3 = abundance-induced spatial heterogeneity, constant $p$ | 110.98 | 2 |
| 28 Jun–30 Aug | Random b | 2 = spatially homogeneous, survey-specific $p$ | 111.66 | 4 |
| 28 Jun–30 Aug | Random b | 1 = spatially homogeneous, constant $p$ | 108.60 | 2 |
| 28 Jun–30 Aug | Random b | 3 = abundance-induced spatial heterogeneity, constant $p$ | 107.22 | 2 |
| 28 Jun–30 Aug | a and b consolidated by site | 2 = spatially homogeneous, survey-specific $p$ | 119.74 | 4 |
| 28 Jun–30 Aug | a and b consolidated by site | 1 = spatially homogeneous, constant $p$ | 116.70 | 2 |
| 28 Jun–30 Aug | a and b consolidated by site | 3 = abundance-induced spatial heterogeneity, constant $p$ | 115.22 | 2 |
| 8 Oct–19 Dec | Random a′ | 2 = spatially homogeneous, survey-specific $p$ | 106.45 | 4 |
| 8 Oct–19 Dec | Random a′ | 1 = spatially homogeneous, constant $p$ | 103.59 | 2 |
| 8 Oct–19 Dec | Random a′ | 3 = abundance-induced spatial heterogeneity, constant $p$ | 101.03 | 2 |
| 8 Oct–19 Dec | Random b′ | 2 = spatially homogeneous, survey-specific $p$ | 99.96 | 4 |
| 8 Oct–19 Dec | Random b′ | 1 = spatially homogeneous, constant $p$ | 96.24 | 2 |
| 8 Oct–19 Dec | Random b′ | 3 = abundance-induced spatial heterogeneity, constant $p$ | 91.87 | 2 |
| 8 Oct–19 Dec | a′ and b′ consolidated by site | 2 = spatially homogeneous, survey-specific $p$ | 93.47 | 4 |
| 8 Oct–19 Dec | a′ and b′ consolidated by site | 3 = spatially homogeneous, constant $p$ | 92.50 | 2 |
| 8 Oct–19 Dec | a′ and b′ consolidated by site | 1 = abundance-induced spatial heterogeneity, constant $p$ | 91.47 | 2 |

= 0.657; $Z_{62}$ = 1.060, $P$ = 0.289). Estimates of mean number of mink visiting the 32 survey sites ($N$; Table 3) ranged from 24 (lower scoring rafts) to 40 individuals (higher scoring rafts). These estimates had broad confidence limits but indicate the number of individual mink on which we based detectability estimates.

## DISCUSSION

Best-fit occupancy models (Royle–Nichols single-season models with spatially heterogeneous abundance) suggested that detectability per mink, raft, and 2-week check interval was around 0.5. Between the 2 periods we considered, site occupancy and total population size remained constant, but there was some evidence that detectability was lower in June–August (around 0.4) than in October–December (around 0.6).

If each raft and check interval were an unrepeatable survey opportunity, such values would be disappointingly low. In population control, however, the use of mink rafts on a continuous basis for several successive check intervals and the deployment density recommended (1 raft/km of river) provide multiple opportunities to detect each mink present within the river system. Given $r$-values in the range we estimated, probability of failing to detect a mink that was in fact present would decrease with increasing independent opportunities (Table 4). In June–August ($r$ = 0.40) probability of failing to detect a mink that was present fell below 10% given 5 detection opportunities and below 5% at 6 opportunities. In October–December ($r$ = 0.62) probability fell below 10% given 3 independent detection opportunities and below 5% at 4 opportunities.

Independence of detection opportunities is crucial to this argument, as well as to the occupancy models used to estimate $r$. As we intended, rafts spaced 4 km apart seemed independent with respect to occupancy status; sites tended

**Table 3.** Estimates of mink occupancy (proportion of sites), population size (i.e., no. of mink visiting those sites), and individual detectability (probability of detection per mink and 2-week survey interval) from occupancy models with abundance-induced spatial heterogeneity. Data are from 32 sites in southern England. Models were applied to each of 2 periods in 2002. Data sets a and b are complementary data sets for the first survey period, each containing data from one track-recording raft out of the pair present at each survey site, randomly selected at the start of the period. Data sets a′ and b′ are equivalent selections from the same population of rafts for the second survey period, freshly randomized at the start of the period. We applied the same model to alternative data sets and to data sets we compiled from the higher scoring raft and lower scoring raft at each site.

| | | Occupancy ($\psi$) | | Population ($N$) | | Detectability ($r$) | |
|---|---|---|---|---|---|---|---|
| Period | Data set | $\psi$ | SE | $N$ | SE | $r$ | SE |
| 28 Jun–30 Aug | Random a | 0.624 | 0.121 | 31.26 | 10.30 | 0.417 | 0.117 |
| 28 Jun–30 Aug | Random b | 0.609 | 0.129 | 30.08 | 10.54 | 0.388 | 0.120 |
| 28 Jun–30 Aug | a and b consolidated by site | 0.672 | 0.110 | 35.71 | 10.72 | 0.459 | 0.112 |
| 28 Jun–30 Aug | High-score raft at each site | 0.718 | 0.127 | 40.49 | 14.39 | 0.364 | 0.118 |
| 28 Jun–30 Aug | Low-score raft at each site | 0.514 | 0.118 | 23.07 | 7.77 | 0.439 | 0.121 |
| 8 Oct–19 Dec | Random a′ | 0.625 | 0.100 | 31.34 | 8.48 | 0.575 | 0.103 |
| 8 Oct–19 Dec | Random b′ | 0.559 | 0.097 | 26.22 | 7.02 | 0.661 | 0.096 |
| 8 Oct–19 Dec | a′ and b′ consolidated by site | 0.651 | 0.091 | 33.71 | 8.31 | 0.739 | 0.085 |
| 8 Oct–19 Dec | High-score raft at each site | 0.671 | 0.091 | 35.60 | 8.88 | 0.678 | 0.093 |
| 8 Oct–19 Dec | Low-score raft at each site | 0.521 | 0.108 | 23.58 | 7.23 | 0.522 | 0.114 |

**Table 4.** Theoretical probability of detecting a mink that is present, given different numbers of independent rafts or 2-week check intervals. If $r$ is probability of detection per individual, raft, and check interval, risk of failing to detect given $n$ independent opportunities (rafts or check intervals) is $(1 - r)^n$ and probability of detection is $1 - (1 - r)^n$. For illustration we have chosen realistic values for $r$ as suggested by our study of mink populations in southern England, 2002.

| Rafts or check intervals | Probability of detection[a] | | |
|---|---|---|---|
| | $r = 0.4$ | $r = 0.5$ | $r = 0.6$ |
| 1 | 0.400 | 0.500 | 0.600 |
| 2 | 0.640 | 0.750 | 0.840 |
| 3 | 0.784 | 0.875 | 0.936 |
| 4 | 0.870 | 0.938 | 0.974[a] |
| 5 | 0.922 | 0.969[a] | 0.990[a] |
| 6 | 0.953[a] | 0.984[a] | 0.996[a] |
| 7 | 0.972[a] | 0.992[a] | 0.998[a] |
| 8 | 0.983[a] | 0.996[a] | 0.999[a] |
| 9 | 0.990[a] | 0.998[a] | 1.000[a] |
| 10 | 0.994[a] | 0.999[a] | 1.000[a] |

[a] Detection probability exceeds 0.95 (i.e., <5% risk of failing to detect a mink that is present).

to have consistent occupancy status within and between the 2 study periods. Furthermore, among sites we scored as occupied at some time in our study, visit histories occurred with frequencies expected by random assortment, implying that visits to the same raft in successive 2-week periods were also independent events (i.e., although successive check periods at a given raft were probably linked by the same individual mink, visits to rafts were neither addictive nor aversive).

There remains the question of whether the precise location of a raft at a site affected detection probability. In other words, at a scale of tens of meters, were there good and bad raft locations, as there are for traps? At each site, the raft pair tended to act as an all-or-nothing detector, so the 2 rafts were clearly not independent. This is convenient because it means the paired raft layout had a small impact on detectability. Extreme data sets, created from the data by selecting the higher and lower scoring rafts of each pair, produced estimates of occupancy and detectability that were not significantly different. The lack of independence between rafts <50 m apart also suggests that the precise location of each raft was not critical, supporting the impressions of operators in this and later field studies (J. C. Reynolds, unpublished data).

We could not address the possibility of false detections, although confusable species were not common. In a more recent project in a different part of England (J. C. Reynolds, unpublished data), look-alike species were more abundant and tracks were, therefore, classified according to operator confidence before traps were set on the same rafts. Subsequent capture histories showed false positives to be a minor risk.

# MANAGEMENT IMPLICATIONS

Mink rafts are valuable both as a survey tool and to guide the control of American mink where it occurs as a damaging alien species outside its native range. In both contexts it is valuable to have an estimate of detectability per mink and check occasion, to define reliability of the inference that no detection indicates absence of mink. In the specific context of mink control, the reactive trapping style encouraged by rafts allows a swift, flexible response to reinvasion, which Harrington et al. (2009) found to be essential for protection of one vulnerable prey species (water vole [*Arvicola terrestris*]) from mink predation. Our analysis showed that random (unskilled) placement of single rafts led to satisfactory detectability and adds confidence to mink population management based on this strategy.

For wildlife population control in general, the approach used here—in which control effort is guided by a monitoring system with known probability of detecting each individual—marks an important shift of emphasis from the individuals removed (i.e., bag data) to those remaining. There are clear parallels between mink rafts and passive detectors used for other species such as camera-traps and track-plots, although the mink raft is perhaps closer to interactive detectors such as scent stations, which solicit field evidence. We are confident that detectability can be measured with benefit in many other wildlife management contexts.

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