Appendix 1
Detailed description of methods and results
We reviewed the animal ecology literature published between 1864 and February 2012 to look for evidence of animal interactions in alpine areas. Searches were conducted in February 2012 in ISI Web of Knowledge, including the following search terms: (sympatr* OR coexist* OR co-occur* OR competit* OR interact* OR facilitat*) AND (alpine OR subalpine OR tundra) AND (herbivore* OR vertebrate* OR mammal* OR bird* OR avi* OR ungulate*). This search yielded 1467 results, and adding common names of alpine species (ptarmigan*, marmot*, squirrel*, pika*, lemming*, vole*, reindeer, caribou, muskox*, hare* and sheep*) increased this number to a total of 1523 results. After removing spurious items, titles and abstracts were examined to determine article relevance. We excluded papers conducted on a single species, those not conducted in alpine environments (defined as above the tree line), not dealing specifically with interspecific interactions and those analyzing interactions among other trophic levels (non-herbivores) or across trophic levels (except for indirect interactions among herbivores mediated by a different trophic level). After applying these criteria, the list of relevant papers was reduced to 54. Other potentially relevant articles were identified through references cited in the previous set of papers, increasing our list to 74 relevant articles.

Only experimental evidence can be used to conclusively demonstrate competitive or facilitative effects and therefore our meta-analysis was conducted only on the subset of experimental approaches (21 out of the 74). Experimental studies included all those studies using
a manipulative approach, and those reporting natural experiments (Diamond 1983). Experimental studies were discarded if obviously biased; e.g. before-after experiments not accounting for seasonal effects, or non-replicated experiments. We focused on studies reporting changes in abundance as a result of species interactions as they were the most frequent, and included those providing data in a format we could include in the meta-analysis (n = 9). Some studies reported several independent comparisons of a single experimental group with its control (e.g. from different species), so we could include a total of 14 comparisons. When comparisons in a given study referred to different times of year (e.g. wet vs dry season) or to different densities of co-occurring species, we conducted separate analyses under two scenarios; benign (wet season, low density of co-occurring species) or more extreme situations when interactions are more likely to be apparent. Results did not differ between approaches, and we refer here to the harsher conditions only, when most (and more intense) interactions are expected to occur.

As a measure of effect size we used the standardized mean difference (Hedges’ g; Borenstein et al. 2009). Our controls were those situations reporting the focal species occurring alone and experimental treatments were those where the focal species co-occurred with another, so that a positive sign in our effect size would indicate a higher abundance of the focal species when co-occurring with another species. We conducted a random-effects meta-analysis and included the taxonomic group of the focal species (birds, rodents and ungulates) and differences in size between the focal and interacting species as moderator variables to account for potential differences among groups of species. Analyses were carried out using the package metafor (Viechtbauer 2010) in R.14.0 (R Development Core Team).
Appendix 2

Evaluation of publication bias using a funnel plot

Publication bias can be inferred from visual inspection of a funnel plot (Borenstein et al. 2009), where the effect size of each study (the strength and direction of alpine herbivore interactions) is plotted against its corresponding standard error. In the funnel plot, the most precise estimates, typically those from the largest studies are at the top, while the less precise are at the base.

Publication bias can be subjectively inferred from the asymmetry of the funnel shape of the original data. In addition, publication bias can be further corroborated by the trim and fill method proposed by Duval and Tweedie (2000), which estimates the number of missing studies due to publication bias. In our case, the number of missing studies on the right hand side of the funnel (i.e. those reporting facilitation) ranged between 0 and 2 ($R_0$ and $L_0$ estimators, respectively), indicating that two studies might be missing from the right hand side of the funnel. In the figure below, solid circles are original data and open circles represent missing studies due to publication bias, as assessed with the trim-and-fill method.
References


