

# When enough is enough. Optimising monitoring effort for large-scale wolf population size estimation in the Italian Alps

Maria Virginia Boiani<sup>1</sup>, Pierre Dupont<sup>2</sup>, Richard Bischof<sup>2</sup>, Cyril Milleret<sup>2</sup>, Olivier Friard<sup>3</sup>, Matt Geary<sup>1</sup>, Elisa Avanzinelli<sup>4</sup>, Achaz von Hardenberg<sup>5</sup>, and Francesca Marucco<sup>3</sup>

<sup>1</sup>University of Chester

<sup>2</sup>Norwegian University of Life Sciences

<sup>3</sup>University of Turin

<sup>4</sup>Maritime Alps Natural Park

<sup>5</sup>University of Pavia

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## Abstract

The ongoing expansion of wolf (*Canis lupus*) populations has led to a growing demand for up-to-date abundance estimates. Non-invasive genetic sampling (NGS) is now widely used to monitor wolves, as it allows individual identification and abundance estimation without physically capturing individuals. However, NGS is resource-intensive, partly because of the wolf elusive behaviour and wide distribution, but also because of the cost of DNA analyses. Optimization of sampling strategies is therefore a requirement for the long-term sustainability of wolf monitoring programs. Using data from the 2020-2021 Italian Alpine wolf monitoring, we investigate how (i) reducing the number of samples genotyped, (ii) reducing the number of transects, and (iii) reducing the number of repetitions of each search transect, impacted spatial capture-recapture population size estimates. Our study revealed that a 25% reduction in the number of transects or, alternatively, a 50% reduction in the maximum number of repetitions yielded abundance estimates comparable to those obtained using the entire dataset. These modifications would result in a 2,046 km reduction in total transect length and 19,628 km reduction in total distance searched. Further reducing the number of transects resulted in up to 15% lower and up to 17% less precise abundance estimates. Reducing only the number of genotyped samples led to higher (5%) and less precise (20%) abundance estimates. Randomly subsampling genotyped samples reduced the number of detections per individual, whereas subsampling search transects resulted in a less pronounced decrease in both the total number of detections and individuals detected. Our work shows how it is possible to optimise wolf monitoring by reducing search effort while maintaining the quality of abundance estimates, by adopting a modelling framework that uses a first survey dataset. We further provide general guidelines on how to optimise sampling effort when using spatial capture-recapture in large-scale monitoring programmes.

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