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Commentary

The mink is not a reliable sentinel species ☆

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ABSTRACT

In a recent review paper, Basu et al. [Basu, N., Scheuhammer, A.M., Bursian, S.J., Elliott, J., Rouvinen-Watt, K., Chan, H.M., 2007. Mink as a sentinel species in environmental health. Environ. Res. 103, 130–144] suggested that the American mink (formerly *Mustela vison*, now *Neovison vison*) should be used as a sentinel species for studies of the effects of pollution on environmental health. They based this assertion in large part on their conclusion that mink meet a set of criteria required by a sentinel species. In this commentary, we suggest that Basu et al. overlooked an important criterion for sentinel species – that the species must be a continuous resident of the environment under evaluation. Across their native range and beyond, mink are commonly farmed for the fur industry, and a long history of studies has shown that where they are farmed, they escape. For example, in southern Ontario, Canada, 64% of the mink have been genetically identified as domestic in origin, or domestic–wild hybrids. Thus, we argue that mink do not meet the criterion of continuous residence, and cannot be reliably used as sentinel species. There is a strong likelihood of biased inference when mink are used for such purposes.

In a recent review, Basu et al. (2007) argued for the use of American mink (*Mustela vison*, now revised to *Neovison vison*; Wilson and Reeder, 2005) as a sentinel species in studies of environmental pollution. Their premise was that mink represent excellent models to address issues related to pollution, as they can provide data on both exposure (i.e., information on type, amount, and availability of contaminants) and effect (i.e., information on sublethal and clinical health responses). To reach their conclusion, Basu et al. (2007) (hereafter Basu et al.) presented several characteristics that make a species a potential "sentinel species", that is a species that can function as a model to assess environmental pollution. These characteristics include widespread distribution, the ability to bioaccumulate pollutants to which they are sensitive, and well-known biology, among others (Table 1).

Although we appreciate Basu et al's attention to this important topic, we contend that mink are not a reliable sentinel species for studies of environmental pollution. A fundamental characteristic of a sentinel species that was overlooked by Basu et al. (i.e., not included in Table 1), is that a sentinel species should be a continuous resident of the environment under evaluation (Landres et al., 1988). This is required because the source of the pollutant being estimated in the sentinel must be confidently assigned to the environment under study. In the case of mink, continuous residency cannot be assumed because of the common and widespread escape of domestic mink from mink farms. Thus, the origins (and therefore exposure to pollutants) of mink sampled *in situ* may actually be unknown.

1. The occurrence of domestic mink in the wild

It has been well known for decades that American mink escape from farms in Europe, and this phenomenon has been studied intensively (Bonesi and Palazon, 2007). Indeed, American mink are not native to Europe but have largely colonized the continent via escape from farms. More recently, we have studied the escape of mink from farms in Canada, and have concluded that its occurrence there is also common and widespread. For example, in southern Ontario, 64% of free-ranging mink sampled were genetically determined to be either of domestic origin, or domestic–wild hybrids (Kidd et al., 2009). We estimate that across Canada in any given year, up to 38% of the mink population harvested by trappers is a farm escapee (Bowman et al., 2007).

Domestic mink escaping from farms can confound studies of environmental pollution. For example, Basu et al. concluded that mink can provide data on spatial trends in environmental Hg

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Table 1
A list of characteristics of sentinel species for studies of environmental health identified as important by Basu et al. (2007).

Widespread distribution
High trophic status
Ability to bioaccumulate pollutants
Maintained and studied in captivity
Captured in sufficient numbers
Restricted home range
Well-known biology
Sensitive to pollutants

Missing from this list is a criterion requiring continuous residence in the environment under evaluation.

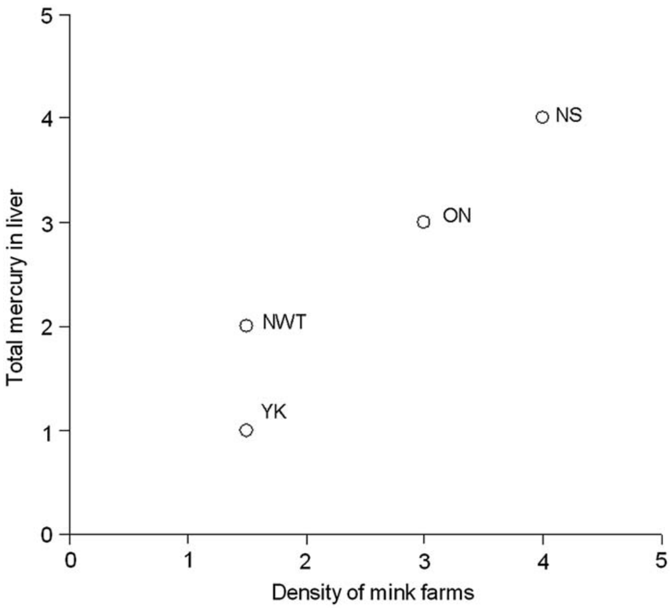

Fig. 1. Mink (*Neovison vison*) farm density and total mercury concentration in livers of free-ranging mink, compared among 4 Canadian jurisdictions. Data on each axis are ranks, from lowest to highest. Mink farm density is based on 2006 data from Statistics Canada (Catalogue 23-013-XIE). Mercury concentrations are an aggregate of studies reviewed by Basu et al. (2007, p. 133), including Evans et al. (2000), Gamberg et al. (2005), Klenavic (2004), Poole et al. (1998), and Yates et al. (2005). Jurisdictions shown are Yukon (YK), Northwest Territories (NWT), Ontario (ON), and Nova Scotia (NS).

pollution (Basu et al., 2007, p. 133). They pointed out that data from several studies of mink show an easterly trend in liver Hg concentrations. This may be so, but there is also a correlation between liver Hg concentrations and the density of mink farms in these same sampled jurisdictions (Fig. 1). This is because of an underlying easterly trend ($r_s = 0.72$, $n = 10$, $P = 0.018$) in the density of mink farms in Canada (Fig. 2). This underlying spatial trend in mink farms is also correlated with escape of mink from farms, and mink harvest by trappers (Bowman et al., 2007). Thus, any inference concerning spatial trends in pollutants estimated from mink can be confounded by the presence of domestic mink. Indeed, it is very likely that burdens of Hg have been under-estimated in eastern Canada because of the greater proportion of domestic escapees in eastern Canadian samples. Although the direction if bias may be negative in this example, the broader issue is that without knowing the level of contaminants of mink feed on farms, it is impossible to know the true direction of any potential bias. Because continuous residency cannot be reliably assumed, it cannot be determined whether all mink sampled actually reflect the pollution in their respective environments.

The exclusion of domestic animals from the trapped samples of mink that are often used in studies of environmental pollution is

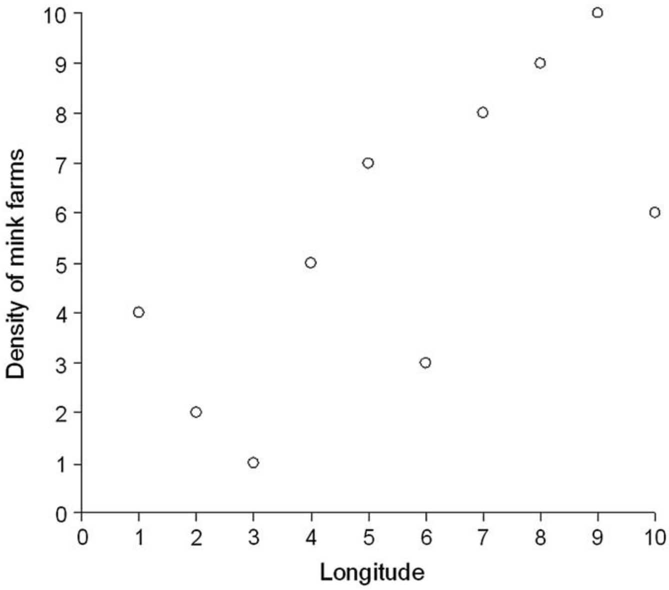

Fig. 2. The longitude of Canadian provinces (at the geographic centroid) compared to the density of mink (*Neovison vison*) farms in each province. Data on both axes are ranks, from lowest (or most westerly) to highest. Mink farm density is based on 2006 data from Statistics Canada (Catalogue 23-013-XIE). There is an easterly trend in mink farm density among the provinces ($r_s = 0.72$, $n = 10$, $P = 0.018$).

not straightforward. Although domestic mink can sometimes be identified by their pelt characteristics, samples donated by trappers are usually skinned, and so this option is not routinely available. Body size could be used as an indication because domestic mink are larger but there is variation in body mass of both domestic and wild mink (Kidd, 2009). Further confounding the use of mass as an index of size is the fact that it appears that domestic mink can lose mass very quickly after escaping from a farm. We have observed the loss of nearly 1 kg in less than 1 month (unpubl. data). A better option may be to use a measure of structural size such as skull length (e.g., Tamlin et al., 2009). Even better, genetic methods could be used (e.g., Kidd et al., 2009), but this adds a costly, time-consuming element to studies of environmental health. Regardless of methodology, it is clear that domestic mink must be excluded from samples taken to characterize environmental pollution. It is not apparent that this step is routinely taken in such studies. We consider it quite likely that escaped domestic mink have been included in many studies of pollution in purportedly wild mink. If we assume that mink originating from mink farms would tend to be less polluted than mink born in the wild in the same geographic area, the inclusion of domestic mink in samples would both contribute to variability in the apparent body burdens of pollutants, and would lower the mean burden. This would lead to the biased inference that the environments being assessed are less polluted than they actually are, and thus mink would be unreliable sentinels.

The issue of escaped domestic mink is particularly relevant for 2 of Basu et al.'s 10 recommendations for using mink as a sentinel species (recommendations 1 and 8). We discuss each of these below.

1.1. Recommendation 1

Basu et al. state that "wild mink" are spread across Europe and South America. They also state that carcasses can readily be obtained from trappers. The implication of these statements is that wild mink can be sampled to provide information on pollution of local environments across Europe and South America.

This is clearly false. All American mink in Europe and South America are either domestic mink or the progeny of domestic mink. This species is only endemic to North America. Furthermore, there is substantial evidence that mink continue to escape from farms at a high rate in many of these jurisdictions (e.g., Hammershøj et al., 2006). Thus, the criterion of continuous residence cannot be easily confirmed. Beyond the issue of continuous residence, we also feel it is inappropriate to suggest using an invasive alien (such as American mink in Europe) as a sentinel for environmental health.

1.2. Recommendation 8

Basu et al. state that ‘‘behavioural tests are a vital component of toxicity programs’’. They argue correctly that it is important to understand how toxins affect behaviour because altered behaviour can be an important sublethal effect of contamination. Although we have not mentioned behaviour in our comment to this point, it has been very clearly demonstrated that owing to pleiotropic effects, the behaviour of domestic mink varies by color line, in a variety of substantial ways. For example, mink of different colors vary in their tendency to behave defensively toward humans (Trapesov et al., 2008). Further, domestic mink very likely have different behaviour than wild mink because domestic animals are often selected for tamability (Trut, 1999). Thus, behavioural data are susceptible to being confounded by domestic mink.

2. Summary

To summarize, we are less confident than Basu et al. that mink can be used reliably as sentinel species in studies of environmental health. We have tried to point out why this is so. Mink farming is a large and global industry. In 2007, nearly 60 million pelts were produced from domestic mink in more than 20 countries. A long history of studies shows that wherever mink are farmed, they routinely escape. Thus, an important criterion for a sentinel species, that of continuous residence in the environment being sampled, cannot be reliably assumed for mink in most jurisdictions. Where this criterion cannot be ensured, we suggest that mink should not be considered a sentinel species.

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