Environmental Research 109 (2009) 940–941

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Commentary

The mink is still a reliable sentinel species in environmental health

Niladri Basu [a,*], Jessica Head [b], Anton M. Scheuhammer [c], Steven J. Bursian [d], Kirsti Rouvinen-Watt [e], Hing Man Chan [f]

[a] Department of Environmental Health Sciences, University of Michigan, Ann Arbor, MI, USA
[b] Cooperative Institute for Limnology and Ecosystem Research, School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI, USA
[c] National Wildlife Research Center, Canadian Wildlife Service, Environment Canada, Ottawa, Ontario, Canada
[d] Department of Animal Science, Michigan State University, East Lansing, MI, USA
[e] Department of Plant and Animal Sciences and Canadian Centre for Fur Animal Research (CCFAR), Nova Scotia Agricultural College, Truro, Nova Scotia, Canada
[f] Community Health Program, University of Northern British Columbia, Prince George, British Columbia, Canada

ARTICLE INFO

Article history:
Received 23 June 2009
Accepted 7 July 2009

We thank Bowman and Schulte-Hostedde (2009) for their useful commentary. As outlined in our paper, mink have several characteristics that support their value as a sentinel species (Basu et al., 2007). Key characteristics of a sentinel species in the field of environmental health are provided in Table 1 of our paper and these were adapted from extensive reviews conducted by academic scientists and government panels (Beeby, 2001; Fox, 2001; LeBlanc and Bain, 1997; National Research Council, 1991; Van der Schalie et al., 1999). As there are few mammalian species that can effectively meet such criteria (Golden and Rattner, 2003), it is no surprise that mink have been recognized as an excellent sentinel by many agencies worldwide. The main assertion by Bowman and Schulte-Hostedde (2009) is that because of the high frequency of ranch escapees, mink are not "a continuous resident of the environment under evaluation" (criteria adapted from a "critique" paper written by Landres et al., 1988), and that this precludes their value as sentinel species. While we agree that the presence of ranched mink in the wild population is a confounding factor for some ecotoxicological studies and should be taken into account when designing environmental research or monitoring studies using mink, we disagree with the conclusion that "the mink is not a reliable sentinel species".

The concept of "residency status", as described by Landres et al. (1988), was concerned with the issue of migratory species. In the context of ecotoxicological monitoring, the criteria of continuous residence ensure that contaminant burdens in sentinel species reflect local levels. As mentioned in our paper, the linear home range of mink is between 1 and 5 km (cited from Lariviere, 1999) and this means that wild mink may offer excellent information on local contamination.

Bowman and Schulte-Hostedde (2009) argue that the presence of domestic mink in the wild population would lead to an underestimation of local pollution levels. They point to their own genetic data, suggesting that 64% of mink sampled in Southern Ontario are domestic or domestic–wild hybrids. However, these data do not address what proportion of trapped mink are recent (<3 months) escapees, first-generation escapees, or escapees that have established themselves in the local ecosystem. Nonetheless, for escapees to thrive it would be expected that they rely on the same prey base as wild endemic mink. Because contaminants such as methylmercury (MeHg) and polychlorinated biphenyls (PCBs) are bioaccumulative and are rapidly assimilated through the diet into tissues (steady-state conditions reached in 2–3 months; Jernelov et al., 1976; Bursian et al., 2006) we would expect that only the most recent escapees may not accurately reflect local contaminant levels. As mentioned by Bowman and Schulte-Hostedde (2009) and from our own experiences, such recent escapees may be identified by careful consideration of fur quality and body size. As stressed in our paper (Recommendation #3), designing monitoring programs with adequate statistical power, careful consideration of demographic information, and preliminary data analysis (e.g., outlier tests) can help improve the quality and accuracy of contaminant monitoring survey results. This may be extended to considering the location and size of nearby fur farms, in relation to targeted monitoring regions. Body burdens of environmental contaminants by less-recent escapees (>3 months) and domestic–wild hybrids are expected to be similar to levels in endemic mink. It is not surprising that a large body of data supports the notion that tissue MeHg and PCB levels in trapped mink do in fact reflect local conditions (Cumbie, 1975; Kucera, 1983; Wren et al., 1986; Foley et al., 1988). Also, the

* Corresponding author. Fax: +1 734 937 7283.
E-mail address: niladri@umich.edu (N. Basu).

0013-9351/$ - see front matter
doi:10.1016/j.envres.2009.07.003

easterly trend in increasing Hg levels across North America observed in mink has been found in other wildlife (e.g., common loons; Evers et al., 1998) and resembles the US EPA's modeled prediction of atmospheric Hg deposition.

Our review also discusses the use of mink for effects assessment in the field, although we suggest that "conclusions from these studies should be drawn cautiously, as the strength of association between exposure to pollutants and changes in population dynamics is generally weak because many other factors, such as habitat loss, disease, and natural cycles, are involved (Fox, 2001; Wren, 1991)." A similar cautionary statement was provided by Landres et al. (1988) early in their paper: "the indicator is a surrogate measure. By definition, indicators may bear no direct or simple cause and effect relationship to the factor or factors of interest". Bowman and Schulte-Hostedde (2009) point to behavioral studies as being particularly problematic in mink. We do not disagree. But, it should be noted that few wildlife species can be studied so readily both in the laboratory and in the field, and while there will always be challenges in extrapolating results from the laboratory to the field, the fact that causal linkages and quantitative exposure-response profiles may be developed in captive mink and then explored in wild animals further reinforces the benefits of mink as a sentinel in environmental health.

References

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.

Beeby, A., 2001. What do sentinels stand for?. Environ. Pollut. 112, 285–298.

Bowman, J., Schulte-Hostedde, A.I., 2009. The mink is not a reliable sentinel species. Environ. Res, in press, doi:10.1016/j.envres.2009.07.004.

Bursian, S.J., Sharma, C., Aulerich, R.J., Yamini, B., Mitchell, R.R., Beckett, K.J., Orazio, C.E., Moore, D., Svirsky, S., Tillitt, D.E., 2006. Dietary exposure of mink (Mustela vison) to fish from the Housatonic River, Berkshire County, Massachusetts, USA: effects on organ weights and histology and hepatic concentrations of polychlorinated biphenyls and 2,3,7,8-tetrachlorodibenzo-P-dioxin toxic equivalence. Environ. Toxicol. Chem. 25, 1541–1550.

Cumbie, P.M., 1975. Mercury levels in Georgia otter mink and freshwater fish. Bull. Environ. Contam. Toxicol. 14, 193–196.

Evers, D.C., Kaplan, J.D., Meyer, M.W., Reaman, P.S., Braselton, W.E., Major, A., Burgess, N., Scheuhammer, A.M., 1998. Geographic trend in mercury measured in common loon feathers and blood. Environ. Toxicol. Chem. 17, 173–183.

Foley, R.E., Jackling, S.J., Sloan, R.J., Brown, M.K., 1988. Organochlorine and mercury residues in wild mink and otter: comparison with fish. Environ. Toxicol. Chem. 7, 363–374.

Fox, G.A., 2001. Wildlife as sentinels of human health effects in the Great Lakes-St. Lawrence basin. Environ. Health Perspect. 109 (Suppl 6), 853–861.

Golden, N.H., Rattner, B.A., 2003. Ranking terrestrial vertebrate species for utility in biomonitoring and vulnerability to environmental contaminants. Rev. Environ. Contam. Toxicol. 176, 67–136.

Jernelov, A., Johansson, A.H., Sorensen, L., Svenson, A., 1976. Methyl mercury degradation in mink. Toxicology 6, 315–321.

Kucera, E., 1983. Mink and otter as indicators of mercury in Manitoba waters. Can. J. Zool. 61, 2250–2256.

Landres, P.B., Verner, J., Thomas, J.W., 1988. Ecological uses of vertebrate indicator species: a critique. Conserv. Biol. 2, 316–328.

Lariviere, S., 1999. Mustela vison. Mammal. Spec. 608, 1–9.

LeBlanc, G.A., Bain, L.J., 1997. Chronic toxicity of environmental contaminants sentinels and biomarkers. Environ. Health Perspect. 105 (Suppl 1), 65–80.

National Research Council, 1991. Animals as Sentinels of Environmental Health Hazards. Committee on Animal as Monitors of Environmental Hazards. National Academy Press, Washington, DC 176 pp.

van der Schalie, W.H., Gardner, H.S., Bantle Jr., J.A., De Rosa, C.T., Finch, R.A., Reif, J.S., Reuter, R.H., Backer, L.C., Burger, J., Folmar, L.C., Stokes, W.S., 1999. Animals as sentinels of human health hazards of environmental chemicals. Environ. Health Perspect. 107, 309–315.

Wren, C.D., Stokes, P.M., Fischer, K.L., 1986. Mercury levels in Ontario mink and otter relative to food levels and environmental acidification. Can. J. Zool. 64, 2854–2859.

Wren, C.D., 1991. Cause-effect linkages between chemicals and populations of mink (*Mustela vison*) and otter (*Lutra canadensis*) in the Great Lakes basin. J. Toxicol. Environ. Health 33, 549–585.