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PERSPECTIVES

A framework to identify enabling and urgent actions for the 2020 Aichi Targets

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Abstract

In 2010, the parties of the Convention on Biological Diversity (CBD) adopted the Strategic Plan for Biodiversity 2011–2020 with the mission of halting biodiversity loss and enhance the benefits it provides to people. The 20 Aichi Biodiversity Targets (Aichi Targets), which are included in the Strategic Plan, are organized under five Strategic Goals, and provide coherent guidance

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on how to achieve it. Halfway through the Strategic Plan, it is time to prioritize actions in order to achieve the best possible outcomes for the Aichi Targets in 2020. Actions to achieve one target may influence other targets (downstream interactions); in turn a target may be influenced by actions taken to attain other targets (upstream interactions). We explore the interactions among targets and the time-lags between implemented measures and desired outcomes to develop a framework that can reduce the overall burden associated with the implementation of the Strategic Plan. We identified the targets addressing the underlying drivers of biodiversity loss and the targets aimed at enhancing the implementation of the Strategic Plan as having the highest level of downstream interactions. Targets aimed at improving the status of biodiversity and safeguarding ecosystems followed by targets aimed at reducing the direct pressures on biodiversity and enhancing the benefits to all from biodiversity and ecosystem services, were identified as having the highest levels of upstream interactions. Perhaps one of the most challenging aspects of the Strategic Plan is the need to balance actions for its long-term sustainability with the need for urgent actions to halt biodiversity loss.

Zusammenfassung

Im Jahre 2010 fasste die Biodiversitäts-Konvention einen Beschluss zum Schutz der Biodiversität für die Dekade 2011–2020. Das primäre Ziel dieses Strategischen Plans ist es, den Verlust von Biodiversität zu reduzieren, sowie ihre enorme Bedeutung für die Menschen zu veranschaulichen. In diesen Strategischen Plan sind die "20 Aichi – Ziele" integriert, die in fünf Kernziele kategorisiert sind und als Leitfaden zur Realisierung der Aichi-Ziele dienen. Im Rahmen des Strategieplans ist es an der Zeit die Maßnahmen zu priorisieren, welche maximale Erfolge zum Erreichen der "20 Aichi–Ziele" bis 2020 versprechen. Dabei muss betrachtet werden, dass bestimmte Maßnahmen zur Zielführung möglicherweise andere Ziele beeinflussen (s.g. abwärts gerichtete Interaktionen="downstream interactions"); im Gegensatz dazu können Ziele wiederum die Maßnahmen beeinflussen (s.g. aufwärts gerichtete Interaktionen="upstream interactions").

Wir untersuchten die Wechselwirkungen zwischen den Kernzielen und den Zeitintervallen, zwischen den durchgeführten Maßnahmen und dem Eintreten der gewünschten Ergebnisse. Diese Untersuchungen sind notwendig, um die wichtigsten Maßnahmen mit den höchsten Effekten innerhalb aller Ziele zu identifizieren. Dabei identifizierten wir Ziele, welche sich primär mit den Ursachen des Rückgangs biologischer Vielfalt beschäftigen und Ziele, in deren Fokus die Verfolgung des Strategischen Plans steht, als hochgradig abwärts gerichtete Interaktionen. Ziele, die sich vornehmlich mit der Sicherung von Ökosystemen zur Verbesserung der biologischen Vielfalt beschäftigen, gefolgt von denen, deren Schwerpunkt auf der Reduktion von direkten Belastungen auf biologische Vielfalt liegt, und jene, die aufzeigen, welchen Mehrwert biologische Vielfalt und Ökosystemleistungen für alle bieten, weisen die höchsten aufwärts gerichteten Interaktionen auf. Einer der schwierigsten Aspekte bei der Umsetzung des strategischen Plans ist die Notwendigkeit einer Balance zwischen Maßnahmen zur Umsetzung einer langfristigen Nachhaltigkeit und der Umsetzung von notwendigen kurzfristigen Sofortmaßnahmen zu finden, welche den Verlust der biologischen Vielfalt aufhalten.

Keywords: Aichi Targets; Downstream interactions; Strategic Plan for Biodiversity 2011–2020; Synergies; Targets interactions; Time-lags; Upstream interactions

Introduction

The Strategic Plan for Biodiversity 2011–2020, adopted by the parties of the Convention on Biological Diversity (CBD) in 2010, presents a set of 20 (Aichi Biodiversity) targets organized under five Strategic Goals (SCBD, 2010). The 20 Aichi Targets that underpin the Strategic Goals are a step forward from the generic 2010 target of "achieving a significant reduction of the current rate of biodiversity loss", as they are framed as a set of desired outcomes required to ultimately halt biodiversity loss and ecosystem degradation. However, tackling 20 targets simultaneously may represent an extraordinary burden for some countries, particularly when one considers the high number of multilateral environmental agreements and protocols in place (Mitchell, 2010).

In the light of slow progress (Tittensor et al., 2014), the 12th Conference of the Parties (CoP) of the CBD, to be held in October 2014, is expected to agree on a "Pyeongchang Roadmap" of actions to enhance progress towards the Aichi Targets by 2020 (CBD, 2014). Here, we identify the main interactions, both positive and negative, between the Aichi Targets based on expert opinion. We explore the synergies (i.e. positive interactions) and the existent time-lags between measures implemented and desired outcomes, to develop a framework that can potentially reduce the overall burden associated with implementing the Strategic Plan (SCBD, 2012).

Each goal, of the Strategic Plan addresses a different challenge related to halting biodiversity loss. Strategic Goal A addresses required socio-economic and institutional

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	T16	T17	T18	T19	T20	SUM
T1		2	2	2	2	1	2	2	2	2	2	2	1	2	2	1	1	2	2	2	34
T2	2		3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	3	2	3	53
T3	1	3		3	3	3	3	3	1	3	2	2	2	3	3	1	1	1	1	2	41
T4	1	1	3		3	3	3	3	2	3	2	2	3	3	3	1	1	1	1	1	40
T5	1	1	1	1		1	3	1	1	3	3	3	2	3	3	1	1	1	1	1	32
T6	1	1	1	3	2		1	1	2	3	1	3	3	3	1	1	1	1	1	1	31
T7	1	1	1	3	3	1		3	2	3	2	3	3	3	3	1	1	1	1	1	37
T8	1	1	1	2	1	2	2		1	3	1	2	1	3	2	1	1	1	1	1	28
T9	1	1	1	1	1	1	1	1		3	1	3	1	3	2	1	1	1	1	1	26
T10	1	1	1	1	3	2	1	1	1		3	3	1	3	2	1	1	1	1	1	29
T11	1	1	1	1	3	3	1	1	1	3		3	3	3	2	1	1	1	1	1	32
T12	1	1	1	1	2	2	1	1	2	2	1		3	2	1	1	1	1	1	1	26
T13	1	1	1	1	1	2	2	1	1	1	1	2		2	1	1	1	1	1	1	23
T14	1	2	1	2	2	3	3	2	1	3	1	2	1		3	1	1	1	1	1	32
T15	1	1	1	1	3	1	3	1	2	2	1	2	2	3		1	1	1	1	1	29
T16	2	1	1	1	1	1	1	1	1	1	1	1	3	1	1		1	3	1	2	25
T17	3	3	2	2	3	2	2	2	2	2	3	2	2	2	2	2		2	2	3	43
T18	2	2	1	2	2	2	2	1	1	1	2	2	2	3	1	1	1		3	1	32
T19	3	2	2	1	2	2	2	2	2	2	2	2	2	2	2	1	2	1		1	35
T20	3	3	2	2	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3		53
SUM	28	29	27	33	43	38	39	31	29	46	35	45	41	50	40	24	24	27	26	26	

Fig. 1. Strength of interactions (either positive or negative) between the Aichi Targets, based on expert opinion, depicted as effect of row (downstream interactions) on column (upstream interactions). Numbers indicate the mode of the strength of the relationship (1 – low, 2 – intermediate, 3 – high). For example, the impact of Target 2 (T2, integration of biodiversity values) on Target 10 (T10, protection of vulnerable ecosystems) is strong, while the impact of T10 on T2 is rather weak. Colours in the top row and first column represent the Strategic Goals. Blue – Strategic Goal A, brown – Strategic Goal B, green – Strategic Goal C, purple – Strategic Goal D, yellow – Strategic Goal E. Shades of grey represent the relative agreement among experts on the strength of the interaction, computed as the percentage of experts that attributed the mode value to that specific entry. White cell – less than 50%, light grey – more than 50% and less than 75%, dark grey – more than 75%.

changes. Strategic Goal B focuses on reducing the direct pressures on biodiversity and ecosystems while Strategic Goal C covers active efforts to improve biodiversity status. Strategic Goal D aims to ensure the flow of benefits from biodiversity and ecosystems to people, especially to the communities whose subsistence is strongly tied to local ecosystem services. Finally, Strategic Goal E aims at developing the conditions required for implementation of the Strategic Plan as well as developing the knowledge base.

Interacting targets

Actions to achieve one target may influence other targets; in turn a target may be influenced by actions taken towards the attainment of other targets. The first type of interactions are downstream interactions, while the latter are upstream interactions. Taking actions to achieve targets with a high number of downstream interactions will help achieving progress towards other targets. These can be seen as enabling actions as they can facilitate the achievement of the whole Strategic Plan. A target with a high level of upstream interactions is a target that will benefit from actions taken to achieve several other targets.

To determine the potential interactions among the twenty Aichi Targets, a group of 18 experts (composed of GBO-4 Technical Report authors and reviewers) qualitatively assessed how the achievement of any given Aichi Target could influence the achievement of the other targets. The following ordinal scores were used by each expert to qualify all the target interactions, either negative or positive, in a matrix: (1) low influence, (2) intermediate influence, and (3) high influence. For each entry of the matrix the mode of all the scores was used as the final level of influence (Fig. 1). The relative agreement between all experts was determined by computing, for each entry, the percentage of experts that attributed the mode value to that specific entry. Finally, for each target we calculated the sum of downstream interactions (sum of scores 1, 2 and 3 row-wise), the sum of upstream

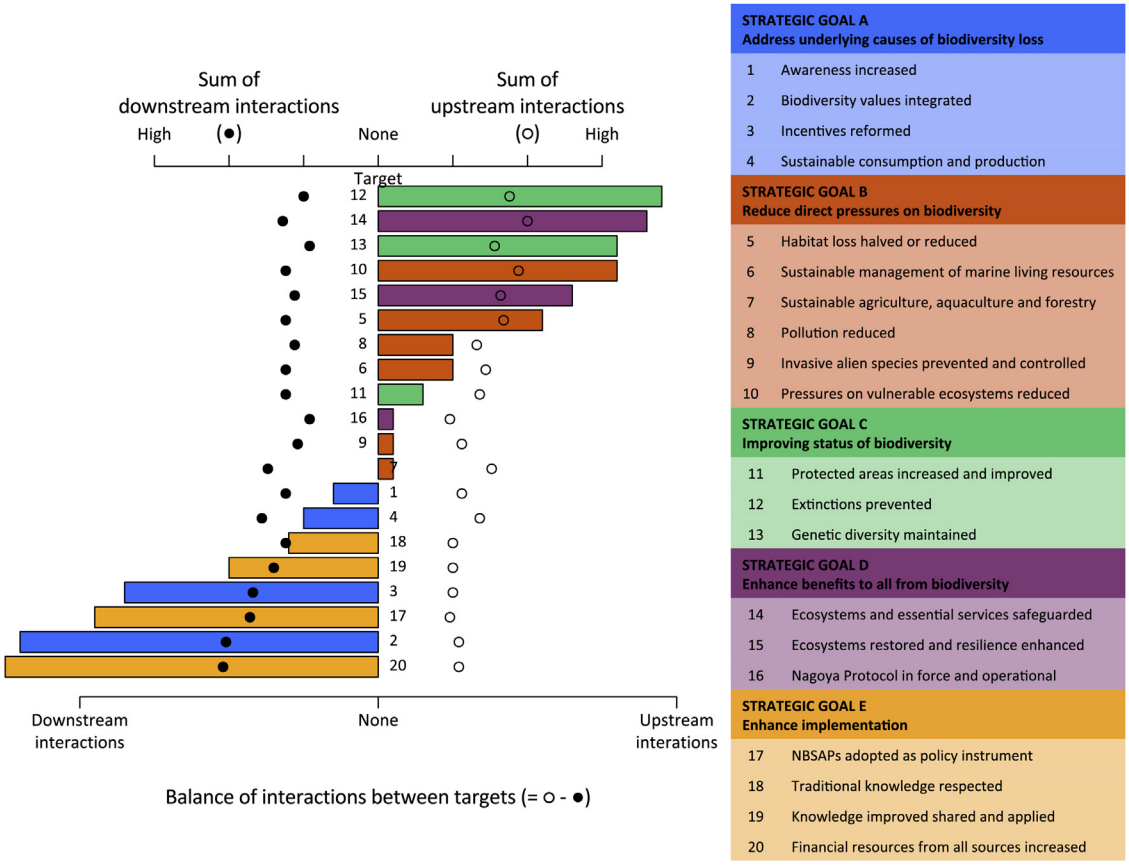

Fig. 2. Net interactions between the Aichi Targets. On the left are the net interactions of the different targets (bars) measured as the difference between the sum of downstream interactions, that is the sum of impacts exerted on other targets (●); and the sum of upstream interactions, that is the sum of impacts received from other targets (○). Actions towards targets with high net downstream interactions will impact other targets, whereas targets with high net upstream interactions will be impacted by other targets. On the right, a short description of each target is presented.

interactions (sum of scores 1, 2 and 3 column-wise), and the difference between these values (Fig. 2). The analysis was done using R and the packages abind and igraph (Csardi & Nepusz, 2006; Plate & Heiberger, 2011; R Core Team, 2014).

We identified targets under Strategic Goals A and E as having the highest level of net downstream interactions (Fig. 2). Generally, their influence spans all targets (Fig. 1). Their role is to create the enabling conditions necessary for implementation of the Strategic Plan (Targets 17 and 20), to develop wider understanding of biodiversity and its benefits for human well-being (Targets 1) to develop the knowledge base necessary for successful implementation of actions (Targets 18 and 19), and to initiate the socio-economic transitions to a more sustainable development through the incorporation of biodiversity and ecosystem values into development policies (Targets 2, 3 and 4). All other targets will be positively affected if people are aware of the importance of biodiversity and ecosystems, and if this importance is reflected in development policies. For example, developing sustainable consumption and production policies (Target 4) will contribute to progress in all targets under Strategic Goal B, focused on reducing pressures on biodiversity.

Targets under Strategic Goal C, followed by targets under Strategic Goals B and D, were identified as having the highest levels of net upstream interactions (Fig. 2). Strategic Goal C represents the more traditional objectives of biodiversity conservation: preventing the extinction of threatened species (Targets 12) and creating protected areas (Target 11). The high level of net upstream interactions in this Strategic Goal reveals the complex nature of these targets that depend on several factors to be successful in the long term. Preventing the extinction of threatened species (Target 12) is the target with most net upstream interactions, which reflects its central importance to biodiversity conservation. Addressing targets related to the main drivers of biodiversity loss, habitat loss (Target 5), overexploitation (Targets 6, 7), invasive alien species (Target 9), climate change (Targets 10 and 15) and pollution (Target 8) will contribute towards the achievement of Target 12. Also, ensuring 17% protected area coverage by 2020 (Target 11) can contribute towards the achievement of Target 12. Yet, recent studies have shown that the current

global network of terrestrial protected areas still falls short of adequately representing biodiversity (Butchart et al., 2012; Cantú-Salazar, Orme, Rasmussen, Blackburn, & Gaston, 2013; Joppa, Visconti, Jenkins, & Pimm, 2013; Venter et al., 2014). Furthermore, establishing new protected areas may contribute little to prevent extinctions unless they are established to encompass viable populations of species that are still not adequately protected (Joppa et al., 2013; Venter et al., 2014). Improving the management of protected areas is also a key challenge in the implementation of Target 11.

Instead of synergies, trade-offs may also occur between different targets. For example, protecting areas with high number of threatened species may not overlap with areas where habitat loss (Target 5) is occurring at faster rates. The adoption of some approaches to sustainable agriculture practices (Target 7) may reduce agricultural yields, which may make more difficult halving the rate of loss of natural habitats (Target 5). However, in many of these cases the trade-offs can be reduced or eliminated by careful consideration of these interactions, both within a country and between countries.

Long-term sustainability versus urgency

The end period for most of the targets is 2020 (except for Targets 10, 16 and 17, which are supposed to be achieved by 2015). However, the likely time-lags between the implementation of actions and the desired outcomes on biodiversity are not reflected in this timeline. Strategic Goals A and E are long-term in nature: their effects on biodiversity will be indirect and only visible in the long run. Strategic Goal A entails deep socio-economic transitions and institutional changes that require long time periods to take effect after proper actions are implemented (Mace et al., 2010; Perrings et al., 2011). Implementation of Strategic Goal E will be quicker, however the effect of their outcomes on biodiversity will only be visible in the long term. Target 17 is an exception and concerns the development of National Biodiversity Strategies and Actions Plans (NBSAPs). This target can be achieved in the short term when adequate governance structures and capacity are in place and depending on the measures it considers, its effects on biodiversity may be fast. Actions towards targets under Strategic Goals A and E will ensure the long-term sustainability of the Strategic Plan by maintaining pressures on biodiversity and ecosystems at low levels and promoting an improvement in their conservation status over time.

Strategic Goals C, B and D focus on addressing the direct pressures on biodiversity and ecosystems, improving its status and enhancing its benefits. The outcomes of actions implemented under these Strategic Goals are expected to have shorter time-lags (Mace et al., 2010; Perrings et al., 2011) as their goal is to halt current biodiversity loss and ecosystems degradation. Given current and projected rates of biodiversity declines (Butchart et al., 2010; Pereira et al., 2010), safeguarding biodiversity and ecosystem services for future generations requires urgent actions that can deliver outcomes in the short-term.

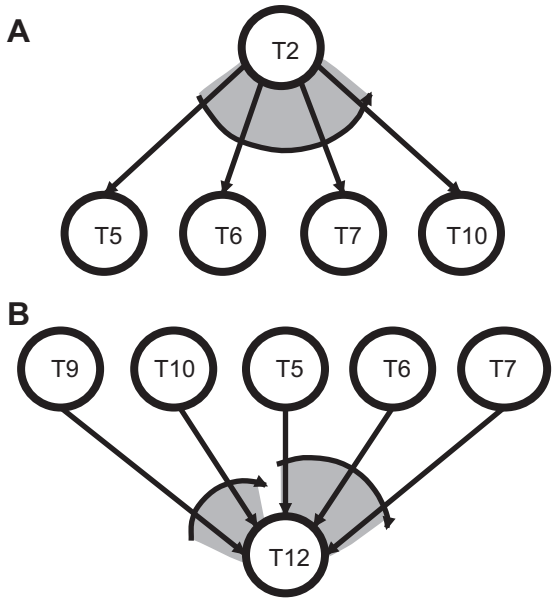

Fig. 3. Schematic representation of the identification of actions that maximize the outcomes. (A) Addressing a downstream target, by selecting an action that will actively influence targets more downstream; (B) addressing an upstream target, by selecting an action that will actively influence targets more upstream.

To Pyeongchang

Perhaps one of the most challenging aspects of the Strategic Plan for Biodiversity is the need to balance actions for its long-term sustainability with the need for urgent actions to halt biodiversity loss. The framework presented here allows the identification of a balanced set of actions that covers all the Strategic Goals. A balanced set of actions should include downstream targets, to ensure the long-term sustainability of the Strategic Plan (for example, Target 2), and upstream targets, focusing on aspects of biodiversity loss that require urgent action (for example, Target 12). Also, this framework allows understanding which specific actions maximize the outcomes for biodiversity (Fig. 3). For example, we see that Target 2 has a strong effect on targets of the Strategic Goal B, namely Targets 5, 6, 7 and 10 (Fig. 1). This means that potentially there are actions to address Target 2, which simultaneously address other targets downstream, and deliver greater advances on the Strategic Plan than an action directed only to Target 2 (Fig. 3A). An action related with the consideration of biodiversity values in specific sectors, like agriculture, forestry and fisheries may contribute to progress on Targets 5, 6 and 7.

When focusing on upstream targets the same rationale applies. Considering the influence of targets of the Strategic Goal B on Target 12, we see that Targets 5, 6, 7, 9 and 10

have a strong level of influence (Fig. 1). When addressing targets that require urgent attention it is also possible to identify actions on upstream targets that will also have an effect on it (Fig. 3B). If actions related, for example, with the reduction of habitat loss, the promotion of sustainable agriculture, forestry and fishing practices are done in areas with higher risk of species extinctions, they will contribute to preventing extinctions.

Our framework can be useful in implementing the Strategic Plan and the proposed "Pyeongchang Roadmap", since implementing actions with high synergistic effects on multiple targets has the potential to promote the achievement of the best possible outcomes in 2020, in the most efficient and effective way.

Ultimately, it will be up to the countries to define their national targets and priorities and to implement the appropriate set of actions to achieve them. Therefore, interactions should be identified at the national level in order to reflect the national biodiversity realities and deliver the best strategic set of actions.

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References

Butchart, S. H. M., Scharlemann, J. P. W., Evans, M. I., Quader, S., Aricò, S., Arinaitwe, J., et al. (2012). Protecting important sites for biodiversity contributes to meeting global conservation targets. *PLoS ONE*, *7*(3), e32529. http://dx.doi.org/10.1371/journal.pone.0032529

Butchart, S. H. M., Walpole, M., Collen, B., van Strien, A., Scharlemann, J. P. W., Almond, R. E. A., et al. (2010). Global biodiversity: Indicators of recent declines. *Science*, *328*(5982), 1164–1168. http://dx.doi.org/10.1126/science.1187512

Cantú-Salazar, L., Orme, C. D. L., Rasmussen, P. C., Blackburn, T. M., & Gaston, K. J. (2013). The performance of the global protected area system in capturing vertebrate geographic ranges. *Biodiversity and Conservation*, *22*(4), 1033–1047. http://dx.doi.org/10.1007/s10531-013-0467-7

CBD. (2014). *Implication of the key findings of the fourth edition of the Global Biodiversity Outlook for the future work of the Convention: Possible elements for the Pyeongchang Roadmap. Convention on Biological Diversity*.

Csardi, G., & Nepusz, T. (2006). The igraph software package for complex network research. *InterJournal, Complex Systems*, 1695.

Joppa, L. N., Visconti, P., Jenkins, C. N., & Pimm, S. L. (2013). Achieving the convention on biological diversity's goals for plant conservation. *Science*, *341*(6150), 1100–1103. http://dx.doi.org/10.1126/science.1241706

Mace, G. M., Cramer, W., Díaz, S., Faith, D. P., Larigauderie, A., Le Prestre, P., et al. (2010). Biodiversity targets after 2010. *Current Opinion in Environmental Sustainability*, *2*(1–2), 3–8. http://dx.doi.org/10.1016/j.cosust.2010.03.003

Mitchell, R. B. (2010). *International environmental agreements database project (Version 2010.2)*. Retrieved from http://iea.uoregon.edu

Pereira, H. M., Leadley, P. W., Proença, V., Alkemade, R., Scharlemann, J. P. W., Fernandez-Manjarrés, J. F., et al. (2010). Scenarios for global biodiversity in the 21st century. *Science*, *330*(6010), 1496–1501. http://dx.doi.org/10.1126/science.1196624

Perrings, C., Naeem, S., Ahrestani, F. S., Bunker, D. E., Burkill, P., Canziani, G., et al. (2011). Ecosystem services, targets, and indicators for the conservation and sustainable use of biodiversity. *Frontiers in Ecology and the Environment*, *9*(9), 512–520. http://dx.doi.org/10.1890/100212

Plate, T., & Heiberger, R. (2011). *Abind: Combine multidimensional arrays*. Retrieved from http://CRAN.R-project.org/package=abind

R Core Team. (2014). *R: A language and environment for statistical computing*. Retrieved from http://www.R-project.org

SCBD. (2010). *COP-10 Decision X/2. Secretariat of the convention on biological diversity*.

SCBD. (2012). *Report of the high-level panel on global assessment of resources for implementing the strategic plan for biodiversity 2011–2020 (No. UNEP/CBD/COP/11/INF/20)*. Montreal, Canada: Secretariat of the Convention on Biological Diversity.

Tittensor, D. P., Walpole, M., Hill, S. L. L., Boyce, D. G., Britten, G. L., Burgess, N. D., et al. (2014). A mid-term analysis of progress towards international biodiversity targets. *Science*, http://dx.doi.org/10.1126/science.1257484

Venter, O., Fuller, R. A., Segan, D. B., Carwardine, J., Brooks, T., Butchart, S. H. M., et al. (2014). Targeting global protected area expansion for imperiled biodiversity. *PLoS Biology*, *12*(6), e1001891. http://dx.doi.org/10.1371/journal.pbio.1001891