A comprehensive framework to assess landscape connectivity for conservation planning

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Résumé

Evaluating landscape connectivity is crucial for guiding conservation agencies and decision-makers to build or ensure coherent networks of protected areas across scales. Traditionally, generic species are used to simplify multi-species connectivity assessments, but tend to over-simplify movement behaviour, likely reducing realism and precision of connectivity model outputs. Despite known limitations in circuit and network theories, commonly used for assessing landscape connectivity, combining them could address their weaknesses. Finally, uncertainty or robustness estimates, essential for guiding decision-making are rarely quantified from those approaches. Here, we propose a versatile framework which first identifies species groups based on species' environmental niches and morphological, biological, and ecological traits and then combines circuit and network theories to assess landscape connectivity for those groups, while integrating uncertainties in modelling choices. Specifically, ecological continuities (i.e., landscape elements contributing to ecological connectivity) are calculated for these groups and used together with group dispersal capacity to derive network-based connectivity metrics for conservation areas. As a showcase, we applied this framework to assess the connectivity of 1619 protected areas in metropolitan France for 193 vertebrate species. Our study revealed that both the protection of ecological continuities and the connectivity of protected areas for 11 mammal and 21 bird groups, respectively, were quite low, with variations among groups. Different protection types contributed unequally to the overall connectivity of group-specific suitable habitats. Considering uncertainty propagation was crucial, as many connectivity metrics varied among repetitions. The proposed modelling framework should enhance decision-making process for spatial planning notably in the context of protected area designation and management by accounting for biodiversity representativeness, landscape functionality and uncertainty in model parameters. Its flexibility

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allows easy application under various environmental conditions, including future scenarios. We demonstrated the urgent need to strategically expand the network of protected areas or the restoration of key ecological corridors in metropolitan France to improve current connectivity of reserves.

Mots-Clés: Circuit theory, dispersal, generic group, metropolitan France, network theory, protected areas, uncertainty, vertebrates