Small patches make critical contributions to biodiversity conservation

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Vast areas of the earth’s land surface have been altered by human activities such as clearing native vegetation for agriculture and livestock grazing, logging of natural forests, and land conversion for urban settlements (1). These activities have had profound impacts on biodiversity and on key ecosystem processes (e.g., pollination and nutrient cycling) (2). Many ecosystems have been markedly reduced in extent (often termed “habitat loss”) (3, 4), with remaining areas subdivided into small, isolated remnants (typically termed “habitat fragmentation”) (5). In PNAS, Wintle et al. (6) explore some perspectives associated with the conservation value of small, isolated remnants and demonstrate that they are more important for biodiversity conservation than often recognized.

A large and rapidly expanding scientific literature has accumulated on the effects of habitat loss and habitat fragmentation (e.g., refs. 5, 7, and 8). Based on concepts such as island biogeography theory (9) and species–area relationships (10), a general conclusion from the myriad of studies to date has been that larger and more-intact patches are better—they support more species and larger populations of individual species that are more likely to persist for longer. Part of the explanation for this is that there are more niches and resources and thus more species (and more individuals of those species) in larger patches (10–12). An outcome of these general conclusions has been a focus of conservation efforts on protecting larger and more-intact areas with high levels of landscape connectivity (e.g., wilderness with relatively limited human impact) (e.g., ref. 13). There is no doubt that large, intact patches are vitally important for the maintenance of some key ecological processes (13) and biodiversity conservation (14). However, Wintle et al. (6) counsel against the uncritical application of this approach. The authors demonstrate the high conservation value of small patches, particularly in heavily modified, human-dominated landscapes. In their global analysis encompassing 28 countries, Wintle et al. (6) show that many species would be lost if small, isolated patches of remnant habitat were ignored and conservation efforts were focused solely on large, intact, and highly connected areas. The work of Wintle et al. (6) adds to the array of more spatially limited case studies that likewise highlight the importance of small (and often relatively isolated) patches for conservation (e.g., refs. 15–19).

There are several reasons why small, isolated patches can make an important contribution to biodiversity conservation. First, in some heavily modified ecosystems, small patches are all that remains; no

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large patches exist. Species endemic to these systems must either persist within the remaining small patches or not at all. The critically endangered temperate woodlands of southeastern Australia are one of many examples of such ecosystems. In these environments, which have been 95 to 99% cleared for agriculture and livestock grazing, there are few patches larger than a few hectares in size (20) (Fig. 1). However, ensembles of temperate woodland patches, including those in poor ecological condition, can nevertheless be species-rich (supporting >150 species of birds) (21). Kirkpatrick and Gilfedder (22) showed that small re-
serves (often in poor ecological condition) supported many rare plant species that had been eliminated from the heavily modified
remainder of the landscape. There are many other ecosystems worldwide that have been extensively modified in which small
remaining patches of remnant vegetation make a major contribu-
tion to the persistence of biodiversity (that likely would otherwise
have been lost) in those regions [e.g., natural grasslands in the
United States (4)] (Fig. 1).
A second reason why small patches can be critical for biodiver-
sity is the absence of key processes that drive species
decline elsewhere. For instance, small patches of remnant
native vegetation are vital for the conservation of native land
snails in New Zealand. The size of these areas precludes populations of feral pigs that can be a major predator of snails in large patches (16).
Small patches can play other crucial ecological roles beyond
conserving sets of species that are extinct elsewhere in a land-
scape or region. For example, they can act as stepping stones that
promote connectivity in otherwise highly modified environments
(23). They also can be nodal points for stimulating natural regen-
eration of modified ecosystems, thereby contributing to vegeta-
tion restoration and broader community and biodiversity recovery
(24, 25). In these and other cases, such patches may be as small as
an individual tree (26).
Island biogeography theory, which has been so widely employed
to promote the conservation of large patches, also may be
invoked to highlight the importance of small patches. That is,
under island biogeography theory, in heavily altered and highly
fragmented landscapes there may be “concentration effects,”
with animal populations retreating from a poor-quality surround-
ing matrix (with limited or no resources) (27) and then being re-
luctant to travel into the surrounding matrix, thereby becoming
confined to remaining small patches (28).

The work by Wintle et al. (6) has significant implications for conser-
vation policy and resource management. In particular, it
suggests that while large intact areas can be critical for conserva-
tion, the potential value of small patches should not be ignored.
Such patches will often have substantial conservation value,
precisely because they typically are located in highly modified
environments where only limited areas of original habitat remain
and the species confined to them are absent from elsewhere in
the landscape. However, the management of small and isolated
patches can be particularly challenging, such as protecting them
from invasive species, edge effects, and clearing. Their protection
also can be costly, although there are good examples of where it
has been successful, especially when the public advocates for
(and participates in) enhanced management (29). Investments in
small and isolated patches should be underpinned by cost-benefit
analyses to assess trade-offs involved with interventions relative to
the conservation outcomes. Such analyses also may be important
to assess the opportunity costs for biodiversity conservation arising
from not managing other (sometimes larger) patches. A further
implication of the work by Wintle et al. (6) is that some policies, like
those for biodiversity offsetting, may require reform, as they cur-
rently have an inherent bias against appropriate protection of small
patches (e.g., ref. 30).
Given that major global initiatives like the Aichi Biodiversity
Targets aim to prevent extinctions, Wintle et al. (6) show that a
focus of policy reform by governments must include not only the
protection of large, intact areas but also small, isolated patches
within highly modified environments. In addition, despite the mas-
ive and rapidly increasing literature on landscape change and
habitat fragmentation, it is remarkable how rarely the contribution
to landscape and regional species pools from taxa inhabiting small
patches has been quantified (but see ref. 15). More empirical work
is urgently needed to underpin the case for their conservation.