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Factors impacting collar malfunction and collar chewing behavior in gray wolves in Yellowstone National Park

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**Background:** Monitoring and research of wildlife species provides essential data for conservation, but is complicated by variation in behavior and habitat. Among wildlife populations, carnivores are notably difficult to study because of their cryptic nature, use of rugged habitat, and ability to move long distances. Radio collars provide an effective tool to monitor such species. However, deploying collars on animals is logistically challenging, expensive, risky, and can cause short-term stress for both the animal and the humans involved in the capture process. While the overall collar performance and data quality justify their use, they sometimes malfunction. When collar performance is unreliable, it can compromise our ability to monitor individuals effectively. This malfunctioning seems to be more prevalent among some social carnivores. For example, in Yellowstone National Park, elk (*Cervus elaphus*), an herbivorous species, and cougars (*Puma concolor*), a solitary carnivore, have low rates of collar malfunction. Alternatively, gray wolves (*Canis Lupus*), a social carnivore, have higher rates of collar malfunction, sometimes due to wolves chewing off the radio collars on other individuals in their packs. We therefore sought to identify what factors affected whether collars were chewed, malfunctioned, or worked well.

**Methods:** We compiled data from 588 radio collars placed on gray wolves in Yellowstone National Park between 1995 and 2023. For each collar, we classified its performance as *malfunction*, *chewed off*, or *neither* and then used generalized linear mixed models (GLMM) to evaluate the factors that affected collar chewing and malfunctions. We included the baseline factors of collar type (VHF or GPS), manufacturer, and the presence of brackets or studs. Additionally, we also included the ecological factors of pack affiliation, pack size at the time of collaring, the age of the collared animal, and the number of pups present in the pack.

**Results/conclusions:** We found that VHF collars were less likely to malfunction than GPS collars. Age of a collared wolf, however, was an important factor that affected both collar chewing events and malfunctions, with collars on younger wolves showing higher rates of failure. We also discovered that some packs were more likely to chew radio collars, suggesting that chewing is a learned behavior. For example, the Cougar Creek pack accounted for nearly one-third of chewed collars in Yellowstone National Park. Moving forward, we recommend biologists use a mixture of VHF and GPS collars in wolf packs to ensure data collection and contact with the pack. We also recommend targeting mature individuals when possible, especially for more expensive GPS collar that are more prone to fail and in packs with a known history of chewing radio collars.