European Commission

Science for Environment Policy

Demand is key to efficiently conserving ecosystems and their services

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Ecosystems provide myriad services upon which human societies and economies depend. However, most efforts to quantify and conserve these **ecosystem services (ES)** focus more on service '*supply*' (functions which potentially benefit humans) than on '*demand*' (human desire for that supply). This study maps supply and benefit for three ES — flood mitigation, crop pollination, and nature-based recreation — in the state of Vermont, northeast USA, and finds that efforts to conserve ES could be more efficient if policymakers consider '*demand*', whilst also decreasing trade-offs with biodiversity protection and conservation.

Safeguarding biodiversity is a key target for many conservation organisations, and a necessary step in maintaining various diverse ES and pushing towards sustainable development. However, it is unclear how both ES and biodiversity can be best protected using the same budgets and across coordinating spatial scales.

Quantifying ES involves both ***supply*** and ***demand***. ***Benefits*** to people arise when these elements interact. For example, while a wetland may dissipate flood peaks, this is only a benefit if people downstream are at risk of flooding — and some demographics will value these services more highly than others.

To this end, the researchers set out to explicitly quantify the consequences of including demand in conservation efforts to safeguard ES and biodiversity[1]. Three ES were chosen — ***flood mitigation***, ***crop pollination*** and ***nature-based recreation*** — but the approach could be applied to a wider range of ES. These three ES are crucial in the mapped area of Vermont, USA, as the state depends heavily on the sectors of food and tourism and recently experienced major flooding. The researchers mapped these ES in terms of supply and benefit (where supply and demand interact), and used an optimisation programme to simulate optimal conservation networks for these ES and for biodiversity.

Conservation costs were approximated based on land value (defined by public tax records for roughly half of the study area, and using a socioeconomic predictive model for the other half). For ***nature-based recreation***, the researchers mapped supply and demand using data on visitation to Vermont state parks, and using geotagged photographs to predict visitation rates to other conserved areas. Demand was represented as population density within a 25-kilometre radius of each site. For ***flood mitigation***, the researchers quantified the supply as the retention of river channel quick-flow (the fast-moving portion of surface runoff most likely to generate a flood), and demand as the number of downstream buildings at risk of flooding. For ***crop pollination***, supply was represented by the abundance of wild bees, which itself depended on the availability of nesting sites and floral resources; for demand, the researchers used a map of pollinator-dependent crops to calculate a distance-weighted sum of these crops in the neighbourhood around each site[2].

The results show that incorporating demand makes conservation efforts targeting ES more efficient — without reducing biodiversity outcomes. It created concentrated pockets of benefit, and shifted the spatial distribution of benefit such that supply acted as a poor proxy.

Importantly, including demand may decrease, rather than exacerbate, trade-offs between ES and biodiversity; for example, conservation actions taken in a small area where there is high demand brought disproportionate benefits, with the remaining budget then available for use in conserving high biodiversity areas. This was true for flood mitigation and crop pollination: in both cases, small pockets of supply provided the most concentrated benefit, with other, larger, areas being comparatively inefficient and providing less.

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1. The study defined this as, rather than diversity of life, the variety of life traditionally prioritised by conservation actions — the component of biodiversity most valued by people. They mapped and quantified this using a statewide map of conservation priorities named BioFinder.

2. This neighbourhood was based on bee foraging distance, the average forage distance being 670 metres.

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Targeting supply also did not capture more biodiversity than targeting benefit, and targeting benefit was more effective in terms of ecosystem services; while this outcome was expected, the results varied across ES. Areas of supply and benefit differed for all three ES (albeit less so for nature-based recreation). Priority areas targeting benefit took up 12.2% and 7.0% of the landscape while capturing 50% and 89% of benefit for flood mitigation and crop pollination, respectively, while, for nature-based recreation, priority areas of supply and benefit were strongly correlated, capturing 17% of benefit each.

Joint targeting of supply, demand, ES and biodiversity greatly improved biodiversity outcomes, with small consequences for benefit. Overall, jointly targeting ES and biodiversity increased the latter by 149% on average, while reducing ES by 13%. However, there is still a biodiversity trade-off in targeting ES: equally weighting ES and biodiversity in multi-factor optimisation models caused a larger trade-off for biodiversity (31% reduction — relative to a single-factor optimisation), than for ES (13% reduction).

As only three ES were analysed in this study, further research is needed to confirm whether these findings are also true of other ES and regions. However, the study's spatial scale — over a US state — is appropriate for policymakers, and the findings have direct consequences for conservation practice: ignoring demand can result in significant missed opportunities. Organisations seeking to protect biodiversity are likely to be more effective in doing so if they consider demand — but they should not assume their actions will have large biodiversity co-benefits unless they explicitly seek these out.

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