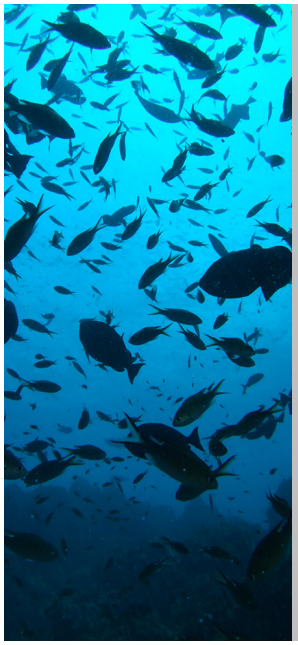

A REVIEW OF EVIDENCE FOR AREA-BASED CONSERVATION TARGETS FOR THE POST-2020 GLOBAL BIODIVERSITY FRAMEWORK

Stephen Woodley*[1], Harvey Locke[1], Dan Laffoley[1], Kathy MacKinnon[1], Trevor Sandwith[2] and Jane Smart[3]

*Corresponding author: stephen.woodley@wcpa.iucn.org

[1]World Commission on Protected Areas, International Union for Conservation of Nature
[2]Global Programme on Protected Areas, International Union for Conservation of Nature
[3]IUCN Biodiversity Conservation Group, International Union for Conservation of Nature

ABSTRACT

Our review of the scientific evidence for large-scale percentage area conservation targets concluded:

1. The 17 per cent terrestrial and inland waters, and 10 per cent marine and coastal targets from Aichi Target 11 of the Strategic Plan for Biodiversity 2011–2020 are not adequate to conserve biodiversity.
2. Percentage area targets cannot be considered in isolation from the quality considerations. Protected and conserved areas need to be selectively located, well governed, and effectively and equitably managed to conserve biodiversity.
3. There is no unequivocal answer for what percentage of the Earth should be protected. Estimates from studies considering a wide set of biodiversity values are very high; well over 50 per cent and up to 80 per cent. Studies that include a narrower subset of biodiversity values are lower, but rarely under 30 per cent, and always with caveats that they are incomplete estimates. Protected area conservation targets should be established based on the desired outcomes (e.g. halting biodiversity loss by 2030).
4. The global protection of a minimum of 30 per cent and up to 70 per cent, or even higher, of the land and sea on Earth is well supported in the literature. The call for 50 per cent of the Earth is a mid-point of these values and is supported by a range of studies.
5. Implementation of large global percentage area targets can be achieved through differentiating the kinds of areas that need protection at a national scale, supported by nationally determined contributions in accordance with local conditions.

Key words: Aichi Targets, Target 11, area-based conservation, post-2020 global biodiversity framework, systematic conservation planning, protected areas

INTRODUCTION

This paper was prepared as a background to considering large-scale conservation targets, as the world heads into the negotiation of the post-2020 Framework for Biodiversity under the Convention on Biological Diversity, scheduled for adoption at the Conference of the Parties in China in October 2020.

We face a global biodiversity crisis. Extinction rates are estimated to be 1,000 times the background rate and future rates could be 10,000 times higher (De Vos et al., 2015). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (Díaz et al., 2019) reports that 75 per cent of the Earth's land surface is significantly altered, 66 per cent of the ocean area is experiencing increasing cumulative impacts, and over 85 per cent of wetlands (by area) have been lost. On average, population sizes of wild vertebrate species have declined precipitously over the last 50 years on land, in freshwater and in the sea, and around 25 per cent of species in assessed animal and plant groups are threatened (Díaz et al., 2019).

The most significant direct drivers of biodiversity loss are habitat loss and fragmentation (changes in land and sea use) and direct exploitation, with over-exploitation being more significant in marine systems. Factors of climate change, invasive alien species, disease and pollution are also important (Díaz et al., 2019). Many of these drivers of biodiversity loss can be managed through area-based conservation, with protected areas and conserved areas (defined by the Convention on

Biological Diversity as 'other effective area-based conservation measures' or OECMs (CBD, 2018)) being the backbone of area-based conservation. Because biodiversity loss is being driven primarily by habitat loss and fragmentation and over-harvest, protected and conserved areas are key policy and practical solutions to biodiversity loss. Area-based conservation may be less effective for addressing some drivers, including widespread pollution, and widespread disease and invasive species.

Setting global priorities for precisely where biodiversity should be conserved is complementary to the question of how much area of land and sea should be conserved. The question of how much land, sea and freshwater to conserve in protected areas and conserved areas (including OECMs under the Convention on Biological Diversity (Jonas et al., 2018)) is central to a larger set of conservation decisions, which include site selection and biodiversity conservation outcomes. In reviewing the percentage area question, the primary consideration must focus on the overall purpose of having such a goal. A reasonable assumption is that the goal of a global protected and conserved area network is to ensure that key drivers of biodiversity loss on land, ocean and freshwater are no longer causing biodiversity loss. Area-based targets should include biodiversity targets (Noss & Cooperrider, 1994) and nature's contributions to sustaining people (ecosystem services including carbon storage). These values are expressed in the 2050 vision of 'Living in Harmony with Nature' for the Strategic Plan for Biodiversity (https://www.cbd.int/kb/record/decision/12268).

Biodiversity, defined as the diversity of genes, species and ecosystems, is distributed very unevenly on planet Earth. For example, the tropics have much higher levels of diversity than the poles, and isolated and island areas

Galapagos marine iguana (Amblyrhynchus cristatus), is unique among modern lizards by foraging in the sea and found only in Galapagos National Park © Dan Laffoley

have higher species endemism because of their isolation. Diversity is a function of overall productivity, water availability, colonisation history and disturbance (Worm & Tittensor, 2018). Therefore the amount of area required to protect biodiversity must be adjusted by this fact of uneven distribution.

Global conservation targets have driven much of the international focus on area-based conservation and there is a rich history of setting conservation targets for protected and conserved areas. Conservation targets have been changing with evolving ideas on biodiversity and ecosystem services and the emergence of sustainable development and conservation biology (Locke, 2018; Sala et al., 2018; Laffoley, 2019). The well-known targets of 10 per cent or 12 per cent of geographical areas, including for countries, natural regions, and vegetation types, were based on representing samples of the Earth's ecosystems and did not include requirements for the persistence of species or ecological processes (Rodrigues & Gaston, 2001). The 10 per cent target originated in 1982, at the Third World Congress on National Parks (Miller, 1984) and was later reinforced at the Fourth World Congress on National Parks and Protected Areas (McNeely, 1993). A 12 per cent target was developed in 1987 with the goal of protecting a representative sample of Earth's ecosystems (World Commission on Environment and Development, 1987).

As conservation biology grew as a discipline, conservation targets continued to include representation but also encompassed broader goals expressed in conservation biology (Noss & Cooperrider, 1994) including:

1. Representing all native ecosystem types in protected areas;
2. Maintaining populations of all native species in natural patterns of abundance and distribution;
3. Maintaining ecological processes such as hydrological processes and fire; and
4. Ensuring resilience to short-term and long-term environmental change.

Aichi Target 11 of the Convention on Biological Diversity contains qualitative language that reflects some of the above goals, including representativeness, connectivity, and areas of particular importance for biodiversity and ecosystem services. But the targets of conserving a minimum of 17 per cent of land and 10 per cent of oceans that are included in Aichi Target 11 were set arbitrarily. The Target 11 percentages were formulated as an interim policy target to encourage progress and push the conservation agenda, while being considered to be achievable.

The IUCN-WCPA Beyond the Aichi Targets Task Force conducted a global survey of conservation scientists in 2018 to explore their perspectives on area-based conservation (Woodley et al., 2019a). It surveyed the membership of the Society for Conservation Biology and received responses from 363 scientists from 81 countries. There was very strong support for large area-based targets from the respondents (78 per cent agreed or strongly agreed they were important) and widespread agreement that the 17 per cent and 10 per cent areas were inadequate (72 per cent agreed).

In recent years, there have been calls for significantly higher global percentage area targets, arguably based on assessing the scientific need for biodiversity conservation. Notable proponents include Half-Earth (https://www.half-earthproject.org/) and the Nature Needs Half movement (https://natureneedshalf.org/) which have been described generically as the movement to protect half the world (Locke, 2018). These efforts are backed by an international coalition of scientists, conservationists and NGOs with the aim of conserving nature at a sufficient scale to allow nature to persist and function for the benefit of all life, including human well-being. A 50 per cent conservation figure is actually not a new idea and was first expressed by the pioneering ecologists, the Odum brothers, almost 50 years ago, "It would be prudent for planners everywhere to strive to preserve 50 per cent of the total environment as natural environment" (Odum & Odum, 1972).

METHODS

This review identified scientific literature relating to area-based conservation targets by searching the titles, abstracts and keywords of publications since 1980 in Web of Science and Google Scholar on 10 July 10 2019, with the keywords "conservation objectives, conservation planning, conservation site prioritization, representation targets, reserve selection, scale analysis, selection of conservation areas, cumulative species—area model, and holistic conservation strategy". Search results were sorted by relevance and the search discontinued when results were determined to be of low relevance. Due to time and resource constraints, our review was restricted to publications in English. The review included published peer-reviewed journal articles and unpublished grey literature, with research findings and conservation plans from around the world covering terrestrial and marine ecosystems. Papers were retained if they contained original research of global or regional

attempts to quantify percentage area targets or systematic or structured reviews of similar papers. The review has been supplemented by other references from known sources.

RESULTS

The search yielded 1,656 papers which were scanned for relevance by title and then abstract. A total of 70 papers were retained and examined in detail, with key papers as listed in Table 1. Rondinini and Chiozza (2010) reviewed methods for setting percentage area conservation targets for habitat types. This is not precisely the same as setting global area-based targets, but the concepts are similar. In general, scientists have used three different types of approaches to determine the area required to conserve biodiversity at large scales, as follows:

Species area curves—The species–area relationship, or species–area curve, describes the relationship between the area of an ecosystem and the number of species found within that area. Larger areas tend to contain larger numbers of species, and empirically, the relative numbers seem to follow systematic mathematical relationships (Brose et al., 2004). The number of species in an area is determined by only four rates: birth, death, emigration and immigration. In his book '*Half Earth*', E.O. Wilson (2016) used species–area curves to argue that half of the Earth should be protected. This is based on global species–area curves where conserving 50 per cent of the Earth would cover 85 per cent of the species on the Earth. If the 50 per cent was configured and located properly, it would cover the species at risk, the endemic species and the naturally rare species. The remaining 15 per cent of species would

Table 1. Key Publications and Conclusions on Global or Regional Percentage Area Required for Conservation Targets

Conclusions	Reference	Approach	Scale and Area
Solution to cover the selected elements equated to protecting a minimum of 27.9 per cent of the global terrestrial area.	Butchart et al., 2015	Global assessment of the minimum needs of all elements of Aichi Target 11	Global—terrestrial
Average values reported for targets from conservation assessments was 30.6 per cent ± 4.5 per cent and for targets using threshold analyses was 41.6 per cent ± 7.7 per cent.	Svancara et al., 2005	Review of the literature – 159 articles reporting with 222 conservation targets	Global—terrestrial
"Several tens of per cent" of the sea is required to meet conservation goals, with an average of 37 per cent, and a median 35 per cent. More than 50 per cent of area required to meet 80 per cent of conservation objectives.	O'Leary et al., 2016	Review of the literature	Global—marine
Set global and regional conservation targets at 50 per cent of the area.	Noss et al., 2012	Review of selected studies of conservation targets	Global
Conserving 50 per cent of the Earth would cover 85 per cent of the species on the Earth.	Wilson, 2016	Species–area curves	Global—terrestrial
"Recent comprehensive conservation plans have delineated around 50 per cent or more of regions for nature conservation."	Pressey et al., 2003	Test of regional conservation goals	Regional—Cape Floristic Region, South Africa
A wildlands design for the southern Rocky Mountains comprises 62 per cent of the ecoregion.	Miller et al., 2003	Systematic conservation planning	Regional—Rocky Mountains, the USA
A retention target is that a minimum of 60 per cent of the entire ecosystem should be conserved in order to avoid a regime shift. Lovejoy and Nobre suggest this be 80 per cent.	Lapola et al., 2014; Lovejoy & Nobre, 2018	Minimum ecosystem size	Regional—Amazon basin
60 per cent of the world's land area (excepting Antarctica) would need to be protected to minimise the extinction risk of the world's terrestrial mammals.	Mogg et al., 2019	Systematic conservation planning using mammals	Global—terrestrial

be lost or survive in the other 50 per cent of the Earth. Species–area curves have not been used extensively in the literature to determine percentage area targets. A review of their uses can be found in Rosenzweig (1995).

Systematic conservation planning — Systematic conservation planning approaches set targets and then select sets of valued ecosystem components, generally species (e.g. Red Listed Species), ecosystem types (e.g. rare or representative) or other abiotic features (e.g. caves or bedrock outcrops) and ecosystem services (e.g. carbon storage). These can then be aggregated to determine an overall percentage area required to meet the selected range of conservation features. Sometimes policy elements are included in these analyses (e.g. redundancy). In contrast to species–area curves, these approaches are bottom-up, rather than top-down. They often require the use of surrogates for the biological features in an area. For example, areas of importance for biodiversity might be selected as Key Biodiversity Areas. Finally, systematic conservation approaches can be applied at a range of spatial scales, from local to regional or global.

In an editorial review of studies on conservation targets, Noss et al. (2012) concluded that conserving 25–75 per cent of a typical region in a natural state was required to conserve biodiversity. Noss et al. (2012) argued that conservation scientists have failed to articulate a bold vision that was based on science, because the numbers are perceived as too high to be socially acceptable. They argued that we should set global and regional conservation targets at 50 per cent of the area, which is slightly above the mid-point of recent evidence-based estimates.

Svancara et al. (2005) conducted a comprehensive review of terrestrial conservation targets, finding 159 articles reporting with 222 conservation targets. They focused on assessing differences between policy-driven and evidence-based approaches. On average, the percentage coverage of an area recommended for evidence-based targets was nearly three times as high as those recommended in policy-driven approaches. Average values reported for targets from conservation assessments was 30.6 per cent ± 4.5 per cent and for targets using threshold analyses was 41.6 per cent ± 7.7 per cent.

Notable for this review is a paper by Butchart et al. (2015), which asked how much of the Earth would be required to achieve the quality elements of Aichi Target 11, and Target 12. The study specifically examined the representativeness of known species groups assessed by the Red List of Species, the representativeness of ecological regions, and KBAs as areas of importance for biodiversity. The conclusion was that an optimal solution to cover the selected elements equated to protecting 27.9 per cent of the global terrestrial area. The paper notes that this is a likely underestimate of the percentage of the land surface required as their selected biodiversity elements did not include all possible species, nor did they consider any ecosystem services.

Ecoregional planning is based on broad goals of conservation biology, including coverage of species and representativeness of ecosystems and ecosystems. When broad conservation goals are considered, many studies call for about half of any given ecoregion to be protected (Noss et al., 2012; Locke, 2014). Examples of comprehensive conservation planning for large regions are instructive for setting global targets. Such studies tend to have far better data sets than global analyses and are based on conserving or protecting selected biodiversity elements (e.g. concentrations or occurrences of rare species), representing all ecosystem types, and meeting the spatial needs of focal species, in particular large carnivores. As an example, in the Rocky Mountains of the USA, systematic conservation planning called for protecting 62 per cent of the entire ecoregion, including 26 per cent of the ecoregion in core areas and much of the remaining area in compatible use and linkage zones (Miller et al., 2003). Reviews of similar studies conducted using ecoregional planning techniques, both globally (Locke, 2013) and more specifically focused on the US (Locke, 2014), generally concluded that about 50 per cent of the area was required to protect the conservation values of any given ecoregion. For example, a plan for the Greater Yellowstone Ecosystem in the USA, which added in explicit population modelling for focal species, concluded that 70 per cent protection of the region was required (Noss et al., 2002). These are high percentage values, but they are based on peer-reviewed estimates of what is required to meet a broad suite of conservation goals, with good data sets.

In marine systems, O'Leary et al. (2016) reviewed 144 studies to assess whether the 10 per cent target contained in Aichi Target 11 for marine protected areas was adequate to achieve, maximise or optimise six environmental and/or socioeconomic objectives. They concluded that it was not adequate. Only 3 per cent of studies met all the objectives with 10 per cent MPA coverage, 44 per cent of studies met all the objectives with 30 per cent coverage, and 81 per cent of studies required more than 50 per cent coverage to meet all the objectives.

Under Aichi Target 11, there has been recent progress is setting aside large no-take protected areas in important areas of high biological diversity © Dan Laffoley

The six objectives considered by O'Leary et al. were:

1. protect biodiversity;
2. ensure population connectivity among MPAs;
3. minimise the risk of fisheries/population collapse and ensure population persistence;
4. mitigate the adverse evolutionary effects of fishing;
5. maximise or optimise fisheries' value or yield; and
6. satisfy multiple stakeholders.

O'Leary et al. also concluded that protecting "several tens of per cent" of the sea is required to meet the conservation goals, with an average of 37 per cent, and a median 35 per cent. Previous reviews (Roberts, 2003 and Gaines et al., 2010) have suggested that 20–40 per cent of coverage by marine protected areas was warranted. They concluded that even the more ambitious target of at least 30 per cent protection called for by the IUCN World Parks Congress 2014 (Wentzel et al. 2016) and its near-unanimous approval by Resolution at the 2016 Hawaii World Conservation Congress is likely insufficient to meet all of the multiple objectives expected of MPA networks. It should be noted that O'Leary et al. do not consider values such as carbon storage, so even these large percentage area targets are likely to be low.

Percentage area targets used in conservation planning are challenging in that they relate to the scale at which they are applied (Pressey et al., 2003). Rodrigues and Gaston (2001) examined the underlying assumptions of using systematic conservation planning to set percentage area conservation targets. They concluded that no single universal target for the minimum percentage of area (such as the 10 per cent) can be appropriate. The actual percentage area is a function of the features that go into the systematic conservation plan. They noted that nations with higher species diversity and/or higher levels of endemism, such as the tropical ones, would require substantially larger

fractions of their areas to be reserved, perhaps up to 75 per cent of the overall area (Mittermeier et al., 1999).

Rodrigues and Gaston (2001) also concluded that a minimum conservation network that is sufficient to capture the diversity of vertebrates will not be sufficient to conserve biodiversity in general because many other more diverse groups with higher levels of local endemism (including plants and many groups of invertebrates) are expected to require considerably larger areas to be fully represented. Even studies that come up with large percentage area numbers often leave important elements out of the calculation.

The third key conclusion from Rodrigues and Gaston (2001) was about the size of selection units (e.g. grid cell size). Small selection units will lead to smaller percentage area targets because the ecological feature can be represented in a small area. However, this is likely misleading as the area will not be ecologically viable for the feature or species in question (Pimm & Lawton, 1998). For large selection units (e.g. the often used 1° ´ 1° or approximately 12,000 km²), it is predicted that 74.3 per cent of the global land area and 92.7 per cent of the tropical rainforests would be required to represent every plant species once, and 7.7 per cent and 17.8 per cent for higher vertebrates.

Rodrigues and Gaston point out some of the challenges in using systematic conservation planning. More importantly they conclude that the inclusion of all species and ecological features in a realistic way always leads to a conclusion that very high percentage area targets are required to conserve biodiversity.

In a global gap analysis, Rodrigues et al. (2004) concluded that "the percentage of area already protected in a given country or biome is a poor indicator of additional conservation needs. They found that current protection levels should not be used as a significant criterion to guide priorities for allocation of future conservation investments." This is because protected areas are often not established in locations where they can make a significant conservation impact.

The most comprehensive analysis to date (Butchart et al., 2012) of protected area coverage of important sites for biodiversity (specifically, Important Bird & Biodiversity Areas [IBAs], and Alliance for Zero Extinction [AZE] sites) showed that the proportion of protected areas which are IBAs or AZEs has been decreasing over time since the 1980s. Recent re-analysis shows that this negative trend has continued over the 2011–2019, that is, the timeframe of Aichi Target 11. This trend has been accompanied by a flattening of the

Botswana's Moremi Game Reserve protects a population of the endangered African wild dog (*Lycaon pictus*) © Alison Woodley

percentage of IBA and AZE sites which are protected over the same time period (Bonga arts, J., 2019. IPBES, 2019).

Mogg et al. (2019) used IUCN Red List criteria to assess area-based conservation targets that would minimise the extinction risk of the world's terrestrial mammals. They concluded that approximately 60 per cent of the Earth's non-Antarctic land surface would require some form of protection to conserve land mammals. They concluded that the Aichi targets will be inadequate to secure the persistence of terrestrial mammals and suggest the need to implement a connected and comprehensive conservation area network, guided by targets based on species persistence.

Several analyses have shown persistent biases in establishment of protected areas away from places important for halting biodiversity loss, and towards places that are "residual"—that is, large, cheap areas not demanded by any other uses of land (Joppa & Pfaff, 2009; Venter et al, 2014) or sea (Devillers et al., 2015). Thus, area protected alone is not a complete metric of conservation. It must be accompanied by a focus on area of importance for biodiversity.

The achievement of large percentage targets is also conflated by concerns over the quality of the protected areas in delivering conservation outcomes after establishment. Leverington et al. (2010), in a study of 8,000 protected areas globally, reported that 40 per cent have significant weakness in management. Sound management is critical to biodiversity outcomes in protected areas on land (Geldmann et al., 2018) and sea (Gill et al., 2017). Sala et al. (2018) reviewed progress on

marine conservation targets and concluded progress was often illusory because many reported protected areas allow fishing and other extractive activities and thus have minimal conservation benefits. They reported that although 7 per cent of the ocean was reported as protected, only 3.6 per cent of the ocean MPAs were implemented, and only 2 per cent of the ocean were strongly or fully protected MPAs. After creation of a few large no-take reserves in the last few years, these numbers have increased to 4.8 per cent of the ocean in implemented MPAs, and 2.2 per cent of the ocean in fully protected MPAs (mpatlas.org). Additionally, Aichi Target 11 calls on implementation of conservation targets to include concerns for social justice, specifically equity. The percentage area conserved may increase as a result of including additional socioeconomic factors to the biological one (Gurney et al., 2015).

Drawing on these concerns, Visconti et al. (2019) have proposed instead focusing solely on quantitative site conservation targets for their desired outcomes, rather than on percentage protected area. Specifically, they suggested a target as "The value of all sites of global significance for biodiversity, including key biodiversity areas, is documented, retained, and restored through protected areas and other effective area-based conservation measures", which they argued would constitute the post-2020 site conservation target most likely to deliver positive benefits for biodiversity. Woodley et al. (2019a) argued that, in addition to a focus on quality, a focus on ambitious percentage areas targets was also required to inform decision makers of the scale of conservation required for science-based targets and to drive ambition.

Minimum sizes of ecosystems to avoid regime shifts

A third general approach to consider percentage area conservation targets is the minimum area required to maintain an intact, functioning ecosystem. This approach includes examining what area is required to maintain the ecological conditions necessary to avoid a regime shift (Rocha et al., 2018) or to maintain a keystone species. Perhaps the best example of this minimum ecosystem size approach is from the Amazon region (Lapola, 2014; Davidson et al., 2012). The Amazon river system produces about 20 per cent of the world's freshwater discharge, and holds about 100 billion tonnes of carbon. Because the Amazon forest transpires so much water, it generates its own rainfall with a wave pattern across the basin. It is predicted that a loss of 40 per cent of the tree cover in the basin (which means a new loss of 20 per cent to add to the current 20 per cent lost) would cause an irreversible change in the entire basin, causing it to change from forest to savannah. So, in this case, a minimum of 60 per cent of the entire ecosystem should be conserved. Lovejoy and Nobre (2018) call for a higher amount of 75–80 per cent forest retention in the Amazon due to the synergies of widespread use of fire, climate change and deforestation.

In addition to the above three approaches, many authors are calling for the retention of intact ecosystems for a range of natural values, including forests (Watson et al., 2018). Intactness targets are based on what remains. For example, there is a call to conserve all the remaining intact forests (Watson et al., 2018).

Canada's boreal forest is one of the largest and most intact ecosystems on the planet. It is a vast storehouse of carbon, and hosts a breeding bird population of 1–3 billion. The boreal forest's Woodland caribou are highly sensitive to human disturbance and a keystone species. They are a good example of a species-based tipping point. It has been calculated that at least 65 per cent of a boreal caribou range should remain undisturbed to provide a 60 per cent probability of retaining Woodland caribou in the system (Environment Canada, 2011). As with the Amazon, a very high retention figure is needed to maintain even basic values in this large ecosystem.

Existing and developing international policy guidance on conservation targets

A key outcome of the IUCN World Parks Congress 2014, held in Sydney, Australia, was the Promise of Sydney, which included the following statement: "Governments and peoples must move far beyond the Aichi targets to adaptive conservation systems that are based on halting biodiversity loss (Aichi Target 12). This must be done through balancing biodiversity and human needs. We need to increase conservation until biodiversity loss is halted. The total area of protected areas and connectivity lands needs to be far higher than current conceptions and delegates agreed on the importance of setting ambitious targets. Percentage area targets are problematic in focusing on area at the expense of biodiversity objectives. Nonetheless, many delegates argued that these should be around at least 30 per cent of the planet for no-take reserves, 50 per cent overall protection, and 100 per cent of the land and water managed sustainably."

Following Sydney, IUCN members passed a resolution WCC-2016-Res-050-EN—Increasing marine protected area coverage for effective marine biodiversity conservation (IUCN, 2016a). This widely supported resolution called for the following:

Canada's Gwaii Haanas National Park Reserve and Haida Heritage Site protects temperate old growth rain forests © Stephen Woodley

- ENCOURAGES IUCN State and Government Agency Members to designate and implement at least 30 per cent of each marine habitat in a network of highly protected MPAs and other effective area-based conservation measures, with the ultimate aim of creating a fully sustainable ocean, at least 30 per cent of which has no extractive activities, subject to the rights of indigenous peoples and local communities;
- ENCOURAGES the Parties to the CBD to consider a new process for developing post-2020 targets to increase the percentage of marine areas highly protected to 30 per cent by 2030.

The history and rationale for the development of marine conservation targets were reviewed by Laffoley (2019). Note that Resolution CC-2016-Res-050-EN establishes IUCN policy for marine protection of at least 30 per cent in highly protected or no-take reserves, and calls for upgraded sustainable management on the rest of the ocean.

In 2019, with adoption of COP Decision 14/8, the Convention on Biological Diversity adopted a definition and criteria of Other Effective Area-based Conservation Measures (OECMs). Adding OECMs to protected areas should make large area-based conservation more achievable. (In this paper we refer to OECMS as conserved areas.)

A key implementation challenge for large percentage area targets is that many areas of the terrestrial world are too developed to consider such targets. To deal with the implementation challenge that one simple percentage target does not fit all the various conditions of the world, the IUCN-WCPA Beyond Aichi Targets Task Force has developed an enabling framework that would operationalise local conservation objectives once a global percentage target is set. The Three Global Conditions for Biodiversity Conservation and Sustainable Use (Locke et al., 2019) are Cities and Farms, Shared Lands and Large Wild Areas. The conservation policy objectives, which vary by condition, include the following:

- Cities and Farms: Secure endangered species, protect all remaining primary ecosystem fragments, maintain pollinators, increase ecological restoration. Mainstream sustainable practices such as nitrogen use reduction and urban planning for compact cities that protect good farmland and provide access to nature for urban dwellers' health and well-being.
- Shared Lands: Establish "ecologically representative and well-connected systems of protected areas … integrated into the wider landscape" (from Aichi Target 11); restore and maintain ecological processes and viable populations of native species (increase area protected and conserved to 25 per cent to 75 per

cent of ecoregion). Practise sustainable resource extraction outside, but integrated with well managed and properly funded protected area networks and sustainable tourism. Local livelihoods include use of wildlife where appropriate and sustainable.

- Large Wild Areas: Retain overall ecological integrity and associated global processes such as carbon storage and rainfall generation, fluvial flows and large migrations; prevent further fragmentation allowing only rare nodes of intense industrial development enveloped in a largely wild matrix. Remove and restore anomalies. Control invasive species as needed. Secure Indigenous knowledge and livelihoods.

Intended for simultaneous use, these conservation responses and sustainable practices offer a coherent basis for common national actions and international cooperation to protect the "Earth ecosystem". Countries with similar conditions have similar responsibilities and options for domestic action. Developed nations can also support efforts elsewhere, especially when their trade footprints cause biodiversity loss in other countries. Such an approach could enable a single global percentage target that is then applied appropriately across all Three Conditions.

A recent paper by Dinerstein et al. (2019) calls for a new global deal for nature where 30 per cent of the planet is protected in well-located and well-connected systems of protected areas, and an additional 20 per cent of the protected area is focused on conserving ecosystems of high carbon value. This combined approach aims to tackle threats to nature from climate change and mass extinction. This call is consistent with IUCN policy statements in the Promise of Sydney and

Italy's Gran Paradiso National PARK was established to protect the endangered Alpine ibex (Capra ibex), and was the source population to successfully re-establish the species in Europe. © Stephen Woodley)

Resolution WCC-2016-Res-050-EN for marine areas. In addition, with significant and accelerating impacts from climate change in polar, temperate and tropical ocean regions, there is a strong case that a new global deal for nature should also include an additional 20 per cent of climate-sensitive management in the marine world (Laffoley—pers comms; Dinerstein, 2019) as an essential element of an overall truly sustainable approach. Nature conservation on 30 per cent or 50 per cent of the land and sea must work in harmony with sustainability approaches on the entire planet.

DISCUSSION

The key conclusions of this review, applicable equally to terrestrial, marine and freshwater ecosystems, are as follows:

1. The 17 per cent terrestrial and 10 per cent marine targets from Aichi Target 11 are not considered adequate to conserve biodiversity by any research, either on sea (O'Leary et al., 2016; Klein et al., 2015) or on land (Butchart et al., 2015; Rodrigues & Gaston, 2001; Noss et al., 2012; Svancara et al., 2005). Even with the best siting of protected areas, there is simply too much species diversity and too high levels of endangerment to cover these elements in relatively small percentages of the global surface. Almost universally, when conservation targets are based on the research and expert opinion of scientists, they far exceed targets set to meet political or policy goals (Svancara et al., 2005; Noss et al., 2012). This is supported by a global survey of conservation scientists conducted in 2017, who massively supported very large percentage area targets to conserve biodiversity (Woodley et al., 2019a).

2. Percentage area targets cannot be considered in isolation from the quality considerations presented in Aichi Target 11. There is concern that a focus on percentage area targets might draw away from a focus on quality (Visconti et al., 2019). Protected and conserved areas are policy tools to achieve nature conservation and need to be selectively located, properly designed, equitably governed, and effectively managed in order to achieve biodiversity outcomes. Questions of ecological design, equitable governance and management effectiveness that lead to conservation outcomes are included in the IUCN Green List of Protected and Conserved Areas Standard (IUCN and World Commission on Protected Areas (WCPA), 2017; Hockings et al., 2019). The question of where to locate protected and conserved areas is too complex for this review, but there is good agreement in the literature that they should focus on areas of importance for biodiversity, including Key Biodiversity Areas (IUCN, 2016b), EBSAs (https://www.cbd.int/ebsa/), significant ecosystem services, and equivalent national and open ocean priorities.

3. There are different approaches to considering percentage area targets, but all approaches call for much higher percentage area targets than are currently in Aichi Target 11. There is no one unequivocal answer to the question of what percentage of the Earth, or a region, should be protected in order to maintain biodiversity. The answers are complicated by spatial scale, patterns of biodiversity and weaknesses in selection approaches. The answers are further complicated by the selected conservation values used in systematic conservation planning approaches. Each selected conservation element raises the percentage targets. For example, selecting only for endangered or rare biodiversity elements will result in a lower percentage area than if ecological connectivity or ecosystem services are also considered. Studies that include a more complete set of values are universally very high, well over 50 per cent and up to 80 per cent. Studies that include a narrower subset of biodiversity values result in lower percentage area targets, but are never under 30 per cent and always include caveats that they are likely inadequate and represent minimum estimates. As such, protected area conservation targets should be established based on the desired outcomes (e.g. halting biodiversity loss by 2030). It is clear in this respect that decisions already taken by the global conservation community on, for example, at least 30 per cent protection of the ocean, can only be way points to what is really needed to address current crises in biodiversity and climate.

4. Large area-based targets should never be considered as percentages for percentages' sake. They should always be determined and implemented, whether at the global, regional or local scale through systematic conservation planning or other science-based approaches. However, there is strong evidence that percentage targets materially increase national conservation efforts. Target 11 is being seen as one of the most successful targets reached (Green et al., 2019) including in mega-diverse countries (Bacon et al., 2019). Area targets alone are insufficient to halt biodiversity loss, and must be

accompanied by a focus on quality, notably the equitable governance and effective management of systems of protected and conserved areas. Protected and conserved areas must also be carefully located in areas where they make a conservation impact for nature conservation. It is clear we need a dramatic increase in both the quality and quantity of protected and conserved areas as an essential means to halt and reverse the catastrophic loss of biodiversity that is undermining all life on Earth. They must also be set in truly sustainable actions across the entire ocean and land space to realise the true benefits.

5. The key conclusion from this review is that the calls for the global protection of a minimum of 30 per cent and up to 70 per cent or even more of the land and sea on Earth are supported in the literature (after removing outliers) whether through studies based on species–area curves, systematic conservation planning or minimum system size approaches. Importantly, these suggested higher conservation targets are not discounted in any of the biodiversity literature. The call for conserving 50 per cent of the Earth is a mid-point of these values and is supported by a range of studies. More importantly, there are no studies that argue that we can maintain biodiversity with low percentage coverage targets. There is consistent scientific agreement that very large-scale conservation is required to deal with the known drivers of biodiversity loss. Suggested conservation targets of 30 per cent or 50 per cent or even 70 per cent, while not based on precision, are consistent with scientific literature on what is required to conserve biodiversity.

ACKNOWLEDGEMENTS

The research underlying this article was commissioned by the IUCN World Commission on Protected Areas Beyond the Aichi Targets Task Force with funding provided by a Gordon and Betty Moore Foundation grant to the Yellowstone to Yukon Conservation Initiative which sponsors the Task Force.

ABOUT THE AUTHORS

Stephen Woodley is an ecologist, who has worked in environmental conservation as a consultant, a field biologist, researcher, and first Chief Scientist for Parks Canada. He has worked on ecological monitoring, species at risk, wildlife disease, ecological restoration, science policy and climate change. In 2011, Stephen began working as Senior Advisor to the Global Protected Areas Programme of the IUCN and continues that work as Vice Chair for Science and Biodiversity of IUCN's World Commission on Protected Areas. The work focus is to understand the role of protected areas as solutions to the current global conservation challenges.

Harvey Locke is Chair of the IUCN-WCPA's Beyond the Aichi Targets Task Force. For the last three years, he has led international consultations on post-2020 conservation targets to protect the earth. He is a global leader in the field of parks, wilderness, and large landscape conservation. He is co-founder of the Yellowstone to Yukon Conservation Initiative and the Nature Needs Half Movement. Named one of Canada's leaders for the 21st century by Time Magazine, he has received many awards for his work including IUCN's Fred M. Packard International Parks Merit Award. He lives in Banff National Park, Canada.

Dan Laffoley a respected leader on Marine Protected Areas and ocean conservation. Scientist, communicator, explorer and conservationist, he is Marine Vice Chair for IUCN's World Commission on Protected Areas, and Senior Advisor on Marine Science and Conservation in the Global Marine and Polar Programme. For over 30 years Dan has been responsible for the creation of many global, European and UK public and private partnerships, and frameworks that underpin modern-day marine conservation. This work includes the concept of Blue Carbon, action on ocean warming and acidification, World Heritage and High Seas conservation, and global guidance on MPAs and MSP.

Kathy MacKinnon is the elected Chair of IUCN's World Commission on Protected Areas. She has spent a lifetime working on protected and conserved areas, from early fieldwork to being the biodiversity specialist at the World Bank. She cochairs the WCPA Task Force on other effective area-based conservation measures (OECMs), and works with Convention on Biological Diversity on a Global partnership for Aichi Target 11. Dr. Mackinnon received the MIDORI prize in 2019.

Trevor Sandwith is a South African ecologist and nature conservation strategist who promotes the integration of protected and conserved areas in sustainable economic and social development. He has experience in the governance and management of protected area systems, and in mainstreaming biodiversity considerations into development policies and planning. At international level, he has specialized in transboundary governance of protected areas and in seeking recognition of ecosystem-based approaches to

address climate change. He is Director of IUCN's Global Protected Areas Programme.

Jane Smart OBE leads IUCN's Biodiversity Conservation Group comprising the Global Species Programme, Global Protected Areas Programme and the World Heritage Programme. She is also Director of IUCN's Global Species Programme. She is leading the development of the IUCN position on the Post-2020 Global Biodiversity Framework.

REFERENCES

Bacon, E., Gannon, P., Stephen, S., Seyoum-Edjigu, E., Schmidt, M., Lang, B., Sandwith, T., Xin, J., Arora, S., Adham, K.N. and Espinoza, A.J.R. (2019). Aichi Biodiversity Target 11 in the like-minded megadiverse countries. *Journal for Nature Conservation* 51: 125723. doi.org/10.1016/j.jnc.2019.125723

Bongaarts, J., 2019. IPBES, 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science□Policy Platform on Biodiversity and Ecosystem Services. Population and Development Review, 45(3), pp.680-681.

Brose, U., Ostling, A., Harrison, K. and Martinez, N.D. (2004). Unified spatial scaling of species and their trophic interactions. *Nature* 428:167–171. doi:10.1038/nature02297.

Butchart, S.H., Clarke, M., Smith, R.J., Sykes, R.E., Scharlemann, J.P., Harfoot, M., Buchanan, G.M., Angulo, A., Balmford, A., Bertzky, B. and Brooks, T.M. (2015). Shortfalls and solutions for meeting national and global conservation area targets. *Conservation Letters* 8(5): 329–337. doi.org/10.1111/conl.12158

Butchart, S.H., Scharlemann, J.P., Evans, M.I., Quader, S., Arico, S., Arinaitwe, J., Balman, M., Bennun, L.A., Bertzky, B., Besancon, C. and Boucher, T.M. (2012). Protecting important sites for biodiversity contributes to meeting global conservation targets. *PloS One* 7(3): e32529. doi.org/10.1371/journal.pone.0032529.

CBD (2018). Decision Adopted by the Conference of the Parties to the Convention on Biological Diversity14/8. Protected areas and other effective area-based conservation measures. CBD/COP/DEC/14/8. 30 November 2018.

Davidson, E.A., de Araújo, A.C., Artaxo, P., Balch, J.K., Brown, I.F., Bustamante, M.M., Coe, M.T., DeFries, R.S., Keller, M., Longo, M. and Munger, J.W. (2012). The Amazon basin in transition. *Nature* 481(7381): 321. doi:10.1038/nature10717.

De Vos, J.M., Joppa, L.N., Gittleman, J.L., Stephens, P.R. and Pimm, S.L. (2015). Estimating the normal background rate of species extinction. *Conservation Biology* 29(2): 452–462. DOI: 10.1111/cobi.12380

Díaz, S., Settele, J., Brondízio, E., Ngo, H., Guèze, M., Agard, J., Arneth, A., Balvanera, P., Brauman, K., Butchart, S. and Chan, K. (2019). *Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. United Nations. Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Seventh session, Paris, 29 April–4 May 2019. IPBES/7/10/Add.1

Dinerstein, E., Olson, D., Joshi, A., Vynne, C., Burgess, N.D., Wikramanayake, E., Hahn, N., Palminteri, S., Hedao, P., Noss, R. and Hansen, M. (2017). An ecoregion-based approach to protecting half the terrestrial realm. *BioScience* 67(6): 534–545. doi.org/10.1093/biosci/bix014

Dinerstein, E., Vynne, C., Sala, E., Joshi, A.R., Fernando, S., Lovejoy, T.E., Mayorga, J., Olson, D., Asner, G.P., Baillie, J.E.M. and Burgess, N.D. (2019). A global deal for nature: Guiding principles, milestones, and targets. *Science Advances* 5(4): eaaw2869. doi.org/10.1126/sciadv.aaw2869

Devillers, R., Pressey, R.L., Grech, A., Kittinger, J.N., Edgar, G.J., Ward, T. and Watson, R., 2015. Reinventing residual reserves in the sea: are we favouring ease of establishment over need for protection?. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 25(4), pp.480-504. DOI: 10.1002/aqc.2445

Environment Canada. (2011). *Scientific assessment to inform the identification of critical habitat for woodland caribou (Rangifer tarandus caribou), boreal population, in Canada: 2011 update*. p. 102.

Gaines, S.D., White, C., Carr, M.H. and Palumbi, S.R., 2010. Designing marine reserve networks for both conservation and fisheries management. *Proceedings of the National Academy of Sciences,* 107(43), pp.18286-18293. doi.org/10.1073/pnas.0906473107

Geldmann, J., Coad, L., Barnes, M.D., Craigie, I.D., Woodley, S., Balmford, A., Brooks, T.M., Hockings, M., Knights, K., Mascia, M.B. and McRae, L. (2018). A global analysis of management capacity and ecological outcomes in terrestrial protected areas. *Conservation Letters* 11(3): e12434. doi.org/10.1111/conl.12434

Gill, D.A., Mascia, M.B., Ahmadia, G.N., Glew, L., Lester, S.E., Barnes, M., Craigie, I., Darling, E.S., Free, C.M., Geldmann, J. and Holst, S. (2017). Capacity shortfalls hinder the performance of marine protected areas globally. *Nature* 543 (7647): 665. doi.org/10.1038/nature21708

Green, E.J., Buchanan, G.M., Butchart, S.H., Chandler, G.M., Burgess, N.D., Hill, S.L. and Gregory, R.D. (2019). Relating characteristics of global biodiversity targets to reported progress. *Conservation Biology* Volume 0, No. 0, 1–10. doi.org/10.1111/cobi.13322

Gurney, G.G., Pressey, R.L., Ban, N.C., Álvarez-Romero, J.G., Jupiter, S. and Adams, V.M. (2015). Efficient and equitable design of marine protected areas in Fiji through inclusion of stakeholder□specific objectives in conservation planning. *Conservation Biology* 29(5): 1378–1389. DOI: 10.1111/cobi.12514

Hockings, M., Hardcastle, J., Woodley, S., Sandwith, T., Wilson, J., Bamert, M., Valenzuela, S., Chataigner, B., Lefebvre, T., Leverington, F.,Lopoukhine, N., MacKinnon, K. and Londono, J.M. (2019) The IUCN Green List of Protected and Conserved Areas: Setting the standard for effective conservation. *PARKS* 25(2) 57-66. DOI: 10.2305/IUCN.CH.2019.PARKS-25-2MH.en

IUCN (2016a). WCC-2016-Res-050-EN—Increasing marine protected area coverage for effective marine biodiversity conservation.

IUCN (2016b). *A Global Standard for the Identification of Key Biodiversity Areas*, Version 1.0. First edition. Gland, Switzerland: IUCN. ISBN 978-2-8317-1835-4

IUCN and World Commission on Protected Areas (WCPA) (2017). *IUCN Green List of Protected and Conserved Areas: Standard, Version 1.1*. Gland, Switzerland: IUCN.

Joppa, L.N. and Pfaff, A., 2009. High and far: biases in the location of protected areas. *PloS one* 4(12), p.e8273.

Jonas, H.D., MacKinnon, K., Dudley, N., Hockings, M., Jessen, S., Laffoley, D., MacKinnon, D., Matallana-Tobón, C.L., Sandwith, T., Waithaka, J. and Woodley, S., 2018. Editorial essay: other effective area-based conservation measures: from Aichi Target 11 to the Post-2020 Biodiversity Framework. *PARKS* 24 (Special issue), pp.9-16. DOI: 10.2305/IUCN.CH.2018.PARKS-24-SI.en

Klein, C.J., Brown, C.J., Halpern, B.S., Segan, D.B., McGowan, J., Beger, M. and Watson, J.E. (2015). Shortfalls in the global protected area network at representing marine biodiversity. *Scientific Reports* 5: 17539. doi.org/10.1038/srep17539

Laffoley, D. (2019, unpublished). Resolution 50—supporting information. A short paper is to explain the context to and justification for the 'at least 30%' MPA target enshrined in Resolution 50, agreed at the 2016 World Conservation Congress in Hawaii. Gland, Switzerland: World Commission on Protected Areas, IUCN. http://danlaffoley.com/publications/

Lapola, D.M., Martinelli, L.A., Peres, C.A., Ometto, J.P., Ferreira, M.E., Nobre, C.A., Aguiar, A.P.D., Bustamante, M.M., Cardoso, M.F., Costa, M.H. and Joly, C.A. (2014). Pervasive transition of the Brazilian land-use system. *Nature Climate Change* 4(1): 27. DOI: 10.1038/NCLIMATE2056

Leverington, F., Costa, K.L., Pavese, H., Lisle, A. and Hockings, M. (2010). A global analysis of protected area management effectiveness. *Environmental Management* 46(5): 685–698. DOI 10.1007/s00267-010-9564-5

Locke, H. (2013). Nature needs half: A necessary and hopeful new agenda for protected areas. *PARKS* 19(2): 13–22. 10.2305/IUCN.CH.2013.PARKS-19-2.HL.en

Locke, H. (2014). Nature Needs Half: A Necessary and Hopeful Agenda for Protected Areas in North America and Around the World. *The George Wright Forum* 31 (3): 359–371.

Locke, H. (2018). The International Movement to Protect Half the World: Origins, Scientific Foundations, and Policy Implications. *Reference Module in Earth Systems and Environmental Sciences*. Elsevier. doi: 10.1016/B978-0-12-409548-9.10868-1

Locke, H., Ellis, E.C., Venter, O., Schuster, R., Ma, K., Shen, X., Woodley, S., Kingston, N., Bhola, N., Strassburg, B.B.N., Paulsch, A., Williams, B., Watson, J.E.M. (2019), Three Global Conditions for Biodiversity Conservation and Sustainable Use: an implementation framework. *National Science Review*: nwz136, doi.org/10.1093/nsr/nwz136

Lovejoy, T. and Nobre, C. (2018). Amazon Tipping Point. *Science Advances* 4 (2): eaat2340 · February 2018 DOI: 10.1126/sciadv.aat2340

McNeely, J.A. (1993). *Parks for Life: Report of the IVth World Congress on National Parks and Protected Areas*. Gland, Switzerland: IUCN.

Miller, B., Foreman, D., Fink, M., Shinneman, D., Smith, J., DeMarco, M., Soulé, M. and Howard, R. (2003). *Southern Rockies Wildlands Network Vision*. Boulder (CO): Southern Rockies Ecosystem Project, Wildlands Project, and Denver Zoo.

Miller, K.R. (1984). 'The Bali Action Plan: a framework for the future of protected areas'. In: J.A. McNeely and K.R. Miller (Eds.), *National Parks, Conservation, and Development: the Role of Protected Areas in Sustaining Society*, pp. 756–764. Washington, DC: Smithsonian Institution Press.

Mittermeier, R.A., Myers, N., Mittermeier, C.G. and Robles, G. (1999). *Hotspots: Earth's biologically richest and most endangered terrestrial ecoregions*. CEMEX, SA, Agrupación Sierra Madre, SC.

Mogg, S., Fastre, C. and Visconti, P. (2019). Targeted expansion of Protected Areas to maximise the persistence of terrestrial mammals. *bioRxiv*: 608992. doi: http://dx.doi.org/10.1101/608992

Noss, R. F. and A. Y. Cooperrider (1994). *Saving Nature's Legacy: Protecting and Restoring Biodiversity*. Washington, D.C., USA: Island Press.

Noss, R.F., Carroll, C., Vance-Borland, K. and Wuerthner, G. (2002). A multicriteria assessment of the irreplaceability and vulnerability of sites in the Greater Yellowstone Ecosystem. *Conservation Biology* 16: 895–908. doi.org/10.1046/j.1523-1739.2002.01405.x

Noss, R.F., Dobson, A.P., Baldwin, R., Beier, P., Davis, C.R., Dellasala, D.A., Francis, J., Locke, H., Nowak, K., Lopez, R. and Reining, C. (2012). Bolder thinking for conservation. *Conservation Biology* 26(1): 1–4. doi.org/10.1111/j.1523-1739.2011.01738.x

Odum, E.P. and Odum, H.T., 1972. Natural areas as necessary components of man's total environment. In *Trans North Am Wildl Nat Res Conf*. 37:178-189

O'Leary, B.C., Winther-Janson, M., Bainbridge, J.M., Aitken, J., Hawkins, J.P. and Roberts, C.M. (2016). Effective Coverage Targets for Ocean Protection. *Conservation Letters* 9(6), 398–404 doi:10.1111/conl.12247 .

Pimm, S.L. and Lawton, J.H. (1998). Planning for biodiversity. *Science* 279(5359): 2068-2069.

Pressey, R.L., Cowling, R.M. and Rouget, M. (2003). Formulating conservation targets for biodiversity pattern and process in the Cape Floristic Region, South Africa. *Biological Conservation* 112: 99–127. doi.org/10.1016/S0006-3207(02)00424-X

Roberts, C.M., Branch, G., Bustamante, R.H., Castilla, J.C., Dugan, J., Halpern, B.S., Lafferty, K.D., Leslie, H., Lubchenco, J., McArdle, D. and Ruckelshaus, M., 2003. Application of ecological criteria in selecting marine reserves and developing reserve networks. *Ecological applications* 13 (sp1), pp.215-228.

Rocha, J.C., Peterson, G., Bodin, Ö. and Levin, S. (2018). Cascading regime shifts within and across scales. *Science* 362(6421): 1379–1383. doi.org/10.1101/364620.

Rodrigues, A.S.L. and Gaston, K.J. (2001). How large do reserve networks need to be? *Ecology Letters* 4: 602–609. doi.org/10.1046/j.1461-0248.2001.00275.x

Rodrigues, A.S., Andelman, S.J., Bakarr, M.I., Boitani, L., Brooks, T.M., Cowling, R.M., Fishpool, L.D., Da Fonseca, G.A., Gaston, K.J., Hoffmann, M. and Long, J.S. (2004). Effectiveness of the global protected area network in representing species diversity. *Nature* 428(6983): 640. doi.org/10.1038/nature02422

Rondinini, C. and Chiozza, F. (2010). Quantitative methods for defining percentage area targets for habitat types in

conservation planning. *Biological Conservation* 143(7): 1646–1653. doi.org/10.1016/j.biocon.2010.03.037

Rosenzweig, M.L. (1995). *Species Diversity in Space and Time*. Cambridge University Press, Cambridge.

Sala, E., Lubchenco, J., Grorud-Colvert, K., Novelli, C., Roberts, C. and Sumaila, U.R. (2018). Assessing real progress towards effective ocean protection. *Marine Policy* 91: 11–13. doi.org/10.1016/j.marpol.2018.02.004

Svancara, L.K., Brannon J.R., Scott, M., Groves, C.R., Noss, R.F. and Pressey, R.L. (2005). Policy-driven versus evidence-based conservation: a review of political targets and biological needs. *BioScience* 55(11): 989–995. doi.org/10.1641/0006-3568(2005)055%5B0989:PVECAR%5D2.0.CO;2

Venter, O., Fuller, R.A., Segan, D.B., Carwardine, J., Brooks, T., Butchart, S.H., Di Marco, M., Iwamura, T., Joseph, L., O'Grady, D. and Possingham, H.P. (2014). Targeting global protected area expansion for imperiled biodiversity. *PLoS Biology* 12(6): e1001891. doi.org/10.1371/journal.pbio.1001891

Visconti, P., Butchart, S.H., Brooks, T.M., Langhammer, P.F., Marnewick, D., Vergara, S., Yanosky, A. and Watson, J.E. (2019). Protected area targets post-2020. *Science* 364(6437): 239–241. doi.org/10.1126/science.aav6886

Watson, J.E., Evans, T., Venter, O., Williams, B., Tulloch, A., Stewart, C., Thompson, I., Ray, J.C., Murray, K., Salazar, A. and McAlpine, C. (2018). The exceptional value of intact forest ecosystems. *Nature Ecology & Evolution* 2(4): 599. doi.org/10.1038/s41559-018-0490-x

Wilson, E.O. (2016). *Half-Earth: our planet's fight for life.* WW Norton & Company.

Woodley, S., Bhola, N. and Locke, H. (2019a). A Global Survey of Conservation Scientists on Global Conservation Targets. *PARKS* 25(2): 19-30. DOI: 10.2305/IUCN.CH.2019.PARKS-25-2SW1.en

RESUMEN

Nuestra revisión de las pruebas científicas relacionadas con los objetivos porcentuales de conservación de las áreas protegidas en gran escala concluyó que:

1. El 17% de las aguas terrestres y continentales, y el 10% de los objetivos marinos y costeros de la Meta 11 de Aichi del Plan Estratégico para la Biodiversidad 2011-2020, no bastan para garantizar la conservación adecuada de la biodiversidad.
2. Los objetivos porcentuales de conservación de las áreas protegidas no pueden desvincularse de las consideraciones de calidad. Para conservar la biodiversidad, las áreas protegidas y conservadas deben establecerse de manera selectiva, estar bien administradas y gestionarse de manera eficaz y equitativa.
3. No hay una respuesta inequívoca sobre qué porcentaje de la Tierra debería protegerse. Las estimaciones de los estudios que consideran un conjunto amplio de valores de biodiversidad son muy elevadas; más del 50 por ciento y hasta el 80 por ciento. Los estudios que incluyen un subconjunto más reducido de valores de biodiversidad son menores, pero casi nunca inferiores al 30 por ciento, y siempre con advertencias de que son estimaciones incompletas. Los objetivos de conservación para las áreas protegidas deben establecerse en función de los resultados deseados (por ejemplo, detener la pérdida de biodiversidad para 2030).
4. La protección global de un mínimo del 30 por ciento y hasta un 70 por ciento, o incluso más, de la tierra y el mar en el planeta se encuentra ampliamente documentada en la literatura. El llamamiento al 50 por ciento de la Tierra, que es un punto medio de estos valores, se apoya en diversos estudios.
5. Es posible lograr la implementación de objetivos porcentuales de conservación para las áreas protegidas a escala mundial, diferenciando los tipos de áreas que precisan protección a escala nacional, con el apoyo de contribuciones determinadas a nivel nacional de conformidad con las condiciones locales.

RÉSUMÉ

Notre examen des preuves scientifiques à l'appui des objectifs de conservation mondiale en termes de pourcentage a conclu que :

1. Les objectifs de 17 pour cent pour les eaux terrestres et intérieures et de 10 pour cent pour les zones marines et côtières de l'Objectif 11 d'Aichi du Plan stratégique pour la diversité biologique 2011-2020 ne sont pas suffisants pour préserver la biodiversité.
2. Les objectifs des zones en termes de pourcentage ne peuvent pas être appréciés indépendamment des considérations de qualité. Les aires protégées et conservées doivent être localisées de manière sélective, bien gouvernées et gérées de manière efficace et équitable afin d'atteindre ou de conserver la biodiversité.
3. Il n'y a pas de réponse claire quant au pourcentage de la Terre à protéger. Les estimations des études portant sur un large éventail de valeurs de biodiversité présentent des chiffres élevées, bien plus de 50 pour cent et jusqu'à 80 pour cent. Les études comprenant un sous-ensemble plus restreint de valeurs donnent des chiffres plus faibles, mais rarement inférieures à 30 pour cent et toujours assortis de mises en garde quant au fait qu'il s'agit d'estimations incomplètes. Les objectifs de conservation des aires protégées devraient plutôt être établis en fonction des résultats souhaités (par exemple, enrayer la perte de biodiversité d'ici 2030).
4. La protection globale étendue au minimum à 30 pour cent et jusqu'à 70 pour cent, voire plus, de la terre et de la mer est bien corroboré dans la documentation. L'appel pour atteindre le point médian de ces valeurs à 50 pour cent de la Terre est étayé par une série d'études.
5. La mise en œuvre des objectifs de conservation mondiale en termes de pourcentage peut être réalisée en différenciant les types de zones nécessitant une protection à l'échelle nationale, soutenues par des contributions déterminées au niveau national et conformes aux conditions locales.