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Small mammal exclosures for studies of hypogeous fungi

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Abstract: Small mammal predation of hypogeous sporocarps ("truffles") make estimates of truffle productivity difficult. To develop effective small mammal exclosures, four screen materials were tested over a 6-week period. Following the test, the selected material, aluminum window screen, was used on 1944 plots in a 2-year study. The failure of only five screens in this study indicates aluminum screen prevents most predation of hypogeous sporocarps.

Key Words: exclosure, hypogeous fungi, mycophagy, northern flying squirrel, northern spotted owl, truffles

Mushrooms and other large fungal fruiting bodies are an important part of the productivity of forest ecosystems. Although they may not represent large amounts of fixed carbon, they can be a vital food source for many mammals (Fogel and Trappe, 1978; Maser et al., 1978). In the Pacific Northwest, such relationships have attracted special attention because hypogeous sporocarps (below-ground fungal fruiting bodies or "truffles") are the main food source of the northern flying squirrel (*Glaucomys sabrinus* (Bachman)) (Maser et al., 1984). The northern flying squirrel, in turn, is a major food source of the threatened northern spotted owl (*Strix occidentalis caurina* (Merriam)) in mesic forests (Carey et al., 1992; Forsman et al., 1991). Productivity of hypogeous fungi, therefore, may influence the owl population by regulating the availability of the flying squirrel's food source.

Several studies on productivity of hypogeous fungi have been reported (Fogel and Hunt, 1979; Hunt and Trappe, 1987; Luoma et al., 1991); however, none of these has accounted for consumption of hypogeous fungi (mycophagy) by small mammals. To the degree that animals remove fruiting bodies of hypogeous fungi from the soil, studies of truffle productivity and standing crop will be biased downward. To overcome this potential problem, we tested four kinds of exclosures to prevent small mammal depredation of hypogeous fungi in study areas: 1) fiberglass window screen, 16 × 18 threads per square inch; 2) aluminum window screen, 16 × 18 threads per square inch; 3) 23 gauge wire hardware cloth of ¼ inch × ¼ inch mesh; and 4) ½ inch × ½ inch mesh hardware cloth.

The exclosures were tested in two stands in which the population of small mammals had been surveyed with trapping grids and the presence of northern flying squirrels had been established (Andrew Carey, pers. comm.). In each stand, two 4-m^2 samples of each of the four materials were laid over four pieces of peanut butter-molasses bait. Four baits were also placed around the edge of each exclosure. One of the two exclosures of each material in each stand was staked down at the edges by 16 penny duplex galvanized nails at 10-cm intervals. Exclosures were left in place for 3 wk, then moved and rebaited for an additional 3 wk.

At the end of each 3-wk period, all unprotected baits at the edge of the exclosures had been consumed indicating local fauna had located the exclosures. All bait under the fiberglass screens had also been consumed. Close inspection revealed that small holes had been chewed in the fiberglass screen directly above the baits. Bait under the aluminum and hardware cloth exclosures remained in place with one exception: bait was gone from under a section of unstaked ½ inch × ½ inch hardware cloth that was not appressed well to the ground. For the other two metal exclosures, the bait underneath was left alone, regardless of edge staking. The hypothesis that screen failure is independent of screen material was rejected ($0.005 < p < 0.001$) using a Chi-square analysis.

These findings suggest that while small mammals are willing to chew through fiberglass, they are not willing to crawl under a metal screen appressed to the ground that they find difficult to chew through. On the basis of these results, we selected the aluminum screen for its flexibility and light weight. We used 216 exclosures of 4-m^2 16 × 18 aluminum window screen in 18 stands. Edges were staked with nails at 10-cm

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intervals to insure that screens conformed well to the ground.

In two years of subsequent use, the exclosures were checked and moved nine times. At each checking date, the area that had been screened and a paired unprotected plot were carefully raked for truffles. Nearly one fifth of the 1944 exclosure plots contained truffles, some with more than 60 *Elaphomyces granulatus* Fries sporocarps in their 4-m^2 area. Truffles were found in 205 exclosure plots and 177 unprotected plots. In stand samples where truffles were relatively scarce (i.e., standing crop biomass less than 1.2 kg/ha), open plots contained only 40% of the biomass of exclosure plots (North, 1993). Many of the exclosures in these low biomass stands showed signs of chewing, but no evidence of successful entry was found.

In the course of 2 yr of sampling, only five of the 1944 exclosures failed. Two were ripped up by elk (*Cervas elaphus* (Linneaus)) and three were chewed through and a small hole was dug beneath into the soil. Evidently, small mammals are reluctant to crawl under screen exclosures if they are well appressed to the ground. These results indicate that aluminum window screen with edges staked to the ground effectively prevents most entry by small mammals.

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