PERSPECTIVES

CONSERVATION

Dynamic priorities for conserving species

Animals' ranges must be conserved while allowing movement for sustaining biodiversity

By **Jenny L. McGuire**[1,2] and **Benjamin R. Shipley**[2]

Protected areas serve to preserve the remaining biodiversity on our planet. However, today, only about 14% of terrestrial lands are protected, which will not be sufficient to support the planet's fabric of life into the future (*1*, *2*). Humans continue to encroach on the habitats of many plants and animals. Simultaneously, the environmental conditions within protected areas are changing because of shifting climates, pollution, and invasive species, which all fundamentally alter ecosystems globally. To effectively conserve biodiversity, researchers and policy-makers must critically reexamine both the lands being preserved and the protection strategies being used in conservation. On pages 1094 and 1101 of this issue, Allan *et al.* (*3*) and Brennan *et al.* (*4*), respectively, evaluate the preservation capacity of today's protected areas in different but complementary ways. Allan *et al.* estimate the minimum land area necessary to support today's terrestrial biodiversity, whereas Brennan *et al.* identify the connectedness necessary to allow wildlife to successfully adapt to global change.

Many efforts have attempted to identify the most effective land conservation strategies for preserving biodiversity into the future. For example, biologist and naturalist E. O. Wilson famously advocated for a half-Earth conservation strategy, arguing that we must preserve 50% of terrestrial lands to provide sufficient land for species from across the fabric of life to have a sustainable future (*5*). Different conservation approaches prioritize different strategies for preserving biodiversity, focusing on small-ranged species, on regions with the highest number of species, or on regions that serve a specific role such as carbon sequestration (*6*, *7*). As expected, there is broad controversy over these strategies and their implementation. These efforts must consider many factors to decide on the amount of land that needs conserving to preserve biodiversity and the most effective strategies for selecting those lands, including the extent to which humans should be integrated into or excluded from protected areas.

The United Nations Convention on Biodiversity has opted for a step-by-step strategy for expanding protected areas. In 2010, as part of the "Strategic Plan for Biodiversity," they crafted Aichi Target 11, which called on member countries to increase terrestrial land area conservation from approximately 14 to 17% by 2020 "through effectively and equitably managed, ecologically representative and well connected systems of protected areas…" (*8*). The latest Convention, held in 2021, has increased this land area conservation goal from 17 to 30% (*1*). Allan *et al.* and Brennan *et al.* each address a different component of Aichi Target 11.

Allan *et al.* aim to identify an overall target for the amount of land area that needs to be conserved. They calculate the area necessary to simultaneously protect 17% of each distinct habitat type, as prescribed by Aichi Target 11, and a sustainable portion of

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Protected areas must be expanded and connected to conserve imperiled wildlife, such as the Baudrier's Chameleon in Madagascar's Ranomafana National Park, pictured here. Future conservation efforts must involve all stakeholders, including local human populations who rely on the land's natural resources.

each of 35,561 animal species' geographic ranges. On the basis of these criteria, they estimate that 44% of Earth's total terrestrial area must be conserved to maintain today's biodiversity. Currently, 70% of this 44% area is still unaltered by humans. However, future land conversion scenarios indicate that the percentage is shrinking rapidly. For the other 30% of land that would require restoration to conserve biodiversity, predictive scenarios estimate that between 1 and 5% of this land will instead be converted to heavy human use by 2050 (*9*). Allan *et al.* set a concrete baseline goal for conserving biodiversity given current global distributions, identifying specific target regions for intensive and socially conscious increases in conservation action.

Brennan *et al.* take a different approach and address the connectedness of protected areas to inform international sustainability development goals. They consider the dynamic nature of wildlife needs to adapt and migrate in response to ongoing global change. Animal movement across landscapes is necessary for maintaining biodiversity because it allows populations of species to track food sources and interbreed, increasing genetic diversity. Movement is especially critical in these times of dynamic global change because animals must shift their ranges to adapt to human-affected landscapes and changing climates (*10*, *11*). Brennan *et al.* identify the land areas that could effectively create connectedness between current protected areas, allowing animal movement between those regions to increase their chance of survival. By evaluating the isolation of each protected area, they highlight the most important regions for increasing connectivity, notably across large portions of Eastern Europe and Central Africa. Although only a third of critical connectivity areas are currently protected, the identified critical connectivity areas overlap strongly with areas considered to be a high priority for conservation (*12*). Echoing Allan *et al.*'s calls for socially conscious, adaptive conservation strategies, Brennan *et al.* propose that reducing human development in the corridors between protected areas may improve connectivity for mammals more efficiently than would adding new protected areas. This could be achieved through meaningful engagement of local citizens and partial restoration of degraded habitats.

There is little controversy that to maintain the already greatly reduced amounts of biological diversity on Earth, the coverage for protected areas needs to expand. The important questions are how these expansions should be prioritized and how the billions of humans currently living on these lands can be part of the conservation plans. Records of past environmental change demonstrate that both plants and animals will dynamically shift their distributions in response to climate change and human impacts (*10*, *13*). Now that Allan *et al.* have identified the priority areas for preserving the ranges of today's animals, the data must be integrated with those from Brennan *et al.* for promoting movement for animals locally and across broader landscapes (*9*, *11*, *14*). Once those regions are identified, the hard work begins, which involves on-the-ground coordination with local communities to identify strategies that promote coexistence and economic prosperity (*15*).

Together, Brennan *et al.* and Allan *et al.* explore two key components of the Convention on Biological Diversity's Aichi Target 11. Allan *et al.* identify the specific land area required to maintain reasonable range sizes for animals, whereas Brennan *et al.* identify the lands necessary to create and maintain connectivity between existing protected areas. Given the unprecedented rapidity of global change today, both strategies will be critical for maintaining the fabric of life in the near future. ■

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DRUG DISCOVERY

Inhibiting protein synthesis to treat malaria

Covalent prodrugs inhibit protein synthesis targets killing parasites but not human cells

By **Alexander V. Statsyuk**

Although traditionally avoided because of fears about toxicity, there is a renewed interest in covalent drugs that irreversibly bond with target proteins owing to their enhanced potency and prolonged pharmacological effects. Traditional efforts to treat malaria have focused on developing covalent drugs with a radical (arteminisin) and electrophilic (falcipain inhibitors) mechanism of action, but nucleophilic drugs have not been pursued. On page 1074 of this issue, Xie *et al.* (*1*) identify the nucleophilic prodrug ML901, which inhibits protein synthesis in *Plasmodium falciparum* (a parasite that causes malaria) but not in human cells, leading to selective toxicity.

Upon infecting red blood cells, *P. falciparum* consumes the cytosol, which contains 95% of hemoglobin, and accumulates large amounts of heme (*2*). This heme is detoxified through polymerization into hemozoin. Three proteases degrade hemoglobin: plasmipepsin I and II and falcipain. The resulting amino acids are used for protein synthesis in the rapidly diving parasite (see the figure). Traditional drugs quinine and chloroquine act by inhibiting hemozoin formation, but arteminisin relies on heme for its activation (*3*). Heme converts arteminisin into a highly reactive radical, which covalently modifies heme and many other proteins that are essential for the survival of *P. falciparum*. Covalent modification of essential parasite proteins but not those of human cells renders them inactive, leading to selective toxicity (*4*, *5*). Because heme is

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