The health of ecosystems based on the ground beetle

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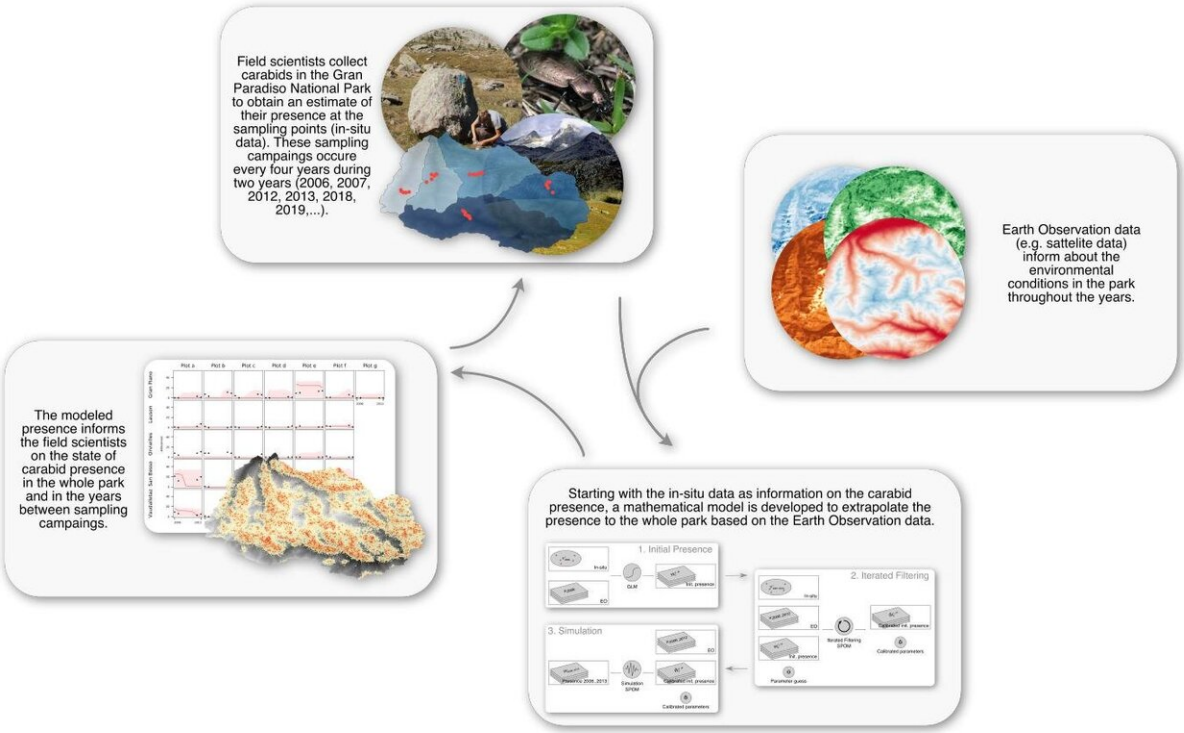
Credit: Ecopotential / Antonello Provenzale

EPFL scientists just published an open tool for predicting the dynamics of ground beetle populations—important bioindicators for sustainable park management and for monitoring ecosystems—in Italy's Gran Paradiso National Park. The tool incorporates satellite and other remote sensing data.

Ground beetles may be creepy, but their presence is usually a sign of a healthy ecosystem and is appreciated for pest control in agriculture. Technically known as carabids, these critters are sensitive to environmental change, so the number of species that one can observe in an ecosystem shows how healthy a habitat is in terms of pollution or diversity of the ecosystem.

In a collaboration with Italian scientists as part of the European project Ecopotential, EPFL scientists built a model to predict the dynamics of two carabid species across the landscape of Gran Paradiso National Park in the Graian Alps, in Northern Italy, now combining field measurement with advanced remote sensing. The results are published in *PNAS* and the open-model is available on GitHub.

"The main result of this work, which I deem important, is to suggest that an integrated ecohydrological framework blending field evidence, both theoretical and remotely acquired, has contributed substantially to our understanding of key indicators of ecological well-being, carabid beetles, in complex environments like iconic mountains," explains Andrea Rinaldo, who leads the Laboratory of Ecohydrology.

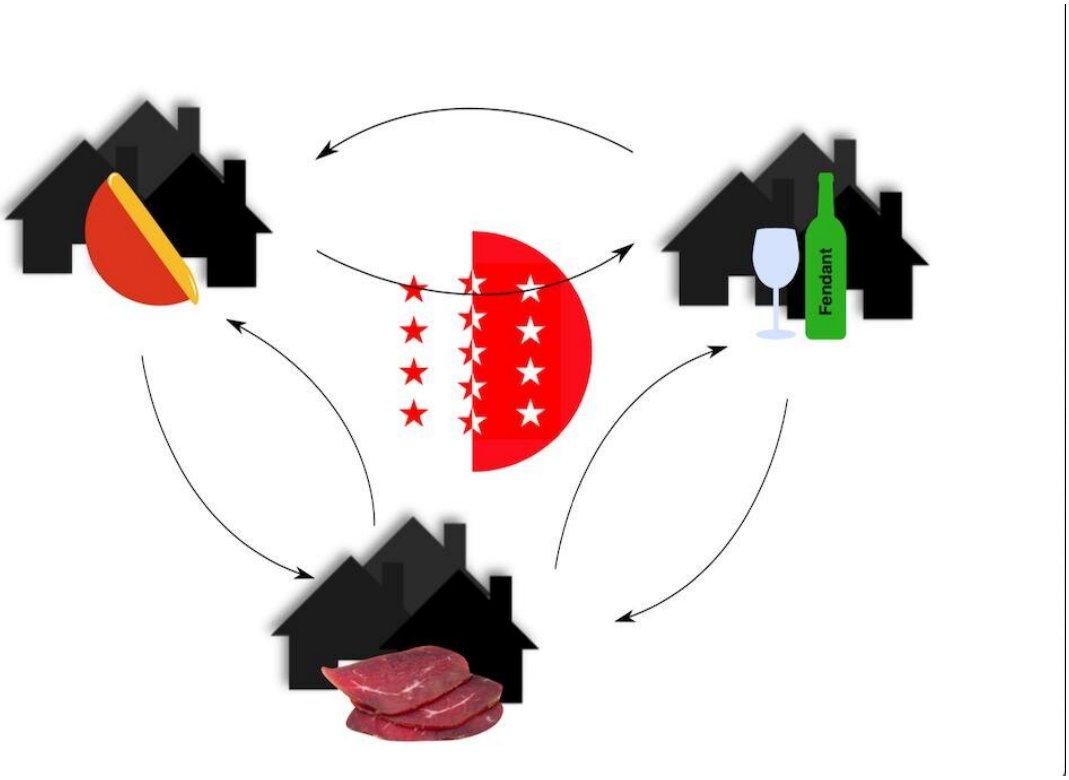


Credit: Ecole Polytechnique Federale de Lausanne

Carabids are classified by scientists to exist in metapopulations, i.e. spatially distinct populations of the same species which need to interact at some level in order to survive. Other examples of metapopulations include butterflies or fish.

The idea behind the EPFL research is to take into account this metapopulation characteristic of the carabid species and match four years of population data as measured by field scientists between 2006 until 2013, in the Gran Paradiso National Park. In order to correctly replicate the field data, the model incorporates advanced environmental data from satellites, plane observations and LIDAR scanning, to include parameters like temperature, solar radiation, forest mapping, vegetation

and humidity. The EPFL scientists focused on the Carabus depressus and Pterostichus flavofemoratus carabid species (data available on dryad), out of an estimated 90 species so far observed in the Italian Park.



An example of metapopulation. A metapopulation relies on the spatial interactions between multiple local populations to persist in a landscape. If a metapopulation were to be represented as a collection of villages in Valais, where each village produces either cheese, wine or dried meat, the whole population would only be able to survive thanks to the exchanges between the villages. The same concept applies here to carabid beetles, where exchanges between local populations must occur in order to keep the species alive as a whole. Credit: Ecole Polytechnique Federale de Lausanne

"The advantage of integrating the dynamics of the species, such as the

metapopulation, is that we don't infer the presence of the species based on environmental drivers alone, but also on interactions between local populations," explains Jonathan Giezendanner, first author of the study. "This means that the species can survive in parts of the landscape although the environmental drivers wouldn't necessarily permit it. This is useful for understanding the lags between environmental change and species behavior."

Knowing the carabid population dynamics and how it evolves over time could potentially help park rangers in their management of the Gran Paradiso Park. The model could be used to predict future dynamics of the carabid species more generally, or any species that exhibit metapopulation behavior.

More information: Jonathan Giezendanner et al. Earth and field observations underpin metapopulation dynamics in complex landscapes: Near-term study on carabids, *Proceedings of the National Academy of Sciences* (2020). DOI: 10.1073/pnas.1919580117

Provided by Ecole Polytechnique Federale de Lausanne

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