Draft for consultation

Note: this document is an advance review version of an information document for the twenty-second meeting of the Subsidiary Body on Scientific, Technical and Technological Advice under agenda item 6 – Updated scientific assessment of progress towards selected Aichi Biodiversity Targets and options to accelerate progress[1]

Updated scientific assessment of progress towards selected Aichi Biodiversity Targets and options to accelerate progress

I. Background

1. In decision XII/1 the Conference of the Parties welcomed the fourth edition of the Global Biodiversity Outlook and recognized that there had been encouraging progress towards meeting some elements of most Aichi Biodiversity Targets but, in most cases, the progress will not be sufficient to achieve the targets unless further urgent and effective action is taken to reduce the pressures on biodiversity and to prevent its continued decline.

2. In decision XIII/30 the Conference of the Parties requested the Executive Secretary, subject to the availability of resources, to prepare, in collaboration with members of the Biodiversity Indicators Partnership and other relevant partners, for the consideration of the Subsidiary Body on Scientific, Technical and Technological Advice at a meeting held prior to the fourteenth meeting of the Conference of the Parties, updated scientific assessments of progress towards Aichi Biodiversity Targets, focusing in particular on those targets on which the least progress has been made and making use of available data and the indicators contained in the annex to decision XIII/28, as appropriate, as well as other information sources used for the fourth edition of the Global Biodiversity Outlook. In the same decision the Executive Secretary was requested to develop options to accelerate progress towards the achievement of those targets which have been identified as the least advanced. In light of these request the following note has been prepared.

3. The mid-term term assessment of progress towards the attainment of the Aichi Biodiversity Targets contained in GBO-4 concluded that, with the exception of Target 16 on the Nagoya Protocol, no target was on track to be met. Seven targets (Targets 2, 3, 4, 6, 9, 13 and 15) had at least one element which was assessed as having had no significant overall progress made and a further 5 targets (Targets 5, 8, 10, 12 and 14) had at least one element which was assessed as moving away from the target. Seven Targets (1, 7, 11, 17, 18, 19 and 20) were assessed as having at least one element for which progress was being made but at a rate that would not allow the targets to be reached by the deadline. Given the overall limited progress that has been towards the achievement of the Aichi Biodiversity Targets this assessment addresses all 20 targets.

4. In order to prepare this note scientific literature, primarily from peer reviewed journals, was reviewed. The review was limited to publications that were published between 2014, the year the fourth edition of the Global Biodiversity Outlook was published, and 2018. The Secretariat engaged a group of interns[2] to collect and summarize relevant information from relevant databases of scientific journals. In addition indicators information was reviewed. Of the indicators used in GBO-4, 28 have had additional data points added. In addition a further 16 indicators not used in GBO-4 have been identified. This information is synthesized in this document in section II of this document while section III provides some overarching observations.

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1 Montreal, Canada, 2-7 July 2018. See: CBD/SBSTTA/22/1 available at https://www.cbd.int/meetings/SBSTTA-22

2 David Barrington Marquis, Madeleine Cazes, Cristina del Rio Cubilledo, El Gibbor Djiki, Louis Donelle, Sara El-Nounou, Sebastien Macdonald Dupuis, David Hoffmann, Yui Matsuo, Gabriel Ouellette, Alexandre Poulin, Fatima Shire, Jan Bernd Sievernich, Yidan Xu

II. Updated Scientific Assessment

Target-by-target analysis

Target 1:By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

5. Since the release of GBO-4 there has been relatively little published scientific information assessing peoples' awareness of biodiversity at the global level. However some assessments at the national scale have been undertaken. For example one study which reviewed media coverage of biodiversity issues between 1991 and 2016 in Canada, the United Kingdom and the United States found that media coverage of climate change issues was significantly higher that for biodiversity and concluded that information on the the challenges facing biodiversity is not reaching the general public[3].

6. Various studies have been undertaken on different approaches, tools and means of raising awareness as well as on advancing the understanding of what constitute effective awareness raising mechanisms. There is also a growing recognition of the relationship between environmental education and attractions such as zoos and aquariums[4]. For example one study determined that visitors to zoos and aquariums who were exposed to educational material, such as interpretive graphic panels and informative films regarding biodiversity, during their visits exhibited an increase in their understanding of biodiversity and of their awareness of actions they could take to protect it[5]. Other studies have attempted to understand how a growing trend towards urbanization may be having a negative effect on people's awareness of biodiversity and relatedly how there is a need to understand how people who live in urban environments understand biodiversity[6]. Studies have also explored how digital games can contribute to biodiversity awareness[7] and how tourism, in particular eco-tourism, can be used to increase biodiversity awareness.

7. There are three indicators related to Aichi Biodiversity Target 1 which have been updated since the publication of GBO-4. Two of these are related to the Biodiversity Barometer (% of respondents that have heard of biodiversity and % of respondents giving correct definition of biodiversity) suggest improvements in people's awareness of biodiversity[8]. The third indicator (online interest in biodiversity) suggests a decline[9].

8. The scientific information that has become available since the publication of GBO-4 suggests that the progress towards this target is largely unchanged from what was previously reported. The scientific literature suggests that the actions identified in GBO-4 remain relevant to the achievement of this Aichi Biodiversity Target. Additional possible actions to accelerate progress towards this target identified in the literature include, the need to develop national communication strategies for biodiversity which speak to specific national priorities and which frame biodiversity in a similar light to other economic and social

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3 Legagneux P, et al (2018) Our House Is Burning: Discrepancy in Climate Change vs. Biodiversity Coverage in the Media as Compared to Scientific Literature. Front. Ecol. Evol. 5:175. doi: 10.3389/fevo.2017.00175

4 Moss, A., et al (2015) Evaluating the contribution of zoos and aquariums to Aichi Biodiversity Target 1. Conservation Biology, 29: 537–544. doi:10.1111/cobi.12383

Clayton, S. etal (2017) Public Support for Biodiversity After a Zoo Visit: Environmental Concern, Conservation Knowledge, and Self-Efficacy, Curator: The Museum Journal, 60, 1, 87

5 Moss, A. etal (2017), Impact of a global biodiversity education campaign on zoo and aquarium visitors. Frontiers in Ecology and the Environment, 15: 243–247. DOI: 10.1002/FEE.1493

6 Shwartz, A. (2014) Enhancing urban biodiversity and its influence on city-dwellers: An experiment, Biological Conservation, 171- 82-90,

7 Sandbrook, C., (2015), Digital Games and Biodiversity Conservation. Conservation Letters, 8: 118–124.

8 Union for Ethical BioTrade (UEBT), Biodiversity Barometer (Amsterdam, 2017). http://www.biodiversitybarometer.org/

9 Internet Live Stats, 2017. Google Search Statistics. http://www.internetlivestats.com/google-search-statistics/

imperatives has been noted[10]. Relatedly it has also been suggested that an international communication strategy for biodiversity would be beneficial, in particular given that the level of media attention devoted to biodiversity is generally limited. The role of the scientific community in raising awareness of biodiversity issues by conveying accurate and clear information, by focusing on global biodiversity issues and on the value of biodiversity to human wellbeing and by fostering the interest of media in biodiversity has also been noted[11].

Target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

9. The integration of biodiversity values into national and local policies and processes is an issue for which there is relatively little scientific information. The information that is available generally focuses at the national or regional level. For example one recent study explored different opportunities and challenges related to the mainstreaming of ecosystem services in policies of the European Union. Among the issues identified were the difficulty of reflecting ecosystems services across various spheres of responsibility and the need for policy makers to consider the dynamics that may exist between different policies[12]. Another obstacle identified in the literature is the need to reconcile different perceptions among stakeholders of what constitutes an ecosystem service[13]. One possible tool to facilitate the implementation of this target is the System of Environmental and Economic Accounting (SEEA) adopted by the United Nations Statistical Commission. However the integration of this framework into national accounting systems has been limited to date[14].

10. The scientific information that has become available since the publication of GBO-4 suggests that the progress towards this target is largely unchanged from what was previously reported. Similarly the scientific literature suggests that the actions identified in GBO-4 remain relevant to the achievement of this Aichi Biodiversity Target.

Target 3: By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.

11. The issue of incentives, including subsidies, harmful to biodiversity is not widely explored in scientific literature. As such there has been relatively little global level information on this issue published since the release of the fourth edition of the Global Biodiversity Outlook. Progress towards the attainment of this target will be further considered during the second meeting of the Subsidiary Body on Implementation.

Target 4:By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

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10 Maze, K., etal (2016) Making the case for biodiversity in South Africa: Re-framing biodiversity communications. Bothalia, 46, dec.

11 Legagneux P, etal (2018) Our House Is Burning: Discrepancy in Climate Change vs. Biodiversity Coverage in the Media as Compared to Scientific Literature. Front. Ecol. Evol. 5:175. doi: 10.3389/fevo.2017.00175

12 Schleyer, C. etal (2015) Opportunities and challenges for mainstreaming the ecosystem services concept in the multi-level policy-making within the EU, Ecosystem Services. 16. 174-181,

13 Verburg, R. etal (2016) Governing ecosystem services, National and local lessons from policy appraisal and implementation, Ecosystem Services,18. 186-197,

14 Vardon, M. (2016). The accounting push and the policy pull: balancing environment and economic decisions, Ecological Economics, 124. 145-152.

12. The information published since GBO-4 has identified various actions which are being taken by countries to make production and consumption more sustainable. For example some countries have put in place policies promoting green development while others have implemented tariff systems to encourage renewable energy production and consumption[15]. Further some countries have put in place initiatives to reduce greenhouse gas emissions and programmes to modernize agricultural equipment[16]. Other studies have looked at the use of various certification systems[17].

13. Much of the scientific information that has become available since the publication of GBO-4 has focused on the national or regional levels. By comparison there has been relatively little global level information summarizing trends and issues related to global sustainable production and consumption. However one global assessment estimated that green consumption represented less than 4% of global consumption and that strategies to increase this, particularly in emerging economies are required[18]. Further it has also been observed that greater awareness is helping to increase the demand for greener products and services and that in industries, such as the food industry, this has led to improvements in labelling[19]. There has also been growing recognition of the role of trade patterns and teleconections on the production and consumption of resources[20]. For example an assessment of the material footprints of 186 countries found that countries' use of resources from non-domestic sources is about three times larger than the physical quantity of traded goods[21]. The same study also found that as wealth increases countries tend to reduce their consumption of domestic resources through international trade thereby allowing their material consumption to increase.

14. Three indicators used in GBO-4 have been updated since the report was released. These are the percentage of countries that are Category 1 CITES Parties[22], which shows and increase, and the Red List Index for the impacts of utilization[23] and the Ecological Footprint[24], both of which show a decrease. In addition a new indicator, the Red List Index for international traded species[25], has become available since GBO-4 was published and it also shows a decline.

15. The scientific information that has become available since the publication of GBO-4 suggests that the progress towards this target is largely unchanged from what was previously reported. Similarly the scientific literature suggests that the actions identified in GBO-4 remain relevant to the achievement of Aichi Biodiversity Target 4.

Target 5:By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

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15 Pretty, J. and Bharucha, Z. P. (2014). Sustainable intensification in agricultural systems, Annals of Botany, Volume 114, 8, 1571–1596,

16 Moraes Sá, J. (2017). Low-carbon agriculture in South America to mitigate global climate change and advance food security, Environment International, 98, 102-112,

17 Keahey, J. (2017). The Promise and Perils of Market-based Sustainability Sociology of Development, 3(2), 43-162.

18 Blok, V. etal (2015). From best practices to bridges for a more sustainable future: advances and challenges in the transition to global sustainable production and consumption: Introduction to the ERSCP stream of the Special volume, Journal of Cleaner Production, 108(A), 19-30.

19 Miranda-Ackerman, M. etal (2017). Extending the scope of eco-labelling in the food industry to drive change beyond sustainable agriculture practices, Journal of Environmental Management,204(3), 814-824,

20 Vörösmarty, C.J. etal (2015). What scale for water governance? Science. 349 (6247).

21 Wiedmann, T.O. etal (2015). The material footpring of nations. Proceedings of the National Academy of Sciences 112(20), 6271-6276.

22 CITES, National laws for implementing the Convention. https://cites.org/legislation

23 IUCN Red List Index. http://www.iucnredlist.org/about/publication/red-list-index

24 Galli, A., etal. (2014). Ecological footprint: Implications for biodiversity. Biological Conservation, 173, 121-132.

25 IUCN Red List Index. http://www.iucnredlist.org/about/publication/red-list-index

16. Since the publication of GBO-4 numerous studies on various habitats have been published. Some of these are based on new information while others are further examinations of data sets which were available when GBO-4 was published.

17. With regards to forests, globally the annual rate of net forest loss was halved from 7.3 million hectares per year in the 1990s to 3.3 million hectares per year between 2010 and 2015. From 2010 to 2015, tropical forest area declined at 58% of the rate in the 1990s. Temperate forest area expanded at a rate of 2.2 million hectares per year while boreal and sub-tropical forest areas showed little net change. On a regional basis forest area is expanding in Europe, North America, the Caribbean, East Asia, and Western-Central Asia, but is declining in Central America, South America, South and Southeast Asia and Africa[26]. Specifically with regards to primary forests, forest area has declined by 2.5% globally and by 10% in the tropics over the period 1990-2015[27].

18. Intact primary forests declined 7.2% between 2000 and 2012 as a result of fragmentation and this rate of loss appears to be increasing. For example the rate of loss in tropical forests was three times larger in 2011-2013 than in 2001-2003[28]. Nearly 20% of the world's remaining forest is within 100 meters of a forest edge and more than 70% are within 1 kilometre[29]. In one assessment of published global tree cover data, including both forest and forest interior areas, between 2000 and 2012 the net rate of forest loss was calculated at 3.2% of all forest area. In comparison 9.9% of forest interior area was lost between 2000 and 2012. One of the conclusions from this study is that considering forest loss alone does not appropriately account for the ecological risk resulting from fragmentation[30].

19. Among the causes of forest lost explored in the literature have been economic factors, fire[31] and insect pests, sever weather and diseases[32]. Forest policies aimed and maximizing profits and unsustainable tenure regimes have also been identified as causes of forest loss[33].

20. A number of studies have attempted to project trends in forest area. For example one study projected global forest area to 2030 and concluded that forest area is expected to continue to decline but that the rate of loss will decrease from 0.13% at the beginning of the century to 0.06% per year by 2030. This decline is the result of a decrease in the rate of natural forest loss and an increase in planted forests. However it is important to note that though the overall rate of forest loss in 2030 is projected to be small it masks important regional differences and in some regions forest area is projected to continue declining[34]

26 Keenan, R. etal (2015). Dynamics of global forest area: Results from the FAO Global Forest Resources Assessment 2015, Forest Ecology and Management, 352, 9-20,

27 Morales-Hidalgo, D. etal (2015). Status and trends in global primary forest, protected areas, and areas designated for conservation of biodiversity from the Global Forest Resources Assessment, Forest Ecology and Management, 352, 68-77,

28 Potapov, P. etal (2017). The last frontiers of wilderness: Tracking loss of intact forest landscapes from 2000 to 2013.Science Advances 3(1)

29 Haddad, Nick M. etal (2015). Habitat fragmentation and its lasting impact on Earth's ecosystems. Science Advances. 1(2)

30 Riitters, K., et al. (2016) A global evaluation of forest interior area dynamics using tree cover data from 2000 to 2012. Landscape Ecology 31: 137. https://doi.org/10.1007/s10980-015-0270-9

31 Jolly, W. etal (2015). Climate-induced variations in global wildfire danger from 1979 to 2013, Nature Communications, 6, 7537.

32 van Lierop, P. (2015). Global forest area disturbance from fire, insect pests, diseases and severe weather events, Forest Ecology and Management, 352, 78-88.

33 Brandt, J. S., etal (2017). Effects of national forest-management regimes on unprotected forests of the Himalaya, 31-6, 1271-1282.

34 d'Annunzio, R. (2015). Projecting global forest area towards 2030, Forest Ecology and Management, 352, 124-133.

21. Global mangrove cover was estimated to be 138,000 square kilometres in 2000, less than half of what it was in 1950[35]. A further study estimated that global mangrove area has decreased from 170,000 square kilometers to 140,00 square kilometers between 1997 and 2014[36].Trends in mangrove cover are generally negative however there is high uncertainty making it difficult to determine rates of loss with any significant confidence[37]. Further while mangroves continue to be lost the rate of loss appears to be declining. Globally between 2000 and 2012, the rate of mangrove loss was estimated to be 0.16% and 0.39% per year. By comparison in the 1980s rate of loss was estimated at 0.99% per year and in the 1990's it was estimated at 0.70% per year. However there are regional differences. For example in Southeast Asia mangrove loss, between 2000 and 2012, has been estimated to be between 3.58% and 8.08%[38]. However other studies have estimated the rate of loss in Southeast Asia to be significantly lower. For example one study estimated that mangrove forest loss to on average 0.18% per year between 2000 and 2012[39]. Among the main drivers of mangrove loss are wood cutting for firewood and timber and clearing for aquaculture.

22. Wetlands have declined by about a 31% between 1970 and 2008. Further the rate of decline appears to be constant[40]. Another study concluded that in the absence of human intervention there would be approximately 29.83 million square kilometres of wetlands. However as of 2009 33% of global wetlands had been lost[41].

23. Permanent surface water (both inland and coastal), based on satellite images from between 1984 and 2015, is estimated to have declined by almost 90,000 square kilometres. A further 72,000 square kilometres have gone from being permanent to seasonal. Over the same period 213,000 square kilometres of permanent water bodies emerged of which 29,000 square kilometres used to be seasonal. Much of the increase that has been observed is the result of the filling of reservoirs. However these global trends also obscure strong regional variation. For example more than 70% of the loss in global permanent water occurred in the Middle East and Central Asia[42]. An addition pressure on the world's inland water systems is fragmentation. For example 48% of global river volume is moderately or severely impacted by flow regulation and/or fragmentation. The same study identified a total of 6374 large dams that currently exist and identified an additional 3377 planned or proposed dams. Assuming that all planned dams are built and dams currently under construction are completed, by 2030 93% of global river volume would be moderately or severely impacted[43].

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35 Polidoro, B., (2014). Global patterns of mangrove extinction risk: Implications for ecosystem services and biodiversity loss. In B. Maslo & J. Lockwood (Eds.), Coastal Conservation(Conservation Biology, pp. 15-36). Cambridge: Cambridge University Press. doi:10.1017/CBO9781139137089.003

36 Pérez, A, etal. (2017). Changes in organic carbon accumulation driven by mangrove expansion and deforestation in a New Zealand estuary. Estuarine, Coastal and Shelf Science 192, 108-116.

37 Friess, D. A. etal (2014), Variability in mangrove change estimates and implications for the assessment of ecosystem service provision. Global Ecology and Biogeography, 23: 715–725. doi:10.1111/geb.12140.

38 Hamilton, S. E. etal (2016), Creation of a high spatio-temporal resolution global database of continuous mangrove forest cover for the 21st century (CGMFC-21). Global Ecol. Biogeogr., 25: 729–738. doi:10.1111/geb.12449

39 Richard, D. etal (2016). Rates and drivers of mangrove deforestation in Southeast Asia, 2000–2012. Proceedings of the National Academy of Sciences, 113(2), 344-349.

40 Dixon, M.J.R., etal (2016) Tracking global change in ecosystem area: The Wetland Extent Trends index. Biological Conservation, 193, 27-35.

41 Shengjie Hu, etal (2017). Global wetlands: Potential distribution, wetland loss, and status,Science of The Total Environment, 586, 319-327.

42 Pekel, J etal (2016). High-resolution mapping of global surface water and its long-term changes. Nature, 540, 418-422.

43 Grill,G. et al (2015) An index-based framework for assessing patterns and trends in river fragmentation and flow regulation by global dams at multiple scales Environmental. Research. Letters. 10 015001

24. Assessments of grasslands often arrive at different results[44] as there are various definitions and classes of grasslands[45] and land cover maps generally have a high level of uncertainty[46]. Globally agricultural expansion remains a main threat to grasslands, however many high income countries are experiencing farmland abandonment[47]. A number of the studies published since GBO-4 have focused on better understanding grassland trends in specific countries including Brazil[48], Mexico[49], and Mongolia[50]. These studies generally indicate a decline in grassland area.

25. An assessment looking at trends in the marine environment found that trends in habitat modification, including coral cover loss, mangrove loss, change in the cumulative number of marine wind turbines, change in cumulative area of the seabed under contract for mineral extraction in international waters, trends in volume of global container port traffic and in change in the cumulative number of marine dead zones, suggest that habitat change may be an increasingly important threat to marine wildlife[51]. For example both dredging[52] and bottom trawling[53] can have a range of impacts on the marine environment depending on how they are carried out and regulated.

26. For kelp forests and sea grasses there is a high degree of geographic variations in trends, both in terms of the magnitude of change and the direction. One analysis observed that 38% of ecoregions had declining trends in kelp forests while 27% of ecoregions showed positive trends and 35% had no detectable change[54]. With regards to seagrasses a review of these ecosystems in the Western Pacific region found that in three sites seagrasses were stable, at four sites they were declining as a result of nutrient pollution and at three sites they were declining as a result of sedimentation. Further two sties experienced near complete loss of seagrasses but begun to recover once sedimentation was reduced[55].

27. Two indicators used in GBO-4 have been updated since the report was released. The Wetland Extent Trends Index[56] and the Wild Bird Index for habitat specialists both show declines. In addition two

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44 Dunn, J. B., etal (2017), Measured extent of agricultural expansion depends on analysis technique. Biofuels, Biofuels, Bioproducts and Biorefining., 11: 247–257. doi:10.1002/bbb.1750

45 Dixon, A. P., etal (2014), Distribution mapping of world grassland types. J. Biogeogr., 41: 2003–2019. doi:10.1111/jbi.12381

46 Congalton, R.Getal (2014) Global Land Cover Mapping: A Review and Uncertainty Analysis. Remote Sensing. 6, 12070-12093.

47 Queiroz, C., etal (2014), Farmland abandonment: threat or opportunity for biodiversity conservation? A global review. Frontiers in Ecology and the Environment, 12: 288–296. doi:10.1890/120348

48 Hermann, J.-M., etal. (2016). Forest–grassland biodiversity hotspot under siege: land conversion counteracts nature conservation. Ecosystem Health and Sustainability2(6):e01224. doi:10.1002/ehs2.1224

49 Pool, D etal (2014). Rapid expansion of croplands in Chihuahua, Mexico threatens declining North American grassland bird species, Biological Conservation, 170,274-281.

50 Wang, Z. etal (2017). What is the main cause of grassland degradation? A case study of grassland ecosystem service in the middle-south Inner Mongolia, CATENA, 150, 100-107.

51 McCauley, D. J. etal (2015). Marine defaunation: Animal loss in the global ocean, Science 347(6219)

52 Victoria L. G. etal (2015) A review of impacts of marine dredging activities on marine mammals, ICES Journal of Marine Science, Volume 72, Issue 2, 328–340,

53 Clark, M. etal (2016) The impacts of deep-sea fisheries on benthic communities: a review, ICES Journal of Marine Science, Volume 73, i51–i69.

54 Krumhansl, Kira A. etal (2016). Global patterns of kelp forest change over the past half-century, Proceedings of the National Academy of Sciences 113 (48) 13785-13790.

55 Short, etal (2014). Monitoring in the Western Pacific region shows evidence of seagrass decline in line with global trends, Marine Pollution Bulletin, 83(2). 408-416.

56 Dixon, M.J.R.etal (2016, with updated data) Tracking global change in ecosystem area: The Wetland Extent Trends index. Biological Conservation 193, 27–35.

new indicators, area of tree cover loss[57] and Red List Index for forest specialists[58] both show trends negative for biodiversity.

28. Most of the scientific information related to this target that has become available since GBO-4 was published is focused on forests. Information on other habitats is increasing but is still limited at the global level. However advances in remote sensing are opening up new opportunities to more effectively monitor changes in the Earth's ecosystems. Overall the literature reviewed for this assessment suggests that the situation is largely unchanged from what was previously reported in GBO-4. Namely that globally the rate of deforestation is declining but with significant regional variation, that other habitats many continue to experience high rates of decline and habitats of all types continue to be fragmented and degraded. Similarly the recent scientific information suggests that the actions identified in GBO-4 to accelerate progress towards this target remain relevant.

Target 6:By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

29. FAO estimated that marine capture production rose between 1950 and 1988 when it reached 78 million tonnes (excluding anchoveta). Between this time and 2003 marine capture production levelled off and between 2003 and 2009 marine capture production remained stable. Since 2010 it has increased and in 2014 reached 78.4 million tonnes[59]. However another study makes use of a wide variety of data and information sources to derive estimates for all fisheries components missing from official reported data suggests that marine capture production peaked at 130 million tonnes in 1996, and has been declining since. This decline is associated with declines in industrial catches and to a lesser extent declining discards, and despite industrial fishing having expanded from industrialized countries to the waters of developing countries[60.]

30. The percentage of fish stocks fished at biologically unsustainable levels increased from 10% in 1974 to 26% in 1989. Since 1990 the number of stocks being fished at unsustainable levels has continued to increase, though more slowly then it has in the past, and reached 31.4% in 2013[61]. Other studies have also suggested declines in the sustainability of fisheries. For example one study estimated that percentage of fisheries below critical thresholds increased from 63% in 2006 to 68% in 2012[62]

31. A meta-analysis of 4,713 fisheries, representing 78% of global reported fish catch, found that the median fishery is overfished but that conditions are highly heterogeneous. Further 32% of assessed fisheries were found to be in good biological condition but not necessarily in good economic condition. The assessment further concluded, based on a business as usual scenario the continued collapse of many

57 Hansen, M.C., etal (2013). High-resolution global maps of 21st-century forest cover change. Science, 342(6160), pp.850-853. Data available online from http://earthenginepartners.appspot.com/science-2013-global-forest.
Heino, M., etal. (2015). Forest loss in protected areas and intact forest landscapes: a global analysis. PloS one, 10(10), p.e0138918.

58 Hansen, M.C., etal (2013). High-resolution global maps of 21st-century forest cover change. Science, 342(6160), pp.850-853. Data available online from http://earthenginepartners.appspot.com/science-2013-global-forest.

59 FAO. 2016. The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome. 200 pp.

60 Pauly, D., and Zeller, D. (2016). Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining. Nature communications, 7

61 FAO. 2016. The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome. 200 pp.

62 Worm, B. (2016). Averting a global fisheries disaster. Proceedings of the National Academy of Sciences, 113(18), 4895-4897.

of the world's fisheries[63]. However the same assessment found that sound management reforms to global fisheries could increase annual catch by 16 million metric tonnes, increase biomass by 619 million metric tonnes and increase profits by 53 billion US$ relative to a business as usual scenario. A further meta-analysis of 785 fish stocks found that 56% of stocks are below biomass maximum sustainable yield (bMSY) and 33% of these are below 80% of bMSY[64].

32. Other studies have examined situations regarding marine fisheries in specific areas. For example one study estimated that in the Baltic Sea, when illegal fishing is accounted for, actual catches may be 35-40% higher than reported[65] while another has shown that harvest control rules in the Barents Sea has led to an increase in cod biomass[66].

33. With regards to the marine environment more generaly, one study examined the cumulative impacts on the marine ecosystem resulting from fishing, climate change and ocean and land stressors. The assessment found that that 66% of the ocean and 77% of the area under national jurisdiction showed increased human impact while 5% of the ocean is heavily impacted, 10% has a very low level of impact. However there have been some signs of improvement.[67].

34. Other studies have looked at specific marine ecosystems. For example one assessment focusing on the Western and Adriatic regions of the Mediterrnean Sea concluded that all fisheries resources are at risk of overexploitation[68]. A similar study concluded that global biomass production in the marine environment predicted a long-term decline in global marine catch[69]. Given the importance of agricultural and fisheries productivity to human wellbeing such trends are a challenge to the prospects for reaching Aichi Target 14.

35. A variety of research has also been undertaken on the effect of marine protected areas on fisheries[70]. This research shows that marine protected areas have the potential to make important

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63 Costello, C. et al. (2016). Global fishery prospects under contrasting management regimes. Proceedings of the National. Academy of Science5125.5129

64 Rosenberg, A.A et al., (2017). Applying a New Ensemble approach to estimating stock status of marine fisheries around the world. Conservation Letters. Doi: 10.1111/conl.12363

65 Beddington, J. R., etal (2007). Current problems in the management of marine fisheries. science, 316(5832), 1713-1716.

66 Kjesbu, O. S., etal (2014). Synergies between climate and management for Atlantic cod fisheries at high latitudes. Proceedings of the National Academy of Sciences, 111(9), 3478-3483.

67 Halpern, B. S. et al. (2015) Spatial and temporal changes in cumulative human impacts on the world's ocean. Nature Communications. 6:7615 doi: 10.1038/ncomms8615.

68 Liquete, C. etal (2016). Ecosystem services sustainability in the Mediterranean Sea: Assessment of status and trends using multiple modelling approaches. Scientific Reports 6, 34162.

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contributions to the attainment of this Aichi Biodiversity Target. However their overall effect will depend on social, economic, and ecological objectives and conditions and therefore they may not be an optimal approach to reaching this target. Ultimately their benefits need to be considered on a case-by-case basis. The issue of marine protected areas is further considered under Aichi Biodiversity Target 11.

36. Other studies have explored means of improving the governance of fisheries. Among the issues raised has been the need to embed fisheries governance within a broader perspective on human rights to achieve changes in small-scale fisheries management[71]. Further one study found that applying sound management reforms to global fisheries could result in an annual increase of more than 16 million metric tons of fish catch[72].

37. Four indicators used in GBO-4 have been updated since the report was released. Three of these indicators, proportion of fish stocks in safe biological limits[73], the marine trophic index[74] and the Red List Index for the impacts of fisheries[75], all show negative trends. One indicator, Marine Stewardship Council certified fisheries (tonnes)[76], shows improvement.

38. The scientific information that has become available since the publication of GBO-4 suggests that the progress towards this target is largely unchanged from what was previously reported. Similarly the he scientific literature suggests that the actions identified in GBO-4 remain relevant to the achievement of this Aichi Biodiversity Target.

Target 7: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

39. There has relatively little scientific information assessing the sustainability of agricultural systems at a global level since the publication of GBO-4. Much of the recent literature related to the sustainable management of agriculture has focused on the use of different agricultural techniques. For example one study concluded that small-scale habitat restoration within intensive agricultural landscapes had positive effects on species vulnerable to habitat degradation[77]. Similarly removing a small percent of agricultural land from production at field edges to create wildlife habitat increased total agricultural yields. Relatedly in a study where 10% of cropland was replaced with strips of native plant species it was found that it resulted in greater insect taxa richness, greater pollinator abundance, greater native bird species richness and a greater abundance of bird species of conservation need when compared to fields which did not have such strips. It was also observed that these trips reduced water runoff, greater soil and phosphorus retention. Overall the effect of the crop strips was an increase in biodiversity and ecosystem services and a modest reduction in crop production, equal to the land area taken out of crop production[78]. A further study found that creating annual flower strips along wheat fields reduced cereal leaf beetle

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76 Marine Stewardship Council, 2017. *MSC global impacts report 2017*. MSC, London. Marine Stewardship Council, 2014. *MSC Fisheries Certification Requirements. Version 2*. MSC, London.

77 Kremen, C. and M’Gonigle, L. K. (2015). Editor's Choice: Small-scale restoration in intensive agricultural landscapes supports more specialized and less mobile pollinator species. Journal of Applied Science, 52-3, 602–610.

78 Schulte, L. etal (2017). Prairie strips improve biodiversity and the delivery of multiple ecosystem services from corn–soybean croplands. Proceedings of the National Academy of Sciences. 10.1073/pnas.1620229114

density and plant damage caused by these by increasing the presence of natural enemies to cereal left beetles. The study concludes that flower strips promote pest control and could be considered as an alternative to insecticides[79].With regards to pesticides a study of 946 non-organic arable commercial farms in France found that in 77% of cases there was no conflict between low pesticide use and productivity. The study further found that pesticide use could be reduced by 42% without having a negative effect on productivity or profitability in 59% of farms[80]. This information is also relevant to Aichi Biodiversity Target 8.

40. Further many studies of traditional farming systems emphasize the importance of enhancing plant diversity and complexity in farming systems to increase yield stability and reduce vulnerability to extreme climatic events[81]. Similarly empowering smallholder farmers to improve yields and improved economic gains sustainably has been shown to be an effective. For example a study of smallholder farmers in China found that addressing yield limiting facts involving agronomic, infrastructural and socio-economic conditions resulted, in some cases, in yield increased from 67.9% of the attainable to level to 97% of the attainable level over a 5 year average[82].

41. Research on various approaches to agriculture have also been published. For example integrated crop water management, which combines irrigation efficiency improvements, better use of rain water and other low-tech solutions, has the potential to largely increase global production and close the water-related yield gap[83]. Further there has also been growing work on what has been termed precision agriculture, where tools such as machine learning, have been used for the early identification of plant diseases weed detection[84]. However the application of such techniques has remained limited owing to their relatively high costs[85].

42. The potential benefits of increasing pollinator diversity as a means of increasing crop yields has also been explored in scientific literature published since the release of GBO-4. For example a study, based on an assessment 344 fields in Africa, Asia and Latin America of 33 pollinator dependent crops, concluded that in fields less than 2 hectares yield gaps could be closed by on average 24% through greater pollination[86]. The issue of pollination is further discussed under Aichi Biodiversity Target 14.

43. There have also been increases in the use of organic farming which is currently practiced on an estimated 37.2 million hectares of agricultural land in 162 countries. However this represents less than one percent of global agricultural land in 2011[87]. An assessment of organic agriculture found that it increased species richness by on average 30%[88] while another study found that they produce around 20% lower yields compared with conventional agriculture, but that yields were more profitable and delivered

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79 Tschumi, M. (2018). High effectiveness of tailored flower strips in reducing pests and crop plant damage. Proceedings of the Royal Society B. 282.

80 Lechenet, M. etal (2017) Reducing pesticide use while preserving crop productivity and profitability on arable farms. Nature Plants 3, 17008.

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86 Garibaldi, L.A. etal (2016). Mutually beneficial pollinator diversity and crop yield outcomes in small and large farms. Science 351 (6271), 388-391.

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greater ecosystem services and social benefits[89]. It has also been noted that growers are increasingly turning to certified organic farming systems to provide verification of production methods, decrease reliance on non-renewable resources, and capture high-value markets and premium prices[90]. Similarly there has been a growing use of no-till agricultural methods which has been estimated to be used in 125 million hectares, or about 9% of global arable land[91]. Both conservation and organic agriculture techniques have been found to increase the abundance and biomass of all soil organisms, with the exception of predaceous nematodes, compared to conventional systems[92]. However despite the potential benefits of conservation agriculture, studies have found that it is not widely applied due to limited economic incentives, particularly for smallholder farmers, to do so[93]. Further while the growing use of organic and no-till agricultural is generally regarded as positive, there is no guarantee that such methods are sustainable by themselves. One study exploring the potential benefits of organic agriculture for production found that the greater use of organic agriculture in combination with efforts to reduce food waste and to reduce consumption and production of animal products could deliver substantial benefits to food systems[94].

44. Other studies have explored the conditions which facilitate sustainable agricultural management. For example an analysis of South American countries found that in countries with good conventional governance, agricultural intensification led to an expanded agricultural footprint while in countries with strong environmental governance, agricultural intensification led to a contracted agricultural footprint[95]. Scientific literature has also been paying more attention to potential nature based approaches for the sustainable intensification of agriculture[96].

45. With regards to forestry, policies related to sustainable forest management are reported to be in place for 98% of permanent forest land, some 1.1 billion hectares[97]. However another studies have observed that the application of sustainable forest management in low-income and tropical countries is modest[98].

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89 Reganold, J. P., and Wachter, J. M. (2016). Organic agriculture in the twenty-first century. Nature Plants 2 - 1522.

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90 Reganold, J. P., and Wachter, J. M. (2016). Organic agriculture in the twenty-first century. Nature Plants 2 - 1522.

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Stevenson, J. R., etal (2014). Evaluating conservation agriculture for small-scale farmers in Sub-Saharan Africa and South Asia. Agriculture, Ecosystems & Environment 187, 1-10.

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46. Between 1990 and 2015 the area of planted forest has increased from 4.06% to 6.95% of total forest area, though between 2010 and 2015 the rate of increase slowed to 1.2%. This is below the 2.4% rate of increased that it has been suggested is needed to supply the world's timber and fibre demand[99]. Most planted forests are composed of native species and twenty countries accounted for 85% of the world's planted forest area while a different 20 countries accounted for 87% of roundwood supply[100].

47. Research published since the preparation of GBO-4 has contributed to the understanding of the relationship between tree diversity and ecosystem productivity. For example an assessment of forest data from 44 countries found that a 10% loss in biodiversity loss resulted in a 3% decline in productivity, suggesting that the economic value of maintaining biodiversity for forest productivity is more than five times greater than the global conservation costs[101].

48. With regards to aquaculture, it has been estimated to be the fastest growing animal based food production sector, and in 2016 it provided more than 50% of the fish consumed globally[102]. Approximately 90% of aquaculture production takes place in developing countries. There is a diversity of species used in aquaculture practices but it is generally dominated by 35 species[103].

49. One of the main issues in the sustainable management of aquaculture is the products being used as feed. It has been estimated that more than 70% of global aquaculture production depends on external sources of feed. With increasing rates of aquaculture production, feed use is also increasing. Since 2000 is has been growing at an average annual rate of 10.3% and is expected to reach 65.4 million tonnes by 2020 compared to 39.6 million tons in 2012[104]. Aquaculture feed is currently derived from crop and crop byproducts, wild caught fish, fish processing byproducts and livestock byproducts[105]. As demand for aquaculture feed grows competition for these crops and products will also increase, with potential implications for food security[106]. However over the last few years there have also been improvements to feeding efficiencies for some aquaculture species such as Atlantic salmon, shrimp and tilapias[107].

50. Aquaculture has been found to have potential impacts on coastal environments. Some studies have found that aquaculture has resulted in land use change, the loss of coastal wetlands, pollution[108] and

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Sloan, S. and Jeffrey, A.S. (2015). Forest Resources Assessment of 2015 shows positive global trends but forest loss and degradation persist in poor tropical countries, Forest Ecology and Management, 352, 134.

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Food and Agriculture Organization of the United Nations (FAO). (2015). Global Forest Resources Assessment 2015 - How are the world's forests changing? Second edition. Food and Agriculture Organization (FAO). Rome, Mountain Forum

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increased sensitivity to erosion. Aquaculture has also been linked to land subsidence[109]. Further aquaculture has been linked to the introduction of veterinary medicines in water systems. For example one study estimated that on average 25% of veterinary medicines used in aquaculture ponds enter the largest environment[110].

51. Three indicators used in GBO-4 have been updated since the report was released. Two of these, area of agricultural land under organic production[111] and area of forest under sustainable management[112], show positive trends. The other indicator, the Wild Bird Index for farmland birds, shows a decline. In addition one indicator, nitrogen use balance[113], has become available since GBO-4 was published, and shows a trend negative for biodiversity.

52. The scientific information that has become available since the publication of GBO-4 suggests that the situation is largely unchanged from what was previously reported. Similarly the scientific literature suggests that the actions identified in GBO-4 remain relevant to the achievement of this Aichi Biodiversity Target.

Target 8: By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.

53. Since the publication of GBO-4 a range of literature relevant to this target has been published. As with GBO-4 most of the available global information continues to focus on the effects of nutrients. There is comparatively less global information available on other pollution sources. One exception to this is plastic pollution for which several new studies have been undertaken in recent years

54. Without mitigation efforts nitrogen pollution is predicted to rise between 100-150% above 2010 levels by 2050[114]. Estimates suggest that 50% of current nitrogen use is wasted and ends up as pollution[115] with negative effects on terrestrial and aquatic environments. Global nitrogen and phosphorus transport to the sea has more than doubled in the twentieth century, despite significant anthropogenic slowing of waterways, such as through the construction of canals and dams which increases nutrient retention[116]. For

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Ocean and Coastal Management, 119, p244.

109 Chen, Y., etal (2014). The influence of polarimetric parameters and an object-based approach on land cover classification in coastal wetlands. Remote Sens. 6, 12575-12592

110 Rico, A., and Van den Brink, P.J., (2014). Probabilistic risk assessment of veterinary medicines applied to four major aquaculture species produced in Asia. Sci. Total Environ. 468-469, 630-641.

111 FiBL, Data collection on organic agriculture world-wide http://www.organic-world.net/statistics/statistics-data-collection.html

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112 https://www.bipindicators.net/indicators/area-of-forest-under-sustainable-management-certification, https://info.fsc.org/, http://www.pefc.co.uk/

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114 Bodirsky, B. L., etal (2014). Reactive nitrogen requirements to feed the world in 2050 and potential to mitigate nitrogen pollution. Nature Communications, 5, 3858.

115 Lassaletta, L, etal (2014). 50 year trends in N use efficiency of world cropping systems: the relationship between yield and N input to cropland. Environmental Research Letters, 9(10), 105011.

116 Suwarno, D., etal (2014). The effects of dams in rivers on N and P export to the coastal waters in Indonesia in the future. Sustainability of Water Quality and Ecology, 3, 55-66.

Maavara, T., etal (2015). Global phosphorus retention by river damming. Proceedings of the National Academy of Sciences, 112(51), 15603-15608.

Beusen, A. H. W., etal (2015). Coupling global models for hydrology and nutrient loading to simulate nitrogen and phosphorus retention in surface water–description of IMAGE–GNM and analysis of performance. Geoscientific Model Development, 8(12), 4045-4067.

example in East Asia, many large rivers and their estuaries, including the Yangtze river[117], the Changjiang river[118], the Pearl River[119] and Sanggou Bay[120], are severely affected by nutrient pollution, with increasing frequency of harmful algal blooms and growing hypoxic areas harmful to biodiversity. Similarly estimates suggest that anthropogenic nitrogen and phosphorus sources (from agriculture and domestic sewage) outweigh natural sources 5-1 for nitrogen and 10-1 for phosphorous in the Parnaíba River Delta in Brazil, the largest river delta in the Americas[121]. An increasingly important cause of nutrient pollution in freshwater and coastal waters is aquaculture[122], as it generally suffers from low nitrogen and phosphorus use efficiency[123] and can produce nutrient loads 100 to 1000 times higher than surrounding tidal waters[124].

55. Most research on nutrient pollution in the terrestrial environment relates to its effects on grassland vegetation. There is broad consensus that nutrient enrichment in grasslands generally reduces species diversity and richness[125]. Both nitrogen and phosphorous are susceptible to accumulate in soils[126]. Large

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125 Ceulemans, T., etal (2014). Soil phosphorus constrains biodiversity across European grasslands. Global change biology, 20(12), 3814-3822.

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Simkin, S. M., etal (2016). Conditional vulnerability of plant diversity to atmospheric nitrogen deposition across the United States. Proceedings of the National Academy of Sciences, 113(15), 4086-4091

Soons, M.B., etal (2016). Nitrogen effects on plant species richness in herbaceous communities are more widespread and stronger than those of P. Biological Conservation.

accumulations of nutrients in major agricultural basins can continue to leach into water for decades, producing large time lags between regulation and effect seen[127]. For example despite nitrogen deposition to peatlands in the United Kingdom falling in recent years, 69% of peatlands were still found to be above critical nitrogen levels[128]

56. Effects of nutrient pollution on faunal diversity is not as well studied as effects on vegetation[129], however there seems to be agreement that nitrogen deposition negatively affects fauna across ecosystem types[130] by shifting vegetation community structure to one which favours herbivores with generalist or nitrophilous diets[131] and disrupts food web at multiple trophic levels[132].

57. In the literature a great deal of attention has been directed towards means of enhancing nutrient use efficiency. For example with regards to aquaculture it has been observed that organic aquaculture releases significantly less nitrogen and phosphorus relative to intensive methods[133] and that integrated multi-trophic aquaculture, systems cultivating multiple species at once, greatly increase nutrient efficiency. Further it has been shown that adjusting the time of harvest to tidal patterns can reduce nutrient emissions by 10% without incurring extra costs to aquaculture operations[134]. It has also been shown that

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Zhang, Y., etal (2014). Rapid plant species loss at high rates and at low frequency of N addition in temperate steppe. Global change biology, 20(11), 3520-3529

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127 Yan, X., etal (2014). Fertilizer N recovery efficiencies in crop production systems of China with & without consideration of residual effect of N. Environmental Research Letters, 9(9), 095002.
Powers, S. M., etal (2016). Long-term accumulation and transport of anthropogenic phosphorus in three river basins. Nature Geoscience, 9(5), 353-356.

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130 Nijssen, M. E., etal (2017). Pathways for the effects of increased nitrogen deposition on fauna. Biological Conservation.
WallisDeVries, M. F., and Bobbink, R. (2017). Nitrogen deposition impacts on biodiversity in terrestrial ecosystems: Mechanisms and perspectives for restoration. Biological Conservation. Editorial

131 Ferreira, R. C., etal (2015). Responses of estuarine nematodes to an increase in nutrient supply: an in situ experiment. Marine pollution bulletin, 90(1), 115-120.
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132 Meunier, C. L., etal (2016). Impact of nitrogen deposition on forest and lake food webs in nitrogen-limited environments. Global change biology, 22(1), 164-179.

133 Silva, C. A. R., Sternberg, L. D. S. L., Dávalos, P. B., & de Souza, F. E. S. (2017). The impact of organic and intensive farming on the tropical estuary. Ocean & Coastal Management, 141, 55-64.

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mangroves can act as nutrient sinks for aquaculture[135], however with possible negative repercussions on the mangroves[136].

58. Possible actions to improved nutrient use efficiency in the terrestrial environment have also been explored in the scientific literature. These include incentivizing crop varietals engineered for lower nutrient requirements[137], implementing modern integrated soil-crop system management which has been shown to achieve 97-99% of yields from intensive systems while using significantly less fertilizer[138], using precise nitrogen-use targets[139] based on specific crop type and region[140], and the application of fertilizer directly onto crops rather than mixed in to the soil[141]. Furthermore appropriatly timing fertilizer application and the use of cover crops has been shown to reduce nitrogen losses by 30%. Similarly the use of woodchips as ground cover exhibited an 80% removal of nitrogen while wetlands reduced nitrogen output by 45%[142]. The recycling of nutrient-rich (particularly potasium-rich) bioresources, such as manure[143] and animal bones[144] represents a means of reducing nutrient emissions while avoiding unnecessary nutrient use.

59. A further means of reducing the need for nutrient application that has been explored in the literature is to make better use of the nutrients which have accumulated in soils. Nitrogen and phosphorus are susceptible to accumulate in soils[145] and it has been observed that large buildups of nutrients in major agricultural basins can continue to leach into water for decades, producing large time lags between regulation and effect seen[146]. As such there is a potential to make better use of these accumulated nutrients

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139 Bai, Z., Ma, L., Ma, W., Qin, W., Velthof, G. L., Oenema, O., & Zhang, F. (2015). Changes in phosphorus use and losses in the food chain of China during 1950–2010 and forecasts for 2030. Nutrient cycling in agroecosystems, 104(3), 361-372.

140 Zhang, X., Davidson, E. A., Mauzerall, D. L., Searchinger, T. D., Dumas, P., & Shen, Y. (2015). Managing nitrogen for sustainable development. Nature, 528(7580), 51-59.

141 Withers, P. J., etal (2014). Feed the crop not the soil: rethinking phosphorus management in the food chain

142 David, M. B., etal (2015). Navigating the socio-bio-geo-chemistry and engineering of nitrogen management in two Illinois tile-drained watersheds. Journal of environmental quality, 44(2), 368-381.

143 Bai, Z. H., etal (2014). Changes in pig production in China and their effects on nitrogen and phosphorus use and losses. Environmental science & technology, 48(21), 12742-12749.
Bai, Z., etal (2015). Changes in phosphorus use and losses in the food chain of China during 1950–2010 and forecasts for 2030. Nutrient cycling in agroecosystems, 104(3), 361-372.
Strokal, M., etal (2016). Alarming nutrient pollution of Chinese rivers as a result of agricultural transitions. Environmental Research Letters, 11(2), 024014.
Withers, P. J., etal (2014). Feed the crop not the soil: rethinking phosphorus management in the food chain.

144 Simons, A., etal (2014). Filling the phosphorus fertilizer gap in developing countries. Nature Geoscience, 7(1), 3-3.

145 Van Meter, K. J., etal (2016). The nitrogen legacy: emerging evidence of nitrogen accumulation in anthropogenic landscapes. Environmental Research Letters, 11(3), 035014.

146 Yan, X., etal (2014). Fertilizer N recovery efficiencies in crop production systems of China with & without consideration of residual effect of N. Environmental Research Letters, 9(9), 095002.
Powers, S. M., etal (2016). Long-term accumulation and transport of anthropogenic phosphorus in three river basins. Nature Geoscience, 9(5), 353-356.

in some regions[147]. For example it has been estimated that if China were to effectively tap its soils' legacy phosphorus it could provide 20% of its phosphorous needs over next 30 years[148].

60. Establishing legislation and policies related to nutrient use has been shown to be effective in reducing nutrient pollution. For example in the Baltic Sea Regulations from the 1980s have stabilised nutrient loads[149] however at levels which are still high[150]. Similarly the European Union has established critical loads and regulates nitrogen emissions which has been shown the effective in reducing nutrient pollution[151].

61. With regards to plastics, various assessments have shown that plastic debris is found throughout the marine environment[152].It has been estimated that in 2010 275 million metric tonnes of plastic waste was generated of which between 4.8 and 12.7 million metric tonnes entered the ocean. It is further estimated that by 2025 the cumulative quantity of plastic waste that could enter the ocean from land will increase by an order of magnitude[153]. Other studies have estimated that the concentration of plastic pollution to be on the order of 580,000 pieces per square kilometre. A substantial proportion of plastic entering the marine environment originates from large rivers with population rich catchments[154]. While less information is available on the presence of plastic in freshwater systems, it has been suggested that the presence and impacts of plastic pollution maybe just as prevalent in freshwater environments then it is in the marine environment[155].

62. Marine plastic has been found to have various effects on biodiversity. 340 publications have documented encounters between 693 species and marine debris, 92% of which were related to plastic. Further 17% of these species were listed as threatened or near threatened[156]. In addition one study projected that by 2050 99% of all seabird species will have ingested plastic[157]. Marine plastics have also been found in various other species including cetaceans[158]. Further recent studies have also pointed to the

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147 Withers, P. J., etal (2014). Feed the crop not the soil: rethinking phosphorus management in the food chain.
148 Sattari, S. Z., etal (2014). Key role of China and its agriculture in global sustainable phosphorus management. Environmental Research Letters, 9(5), 054003.
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151 Jones, L., etal (2016). Can on-site management mitigate nitrogen deposition impacts in non-wooded habitats?. Biological Conservation.
WallisDeVries, M. F., and Bobbink, R. (2017). Nitrogen deposition impacts on biodiversity in terrestrial ecosystems: Mechanisms and perspectives for restoration. Biological Conservation. Editorial.

152 Pham CK, et al. (2014) Marine Litter Distribution and Density in European Seas, from the Shelves to Deep Basins. PLoS ONE 9(4): e95839. https://doi.org/10.1371/journal.pone.0095839

Desforges, J. etal (2014). Widespread distribution of microplastics in subsurface seawater in the NE Pacific Ocean. Marine Pollution Bulletin. 79 (1-2),94-99.

153 Jambeck, J.R., etal (2015) Plastic waste inputs from land into the ocean. Science. 347 (6223), 768-770.

154 Schmidt, C. etal (2017). Export of Plastic Debris by Rivers into the Sea Environmental Science & Technology 51 (21), 12246-12253.

155 Eerkes-Medrano, D. etal (2015). Microplastics in freshwater systems: A review of the emerging threats, identification of knowledge gaps and prioritisation of research needs. Water Research 75, 63

156 Gall, S.C and Thompson, R.C. (2015). The impact of debris on marine life. Marine Pollution Bulletin.92 (1-2). 170-179.

157 Wilcox, C. etal (2015). Threat of plastic pollution to seabirds is global, pervasive, and increasing. Proceedings of the National Academy of Sciences. 112 (38). 11899-11904

158 Besseling, E, etal (2015)/ Microplastic in a macro filter feeder: Humpback whale Megaptera novaeangliae. Marine Pollution Bulleting. 95 (1), 248-252.

Baulch, S. and Perry C. (2014). Evaluating the impacts of marine debris on cetaceans. Marine Pollution Bulletin. 80 (1-2). 210-221.

negative effect of plastic pollution on coral reefs. An assessment of 150 reefs in the Asia Pacific region found that the likelihood that corals were affected by diseases increased between 4% and 89% when they were in contact with plastic. The study further estimated that 11.1 billion plastic items were found in the coral reefs in the region and this could increase by a further 40% by 2025[159].

63. One means of reducing the amount of plastic entering the environment is to institute interventions to reduce the use of plastic bags. Numerous governments, at different scales, have enacted strategies, including outright bans, partial bans, customer charges, taxes and fees related to the use of plastic bags, as well as regulating the thickness of plastic bags. However, while there appears to be growing momentum with regards to the introduction of these types of measures relatively little research has been carried out on their effectiveness[160].

64. One indicator used in GBO-4, the Red List index (impacts of pollution) [161], has been updated since the report was released. This indicator shows a decrease. In addition one new indicator, pesticide use[162], has become available since GBO-4 was prepared. This indicator also shows a trend negative for biodiversity.

65. The scientific information that has become available since the publication of GBO-4 suggests that the progress towards this Aichi Biodiversity Target is largely unchanged from what was previously reported. Similarly the scientific literature suggests that the actions identified in GBO-4 remain relevant to the achievement of this Aichi Biodiversity Target.

Target 9: By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

66. Introduction pathways for invasive alien species are generally well identified however it has been suggested that more attention needs to be devoted to identifying mechanism related to spread of invasive alien species once they have been introduced so that appropriate measures can be more easily taken[163]. For example a review of 22 research articles examining the dispersal of alien plant species found that water birds, such as ducks, geese, swans, herons and gulls, were common mechanism of secondary introduction[164]. Further even though pathways are relatively well known, there is limited data on the establishment and spread of species[165].

67. A number of approaches to prioritizing potential invasive alien species have been reviewed in the literature. Some of these approaches, such as FinnPrio, have been developed in light of specific national

159 Lamb, Joleah B. etal (2018). Plastic waste associated with disease on coral reefs. Science 359 (6374) 460-462.

160 Xanthos, D. etal. (2017). International policies to reduce plastic marine pollution from single-use plastics (plastic bags and microbeads): A review. Marine Pollution Bulletin, 118 (1–2), 17-26.

161 IUCN Red List Index http://www.iucnredlist.org/about/publication/red-list-index

162 Food and Agriculture Organization of the United Nations. FAOSTAT. Pesticides (use). (Latest update: Dataset) Accessed (06 Mar 2014). http://ref.data.fao.org/dataset?entryId=5e70fee4-fb65-43b6-8da1-b6de4626b9bd&tab=about

163 Baker, C.M. (2016) Target the Source: Optimal Spatiotemporal Resource Allocation for Invasive Species Control. Conservation Letters 10(1), 41-48.

Chapman, D etal (2016). Modelling the introduction and spread of non-native species: international trade and climate change drive ragweed invasion. Global Change Biology 22, 3067–3079 doi: 10.1111/gcb.13220.

164 Green, A., J. (2016). The importance of water birds as an overlooked pathway of invasion for alien species. Diversity and Distribution Vol. 22

165 Davidson etal, (2017). Development of a risk assessment framework to predict invasive species establishment for multiple taxonomic groups and vectors of introduction. Management of Biological Invasions Vol. 8 Issue 1

Greve et al, (2017). Terrestrial invasions on sub-Antarctic Marion and Prince Edward Islands. Bothalia - African Biodiversity & Conservation Vol. 48

contexts[166]. Others, such as the Generic Impact Scoring System which scores 12 types of impacts and associated risks, are more general[167]. Other more general approaches include relative impact potential which attempts to determine the impact of management schemes and what consequence certain invasive alien species have on specific environments[168], classifying invasive alien species according to the magnitude of their impacts[169], and horizon scanning, which attempts to project current risks into the future based on experiences from surrounding and/or related environments[170].

68. A number of obstacles to the application pest risk analysis schemes have also been identified in the literature, including the lack of trained professionals, the presence of vulnerable biodiversity, the remoteness of the areas being considered and the consideration of cultural, economic and social issues which impact people[171]. Studies have also identified ways to improve the effectiveness of pest risk analysis schemes by, for example, ensuring the participation of local experts, including indigenous peoples and local communities[172].

69. Studies have also explored different techniques to identify invasive alien species. These include the use of environmental DNA (eDNA) to identify potential invasive species from the DNA of other known invasive species[173]. eDNA has been found in some studies to outperform standard survey methods[174]. The potential applications of eDNA techniques, including eDNA barcoding, are increasingly being recognized and explored[175]. Other identification techniques based on genetic material discussed in the literature include Double Droplet Polymerase Chain Reaction[176], and Dual Loci[177]. The potential use of

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166 Heikkila etal. (2016). FinnPRIO: a model for ranking invasive plant pests based on risk. Biological Invasions Vol.18

167 Nentwig et al. (2016). The generic impact scoring system (GISS): a standardized tool to quantify the impacts of alien species. Environmental Monitoring Assessment Vol. 188

168 Dick et al. (2017). Invader Relative Impact Potential: a new metric to understand and predict the ecological impacts of existing, emerging and future invasive alien species. Journal of Applied Ecology Vol. 54

169 Blackburn TM, et al. (2014) A Unified Classification of Alien Species Based on the Magnitude of their Environmental Impacts. PLoS Biol 12(5): e1001850.

170 Matthews, J., etal (2017). A new approach to horizon-scanning: identifying potentially invasive alien species and their introduction pathways. Management of Biological Invasions, 8(1), 37-52. DOI: 10.3391/mbi.2017.8.1.04.

171 Shackleton etal. 2016. Identifying barriers to effective management of widespread invasive alien trees: Prosopis species (mesquite) in South Africa as a case study. Global Environmental Change Vol. 38

Soliman and al. 2016. A Regional Decision Support Scheme for Pest Risk Analysis in Southeast Asia. Risk Analysis Vol 36

Walsh etal. 2016 Outbreak of an undetected invasive species triggered by a climate anomaly. Ecosphere Vol. 7

172 Soliman etal. 2016. A Regional Decision Support Scheme for Pest Risk Analysis in Southeast Asia. Risk Analysis Vol 36

Stamoulie and al. 2017. Coral reef grazer-benthos dynamics complicated by invasive algae in a small marine reserve. Scientific Reports.

173 Simmons and al. 2015. Active and passive environmental DNA surveillance of aquatic invasive species. Canadian Journal of Fisheries and Aquatic Sciences Vol. 73

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174 Lim and al. 2016. Next-generation freshwater bioassessment: eDNA metabarcoding with a conserved metazoan primer reveals species-rich and reservoir-specific communities. Royal Society Open Science

Comtet and al. 2015. DNA (meta)barcoding of biological invasions: a powerful tool to elucidate invasion processes and help managing aliens. Biological Invasins Vol. 10

175 Corlett, R.T. 2017. A bigger toolbox: Biotechnology in Biodiversity Conservation. Trends in Biotechnology Vol. 35

Dahl, K.A., Patterson, W.F., Robertson, A. et al. Biol Invasions (2017) 19: 1917. https://doi.org/10.1007/s10530-017-1407-3

Port, J. A., O'Donnell, J. L., Romero-Maraccini, O. C., Leary, P. R., Litvin, S. Y., Nickols, K. J., Yamahara, K. M. and Kelly, R. P. (2016), Assessing vertebrate biodiversity in a kelp forest ecosystem using environmental DNA. Mol Ecol, 25: 527–541. doi:10.1111/mec.13481

176 Nathan L.M. etal (2014)Quantifying Environmental DNA Signals for Aquatic Invasive Species

participatory citizen science in the identification of invasive alien species has also been noted, particularly given that it is cost and time efficient and can be applied to large areas[178]. For example one study found that when citizen science was combined with the use of mobile applications or picture identification sheets participants were 90% accurate in their identifications[179].

70. Research has also been undertaken to better determine what types of habitats are more prone to invasion. For example invasive alien species have been found to be able to take advantage of artificial structures in the marine environment, such as docks and wave breaks, more so than native species[180]. It has also been observed that research facilities in remote areas may be potential introduction pathways[181]. Artificial beaches and dunes have also been found to be vulnerable to invasion[182] while artificial water catchments have been found to be a possible introduction pathway to the wider environment[183]

71. Much of the research on invasive alien species since the publication of GBO-4 has focused on techniques for preventing, controlling or eradicating invasive alien species. For example the use of sodium hypochlorite as a means of controlling species invading coral reefs[184] has been explored as has the use of sodium hydroxide to treat ship ballast water for invasive bacteria[185]. Other studies looked at the effectiveness of other control methods including self-resetting traps and toxicant-free bait[186], and phytosanitary irradiation[187]. Biological control of invasive species is a further method which has been explored in the literature. However many studies have noted the importance of post release monitoring programs, and the potential for secondary invasions from the introduction of biological control agents[188] and the need to consider the effect of the biological control agent on the ecosystem it is being introduced to[189]. One general observation from the available scientific literature related to eradication is that there is

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Across Multiple Detection Platforms. Environmental Science and Technology. 48, 12800-12806.

177 Wang, A. etal (2017) Evaluation of six candidate DNA barcode loci for identification of five important invasive grasses in eastern Australia. PLoS ONE 12(4):e0175338.

178 Goczal, R. etal (2016)Citizen monitoring of invasive species: wing morphometry as a tool for detection of alien Tetropium species. Journal of Applied Entomology. 141, 496-506.

179 Maistrello, L. (2016). Citizen science and early detection of invasive species: phenology of first occurrences of Halyomorpha halys in Southern Europe. Biological Invasions. 18, 3109-3116.

180 Lagos and al. 2017. Do low oxygen environments facilitate marine invasions? Relative tolerance of native and invasive species to low oxygen conditions. Global Change Biology Vol 23

181 Hughes and al. 2016. Evaluation of non-native species policy development and implementation within the Antarctic Treaty area. Biological Conservation Vol. 200

182 Pedram and al. 2016. The Role of Beach Nourishment on the Success of Invasive Asiatic Sand Sedge. Northeastern Naturalist Vol. 22

183 Drake and al. 2017. Graph theory as an invasive species management tool: case study in the Sonoran Desert. Landscape Ecology Vol.32

184 Altvater, L. etal (2017). Use of sodium hypochlorite as a control method for the non-indigenous coral species Tubastraea coccinea Lesson, 1829. Management of Biological Invasions 8(2), 197-204.

185 Starliper, C.E. etal (2015). Efficacy of pH elevation as a bactericidal strategy for treating ballast water of freight carriers. Journal of Advanced Research. 6, 501-509.

186 Carter, A. etal (2016). Controlling sympatric pest mammal populations in New Zealand with self-resetting, toxicant-free traps: a promising tool for invasive species management. Biological Invasions. 18, 1272-1736.

187 Hallman, G. (2016).Phytosanitary Irradiation of Heliothis virescens and Helicoverpa zea (Lepidoptera: Noctuidae). Florida Entomologist. 99(2). 178-181.

188 González, E. etal (2107). Secondary invasions of noxious weeds associated with control of invasive Tamarix are frequent, idiosyncratic and persistent. Biological Conservation. 213, 106-114.

189 Stamoulis, K. A. (2016). Coral reef grazer-benthos dynamics complicated by invasive algae in a small marine reserve. Scientific Reports. 7.

generally a lack of methods which have been found to be successful and could be applied to a variety of species in different taxonomic groups[190].

72. One indicator used in GBO-4 related to this target, the Red List Index (impacts of invasive alien species) has been updated since the report was released. The indicator shows a decline[191].

73. The scientific information that has become available since the publication of GBO-4 suggests that the progress towards this target is largely unchanged from what was previously reported. Similarly the information published since 2014 indicates that the actions identified in GBO-4 to accelerate progress towards this target remain relevant. Other potential actions which have been identified in the literature include undertaking actions to diversity species lists were there are gaps for some genus[192], greater efforts to identifying secondary invasion pathways[193], identifying areas at high risk of invasion[194], linking databases on invasive alien species[195] and greater efforts to control and contain invasive alien species along trade routes[196].

Target 10: By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

74. There has been relatively little scientific information published on the global status of coral reefs since the release of GBO-4. However an assessment of sea surface temperatures found that 97% of areas examined showed rising sea surface temperatures and that the occurrence of temperatures known to cause bleaching increased threefold between 1985-1991 and 2006-2012. Climate models suggest that this trend is likely to continue[197]. Further by 2050 there is a high probability that more than half of tropical corals will suffer a collapse and that the coral reefs that remain will be dominated by those taxa which are most resistant to pressures[198]. There has also been research to better understand the extent to which coral reefs are covered by protected areas. For example it is estimated that approximately 27% of the world's coral reef area are located in protected areas but with significant geographic variation[199].

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190 van Wilgen, B, W. and Wannenburgh, A. (2016). Co-facilitating invasive species control, water conservation and poverty relief: achievements and challenges in South Africa's Working for Water programme. Current Opinion in Environmental Sustainability. 19, 7-17.

Lodge, D.M. etal (2016). Risk Analysis and Bioeconomics of Invasive Species to Inform Policy and Management. Annual Review of Environment of Resources. 41, 453-88.

191 IUCN Red List Index http://www.iucnredlist.org/about/publication/red-list-index

192 Liedhold et al. 2016 Global compositional variation among native and non-native regional insect assemblages emphasizes the importance of pathways. Biological Invasions Vol.18

193 Solarz et al. 2017. Birds and alien species dispersal: on the need to focus management efforts on primary introduction pathways – comment on Reynolds et al. and Green. Diversity and Distribution: A journal of Conservation Biogeography Vol.23

194Vanderhoeven etal. 2017. Tracking Invasive Alien Species (TrIAS): Building a data-driven framework to inform policy. Research Ideas and Outcomes Vol. 3

Hyatt-Twynam etal. 2017. Risk-based management of invading plant disease. New Phytologist Vol. 214

195 Saul etal. 2016. Assessing patterns in introduction pathways of alien species by linking major invasion data bases. Journal of Applied Ecology Vol.54

196 Roy and al. 2014. Horizon scanning for invasive alien species with the potential to threaten biodiversity in Great Britain. Global Change Biology Vol 20, Issue 12

197 Heron, S. F. et al. (2016) Warming Trends and Bleaching Stress of the World's Coral Reefs 1985–2012. Sci. Rep. 6, 38402; doi: 10.1038/srep38402.

198 Tkachenko, K.S. (2017) Coral reefs in the face of ecological threats of the 21st century. Biology Bulletin Reviews 7: 64. https://doi.org/10.1134/S2079086416050091

199 White, A. T., etal (2014). Marine protected areas in the Coral Triangle: progress, issues, and options. Coastal Management, 42(2), 87-106

75. Various regional, national and subnational assessments of coral reefs have also been undertaken. For example one study concluded that of the coral reefs in the Pacific, those in Australia were the least affected by local threats but that extensive bleaching has occurred on the Great Barrier Reef. Further in the Atlantic and Caribbean region coral cover has fallen on average 47% over the 27 year period leading to 2012[200] and that temperature increases have impacted parts of the Caribbean, such as the Florida Keys[201].

76. Most of the focus in the scientific literature has been on the effects of climate change and/or ocean acidification on coral reefs as opposed to the other pressures as specified in Aichi Biodiversity Target 10. One exception to this is research related to coastal nutrient pollution which has been identified as one of the major factors contributing to the increase in coral disease and coral bleaching[202], affecting around 25% of reefs worldwide[203].

77. A major focus in resent scientific literature has been on increasing the understanding of how coral reefs respond to warming temperatures and their ability to recover from disturbances[204]. For example some research has found that some corals have developed resistance to warming ocean temperatures and that this adaptation process has been occurring since the beginning of the industrial period[205]. Similarly, in places such as the Great BarrierReef, research has found that bleaching events of the past three decades have been mitigated by induced thermal tolerance of reef-building corals but that this protective mechanism may be lost as a result of increasing temperatures[206]. Other studies have looked at the effects climate change and ocean acidification on changes to reef dynamics, such behavioural changes in reef fish[207] as well as predation rates[208]. Some studies have also attempted to predict the occurrence of bleaching events in the future. For example in has been estimated that in some regions annual bleaching

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200 Sale, P. F. (2015). Coral reef conservation and political will. Environmental Conservation, 42(02), 97-101.

201 Manzello, D. P. (2015). Rapid recent warming of coral reefs in the Florida Keys. Scientific reports, 5, 16762.

202 Vega Thurber, R. L., etal (2014). Chronic nutrient enrichment increases prevalence and severity of coral disease and bleaching. Global change biology, 20(2), 544-554.

203 Kroon, F. J., etal (2014). Informing policy to protect coastal coral reefs: Insight from a global review of reducing agricultural pollution to coastal ecosystems. Marine pollution bulletin, 85(1), 33-41.

204 Kavousi, J., Reimer, J. D., Tanaka, Y., & Nakamura, T. (2015). Colony-specific investigations reveal highly variable responses among individual corals to ocean acidification and warming. Marine environmental research, 109, 9-20.

Elahi, R., etal (2016). Ocean warming and the demography of declines in coral body size. Marine Ecology Progress Series, 560, 147-158.

Bozec, Y. M., etal (2015). The dynamics of architectural complexity on coral reefs under climate change. Global change biology, 21(1), 223-235.

Burdett, H. L., etal (2014). Effects of high temperature and CO2 on intracellular DMSP in the cold-water coral Lophelia pertusa. Marine biology, 161(7), 1499-1506.

Swain, T. D., etal (2016). Coral bleaching response index: a new tool to standardize and compare susceptibility to thermal bleaching. Global change biology, 22(7), 2475-2488.

Munday, P. L., etal (2017). Potential for adaptation to climate change in a coral reef fish. Global change biology, 23(1), 307-317.

205 Logan, C. A., etal (2014). Incorporating adaptive responses into future projections of coral bleaching. Global Change Biology, 20(1), 125-139.

206 Ainsworth, T. D., etal (2016). Climate change disables coral bleaching protection on the Great Barrier Reef. Science, 352(6283), 338-342.

207 Nagelkerken, I., and Munday, P. L. (2015). Animal behaviour shapes the ecological effects of ocean acidification and warming: moving from individual to community-level responses. Global change biology. 22(3),974-989.

208 Ferrari, M, etal (2015). Interactive effects of ocean acidification and rising sea temperatures alter predation rate and predator selectivity in reef fish communities. Global change biology 21(5): 1848-1855.

will begin occurring between 2020 and 2034 and possibly sooner[209] and as a consequence coral rugosity will decrease dramatically over the next three decades[210].

78. Studies have also been undertaken to explore the possibility of restoring or rehabilitant coral reefs through various process. One approach to coral restoration is the gardening concept whereby coral-nubbins are farmed in nurseries and then transplanted. Over 86 coral species and more than 100,000 colonies have been successfully farmed to date[211]. Another form of restoration is larval seeding, however there are questions concerning the long term effectiveness of this approach[212].

79. Most of the research related to Target 10 has tended to focus on coral reefs. However a number of studies have also explored the negative impacts of climate change and drought on inland water systems[213]

80. Three indicators used in GBO-4 have been updated since the report was released. These indicators, percentage live coral cover[214], glacial mass balance[215] and mean polar sea ice extent, all shows trends negative for biodiversity. In addition two indicators, climate impact index for birds and area of mangrove forest cover[216], have become available since GBO-4 was published. Both of these indicators also show trends negative for biodiversity.

81. The scientific information that has become available since the publication of GBO-4 suggests that the situation is largely unchanged from what was previously reported. Similar the scientific information published since 2014 suggests that the actions identified in GBO-4 to accelerate progress towards this target remain relevant. Further some studies have further emphasized the importance of addressing issues related to sediment input to coral reefs[217], the need to strengthen management responses[218] as well as the need to design and manage marine protected areas with the effects of climate change in mind[219]. Further, as mentioned in relation to Aichi Biodiversity Target 8, reducing pollution, such as plastic, could greatly reduce the pressures on coral reefs. Actions to reach Aichi Biodiversity Target 10 for coral reefs and

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209 Manzello, D. P. (2015). Rapid recent warming of coral reefs in the Florida Keys. Scientific reports, 5, 16762.

210 Bozec, Y. M., etal (2015). The dynamics of architectural complexity on coral reefs under climate change. Global change biology, 21(1), 223-235.

211 Rinkevich, B. (2014). Rebuilding coral reefs: does active reef restoration lead to sustainable reefs? Current Opinion in Environmental Sustainability. 6, 28-36.

212 Edwards AJ, etal (2015) Direct seeding of mass-cultured coral larvae is not an effective option for reef rehabilitation. Marine Ecology Progress Series. 525:105-116.

213 Mosley, L. (2015). Drought impacts on the water quality of freshwater systems; review and integration,

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214 Obura, D., etal (2017). Coral reef status report for the Western Indian Ocean. Global Coral Reef Monitoring Network (GCRMN)/International Coral Reef Initiative (ICRI). pp 144.

215 WGMS, 2016. Global Glacier Change Bulletin No. 1 (2012–2013). Zemp, M., Gärtner-Roer, I., Nussbaumer, S. U., Hüsler, F., Machguth, H., Mölg, N., Paul, F., and Hoelzle, M. (eds.), ICSU(WDS)/IUGG(IACS) /UNEP/UNESCO/WMO, World Glacier Monitoring Service, Zurich, Switzerland, 230 pp., publication based on database version: doi:10.5904/wgms-fog-2015-11.

216 Hamilton, S.E. and Casey, D., (2016). Creation of a high spatio-temporal resolution global database of continuous mangrove forest cover for the 21st century (CGMFC-21). Global Ecology and Biogeography 25(6),729-738. doi: 10.1111/geb.12449.

217 Oleson, K. L., etal (2017). Upstream solutions to coral reef conservation: The payoffs of smart and cooperative decision-making. Journal of Environmental Management, 191, 8-18.

218 Sale, P. F. (2015). Coral reef conservation and political will. Environmental Conservation, 42(02), 97-101.

219 Magris, R. A., etal. (2015). Conservation planning for coral reefs accounting for climate warming disturbances. PloS one, 10(11), e0140828.

Chollett, I., etal (2014). Redefining thermal regimes to design reserves for coral reefs in the face of climate change. PloS one, 9(10), e110634.

closely associated ecosystems were adopted by the Conference of the Parties to the convention in decision XII/23.

Target 11: By 2020, at least 17 per cent of terrestrial and inland water areas, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

82. It is estimated that protected areas covered 15% of terrestrial and inland waters, excluding Antarctica[220]. In the marine environment, 6.96% of the entire ocean and 16.02% of areas under national jurisdiction were protected[221]. However the World Database on Protected Areas on which these figures are based does not include complete information on privately protected areas or on areas conserved by indigenous peoples and local communities. Work is underway to better understand what would constitute other effective area based conservation measures[222], and if all information on these areas were included the figures would likely by higher. Further a number of countries have made commitments to further expand their protected areas systems, suggesting that these numbers will increase between now and 2020.

83. With regard to the representativeness of protected areas in October 2017 it was estimated that 43.9% of non-Antarctic terrestrial ecoregions had 17% of their area covered by protected areas[223] while 40.5% of marine areas had more than 10% of their area protected. However one assessment found that some terrestrial ecoregions had so little natural or semi-natural area left that having 17% of their area protected would not be possible[224]. In 2016, 19.3% of key biodiversity areas were completely covered by protected areas and 19.5% of Alliance for Zero Extinction sites were completely covered[225]. One assessment concluded that between 25 and 37% of terrestrial ecoregions had protected area networks of sufficient size and configuration to maintain connectivity for median dispersal distances of between 1 and 100 kilometers. For protected areas globally, between 8.5% and 11.7% are considered ‘well-connected’ for the same range of median dispersal distances[226].

84. With regards to management effectiveness, as of 2015, only about 21% of Parties to the CBD have completed management effectiveness evaluations in at least 60% of their protected areas[227]. Further a study evaluating 722 protected areas sites with multiple management effectiveness assessments, found

220 UNEP-WCMC and IUCN (2017a), Protected Planet: World Database on Protected Areas (WDPA) [On-line], [December, 2017], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net. Reference for terrestrial protected area coverage.

221 UNEP-WCMC and IUCN (2017b) Marine Protected Planet [On-line], [December, 2017], Cambridge, UK: UNEP-WCMC and IUCN Available at: www.protectedplanet.net/marine. Reference for marine protected area coverage.

222 Laffoley D, et al. (2017). An introduction to ‘other effective area-based conservation measures’ under Aichi Target 11 of the Convention on Biological Diversity: Origin, interpretation and emerging ocean issues. Aquatic Conservation: Marine Freshwater Ecosystems. 2017;27(S1):130–137.

223 JRC (Joint Research Centre of the European Commission) (2017), The Digital Observatory for Protected Areas (DOPA) Explorer 2.0 [On-line], [10/2017], Ispra, Italy. Available at: http://dopa-explorer.jrc.ec.europa.eu. Reference for coverage of terrestrial and marine ecoregions.

224 Dinerstein, E., etal (2017). An ecoregion-based approach to protecϴng half the terrestrial realm. BioScience, bix014, doi: 10.1093/biosci/bix014.

225BirdLife International (2016). Analysis of protected area coverage of Key Biodiversity Areas using the April 2016 WDPA release for the Protected Planet Report 2016.

226 Bastin, S.S., etal (2017). Protected areas in the world’s ecoregions: how well connected are they? Ecological Indicators, 76, 144– 158. doi: 10.1016/j.ecolind.2016.12.047.

227 Coad, L., etal (2015). Measuring impact of protected area management interventions: current and future use of the Global Database of Protected Area Management Effectiveness. Philosophical Transactions of the Royal Society B, 370 (1681). doi: 10.1098/rstb.2014.0281.

that almost 70% showed an improvement in management while about 25% had decreases[228]. In the marine environment an assessment of 218 marine protected areas exploring the relationship between management processes, fish populations and ecological effects found that many marine protected areas failed to be meet thresholds for effective and equitable management. While 71% of the marine protected areas were found to have positive effects on fish populations, the results were high variable. The provision of adequate staff and financial resources were found to be the highest predictor of conservation impact, with adequately resourced marine protected areas having 2.9 times greater ecological effects than those marine protected without sufficient resources[229]. Research has been undertaken to develop indicators to be able to better assess and track management effectiveness[230].

85. In recent years there has been an increase in the number of protected areas with shared or private governance or being governed by indigenous peoples and local communities[231]. Protected areas which consider social issues in their design and management, often have more positive conservation outcomes[232]. However there have been relatively few assessments of the social impacts of protected areas[233].

86. Two indicators used in GBO-4 have been updated since the report was released. Percentage of marine and coastal areas covered by protected areas and percentage of terrestrial areas covered by protected areas[234], both show positive trends. In addition the indicator, percentage of key biodiversity areas covered by protected areas, which was not used in GBO-4, has a positive trend as well.

87. There has been significant progress towards the attainment of this target since it was adopted and the commitments that have been made by Parties suggest that progress will continue to be made between now and 2020[235]. Overall the scientific information that has become available since the publication of GBO-4 suggests that progress towards this target is largely unchanged from what was previously reported. Similarly the scientific literature suggests that the actions identified in GBO-4 remain relevant to the achievement of this Aichi Biodiversity Target.

Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

88. While significant data gaps and time lags remain, Aichi Biodiversity 12 continues to be one of the Aichi Targets for which the most information is available. Since the publication of GBO-4 numerous publications related to species extinction and conservation status have been published. Many of these have focused on more detailed assessments of indicators related to conservation status. For example, at the global level, an assessment of Red List Index information for vertebrates from 1988-2008 found that more than 50% of the global deterioration in the conservation status of birds, mammals and amphibians in the Red List Index was concentrated in less than 1% of the world's surface area, 4% of its ecoregions and

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228 Geldmann, J., etal (2015). Changes in protected area management effectiveveness over time: A global analysis. Biological ConservaƟon, 191, 692–699. doi: 10.1016/j.biocon.2015.08.029

229 Gill, D. A., etal (2017) Capacity shortfalls hinder the performance of marine protected areas globally. Nature 543, 665-669.

230 Zafra-Calvo, N. etal (2017). Towards an indicator system to assess equitable management in protected areas, Biological Conservation, 211(A).134-141.

231 Juffe-Bignoli, etal (2014). Protected Planet Report 2014. Cambridge, UK: UNEPWCMC

232 Oldekop, J.A., etal A global assessment of the social and conservation outcomes of protected areas. Conservation Biology, 30(1), 133–141. doi: 10.1111/cobi.12568

233 Franks, P. and Small, R. (2016). Understanding the social impacts of protected areas: a community perspecƟve. IIED Research Report. London: IIED.

234 IUCN and UNEP-WCMC (2016), The World Database on Protected Areas (WDPA) [On-line], Cambridge, UK: UNEP-WCMC. Available at: www.protectedplanet.net.

235 Gannon, P. etal (2017). Status and prospects for achieving AICHI biodiversity target 11: Implications of national commitments and priority actions. Parks 23.2, 13-26.

4% of countries[236]. An analyses of range contraction, based on information on 27,600 vertebrate species and information on extinctions between 1900 and 2015 in 177 mammal species, concluded that the rate of population loss in terrestrial vertebrates is extremely high with 32% of species decreasing. Further of the 177 mammal species assessed all have lost 30% or more of their range while 40% have undergone population declines[237].

89. In addition to global studies on trends in species conservation status and extinction there have also been a range of publications examining the conservation status of specific species. For example an assessment of plants based on a Sampled Red List Index (SRLI) found that more than 20% of plant species assessed are threatened with extinction. Most threatened plant species are found in tropical rain forest where the greatest threat to plants is habitat conversion resulting from livestock and agriculture, and the harvesting of natural resources. Gymnosperms (e.g. conifers and cycads) are the most threatened group. However a third of plant species considered had yet to be assessed or are so poorly known that their threat status could not be assessed[238]. Further an assessment of trends in pollinators found that pollinating bird and mammal species are deteriorating in status with on average 2.5 species per year moving one Red List category closer toward extinction between 1988 and 2012. This represents a substantial increase in the extinction risk across this group of species[239]. Also while the conservation status of bats improved from 1985 to 2000 as human disturbances to roosting sites were reduced, it then declined sharply (7%) by 2015 due principally to threats from white nose syndrome and wind energy[240]

90. There is comparatively less information on marine extinctions compared to terrestrial ones. However a study looking extinction rates in marine and non-marine species found that for the best studied taxonomic groups on average between 20 and 25% of species are threatened with extinction regardless of the realm they inhabit[241]

91. A number of studies have focused on extrapolating current extinction and conservation status trends into the future using various scenarios and models. For example an assessment based on spatial distribution models with historical and projected deforestation suggest that between 36% and up to 57% of all Amazonian tree species are likely to qualify as globally threatened under International Union for Conservation of Nature (IUCN) Red List criteria by 2050. This would increase the number of threatened plant species on Earth by 22%[242]. Similarly under different climate and land use change scenarios and assuming a business as usual scenario it was found that population abundance of terrestrial carnivore and ungulate species declined by between 18-35% while extinction increased from between 8 and 23% by 2050. However an alternative scenario, one in which meat consumption per capita is limited, waste in the agricultural production chain is reduced and where less energy-intensive lifestyles are adopted, resulted in reductions in extinction risk and population losses[243]. Further a meta-analysis of 131 published papers projecting the impacts of climate change on species extinction concluded that as temperature rise

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236 Rodrigues ASL, et al. (2014) Spatially Explicit Trends in the Global Conservation Status of Vertebrates. PLoS ONE 9(11): e113934. https://doi.org/10.1371/journal.pone.0113934

237 Ceballos, G. etal (2017). Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines. Proceedings of the National Academy of Sciences. 114(30):201704949

238 Brummitt NA, et al. (2015) Green Plants in the Red: A Baseline Global Assessment for the IUCN Sampled Red List Index for Plants. PLoS ONE 10(8): e0135152. https://doi.org/10.1371/journal.pone.0135152

239 Regan, E. C., (2015), Global Trends in the Status of Bird and Mammal Pollinators. Conservation Letters, 8: 397–403. doi:10.1111/conl.12162

240 Hammerson, G.A. etal (2017). Strong geographic and temporal patterns in conservation status of North American bats, Biological Conservation, 212(A) 144-152,

241 Webb, Thomas J. and Mindel, Beth L. (2015)Global Patterns of Extinction Risk in Marine and Non-marine Systems. Current Biology 25(4), 506-511.doi: 10.1016/j.cub.2014.12.023

242 ter Steege, Han etal (2015). Estimating the global conservation status of more than 15,000 Amazonian tree species Science Advances 1(10) DOI: 10.1126/sciadv.1500936

243 Visconti, P., etal (2016), Projecting Global Biodiversity Indicators under Future Development Scenarios. CONSERVATION LETTERS, 9: 5–13. doi:10.1111/conl.12159

extinction risk will accelerate. The proportion of species that could go extinct as a result of climate change will increase from 2.8% at present to 5.2% with a 2°C post-industrial temperate rise. If temperature increase reaches 3°C extinction risk is estimated to increase to 8.5%. While if temperatures rise by 4.3°C climate change will threaten up to 16% of species. Extinctions were predicted to be highest in South America, Australia, and New Zealand and were not found to vary by taxonomic group[244].

92. Scenario studies have also been undertaken for specific ecosystems. For example an assessment of the Brazilian Cerrado found 46% of native vegetation cover has been lost and that less than 20% remains undisturbed. Under a business as usual scenario it is projected that 31-34% of the remaining Cerrado would be lost by 2056 and that this would bring about the extinction of approximately 480 endemic plant species. However an alternative scenario, one where a mix of policies to reconcile agricultural expansion, conservation and restoration, could allow for the regions projected increase in crop and beef production without further loss to the Cerrado[245].

93. Two indicators used in GBO-4 have been updated since the report was released. These indicators, Red List Index[246] and the Living Planet Index, both show trends negative for biodiversity.

94. A review of the scientific information that has become available since the publication of GBO-4 suggests that the situation is largely unchanged from what was previously reported. Namely that conservation status is worsening globally and that globally there has been no meaningful change in the rate of extinction. While there have been some regional, national and local successes, on the whole species are increasingly at risk of extinction and the world community is not currently on track to reach Aichi Biodiversity Target 12.

95. The scientific literature that has been published since 2014 suggests that the actions identified to accelerate progress towards this target in GBO-4 remain relevant. In addition there is increasing evidence that it is possible to improve the conservation status of species. For example it has been estimated, based on IUCN Red List data from 1996 to 2008, that in the absence of conservation action at least 148 species would have deteriorated by one Red List Category, 6 of which would have been listed as extinct or extinct in the wild[247]. The same assessment noted that while some species benefited from highly targeted actions most benefited from conservations actions, such as habitat protection, more generally. Since the publication of GBO-4 a number of publications have noted to the need to enhance monitoring systems for species. For example an assessment based on the IUCN Red List noted that unless funding is scaled up by 2025, 83% of Red List assessments would be outdated and the average age of assessments will be above 30 years[248]. Similarly a set of priority regions has been identified to help assess the conservation status of fresh water fish[249].

Target 13: By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

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244 Urban, Mark C. (2015). Accelerating extinction risk from climate change. Science 348 (6234)571-573

10.1126/science.aaa4984

245 Strassburg, B.B.N. etal (2017). Moment of truth for the

Cerrado hotspot. Nature Ecology and Evolution. 0099

246 IUCN Red List Index http://www.iucnredlist.org/about/publication/red-list-index

247 Hoffmann, M., etal (2015), The difference conservation makes to extinction risk of the world's ungulates. Conservation Biology, 29: 1303–1313. doi:10.1111/cobi.12519

248 Rondinini, C., etal (2014), Update or Outdate: Long-Term Viability of the IUCN Red List. Conservation Letters, 7: 126–130. doi:10.1111/conl.12040

249 Hermoso, V., etal (2017), Optimal allocation of Red List assessments to guide conservation of biodiversity in a rapidly changing world. Glob Change Biol, 23: 3525–3532. doi:10.1111/gcb.13651

96. In situ conservation networks should be able to capture a large proportion allelic variation of cultivated plants. However they are less likely to capture rare variations[250]. Further while genetic erosion has and continues to occur worldwide, a large amount of crop diversity is still retained in developing countries by smallholder farmers[251].

97. With regards to ex situ plant conservation, over 1,750 gene banks have been established. These banks maintain approximately 7.4 million accessions[252]. However it has been estimated that only between 28% and 38% of threatened plans have five populations in ex situ collections[253]. Crop wild relatives are estimated to only represent between 2 and 18% of accessions[254]. Some specific crop wild relatives that have been identified as being under represented in collections and at risk are sweet potato[255], potato[256] and eggplant[257]. One issue which has been identified as possible obstacle to the conservation of crop wild relatives is that it is often unclear if they fall under the responsibility of the conservation or agriculture communities[258].

98. Protected areas also contain crop wild relatives; however protected areas are rarely established for this purpose and are therefore conserved passively. As such these species are rarely subject to monitoring and management interventions[259].

99. In addition to ex situ and in situ conservation issues, several studies have been published since GBO-4 exploring how different techniques can be used to better identify, catalogue and store genetic information. For example advances in DNA sequencing is enabling the more efficient sequencing of crop wild relatives and is enabling their use for crop improvements[260]. Similarly advances in next-generation DNA sequencing (NGS) technology has facilitated the sequencing of diverse crop genomes as well as

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250 Whitlock, R. et al., (2016). Consequences of in-situ strategies for the conservation of plant genetic diversity. Biological Conservation, Volume 203, pp. 134-142.

251 Bellon, M. R., etal (2014). Conserving landraces and improving livelihoods:. International Journal of Agricultural Sustainability how to assess the success of on-farm conservation projects?, 13(2), p. 167–182.

252 Tyagi, R. K. and Agrawal, A., 2015. Revised genebank standards for management of plant genetic resources. Indian Journal of Agricultural Sciences, 85(2), pp. 157-165.

253 Whitlock, R. et al., 2016. Consequences of in-situ strategies for the conservation of plant genetic diversity. Biological Conservation, Volume 203, pp. 134-142.

254 Dempewolf, H. et al., 2017. Past and Future Use of Wild Relatives in Crop Breeding. Crop Science, Volume 57, p. 1070–1082.

255 Khoury, C. K. et al., 2015. Crop wild relatives of pigeonpea [Cajanus cajan (L.) Millsp.]: Distributions, ex situ conservation status, and potential genetic resources for abiotic stress tolerance. Biological Conservation, Volume 184, pp. 259-270.

256 Castaneda Alzarez, N. P. et al., 2015. Ex Situ Conservation Priorities for the Wild Relatives of Potato (Solanum L. Section Petota). PLOS One. 10(8): e0135152.

257 Syfert, M. M. et al., 2016. Crop wild relatives of the brinjal eggplant (Solanum melongena): Poorly represented in genebanks and many species at risk of extinction. American Jounral of Botany, 103(4), pp. 635-651.

258 Edwards, C. E., 2017. Strengthening the Link between International Conservation Policy and Plant Conservation Genetics to Achieve More Effective Plant Conservation. Annals of the Missouri Botanical Garden, 102(2), pp. 397-407.

259 Maxted, N. et al., (2015). ECPGR Concept for in situ conservation of crop wild relatives in Europe, s.l.: European Cooperative Programme for Plant Genetic Resources.

260 Brozynska, M., etal (2016). Genomics of crop wild relatives: expanding the gene pool for crop improvement. Plant Biotechnology Survey, Volume 14, p. 1070–1085.

Dempewolf, H. et al., (2017). Past and Future Use of Wild Relatives in Crop Breeding. Crop Science, Volume 57, p. 1070–1082.

facilitated the association of different genetic traits to crop traits[261]. Further DNA sequencing platforms are continuning to improve as are software programmes for assessing genetic diversity[262]

100. With regards to farmed and domesticated animals, there is a general trend towards reduced genetic variation both in and across breeds[263]. Further a general observation from the literature suggests that the instittional frameworks and capacity to manage animal genetic resources needs to be enhanced[264]. However globally, national gene banking efforts have increased[265].

101. While there are few recent global studies on the status on farmed and domesticated animal genetic diversity a number of assessments at the regional and national scale have been undertaken. For example one assessment concluded that in Africa, livestock genetic resources are at risk as a resulted of uncontrolled corss breeding and domestic breeds being placed with exotic ones. While more than 15 indingenous cattle breeds have been named in Africa these breeds remain largely uncharacterized[266]. In addition genetic information has been collected for a number of species from various countries and regions, including cattle in Africa[267], chicken in Oman[268] and in the African, Asian and European regions[269], goats in Asia[270] and sheep in South Africa[271] and Italy[272]. Further it is anticipated that, much like for crop and crop wild relatives, that the conservation farmed and domesticated animals will benefit from advances made in next-generation DNA sequencing. However this technology will need to become more readily available for it to reach its full potential[273]

102. Two indicators have become available since 2014 related to this target. The first of these, the number of plant genetic resources for food and agriculture secured in conservation facilities[274], shows an

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261 Abberton, M. et al., (2016). Global agricultural intensification during climate change: a role for genomics. Plant Biology Journal, Volume 14, p. 1095–1098.

262 Henry, R. J., (2014). Sequencing of wild crop relatives to support the conservation and utilization of plant genetic resources. Plant Genetic Resources, Volume 12, p. S9–S11.

Govindaraj, M., etal (2015). Importance of Genetic Diversity Assessment in Crop Plants and Its Recent Advances: An Overview of Its Analytical Perspectives. Genetics Research International. Volume 2015, 431487,

263 Biscarini, F. et al., 2015. Challenges and opportunities in genetic improvement of local livestock breeds. Frontiers in Genetics, Volume 6.

264 Leroy, G. et al., 2017. Stakeholder involvement and the management of animal genetic resources across the world. Livestock Science, Volume 198, pp. 120-128.

265 Rezende Paiva, S., etal (2016). Conservation of animal genetic resources – A new tact. Livestock Science, Volume 193, pp. 32-38.

266 Mwai, O., etal (2015). African Indigenous Cattle: Unique Genetic Resources in a Rapidly Changing World. Asian-Australasian Journal of Animal Sciences, 28(7), pp. 911-921.

267 Kim, J. et al., (2017). The genome landscape of indigenous African cattle. Genome Biology, 18(34).

268 Al-Qamashoui, B., etal (2014). Assessment of genetic diversity and conservation priority of Omani local chickens using microsatellite markers. Tropical Animal Health and Production, 46(5), pp. 747-752.

269 Lyimo, C. M. et al., (2014). Global diversity and genetic contributions of chicken populations from African, Asian and European regions. Animal Genetics, 45(6), pp. 836-848.

270 Periasamy, K. et al., (2017). Mapping molecular diversity of indigenous goat genetic resources of Asia. Small Ruminant Research, Volume 148, pp. 2-10.

271 Cloete, S., etal (2014). The adaption of the South Africa sheep industry to new trends in animal breeding and genetics: A review. South African Journal of Animal Science, 44(2), pp. 307-321.

272 Ciani, E. et al., (2014). Genome-wide analysis of Italian sheep diversity reveals a strong geographic pattern and cryptic relationships between breeds. Animals Genetics, 45(2), pp. 256-266.

273 Bruford, M. W. et al., (2015). Prospects and challenges for the conservation of farm animal genomic resources, 2015-2025. Frontiers in Genetics, Volume 6.

Mwai, O., etal (2015). African Indigenous Cattle: Unique Genetic Resources in a Rapidly Changing World. Asian-Australasian Journal of Animal Sciences, 28(7), pp. 911-921.

274Food and Agriculture Organization of the United Nations. SDG Indicator 2.5.1 - Conservation of genetic resources for food and agriculture. http://www.fao.org/sustainable-development-goals/indicators/2.5.1/en/

increase, while the other, the Red List index for wild relative of farmed and domesticated species[275], shows a decline.

103. A review of the scientific information which has become available since the publication of GBO-4 suggests that the progress towards this target is largely unchanged from what was previously reported. Further the scientific literature that has been published since 2014 suggests that the actions identified to accelerate progress towards this target in GBO-4 remain relevant. Additional possible actions identified in the literature include increasing awareness among policy makers of the role of genetic resources in climate change adaptation[276] and the need for better information sharing systems for genetic resources[277].

Target 14:By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

104. Aichi Target 14 is a broad target. This makes assessing progress towards its attainment challenging. Further, progress towards its attainment is interrelated with progress towards other Aichi Biodiversity Targets, including targets 5, 6, 7, 10, 11, 12, 13 and 18. As such information on the progress towards these targets can also inform progress towards Aichi Target 14.

105. A recent assessment using a set of 21 indicators related to 13 different ecosystems services found that 60% of the indicators related to ecosystem benefits had positive trends while 86% of state indicators showed a decline. The assessment concludes that there has been no overall progress in reaching Aichi Target 14[278].

106. With regards to the marine environment, the Ocean Health Index, which measures changes to ten societal objectives related to ocean health, increased by one point between 2012 and 2013, a small positive change. At the country level scores, on average improved by 0.06 points[279]. Other studies have looked at specific marine ecosystems. For example one assessment focusing on the Western and Adriatic regions of the Mediterrnean Sea concluded that all fisheries resources are at risk of overexploitation[280]. A similar study concluded that global biomass production in the marine environment predicted a long-term decline in global marine catch[281]. Given the importance of agricultural and fisheries productivity to human wellbeing such trends are a challenge to the prospects for reaching Aichi Target 14. Information related to fisheries is further addressed under the section of this note dealing with Aichi Biodiversity Target 6.

107. Mangrove ecosystems have received considerable attention in the scientific literature. Mangroves provide a range of ecosystem services and as such are particularly relevant to Aichi Target 14. As noted under Aichi Biodiversity Target 5, mangroves are in decline globally. Such declines can have various effects. For example one study on the Matang Mangrove Forest Reserve (MMFR) in Peninsular Malaysia found that ecosystem services, including cockle production, are declining and that pressures on species,

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275 IUCN Red List Index http://www.iucnredlist.org/about/publication/red-list-index

276 Belew, A. K., etal (2016). The State of Conservation of Animal Genetic Resources in Developing Countries: A Review. International Journal of Pharma Medicine and Biological Sciences, 5(1), pp. 58-66.

277 Scherf, B. and Baumung, R., (2015). Monitoring the implementation of the Global Plan of Action for Animal Genetic Resources. Biodiversity, 16(2-3), pp. 149-156.

278 Shepherd, E.J. etal. (2016). Status and Trends in Global Ecosystem Services and Natural Capital: Assessing Progress Toward Aichi Biodiversity Target 14. Conservation Letters, November/December 2016, 9(6), 429–437.

279 Halpern, B. S. et al. (2015) Spatial and temporal changes in cumulative human impacts on the world's ocean. Nature Communications. 6:7615 doi: 10.1038/ncomms8615.

280 Liquete, C. etal (2016). Ecosystem services sustainability in the Mediterranean Sea: Assessment of status and trends using multiple modelling approaches. Scientific Reports 6, 34162.

281 Galbraith, E.D. etal (2017). A coupled human-Earth model perspective on long-term trends in the global marine fishery. Nature Communications 8, 14884.

such as migratory birds, are increasing as a result of mangrove loss and degradation. These pressures are largely the result of wood harvesting and charcoal production[282].

108. Another issue relevant to Aichi Target 14 explored in the literature is freshwater. One assessment of global freshwater ecosystems estimates that 82% of the world's population relies on upstream areas which are highly threatened for water services. In some countries, such as China and India the percentage could be as high as 88%. Developing countries are particularly vulnerable to this threat as they often lack the means to construct infrastructure that can reduce water related threats[283]. A second study looking specifically at protected areas reached a similar conclusion. It estimated that on a global scale 80% of downstream communities that rely on freshwater from upstream protected are using water that is under threat[284]. Studies related to the provision of freshwater have also been undertaken at the national level. For example a study examining wetland degradation in Madagascar concluded that overexploitation, climate change, invasive species and other human disturbances is causing freshwater habitat loss with related impacts on species abundance and diversity[285].

109. Ecosystem services provided by soils have also been examined in the scientific literature. A global assessment on soil health indicates that soil erosion affects mostly Asia, Sahel, Central America and Africa[286]. However pressures on soil are widespread. For example an assessment of soil in the European Union concluded that, soil erosion and land intensification as a resulting from urbanization have resulted in the loss soil functions[287].

110. Work has also been undertaken to determine the relationship between diversity and the provision of ecosystem services. For example a study of grassland plants indicates that 84% of 147 grassland plant species considered in 17 different biodiversity experiments promoted ecosystem functioning. Further the different species promoted ecosystem functioning in different ways, at it different periods of time and under different circumstances. The study ultimately concludes that more species are needed to maintain ecosystem functions and services then have been previously suggested[288].

111. A further ecosystem service which has received considerable attention is pollination. Pollinators, pollination and food production was the focus of one the thematic assessments undertaken by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services[289]. Among the key messages of that assessment was that between 5 and 8 percent of current global crop production depends on animal pollination and that wild pollinators have decline in occurrence and diversity at local and regional scales. Other studies have found that the diversity of pollinators and pollination services, decrease with the intensification of agriculture[290]. As two-thirds of the world's major food crops are pollinator-dependent, agriculture intensification may lead to adverse effect on yields. Conversely the

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282 Aziz, A. etal. (2015). Investigating the decline of ecosystem services in a production mangrove forest using Landsat and object-based image analysis. Estuarine, Coastal and Shelf Science 164, 353-366.

283 Green, P. A., (2015). Freshwater ecosystem services supporting humans: Pivoting from water crisis to water solutions. Global Environmental Change 34, 108-118.

284 Harrison, I.J. (2016). Protected areas and freshwater provisioning: a global assessment of freshwater provision, threats and management strategies to support human water security. Aquatic Conservation: Marine and Freshwater Ecosystems 26, 103-120.

285 Bamford, A etal. (2017). Profound and pervasive degradation of Madagascar's freshwater wetlands and links with biodiversity. Plos ONE 12, no. 8: 1-15.

286 Rojas, R. V., etal (2016). Healthy soils, a prerequisite for sustainable food security. Environ. Earth Sci. 75:108.

287 European Environment Agency. (2015). The European Environment State and Outlook 2015.

288 Isbell, F. (2017). High plant diversity is needed to maintain ecosystem services. Nature 477, 199-202.

289 IPBES (2016). The assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on pollinators, pollination and food production. S.G. Potts, V. L. Imperatriz-Fonseca, and H. T. Ngo, (eds). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. 552 pages.

290 Deguines, N., etal (2014), Large-scale trade-off between agricultural intensification and crop pollination services. Frontiers in Ecology and the Environment, 12: 212–217. doi:10.1890/13005

increasing wild insect pollinator richness and abundance was found to result in high and more consistent crop yields[291]. However a further study has shown that achieving a 50% pollination threshold in a single site requires on average 5.5 bee species but that over a larger region 55 species were needed. The study ultimately concludes that providing crop pollination in natural systems must increase by an order of magnitude when compared with field experiments[292].

112. A number of studies have been published since the release of the fourth edition of the Global Biodiversity Outlook examining the impacts of human vulnerability and health resulting from various forms of biodiversity loss. For example one study found that the Mediterranean Sea's capacity to provide and supply coastal protection is declining[293]. Similarly in Southern Spain there has been an observed increase in coastal hazards, including flooding, shoreline erosion, storm surges and sea level rise, as a result of land use change associated with urbanization and tourism.

113. With regards to human health, deforestation has been associated with a range of health issues including malaria transmission and increased microbial load in water bodies. For example in Cambodia, an assessment found that each 10% loss in forest area was associated with an increase of about 14% in the incidence of diarrhea in children under 5 years of age. In contract a 10% increase in protected area coverage was associated with a 3.5% decrease in diarrhoea [294] Medicinal plants, an important element of human health in some countries, has also received attention in the literature. For example a study of medicinal plant use in Lingshi, Bhutan found that some plant species have been highly exploited as international demand has increased. This in turn has resulted in illegal harvesting practices[295]. Similarly a study examining medicinal plans in China estimated that 603 are threatened, 44 are critically endangered, 189 are endangered and 370 and vulnerable[296]. There has also been research linking the impact of human activities to microbiota and human and ecosystem health[297].

114. Two indicators related to this target have been updated since 2014. Both indicators, the Red List Index for pollinator species and the Red List Index for species used for food and medicine show declines.

115. Overall the information that has becomes available since the publication of the fourth edition of the Global Biodiversity Outlook suggests that Aichi Biodiversity Target 14 is not currently on track to be reached. However the amount of information remains limited, particularly with regards to cultural issues and issues associated with the needs of women and the poor and vulnerable. The fourth edition of the Global Biodiversity Outlook identified a range of actions which would help to accelerate progress towards this Aichi Biodiversity Target. The information that has become available since the publication of GBO-4 indicates that these actions remain relevant.

Target 15:By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

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291 Garibaldi, L. A., etal (2014), From research to action: enhancing crop yield through wild pollinators. Frontiers in Ecology and the Environment, 12: 439–447. doi:10.1890/130330

292 Winfree, R. etal (2018). Species turnover promotes the importance of bee diversity for crop pollination at regional scales Science 359, 791-793.

Kremen, C. (2018). The value of pollinator species diversity. Science 359 (6377), 741-742.

293 Liquete, C. etal (2016). Ecosystem services sustainability in the Mediterranean Sea: Assessment of status and trends using multiple modelling approaches. Scientific Reports 6, 34162.

294 Pienkowski, T. etal (2017). Empirical evidence of the public health benefits of tropical forest conservation in Cambodia: a generalised linear mixed-effects model analysis, The Lancet Planetary Health 1(5) e180-e187.

295 Lakey etal (2016). Ecological status of high altitude medicinal plants and their sustainability: Lingshi, Bhutan. BMC Ecology 16, no. 1

296 Chi, X, et al. (2017). Threatened medicinal plants in China: Distributions and conservation priorities. Biological Conservation 210 (A): 89-95.

297 Flandroy, L. etal (2018). The impact of human acitivities and lifestyles on the interlinked microbiota and health of humans and of ecosystems. Science of the Total Environment. 627, 10-18-1038.

116. The scientific literature on restoration, carbon sequestration and ecosystem resilience published since the release of GBO-4 has addressed a range of issues. Various case studies looking at the effects and approaches to restoration activities in specific locations have been prepared[298]. Others have further advanced the understanding of different restoration techniques[299] and/or the conditions under which restoration is most likely to be successful[300]. However despite the large amount of research on this subject relatively little focuses on the global scale.

117. Recent literature suggests that land degradation affects about 1.5 billion people, out of these 250 million people reside in drylands and about one billion people in over 100 countries are at risk[301]. Globally the main drivers of land degradation are human in origin and include wetland reclamation, construction, overexploitation of biological resources, and environmental pollution.

118. There are various estimates of the amount of degraded areas globally, in part owing to different ways in which degradation has been defined. For example it has been estimated that two billion hectares of the world's deforested and degraded forest lands contain opportunities for restoration[302]. Specifically with regards to peatlands, a major carbon sink, approximately 15 million hectares are degraded or viable for restoration[303].

119. Numerous studies have documented national restoration projects, some of which are undertaking restoration activities on a significant scale[304]. However since GBO-4 has been published there has been limited new information on the scale of restoration activities globally. An exception to this is an assessment of river ecosystem which found that there has been an increasing trends towards the removal

298 Barral, M. P. etal (2015) Quantifying the impacts of ecological restoration on biodiversity and ecosystem services in agroecosystems: A global meta-analysis, Agriculture, Ecosystems & Environment,202,223-231.

Lü, R. Y. etal (2017) Biodiversity and Ecosystem Functional Enhancement by Forest Restoration: A Meta-analysis in China. Land Degradation and Development., 28: 2062–2073. doi: 10.1002/ldr.2728.

Waldén E, and Lindborg R (2016) Long Term Positive Effect of Grassland Restoration on Plant Diversity - Success or Not? PLoS ONE 11(5): e0155836. doi:10.1371/journal.pone.0155836

299 Kimiti, D. W etal (2017), Low-cost grass restoration using erosion barriers in a degraded African rangeland. Restoration Ecology, 25: 376–384. doi:10.1111/rec.12426

YirdawE., etal (2017). Rehabilitation of degraded dryland ecosystems – review. Silva Fennica vol. 51 no. 1B article id 1673. 32 p. https://doi.org/10.14214/sf.1673

Jiang, T. etal (2015). Current status of coastal wetlands in China: Degradation, restoration, and future management, Estuarine, Coastal and Shelf Science,164, 265-275.

300 Moreno-Mateos, D., etal (2015), Ecosystem response to interventions: lessons from restored and created wetland ecosystems. J Appl Ecol, 52: 1528–1537. doi:10.1111/1365-2664.12518

Yamindago, R. (2015) Restoring coastal ecosystems - a case study Malang and Gresik regency, Indonesia. Journal of Coastal Conservation 19: 119. https://doi.org/10.1007/s11852-015-0373-0

Durka, W., etal (2017), Genetic differentiation within multiple common grassland plants supports seed transfer zones for ecological restoration. J Appl Ecol, 54: 116–126. doi:10.1111/1365-2664.12636

Crouzeilles, R. etal (2016). A global meta-analysis on the ecological drivers of forest restoration success. Nature Communications 7. http://dx.doi.org/10.1038/ncomms11666

301 Yirdaw, E.etal (2017). Rehabilitation of degraded dryland ecosystems – review. Silva Fennica vol. 51 no. 1B article id 1673. 32 p. https://doi.org/10.14214/sf.1673

302 World Resources Institute (2014). Atlas of Forest and Landscape Restoration Opportunities.

303 Haapalehto, T. etal (2014). The effects of long-term drainage and subsequent restoration on water table level and pore water chemistry in boreal peatlands,Journal of Hydrology,519(B), 1493-1505.

304 Parry, L.E. (2014). Restoration of blanket peatlands, Journal of Environmental Management, 133, 193-205.

Himner, R. A., etal (2017), An overview of peatland restoration in North America: where are we after 25 years?. Restoration Ecology, 25: 283–292. doi:10.1111/rec.12434

Liu, Y., etal (2017) Soil Organic Carbon and Inorganic Carbon Accumulation Along a 30-year Grassland Restoration Chronosequence in Semi-arid Regions (China). Land Degrad. Develop., 28: 189–198. doi: 10.1002/ldr.2632., of dams in some countries. For example in the United States more than 1200 dams have been removed mostly within the last two decades[305].

120. Various studies have provided further insight to the benefits of restoration actions. For example a global meta-analysis indicated that the restoration of degraded systems enhanced overall biodiversity by 44%[306]. Similarly in forest restoration, revegetation accelerated recovery of species richness and composition[307]. In wetland ecosystems restoration was found to enhance the diversity of vertebrates, vascular plants, and terrestrial and aquatic invertebrates, but it had no significant effect on macroinvertebrate diversity[308]. There are also potential benefits to soil health following afforestation[309] while an assessment found that the restoration of agroecosystem is usually successful for enhancing biodiversity and the supply of ecosystem services other than agricultural production[310].

121. The benefits of natural restoration has also ben explored in the recent scientific literature. For example an assessment of above ground biomass in 45 forest sites in the neotropics found that secondary forests are highly productive and resilient. They were also found to act as carbon sinks and increased water availability[311]. A similar study concluded that secondary forests in the Latin America Tropics, over a 40 year period, either through natural regeneration or assisted regeneration, could sequester an amount of carbon equal to that generated from fossil fuel use and industrial processes throughout Latin America between 1993 and 2014[312]. However another study, based on twelve years of satellite data, suggests that tropical forests are a net source of carbon as a result of deforestation and forest degradation and disturbance[313].

122. Restoration has also been identified as a potential natural solution to climate change. For example a study found that a combination of 20 conservation, restoration and improved land management actions could increase carbon storage and/or prevent greenhouse gas emissions. These solutions could account of 37% of the carbon dioxide mitigation needed between now and 2030 to have a more than 66% change of keeping warming below two degrees Celsius. The study also concludes that these actions would have additional benefits including improved soil health, increased habitat, better water filtration and flood buffering and enhanced resilience[314].

123. The cost of ecosystem restoration vary with the habitat and technique employed. It has been estimated that the cost of wetland restoration ranged from $6177 (2013 US dollars) per hectare to $160 618 per ha[315]. Similarly synthesis of 235 studies of coral reef, seagrass, mangrove, saltmarsh and oyster

305 Grill, G. et al (2015) An index-based framework for assessing patterns and trends in river fragmentation and flow regulation by global dams at multiple scales. Environmental Research Letters. 10 015001

306 Crouzeilles, R etal (2016). A global meta-analysis on the ecological drivers of forest restoration success. Nature Communications 7. http://dx.doi.org/10.1038/ncomms11666

307 Moreno-Mateos, D., etal (2015), Ecosystem response to interventions: lessons from restored and created wetland ecosystems. J Appl Ecol, 52: 1528–1537. doi:10.1111/1365-2664.12518

308 Meli P, et al. (2017) A global review of past land use, climate, and active vs. passive restoration effects on forest recovery. PLoS ONE 12(2): e0171368. https://doi.org/10.1371/journal.pone.0171368

309 Chengjie R, etal (2016) Linkages of C:N:P stoichiometry and bacterial community in soil following afforestation of former farmland,Forest Ecology and Management,376, 59-66,

310 Barral, M. P. etal (2015) Quantifying the impacts of ecological restoration on biodiversity and ecosystem services in agroecosystems: A global meta-analysis, Agriculture, Ecosystems and Environment, 202, 223-231.

311 Poorter, L. etal (2016) Biomass resilience of Neotrpopical secondary forests. Nature. 530, pages 211–214.

312 Chazdon, R. L. etal (2016). Carbon sequestration potential of second-growth forest regeneration in the Latin American Tropics. Science Advances 2(5) e1501639.

313 Baccini, A. etal (2017). Tropical forests are a net carbon source based on aboveground measurements of gain and loss. Science. 10.1126/science.aam5962.

314 Griscom, B. W. etal (2017). Natural climate solutions. Proceedings of the National Academy of Sciences. 114 (44) 11645-11650.

315 Moreno-Mateos, D., etal (2015), Ecosystem response to interventions: lessons from restored and created wetland ecosystems. J Appl Ecol, 52: 1528–1537. doi:10.1111/1365-2664.12518

reef restoration projects from around the world found that the median and average costs of restoring one hectare of marine coastal habitat was between US$ 80,000 and USD$ 1600000 respectively[316]. However it has also been estimated that the ecosystem restoration and reclamation industry generates 126,000 jobs and approximately 9.5 billion dollars in annual expenditure. Indirectly it has been estimated to generate 15 billion dollars in annual expenditure and another 95,000 jobs[317].

124. A review of the scientific information which has become available since 2014 suggests that progress towards this target is largely unchanged from what was previously reported in GBO-4. Further the recent scientific literature suggests that the actions identified in GBo-4 to accelerate progress towards this target remain relevant. However there is also a growing body of information on actions which could be taken to improve restoration techniques and effectiveness. These include having a greater emphasis on monitoring the effects of restoration activities[318], the need to consider appropriate time scales[319], and tailoring the goals of ecosystem restoration to be able to deal with changing climatic conditions. Further some studies have explored the positive role of legislation in promoting restoration[320] and the positive impact that creating multi-sectoral coalitions or partnerships can have in supporting restoration[321].

Target 16:By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

125. The fourth edition of the Global Biodiversity Outlook concluded that, as the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization entered into force on 12 October 2014, that this target was met. As of January 2018 105 Parties to the CBD have ratified the Protocol and actions continue to be taken to support its operationalization. Progress in the attainment of this target is not readily available from the scientific literature however updated information on the operationalization of the Protocol will be presented and discussed during the second meeting of the Subsidiary Body on Implementation in the context of assessment and review of the effectiveness of the Nagoya Protocol.

Target 17:By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.

126. The fourth edition of the Global Biodiversity Outlook concluded that national biodiversity strategies and action plans were expected to be in place for most Parties by 2015. However by the December 2015 deadline for the target only 69 Parties had submitted an NBSAP prepared or revised/updated after the adoption of the Strategic Plan for Biodiversity 2011-2020. As of January 2018 151 Parties have submitted NBSAPs since COP-10, 139 of which takes the Strategic Plan for Biodiversity

316 Bayraktarov, E., etal (2016). The cost and feasibility of marine coastal restoration. Ecological Applications, 26: 1055–1074.

317 BenDor T, etal (2015) Estimating the Size and Impact of the Ecological Restoration Economy. PLoS ONE 10(6): e0128339. https://doi.org/10.1371/journal.pone.0128339

318 Isbell, F etal (2015). Biodiversity increases the resistance of ecosystem productivity to climate extremes. Nature 526, 574-577.

Lamers, L. P. M., etal. (2015), Ecological restoration of rich fens in Europe and North America: from trial and error to an evidence-based approach. Biol Rev, 90: 182–203. doi:10.1111/brv.12102

Waldén E, and Lindborg R (2016) Long Term Positive Effect of Grassland Restoration on Plant Diversity - Success or Not? PLoS ONE 11(5): e0155836. https://doi.org/10.1371/journal.pone.0155836

319 Crouzeilles, R etal (2016). A global meta-analysis on the ecological drivers of forest restoration success. Nature Communications 7. http://dx.doi.org/10.1038/ncomms11666

320 Vidal, C. etal (2016). Biodiversity Conservation of Forests and their Ecological Restoration in Highly-modified Landscapes. Biodiversity in Agricultural Landscapes of Southeastern Brazil. 136-150. 10.1515/9783110480849-010

321 Meli P, et al. (2017) A global review of past land use, climate, and active vs. passive restoration effects on forest recovery. PLoS ONE 12(2): e0171368. https://doi.org/10.1371/journal.pone.0171368

into account. Information on progress in the attainment of this target is not readily available from the scientific literature however updated information on the development and implementation of NBSAPs will be presented and discussed during the second meeting of the Subsidiary Body on Implementation.

Target 18:By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.

127. Several studies have noted that there appears to be a general decline or erosion of traditional knowledge[322], however there have been few studies documenting progress towards this target at a global level. Numerous studies have document specific examples of how the traditional knowledge, innovations and practices of indigenous peoples and local communities could be strengthened in relevant national legislation and international obligations, such as global patent systems[323] or in combating biopiracy. Other studies have documented experiences in specific regions, such as South Asia[324] and Africa[325]. Various studies also document means in which traditional knowledge can be applied to ecosystem management and conservation[326].

128. While there is growing documentation on the potential value of traditional knowledge, it has been noted that that there is a lack of communication between indigenous peoples and local communities and the scientific community[327]. For example it has been noted that global assessments of biodiversity often do

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322 Hidayati, S. etal (2017). Using Ethnotaxonomy to assess Traditional Knowledge and Language vitality: A case study with the Urang Kanekes (Baduy) of Banten, Indonesia. Indian journal of traditional knowledge. 16. 576-582.

323 Amechi, E. P. (2015) Using Patents to Protect Traditional Knowledge on the Medicinal Uses of Plants in South Africa, Law, Environment and Development Journal 51,

324 Barpujari, I., Sarma, U. K. (2017). Traditional Knowledge in the Time of Neo-Liberalism: Access and Benefit-Sharing Regimes in India and Bhutan.The International Indigenous Policy Journal, 8(1) . Retrieved from: http://ir.lib.uwo.ca/iipj/vol8/iss1/3

325 Kaya, H.O. (2016). Indigenous knowledge and biodiversity for sustainable food security in South Africa. Journal of Human Ecology 52(2): 141-147.

326 Rah, P. (2016). Indigenous knowledge and practices of the Phakeyals: a study in Barphake village of Margherita. The Clarion- International Multidisciplinary Journal. 5. 98. 10.5958/2277-937X.2016.00038.1.

Leni D.etal (2016) Indigenous knowledge and practices for the sustainable management of Ifugao forests in Cordillera, Philippines, International Journal of Biodiversity Science, Ecosystem Services & Management, 12:1-2, 5-13, DOI: 10.1080/21513732.2015.1124453

Chun,J. (2014). A legal approach to induce the traditional knowledge of forest resources,Forest Policy and Economics, 38,40-45.

O'Neill, Alexander R.etal (2017). Integrating ethnobiological knowledge into biodiversity conservation in the Eastern Himalayas. Journal of Ethnobiology and Ethnomedicine13(21).

Pásková, M. (2015). The Potential of Indigenous knowledge for Rio Coco Geopark Geotourism, Procedia Earth and Planetary 15,886-891.

Quave, C. L. and Pieroni, Andrea (2015). A reservoir of ethnobotanical knowledge informs resilient food security and health strategies in the Balkans. Nature Plants 1 (14021). Ritchie, 2015;

Rivero-Romero, A. D. et al (2016). Traditional climate knowledge: a case study in a peasant community of Tlaxcala, Mexico. Journal of Ethnobiology and Ethnomedicine 12(33).

Kaya, H.O. (2016). Indigenous knowledge and biodiversity for sustainable food security in South Africa. Journal of Human Ecology 52(2): 141-147.

327 Abreu, J. S. etal (2017). Is there dialogue between researchers and traditional community members? The importance of integration between traditional knowledge and scientific knowledge to coastal management,Ocean & Coastal Management,141, 10-19.

not take into account local and traditional knowledge[328]. This is despite their being numerous example of how bringing traditional knowledge together with science can lead to constructive solutions to various challenges[329] as well as result in policies which are more tailored to on the ground realities[330]. However an one example which is counter to this general trend is the conceptual framework of the Intergovernmental Platform on Biodiversity and Ecosystem Services which gives explicit consideration of diverse scientific disciplines, stakeholders, and knowledge systems, including indigenous and local knowledge[331].

129. With regards to the integration of traditional knowledge in the operations of the Convention, it has been observed that countries often include actions related to the respect and integration of traditional and local knowledge in their NBSAPs but that participation mechanisms are limited[332]. Further it is has also been observed that there is often limited capacity to meaningfully engage indigenous peoples and local communities in policy decisions[333].

130. A review of the scientific information which has become available since 2014 suggests that the situation is largely unchanged from what was previously reported in GBO-4. Further the recent scientific literature suggests that the actions identified in GBo-4 to accelerate progress towards this target remain relevant.

Target 19:By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

131. The scientific articles referenced in this note indicate that the amount of biodiversity information available is increasing at a rapid pace. These articles imply that progress is continuing to be made towards the attainment of this target and it is clear that significantly more biodiversity information is available today than when Aichi Biodiversity Target 19 was adopted, though gaps remain.

132. While the amount of biodiversity information is increasing there has been less progress in widely sharing this information and in applying it to policy decisions. However there has been research undertaken to help address this. For example research has been undertaken on methodologies for the transfer of knowledge on biodiversity management from experts to citizens, including by using tools such network analysis[334], the development of observation networks[335] as well as by better understanding how people perceive biodiversity information[336]. Similarly there has been work to better document types of knowledge which have tended to receive less attention from the scientific community, such as traditional

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328 Sutherland, W., etal (2014). How can local and traditional knowledge be effectively incorporated into international assessments? Oryx, 48(1), 1-2. doi:10.1017/S0030605313001543

329 Tengö, M., et al. AMBIO (2014) 43: 579. https://doi.org/10.1007/s13280-014-0501-3

330 Barua, Prabal. (2017). Indigenous Knowledge Practices for Climate Change Adaptation in the Southern Coast of Bangladesh. International Journal of Knowledge Management. 15. 1-21.

331 Diaz, S. etal (2015). The IPBES Conceptual Framework – connecting nature and people. Current Opinion in Environmental Sustainability 14, 1-16.

IPBES Decision 2/4: Conceptual framework for the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://www.ipbes.net/sites/default/files/downloads/Decision%20IPBES_2_4.pdf

332 Ferrari, M. etal (2015) Community-based monitoring and information systems (CBMIS) in the context of the Convention on Biological Diversity (CBD), Biodiversity, 16:2-3, 57-67, DOI: 10.1080/14888386.2015.1074111

333 Escott, H. etal (2015). Incentives and constraints to Indigenous engagement in water management,Land Use Policy,49,382-393.

Brondizio, E. S.and Tourneau, F (2016). Environmental governance for all. Science. 352 (6291)

334 Nesshover etal. 2016. The Network of Knowledge approach: improving the science and society dialogue on biodiversity and ecosystem services in Europe. Biodiversity Conservation Vol. 25

335 Despot-Belmont etal. 2017. EU BON's contributions towards meeting Aichi Biodiversity Target 19. Research Ideas and Outcomes Vol. 3

336 Celis- Diez etal 2017. Biocultural Homogenization in Urban Settings: Public Knowledge of Birds in City Parks of Santiago, Chile Sustainability Vol.9

medical knowledge[337] and knowledge related traditional medicinal plants[338]. In addition a range of research has been carried out to develop methods for better collecting and cataloging biodiversity information. This includes work related to DNA barcoding[339]. Given the current limitations in some biodiversity rich countries in relation to biodiversity monitoring studies have also been undertaken to better understand capacity building needs[340] while other studies have attempted to evaluate the funding needs associated with maintain different conservation knowledge products[341].

133. Two indicators used in GBO-4, number of biodiversity papers published[342] and the number of species occurrence records in the Global Biodiversity Information Facility[343], have been updated since 2014. Both indicators show increases. In addition two indicators not used in GBO-4, the species status information index[344] and the proportion of known species assessed through the IUCN Red List[345], have become available since GBO-4 was published. Both of these indicators show positive trends.

134. The information that has become available since the publication of GBO-4 suggests that progress towards this target is largely unchanged from what was previously reported. The amount of biodiversity knowledge available continues to increase and while progress has been made in sharing and applying this knowledge more efforts are needed in this regard. Further the recent scientific literature suggests that the actions identified in GBO-4 to accelerate progress towards this target remain relevant.

Target 20:By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

135. The fourth edition of the Global Biodiversity Outlook concluded that there was insufficient data to report with confidence on progress towards the mobilization of financial resources from all sources. However, based on the data that was available it was concluded that further efforts will be needed to significantly increase the financial resources, from all sources, for effective implementation of the Strategic Plan for Biodiversity 2011–2020 (Target 20). Since the publication of GBO-4 the Conference of the Parties has put in place a financial reporting mechanism which will provide information relevant to the assessment of progress towards this target. Information on progress in the attainment of this target is not readily available from the scientific literature however updated information on resource mobilization will be presented and discussed during the second meeting of the Subsidiary Body on Implementation. Further two indicators used in GBO-4 have been updated since 2014. The indicators, official development

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337 Kim eral. 2015 Development of a template for the classification of traditional medical knowledge in Korea. Journal of Ethnopharmacology Vol. 178

338 Sher etal. 2017. Promoting Sustainable Use of Medicinal and Aromatic Plants for Livelihood Improvement and Biodiversity Conservation under Global Climate Change, through Capacity Building in the Himalaya Mountains, Swat District, Pakistan. Annals of the Missouri Botanical Garden, Vol.102

339 Ashfaq etal. 2017. Mapping global biodiversity connections with DNA barcodes: Lepidoptera of Pakistan. PLoS ONE Vol. 12

340 Schmeller etal (2017). Building capacity in biodiversity monitoring at the global scale. Biodiversity and Conservation 26(12) 2765–2790

341 Juffe-Bignoli etal. (2016). Assessing the Cost of Global Biodiversity and Conservation Knowledge. PLoS ONE Vol. 11 Issue 8

342 Web of Science Service for UK Education http://wok.mimas.ac.uk/

343 The GBIF Network https://www.gbif.org/the-gbif-network

344 Meyer, C., etal (2015). Global priorities for an effective information basis of biodiversity distributions. Nature communications 6: 8221.

345 IUCN Red List of Threatened Species. Summary Statistics. http://www.iucnredlist.org/about/summary-statistics

assistance provided in support of the CBD objectives[346] and funding provided by the Global Environment Facility, both show positive trends.

VI. Conclusions

136. A variety of scientific information relevant to the Aichi Biodiversity Targets has become available since the publication of the fourth edition of the Global Biodiversity Outlook. This information has furthered out understanding of various issues related to biodiversity, including approaches and methodologies to conservation and sustainable use. It has also further out understanding of different biological processes and the ways in which society interacts with and impacts biodiversity. However this information does not easily lend itself to an updated assessment of progress towards the Aichi Biodiversity Targets. Further many of the studies reviewed in this note use different definitions and methodologies, making a direct comparison between their conclusions difficult if not impossible.

137. For a number of the Aichi Biodiversity Targets there has been relatively little information which has become available in last four years. This is particularly the case for those targets which address socio-economic issues, such as Aichi Biodiversity Targets 1, 2, 3, as well as Aichi Biodiversity Target 18. This gaps points to the need to encourage the greater involvement of the social sciences in helping to assess progress towards the targets.

138. Of the 44 indicators reviewed in this note 18 showed trends which could be considered positive for biodiversity. The remainder were negative. All of the 18 indicators showing positive trends related to the responses Parties are taking to conserve and sustainably use biodiversity. The 26 indicators showing trends negative for biodiversity were related to the status of biodiversity, the pressures on it and the benefits it provides. This information suggests, as reported previously in GBO-4, that while the responses to biodiversity loss are increasing, biodiversity is continuing to decline.

139. In most cases, the information that is available does not suggest that there have any significant changes to the assessment of progress towards the attainment of the Aichi Biodiversity Targets as presented in GBO-4. However it is important to note that while this review has focused on research published after 2014, many of the data sets and information these publications are based on were collected prior to this. Therefore there may be time lags between when information on observable changes are collected and when this information is published. Similarly most biological systems require relatively long period of time to respond to change. Therefore it is not surprising that in the four years since GBO-4 was published that there would little observable change to biological systems.

140. The available scientific information suggests that the actions identified in the fourth edition of the Global Biodiversity Outlook to accelerate progress towards the attainment of the Aichi Biodiversity Targets remain relevant. The information in the scientific literature generally provide further specificity as to how the actions identified in GBO-4 could be implemented and/or different issues that should be considered when implementing them.

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346 OECD, 2015. Biodiversity related official development assistance 2015. Available at: https://www.oecd.org/dac/environment-development/Biodiversity-related-ODA.pdf