A Multi-Model Approach to Estimating Wolf Abundance in Montana

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Estimating wolf (*Canis lupus*) abundance is a key component of wolf management in Montana. We developed a multi-model approach to estimate wolf abundance. Our approach eliminates the need for intensive field-based monitoring and introduces biological models of wolf behavior. An occupancy model first estimates annual wolf distribution, based on environmental covariates and wolf observations reported by hunters. A mechanistic territory model predicts territory sizes using simple behavioral rules and limited data for prey resources, terrain ruggedness, and human density. Together, these models predict the number of packs in a given area. Finally, a pack size model demonstrates that pack sizes are generally negatively related to terrain ruggedness, local mortalities, and intensity of harvest management. Total abundance estimates are derived by combining the predicted number of packs and pack sizes. We applied the models to estimate wolf abundance for 2007 – 2019. The population was estimated to have been smallest in 2007, with 91 packs (95% CI = 76 – 107) and 650 wolves (95% CI = 547 – 771). A peak appears in 2011, with a high of 187 packs (95% CI = 170 – 206) and 1254 wolves (95% CI = 1136 – 1383). This coincided with the first years of harvest management, after which the population declined by 7.8% in total abundance between 2011 and 2019. From 2016 – 2019, the population appears to have become somewhat stabilized with an average of 190 packs and 1136 wolves per year, even with an estimated annual harvest rate of >20% in this period.