

Improved double observer survey method to estimate a mountain ungulate population in Gran Paradiso National Park (Italian Alps)

The double observer (DO) is a common census technique to estimate the abundance of wild animal populations while accounting for the issue of imperfect detection, but it can be costly to perform in large or mountainous areas. Here we used computer simulations to test the reliability of a new proposed census method based on total block counts adjusted with only a few DO surveys in a small proportion of the total area to estimate detection probability without the need for individually tagged animals. We simulated populations including a group size effect on detectability and allowing for possible miscounts during the observations. We also compared the effectiveness of several frequentist and Bayesian approaches to assess detection probability with DO data.

Our method was developed in particular for the Alpine ibex (*Capra ibex*) in Gran Paradiso National Park (GPNP) in the Italian Alps, but it can be widely applied to estimate abundance in other species. Alpine ibex in GPNP have been regularly monitored by park rangers with yearly counts following the same protocol since 1956, but an evaluation of the uncertainty around such counts is lacking. Besides, current ibex census methods do not consider imperfect detection leading to an underestimation of abundance and lower precision in population dynamics studies.

Our method proved to be solid and was able to estimate 90-102% of the actual population from just a few subareas (around 10-15% of the total area), with a similar performance as a complete DO survey in the entire area, while block counts largely underestimated the population. We also found different performances of the various approaches to estimate the detection probability, with larger divergence at low detectabilities. Our results suggest that adjusting total block counts with detectability estimated with DO surveys in a subset of the area is a viable and cost effective census strategy potentially useful for estimating abundance in various wild species traditionally counted with total block counts.