Muskrat (*Ondatra zibethicus*) Interference with Aquatic Invertebrate Traps

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In field biology, interactions between wildlife and *in situ* equipment occur often. These interactions have the potential to induce a variety of behaviours in local fauna. Here, we note the destructive behaviour exhibited by the Muskrat (*Ondatra zibethicus*) following deployment of aquatic invertebrate traps for research purposes at 12 wetlands located in central Saskatchewan. Of 24 aquatic insect emergence traps used on seven wetlands in our study, 14 (58%) required recurring repairs. In addition, on several occasions, leaf litter bags and their anchoring stakes were torn or chewed. The recurring damage took place in wetlands with Muskrat lodges. We recommend structural modifications to aquatic invertebrate traps in wetland complexes densely inhabited by Muskrats and other semi-aquatic rodents.

Key Words: Muskrat; *Ondatra zibethicus*; aquatic insect emergence traps; destructive behaviour; prairie wetlands; leaf litter bags

When conducting field studies, biologists occasionally encounter unexpected obstacles arising from natural causes, such as adverse weather, and wildlife interference. Overcoming these obstacles can require a substantial amount of time, energy, and resources and, in some cases, may result in gaps in data or a complete loss of data. These experiences may prove to be valuable, and lessons learned can be applied to future experimental design.

As part of a 2013 study monitoring aquatic insect emergence and benthic macroinvertebrate communities in agricultural wetlands located near Alvena, Saskatchewan (52°31'0.12"N, 106°1'0.12"W), we deployed standard aquatic insect emergence traps and leaf litter bags (Merritt *et al.* 1996; Dangles and Malmqvist 2004). Our floating traps covered a surface area of 1 m^2 above the water column. They consisted of a wooden frame supporting mesh-netting sides, with a collection funnel and flask at the top (Figure 1A). Unfortunately, the lower ledge of the frame at the water edge consisted of an 8-cm-wide ledge allowing Muskrats easy access for perching or sitting.

Accounts of Muskrat biology and life history in Saskatchewan are well documented (e.g., Messier *et al*. 1990; Virgl and Messier 1992). Muskrats' diet consists primarily of the roots, shoots, and rhizomes of emergent hydrophytes (Virgl and Messier 1992); occasionally, they will migrate to upland habitat to feed on row crops, especially in agricultural wetlands (Bucci 2009). Other feeding habits include the construction of feeding huts or eating platforms. Built from mud and compacted vegetation, these resemble Muskrat lodges, standing just above the surface of the water (Link 2005*).

In multiple instances, an individual Muskrat or a pair moved building materials, such as mud, dead vegetation, and twigs, onto our traps (Figure 1A); this design allowed the animals to move freely on and off the ledge. No damage to the frame of the traps occurred, but the netting that funneled imago insects was slightly torn. To our knowledge, the only other account of Muskrat interference with aquatic traps is Marcström's (1964) description of Muskrats damaging fish traps in northern Sweden.

We collected emergence trap samples every 3–4 days and repaired damaged nets during these collections. At some locations, Muskrats were directly observed damaging a trap on multiple occasions, and this prompted modification of the traps. Subsequently, chicken wire, 2.5-cm mesh (Cable Ben-Mor, Model #94002; Rona, Boucherville, Quebec), was fastened around the outside of the traps and across the bottom to protect the netting.

We acknowledge that the addition of chicken wire mesh structure below the floating trap could have an influence on emerging insects, as several aquatic insect taxa, such as Odonata, require substrate (e.g., emergent vegetation) to achieve the final stage of metamorphosis (Merritt *et al.* 1996). Our placement of emergence traps focused on both open water and emergent vegetation habitats and the method for anchoring each trap was identical. Samples collected from emergence traps — with or without chicken wire — in open water habitats did not contain an overabundance of taxa that require substrate. Also, frequent collection of samples allowed for direct observation of potential bias by searching for insect exuviae attached to the emergence traps. A bias in sampling could be inferred by an overabundance of insect exuviae from substrate emerging insects.

Several times, we observed Muskrats seeking refuge under the emergence traps even after modification.

However, the addition of chicken wire under the trap prevented them from surfacing inside the trap, effectively preventing damage (Figure 1B). Adult Muskrats were unable to enter the trap, although a single juvenile Muskrat was observed moving freely over the side of the chicken wire. This same juvenile collected senesced wetland vegetation to create a resting area (Figure 1C). In addition to nesting materials, fresh vegetation was also found on the traps. With a variety of potential predators in the area (e.g., Coyotes, *Canis latrans*; Red-tailed Hawks, *Buteo jamaicensis*; and humans), this suggests that the floating traps provided a safe vantage point to feed.

We assembled leaf litter bags to monitor shifts in benthic macroinvertebrate communities throughout the growing season. Roughly 10 g of dried leaf litter from senesced native wetland vegetation (e.g., Broadleaf Cattail, *Typha latifolia*) were added to a mesh bag. The bags were anchored in the sediment with 1-m spruce stakes. On multiple occasions, while removing leaf litter bags during the course of our experiment, we observed teeth marks on the spruce stakes (Figure 1D). On four instances during early spring, we found evidence of Muskrats chewing open the leaf litter bags. We are uncertain why they did this, as there was no evidence of them feeding on the contents.

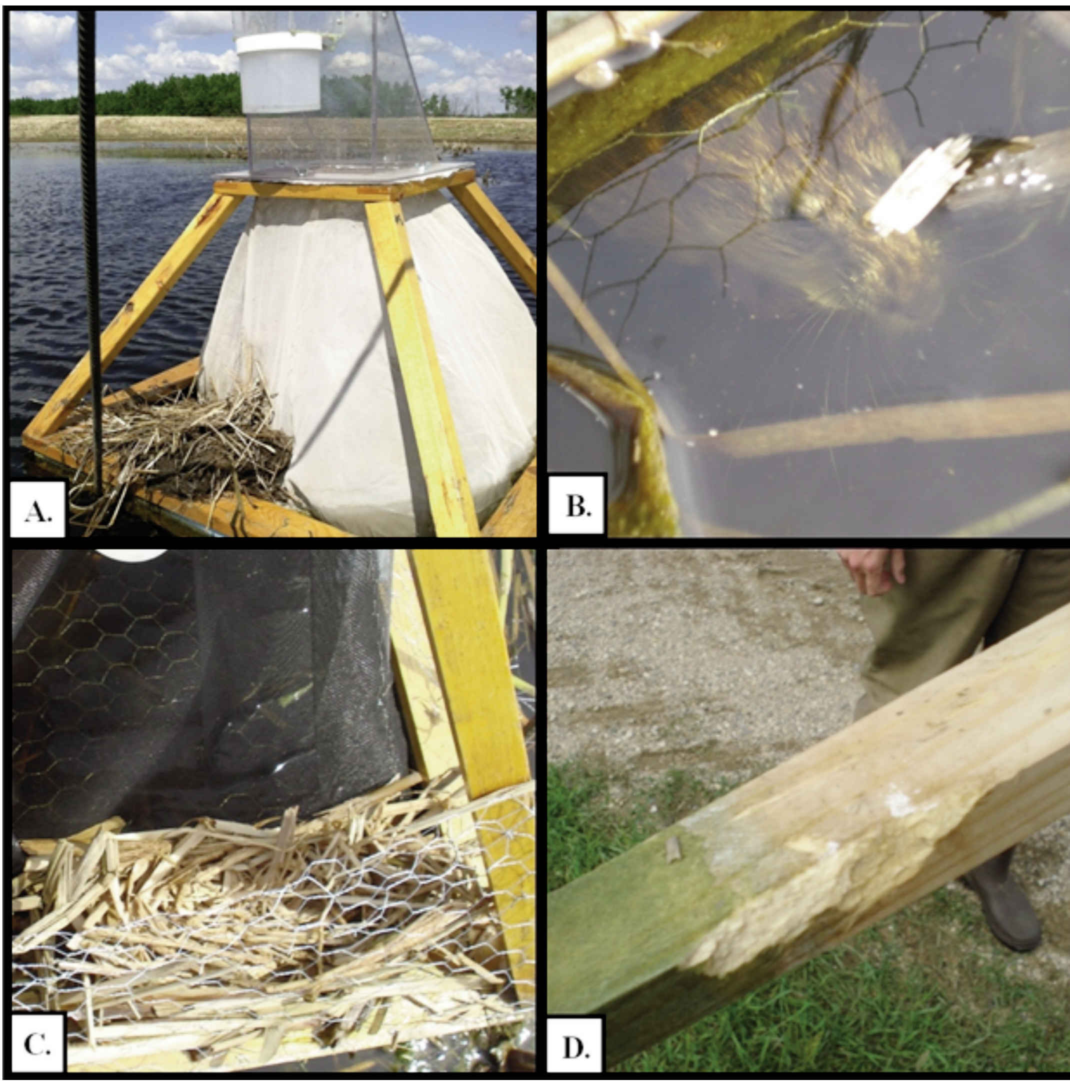

FIGURE 1. (A) Aquatic insect emergence trap (1 m × 1 m) with Muskrat (*Ondatra zibethicus*) building material on its lower ledge. (B) Juvenile Muskrat seeking refuge under an aquatic insect emergence trap. (C) Aquatic insect emergence trap after chicken wire was installed. In this photo, the chicken wire is bent from the juvenile Muskrat moving on and off the trap. (D) Spruce stakes used to anchor the leaf litter bags showing teeth marks and evidence of chewing.

Muskrats display strong territorial behaviour during breeding season; their aggressive behaviour reaches a peak from late April to late May and diminishes in early June (Beer and Meyer 1951). The frequency of our trap repairs was highest from late May into early June, when we suspect invasion of the territory by conspecifics prompted destructive territorial behaviour. Some Muskrats were noticeably agitated by our presence; individual animals were observed sitting on their lodges and chattering their teeth or emitting a sharp, whining noise. Mizelle (1935) recounts observations of swimming muskrats "clapping" their fanned tails on the surface of the water when startled. Other semiaquatic rodents are described as displaying defensive behaviour that involves hissing, whining, or gnashing their teeth toward other individuals (Leighton 1933).

In the absence of aquatic or semiaquatic plants, overwintering Muskrats are known to consume woody material such as tree bark (Lewis *et al*. 2000). The late spring–summer transition that occurred in 2013, our study year, did not support wetland vegetation growth until late May. During winter and early spring, Muskrats do not store food reserves and are confined to foraging beneath the ice (Virgl and Messier 1992). With the lack of available food resources within the wetlands and upland habitat, spruce stakes placed in the wetland flowing ice melt could serve as an easy source of nutrients. However, the leaf litter bags were constructed with nylon and fibreglass mesh (0.25–1 mm), with no apparent nutritional value. Muskrats exhibit feeding plasticity, consuming diverse food items and allowing them to occupy a variety of aquatic ecosystems (Bucci 2009). Like most rodents, they must chew regularly to wear their teeth adequately (Lewis *et al*. 2000). Dental wear in Muskrats is primarily driven by diet and life history strategies — burrowing versus lodging (Lewis *et al*. 2002). Muskrats with varying life history strategies may require greater dental wearing from other activities (e.g., chewing or gnawing woody materials). The dominant plant species at each wetland in our study area, a non-woody monocot, Broadleaf Cattail, might not have been sufficient to achieve dental wearing, which might explain why Muskrats gnawed our stakes and leaf litter bags (Figure 1D).

The spring snow melt in 2013 caused severe flooding throughout Saskatchewan. Reports indicated that, at the height of the flooding, the South Saskatchewan River rose 1.5 m (Water Security Agency 2013*). As a direct effect of this flooding, Muskrats were able to occupy new habitats and move freely throughout their known range. Our field sites in Alvena, Saskatchewan, were roughly 5.5 km from the South Saskatchewan River; thus, flooding may have contributed to a high influx of Muskrats in our study area (F. Messier, University of Saskatchewan Biology Department, August 2013, personal communication).

Based on our experience over the season, we recommend modification of aquatic emergence traps to include a narrower, or nonexistent, perching ledge at the bottom. Where funds are insufficient to construct new traps, shielding the netting and bottom of the traps with chicken wire is effective (Figure 2). As a measure of caution, and to be certain Muskrats cannot gain access to the trap, chicken wire should be firmly attached to all sides and bottom. To prevent damage to leaf litter bags, encasing them in a rigid mesh structure with galvanized wire would fix them to a desirable location, provide protection from Muskrats, and act as a suitable alternative to anchoring with stakes; this strategy could be used in both lotic and lentic freshwater systems. Galvanized wire mesh has been used to protect the soil–surface water interface bordering dams, dikes, canals, and shoreline property from Muskrat burrowing and many state agencies in the United States document these methods in external reports (e.g., Link 2005*). As a final level of precaution, surveys should be conducted to determine whether Muskrats are present before invertebrate traps are installed in wetlands so that modification may be made to protect the traps appropriately. However, because Muskrat lodges are not always apparent, as they are typically hidden within dense emergent vegetation, trap modifications may be made as a preventive measure.

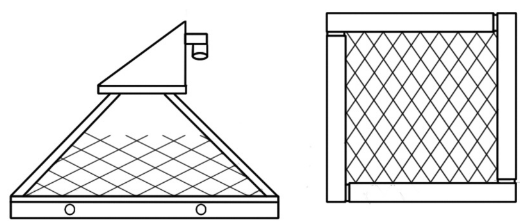

FIGURE 2. Emergence trap with chicken wire fixed to sides and bottom to prevent Muskrat (*Ondatra zibethicus*) entry and damage.

In conclusion, the high Muskrat density in our study area resulted in substantial additional work and time spent during the field season, especially during peak Muskrat breeding season (late April to late May). We hope the advice in this note helps field biologists, entomologists, and wetland scientists planning and executing aquatic invertebrate experiments in habitats occupied by Muskrats or other semi-aquatic rodents, such as beavers.

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