Half Earth or Whole Earth: What Can Natura 2000 Teach Us?

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The call to set aside half of Earth's surface for nature conservation is gaining momentum across the conservation community. We propose that the experiences of Earth's most extensive conservation network, Natura 2000, offers important lessons on the challenges and opportunities of scaling up area-based conservation strategies. Natura 2000 has made unprecedented advances in implementing effective, evidence-based, internationally collaborative conservation policies and practices at continental scales. These advances have relied on strong governance frameworks, standardized policies, close integration of science and policy, flexibility in protection designations, a focus on conservation outside protected areas, economic interests and development, and the engagement and incentivization of stakeholders at different scales of reserve development and operation. Although failures and gaps remain, these hard-won lessons of Natura 2000 have much to offer those aiming to scale up conservation globally to meet the biodiversity challenges of the Anthropocene.

Keywords: no net loss, protected area, Habitats Directive, nature conservation, biodiversity

Scaling up efforts to conserve biodiversity is a pressing challenge. Recently, the Half-Earth and Nature Needs Half calls for action to set aside half of Earth for nature conservation have been gaining momentum (Wilson 2016, Dinerstein et al. 2017, Watson and Venter 2017), leading to debates on the rationale and achievability of such an ambitious and unprecedented conservation target (Buscher et al. 2017, Wiersma et al. 2017, Kopnina et al. 2018). Although the Half-Earth proposal might ultimately yield an optimal path to reversing the biodiversity crisis, its many potential modes of application and their societal consequences demand close examination by scientists, policymakers, and the public. One key question is whether sufficient land or sea is available and where it might be located (Dinerstein et al. 2017, Mehrabi et al. 2018, Pimm et al. 2018). From a policy viewpoint, there is perhaps an even more important question. Upgrading and upsizing existing protected areas can have profound impacts on the success of biodiversity conservation (Pringle 2017). Are there any existing systems of protected areas capable of promoting conservation in terms of a Half-Earth project, or operational examples of large-scale systems for conservation that might be leveraged in a better way?

The Natura 2000 network is the world's largest coordinated system of protected areas, covering a total surface of more than 1.2 million square kilometers (EC 2018a), or about 18% of the total land area of the European Union. For this reason, Natura 2000 is an invaluable example of a large-scale coordinated reserve network developed and operated to address major conservation issues (Gaston et al. 2008, Langhout and Brunner 2017) that might help to guide large-scale conservation efforts in other regions. In the present article, we synthesize the main experiences of Natura 2000 as a guide to policymakers exploring the promises and pitfalls of scaling up conservation.

The origins of Natura 2000

The Natura 2000 network was created across the member states of the European Union through the 1992 Habitats Directive (92/43/EEC), a supranational piece of legislation on biodiversity conservation. This directive is the pillar of biodiversity conservation across the European Union, although other more recent directives (e.g., the Water Framework Directive) interact with and support it. The network is formed by special protection areas designated under the earlier European Union Birds Directive (79/409/EEC, repealed by 2009/147/EC) to protect selected bird species (listed in annex I or migratory species) or special areas of conservation for other animal or plant species and habitats (listed in annex I and II of the Habitats Directive). Furthermore, for birds in general and for other two lists of species (annex IV and V of the Habitats Directive) specific legal requirements not linked to the protected areas of Natura 2000 are also set. The number of species and habitats listed in the annexes of the directive has increased with each European Union enlargement because of negotiations between the European Commission, candidate countries, member states, and experts (Evans 2012). Interestingly, even in the current context of Brexit negotiations for the United Kingdom to leave the European

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Table 1. Transition in conservation approach with the Habitats Directive and Natura 2000 (adapted from Milieu Ltd et al. 2016).

	Before	With
Approach to protected area	Variety of site selection processes	Site selection and designation following a common approach, criteria and ecological features
Main conservation features	Protection of untouched or wild areas (but designation of areas also due to the occurrence of single species); national and regional lists of species, habitats and plant communities	Protection of areas, over all the EU28, hosting 233 codified natural and seminatural habitat types, and specific plants (588), animals (137 invertebrates, 25 amphibians, 26 reptiles, 72 fish, 55 mammals, 194 birds, and migratory birds) and their habitats
Protection approach	Traditional definition of protected areas under strict protection (with some exceptions)	Flexible approach toward a sustainable use of resources
Collaboration	National and regional (particularly for federal countries) focus	Transboundary connectivity
Financial support	Increasing availability of funds (e.g., LIFE funds) also acting as catalyst	
Societal involvement	Low but growing level of awareness and participation	Increasing participation leading higher awareness and knowledge
Knowledge	No systematic data collection; comparability of data at national or regional scale for some countries and at European scale for certain species	Development of scientific knowledge with data collection and representation following agreed formats
Legal system	Stronger and more holistic legal system (strengthening of national legislation; i.e., on hunting)	
Protected area	4% total area[a]	9% of seascape and 18% of terrestrial area covered by Natura 2000 (EC 2018a)

[a]Considering all current member states before 1992 from data reported in the Common Database on Designated Areas, probably underestimated.

Union, it appears that the Natura 2000 elements in the United Kingdom nature conservation framework will be retained or strengthened (see Defra 2018).

Before the establishment of this system, protected areas in Europe were heterogeneous in type and lacked coherence across member states and their approaches (table 1). Pressure by environmental nongovernmental organizations and advice from the scientific community contributed substantially to both nature directives (Habitats and Birds) and were essential both in establishing the network and requiring the use of evidence in developing conservation priorities. The nature directives can also be viewed as an European Union response to international conventions, such as the global Convention on Wetlands (Ramsar, Iran, 1971) and the regional Bern Convention on the Conservation of European Wildlife and Natural Habitats (Evans 2012).

Building and implementing Natura 2000

Natura 2000 does not set a specific area target but, rather, aims at conservation across an area that "should enable the natural habitat types and the species' habitats concerned to be maintained or, where appropriate, restored at a favorable conservation status in their natural range" and "in proportion to the representation within its territory of the natural habitat types and the habitats of species" (article 3 of the Habitats Directive) taking into account "economic, social, cultural, and regional requirements" (recital 7 of the Habitats Directive). For this reason, protected areas represented in the Natura 2000 network go well beyond the relatively remote and easily protected areas that tend to be overrepresented globally (Barnes et al. 2018) but also include parcels of land with high human density and with different economic interests (figure 1). Site selection is operationalized as a scientific process with each site documented using a Standard Data Form (EC 2011) with information on habitat types and species for which each site is proposed and later designated, together with other critical information such as major biodiversity threats and pressures. In addition to site information, member states are asked to periodically (every 6 years) report information on habitat types and species and the main pressures and threats to biodiversity for their entire territory following specific requirements under the different nature directives.

These site selection and status reporting tools are essential for evaluating the extent and effectiveness of the Natura 2000 network in terms of progress toward the favorable conservation status, the main conservation goal of the Habitats Directive, while also enabling anticipation of specific threats and helping prioritize future conservation efforts. Furthermore, these documents follow agreed formats allowing comparability among member states and aggregation of assessments across the entire Natura 2000 system (e.g., EEA 2015). These standardized approaches have positively affected the availability and reliability of data used to guide conservation policy and implementation from the Black Sea to the Atlantic, and the Baltic to the Mediterranean. Scientific methods and data are recognized as essential for implementing the requirements and achieving the aims of the directive, such as for assessing the impacts brought by development plans (Sitzia et al. 2016). Indeed, the assessment of the implications of human activities following a standard approach is an important

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Figure 1. Natura 2000 sites host a large variety of habitat types and species and fall within landscapes with different intensities of human pressures. (a) Site IT3260017 "Colli Euganei-Monte Lozzo-Monte Ricco" in North Italy covers around 150 km^2, within a rural landscape with high human density; (b) cattle grazing maintaining pastures within the IE0004193 "Mid-Waterford Coast" site in Ireland; (c) a forest habitat in the FI0100040 "Nuuksio" site; (d) Salamandra atra aurorae, an endemic salamander subspecies with limited home range, is mainly found within the Alpine Site IT3220036 "Altopiano dei Sette Comuni." Photographs: Tommaso Sitzia.

tool to tackle drivers of biodiversity loss and represents a scaling-up of the application of the Mitigation Hierarchy Framework of Arlidge and colleagues (2018). Technical and scientific best practices and guidance documents clarify the scientific basis for key aspects of the designation and management of Natura 2000 sites (see for example EC 2018b). In this context, education in conservation science is also promoted, in part toward raising attention to conservation needs (see article 18 of the Habitats Directive). Despite these standardized approaches and training investments, data quality and availability remains a limitation, with information on many species and habitats either lacking, being incomplete or outdated (EEA 2015, Lisón et al. 2017).

Building public engagement

Overall, the management of Natura 2000 sites exemplifies the need to engage the wider public in biodiversity conservation. Strong opposition was evident during different stages of Natura 2000 planning and implementation and both hindered and helped to improve conservation efforts. With time and experience, stakeholders' awareness and participation generally improved, yielding an array of *ad hoc* projects to enhance conservation efforts and promote best practices for site engagement. Nevertheless, engaging with society is still a pressing challenge for Natura 2000 (Blicharska et al. 2016).

Development, management, and assessment of the Natura 2000 system has led to the formation of a variety of administrative and policy systems with shared responsibility at different administrative and land-planning levels together with the creation of new jobs and specifically trained personnel (Milieu Ltd. et al. 2016). At the European Union level, the examination and assessment of the network and its results in protecting habitat types and species is based on a coordinated approach in which the European Commission is supported and assisted by the European Environment Agency and its European Topic Centre on Biological Diversity.

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A well-developed legal framework with strong enforcement has been crucial for the effectiveness of Natura 2000; fit-for-purpose environmental laws, including clear pathways for litigations, are an important aspect of effective conservation (Chapron et al. 2017). The nature directives have been assessed as fit for purpose, with an elevated enforceability traced to the possibility of court actions through the European Union legal context (Milieu Ltd et al. 2016, Trouwborst et al. 2017b). Claims of noncompliance can—and mostly are—brought against member states by the European Commission before the European Union Court of Justice (ECJ), although individuals also may invoke the directives before national courts (citizens versus state; Fleurke and Trouwborst 2014, Milieu Ltd et al. 2016, Epstein 2018). This integration of European Union and national levels of interest leads to two levels of species and habitat protection to which an additional level of stakeholders may be added (Epstein 2018).

Legal elements of directive implementation include strict interpretations of scientific concepts by the ECJ and national courts. This legal–science interaction is exemplified by legal cases citing scientific literature as background and justifications, and vice versa. Indeed, compliance with these legal instruments and collaboration among lawyers, managers and conservationists has proved fundamental to effective biodiversity conservation (Trouwborst et al. 2017a), together with local adaptation and flexibility in applying appropriate measures and the link of these with traditional knowledge and practice (Fischer J et al. 2012).

Cultural heritage of local communities is also an important aspect of Natura 2000. Natura 2000 areas overlap spatially with historical, archaeological, and cultural sites, connecting cultural, spiritual, and inspirational values with the values of nature conservation (EC 2017). Many annex I habitat types are part of cultural landscapes shaped by centuries of interactions between people and the environment, as exemplified by numerous cultural heath and meadow sites. Globally, indigenous people are crucial conservation stakeholders and reserve managers across more than 40% of terrestrial protected areas (Garnett et al. 2018). In the European Union, Indigenous Peoples recognized by international organizations are few (e.g. the Sámi of Finland and Sweden) and other local and regional groups and institutions play key roles in conserving and managing biodiversity.

Promises and pitfalls: Lessons from Natura 2000

One key to the success of Natura 2000 is clearly its reliance on a robust international legal system—the exception rather than the rule for international conservation governance. And even with this exceptionally robust legal system, Natura 2000 compliance is still far from perfect. In cases of hostile and conflicting interests, conservation effectiveness can be especially low (López-Bao et al. 2015). An array of issues and conflicts have arisen and still challenge the Natura 2000 network. However, there are positive examples, such as the Rospuda River valley in Poland, where an injunction to avoid Natura 2000 sites helped to successfully reroute a highway (Szulecka and Szulecki 2013). Indeed, the conflicting perceptions of stakeholders in the implementation and management of sites exemplifies the tension between conservation goals and social and economic interests, especially in the most developed areas (Gaston et al. 2008). For example, strong opposition from stakeholders was recorded in certain regions as in the case of the first stages of implementation in France (Alphandéry and Fortier 2001). Nevertheless, experience has shown that through participation and involvement of local people, together with the appreciation of traditional practices and knowledge, major issues of marginalization and disempowerment can, and have been, addressed and overcome (Milieu Ltd. et al. 2016).

From an economic perspective, the direct and indirect costs of Natura 2000 implementation, management and monitoring have been high: an estimated 5.8 billion € per year (Gantioler et al. 2014). Thus, a major concern in the effort to scale up conservation within the Natura 2000 system is economic. Cofunding mechanisms for sites and management, including valuing and monetizing ecosystem services, have been applied, with both drawbacks and success stories, and cases do exist where managing habitats and species has proved both economically and socially beneficial (i.e., 200–300 billion € per year estimated value from ecosystem services; ten Brink et al. 2011).

The Nature and Biodiversity priority area of the LIFE Programme is the main and dedicated funding tool for conservation in Natura 2000 sites (Hermoso et al. 2017) and has been evaluated positively by the scientific community (Kati et al. 2015). Other financial instruments, such as agrienvironment schemes, have proved beneficial to biodiversity conservation and conveyed funding to Natura 2000 management (Sánchez-Fernández et al. 2018, van der Sluis et al. 2018). Still, the integration of Natura 2000 requirements and practices into other policies (e.g., Common Agricultural Policy and Common Fisheries Policy) requires further improvements to achieve conservation success (Doussan and Schoukens 2015). The Prioritized Action Frameworks (PAFs) foreseen by article 8(4) of the Habitats Directive appear to be one effective route to integrate conservation priorities across sectors and for identifying funding tools outside of conservation itself.

Natura 2000 sites are extremely diverse and heterogeneous (figure 1), with high levels of uniqueness linked to the presence of rare species (Hoffmann et al. 2018). Nevertheless, from a conservation perspective, the network's list of target species and habitats and other aspects of conservation design and operation have been criticized (Hochkirch et al. 2013, Maes et al. 2013). Indeed, to achieve the ambitious targets of a favorable conservation status for all species and habitat types as set by the European Union Biodiversity Strategy and the Habitats Directive, further action is still urgently needed (EEA 2015). Given the broad scope of conservation practices already enacted within Natura 2000, enacting new and more effective conservation strategies

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Box 1. Major lessons from Natura 2000 implementation highlighting essential elements for scaling up conservation processes.

- Establishment of a legal framework on the basis of scientific interpretation and enforceable through specific science-based requirements, that can stimulate nonlegal community efforts
- Identifying connected protected areas on the basis of conservation features
- Updatable conservation features (list of habitats and species) on the basis of integrated and recognized scientific methodologies and knowledge
- Inclusion of all countries and stakeholders at an early stage for a transnational and cross-border harmonized and coordinated approach
- Building a common language to assess conservation features
- Management and restoration of species and habitats through legal means
- Political trust and a sense of common nature conservation values from local to national communities
- Policy coordination on nature conservation

through Natura 2000 will not only improve conservation across Europe but will also increase the variety of solutions available globally to achieve conservation goals under complex conservation scenarios.

Despite its limitations, Natura 2000 has achieved major international conservation goals, and both directives have been assessed as fit for purpose in delivering positive biodiversity conservation (Donald et al. 2007, Beresford et al. 2016, van der Sluis et al. 2016, Amano et al. 2017, Koschová et al. 2018). The connectivity of European protected areas is considered especially effective, largely because of coordinated efforts across the Natura 2000 network (Opermanis et al. 2012, 2013, Maiorano et al. 2015, Santini et al. 2016, Saura et al. 2017). Despite being far from a completely interconnected network, the application of domestic spatial planning and nature conservation tools are making visible steps towards this achievement (Verschuuren 2015).

There is further need to increase the permeability of European Union and Eurasian landscapes to species movements outside and among protected areas (Saura et al. 2018). Indeed, conservation beyond protected areas, including land-use alternatives and sustainable production strategies that integrate nature conservation, are increasingly seen as essential for scaling up conservation efforts while sustaining land use in support of human populations (Balmford and Green 2017, Mehrabi et al. 2018). In these efforts, both the nature directives and Natura 2000 directly address human activities beyond protected area boundaries, both in reporting and through specific assessments of impacts. For example, both Natura 2000 and European Union funding systems provide support for managing grasslands and pastures with traditional nonintensive practices, resulting in both biodiversity conservation and rural development targets (Halada et al. 2011). Rapid recent development of green (and blue) infrastructure in urban and periurban areas is also helping contribute to this increased connectivity. Advancing integrated conservation and development strategies is an area of active interest in the policy community across Natura 2000, the European Union, and within national jurisdictions.

Beyond boundaries: Natura 2000 to Whole Earth?

Natura 2000 is an unprecedented example of scaling up conservation across nations and regions that has also improved the coordination and integration of conservation with other human activities (Merken et al. 2010). The added value of the nature directives and of the Natura 2000 network is widely recognized (Milieu Ltd et al. 2016) and lessons learned from their implementation are already being applied outside the original network—for example, the Emerald Network in Eastern Europe and in preaccession countries (Pritchard and Opermanis 2018).

Approaches developed through the nature directives and Natura 2000 have helped to rapidly increase land areas under biodiversity conservation both inside and outside its formal reserve network. Restoring degraded ecosystems and improving connectivity through planning for green and blue infrastructure have been shown to provide even greater opportunities to expand the network under win–win conditions (Vallecillo et al. 2018). Nevertheless, greater attention to ecosystem management and land-use practices outside protected areas would further enhance biodiversity conservation (Saura et al. 2018). Monitoring human effects on biodiversity and considering scenarios that anticipate future anthropogenic effects are also key to effective biodiversity conservation efforts, together with additional, non-area-based strategies (Campagnaro et al. 2018). Finally, communicating both the positive and negative consequences of biodiversity conservation is essential to cultivate better informed, more aware, and more supportive citizens (e.g., through Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services and national assessments; Fischer et al. 2018).

Natura 2000 offers essential lessons for those aiming to scale up conservation efforts globally, including Half-Earth and Nature Needs Half (box 1). As a mature, time-tested, near-continental-scale international conservation system,

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Natura 2000 offers abundant working examples of how to select areas for conservation, how to identify major threats and pressures to biodiversity and potential strategies for managing them, and for the international implementation of specific conservation measures. These are all essential tools for implementing a Half-Earth goal (Watson and Venter 2017). Yet the frailty of area-based approaches has also been proved through the Natura 2000 experience, with the undermining of conservation results by anthropogenic impacts and conservation failures, including ineffective governance and limited stakeholder engagement (Amano et al. 2017, Crist et al. 2017).

With Natura 2000 and the nature directives, biodiversity conservation has been effectively scaled up within the broader context of ongoing international collaboration across the European Union. Any transfer of this experience to other regions must therefore exercise caution and consider the many unique aspects of Europe's biology, history, and politics. But the lessons learned through the creation and sustained management of Earth's largest existing conservation network provide considerable opportunities to enhance the prospects for a major global upscaling of conservation through protected areas with the support of other strategies. Although certain unique features limit replicability and transferability to other international settings, especially the level of international cooperation and strong governance enabled by the European Union, specific knowledge of conservation requirements may help in translating useful experiences. For instance, low connectivity among protected areas recorded in certain regions of the Earth (Saura et al. 2017) could be enhanced following the example of Natura 2000, establishing conservation networks across urban and agricultural regions in the face of potential economic impacts (Fleurke and Trouwborst 2014) where agricultural and other societal pressures on environments are high (Venter et al. 2018).

Clearly, the differing economic, social, and institutional conditions of different regions of the world will shape any implementation of conservation frameworks. But the broad experience achieved through planning and managing the Natura 2000 network over decades across the varying conditions within the European Union, including significant variations in national economic development, can still inform efforts to improve the effectiveness of established protected area networks in which current management is underfunded, ineffective, or lacking (Lindsey et al. 2016). Indeed, international efforts to identify and address the drivers of biodiversity loss through integrated conservation frameworks such as Natura 2000 will become increasingly important in many parts of the world (Arlidge et al. 2018, Dudley et al. 2018).

The lessons of Natura 2000 teach us that biodiversity conservation through a global network of reserves covering half of Earth's surface, as is envisaged in Half-Earth proposals, will succeed only through the emergence of new systems of enhanced international, regional, and local cooperative institutions around the world that engage systematically in conservation strategies beyond area-based efforts alone. Although effective systems of conservation governance must be built to fit the needs of local and regional settings, they still require systematic cooperation among national and international institutions, guidance by scientific expertise, and a strong social contract, as is envisaged in the ecosystem approach of the Convention on Biological Diversity (CBD 2000). This was the challenge of the CBD at its inception. The challenge remains, 25 years later, but with greater urgency. Half-Earth will not be enough. Natura 2000 teaches us that robust efforts to scale up the conservation of biodiversity depend at least as much on scaling up the institutions, science and governance of conservation as they do on scaling up area-based targets, and neither can succeed without stimulating and promoting public interest in and demand for biodiversity conservation over the long term.

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