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CLIMATIC CHANGE AND BIODIVERSITY CONSERVATION

- FINAL -

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INTRODUCTION

There is now a vast literature on the subject of climatic change and biodiversity conservation; a search of the Web of Knowledge using the terms biodiversity AND conservation AND "climate change" reports (14th April 2015) 9,773 publications with these terms in their titles, keywords or abstracts. The earliest paper reported dates from 1988, since when the rate of publication in this field has grown exponentially (*Slide 2*), as has the rate of citation of papers in this field (*Slide 3*). Furthermore, this search excludes many papers that have addressed the responses of species to climatic change but that have not explicitly linked this to biodiversity conservation. The issue of the threat posed by anthropogenic climatic change to global biodiversity is thus not one that has come to be recognised only recently, but one of which we have been aware for more than 25 years. It is thus distressing, especially to those amongst us who have been researching the field throughout most of this time, and advocating the urgent need to take climatic change into account when formulating biodiversity conservation strategies and undertaking management of protected areas and the wider landscape, that practical actions to address this threat have yet to be put in place in many parts of the world.

In this paper (*Slide 4*) I shall begin by reminding us of the evidence relating to anthropogenic climatic change, and why it poses a challenge to those of us concerned with the conservation of biodiversity. I shall then briefly review the evidence as to how species have responded to past climatic changes and how they are responding to the current ongoing climatic changes. It is then relevant to consider why biodiversity matters, especially in the context of climatic change, and thus why it is important to take steps to ensure its conservation. I shall then briefly remind us of what needs to be done, using a synthesis of the recommendations made by this Group in its previous reports and also by reference to some recent publications from other bodies, and outline the evidence as to what is being done, especially by the Parties to the Bern Convention. Finally, I shall offer some personal views as to the priorities for the future if the Parties are to achieve internationally agreed goals with respect to biodiversity conservation.

ANTHROPOGENIC CLIMATIC CHANGE AND WHY IT CHALLENGES BIODIVERSITY CONSERVATION

That the global climate is changing as a result of anthropogenic activities is now without question: in the fifth assessment report of the Intergovernmental Panel on Climate Change, for example, it is stated that "*Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased*" (IPCC, 2013) (*Slide 5*). Most notable amongst the causes of these changes are the increased atmospheric concentrations of carbon dioxide (*Slide 6*), principally as a result of fossil fuel burning, cement production and land-use changes, including forest destruction and wetland drainage, of methane, principally from agricultural sources, notably domesticated ruminants and paddyfield rice cultivation, but also from fossil fuel exploitation and waste disposal in landfills, and of nitrous oxide, primarily as a result of applications of nitrogenous fertilisers in agriculture. In addition, the ozone-destroying CFCs, and the HCFCs that in part have replaced them, continue to make a substantial contribution.

Given, however, that it is clear from the geological record of the Quaternary Period (the last *ca*. 2·6 Ma) that global climatic conditions have changed substantially in the relatively recent geological past, alternating repeatedly between glacial and interglacial conditions approximately every 100 ka (EPICA community members, 2004) (*Slide 7*) and exhibiting smaller magnitude fluctuations on millennial timescales at least during the last glacial stage (Wolff *et al.*, 2010) (*Slide 8*), it is pertinent to ask why we should be concerned about the current and projected anthropogenic global climatic changes? The answer is that it is several of the characteristics of the present and projected anthropogenic changes that cause the concern. In particular:

- The magnitude of the projected mean global temperature increase, of as much as 5°C relative to 1850–1900 by the end of the present century (IPCC, 2013) for a high emissions path (RPC 8.5, van Vuuren *et al.*, 2011) that essentially represents a continuation of the past trend, is comparable to the

estimated magnitude of mean global temperature increase by 4–7°C between the last glacial maximum (*ca*. 21 ka BP) and pre-industrial times (Jansen *et al.*, 2007).

- The rate of the projected mean global temperature increase for the present century is likely to exceed, by at least an order of magnitude, estimates of the rate of mean global temperature increase between the last glacial maximum and the beginning of the Holocene (*ca*. 11·4 ka BP) (Jansen *et al.*, 2007).
- The direction of the change, i.e. towards warmer global mean temperatures than at any time in the recent geological past, combined with the atmospheric carbon dioxide concentration that already is higher than at any time in at least the last 800 ka, and probably than it has been for millions of years, means that projected conditions are without precedent during the lifetime of most species found on Earth today, our own included. As a result, even in terms only of climate, many parts of the Earth are projected to experience by the end of the present century conditions without any present analogue, whilst many current climates will by then no longer be available anywhere on Earth (Williams *et al.*, 2007) (*Slide 9*).

Once again, although confirmed by more recent research, these are not new observations but issues that were already being discussed at least 25 years ago (Graham & Grimm, 1990; Huntley, 1991), as were their implications with respect to biodiversity conservation. Incidentally, it is relevant to note here that the general magnitude of projections of mean global temperature increase has not changed between the IPCC's first and fifth assessment reports ("*the IPCC Business-as-Usual (Scenario A) emissions … will result in a likely increase in global mean temperature of … about 4°C above pre-industrial before the end of the next century*" (IPCC, 1990); "*relative to the average from year 1850 to 1900, global surface temperature change by the end of the 21st century is … about as likely as not to exceed 4°C for RCP8.5*" (IPCC, 2013); (*Slide 10*)). It is also relevant to note that, whereas in its second assessment report (Nicholls *et al.*, 1996) IPCC placed emphasis upon the then recently reported evidence from Greenland ice cores of rapid temperature fluctuations during the last glacial stage (GRIP Members, 1993), implicitly assuming that these had been a global phenomenon, recent precisely-dated evidence indicates that, at least during the last deglaciation, locally very rapid climatic changes were regionally time-transgressive (Lane *et al.*, 2013), indicating the progressive movement of a front rather than a globally synchronous rapid change, something also previously inferred, for example, from records of ocean surface temperature (e.g. Kroon *et al.*, 1997). Furthermore, it became clear more than a decade ago that temperature fluctuations in Greenland and Antarctica were out of phase during the last glacial stage (Blunier & Brook, 2001), and thus that the rapid temperature changes recorded in Greenland do not reflect changes of similar magnitude in global mean temperatures. The unprecedented characteristics of projected global climatic changes, at least in the context of the Quaternary geological record, is thus once again clear, as reflected in the IPCC Fourth Assessment Report (Jansen *et al.*, 2007).

HOW SPECIES RESPOND TO CLIMATIC CHANGE

Species may in principle respond to climatic change in a number of ways according to the rate and magnitude of the change (Huntley *et al.*, 2010) (*Slide 11*). Note that the six options illustrated are not exclusive options, two or more often occurring together and some being mechanistically linked. Furthermore, extinction is in reality a result of the failure by a species to achieve a sufficient rate or magnitude of response by some combination of the other mechanisms.

Not all of these potential responses can be deduced from the Quaternary fossil record, the obvious exception being that of behavioural responses. However, the Quaternary record does provide clear evidence of range shifts (*Slide 12*), shifts in relative abundance (*Slide 13*), morphological adaptation, probably reflecting genetic adaptation, albeit within the range exhibited by the species across its present range (*Slide 14*), and extinctions (*Slide 15*). The same fossil record also demonstrates that, as Bennett has argued (Bennett, 1990, 1997), species have not shown macro-evolutionary responses even to the glacial–interglacial time-scale of climatic changes, but only to much longer-term trends in climatic conditions and/or in the availability of novel environments (*Slide 16*). The Quaternary record also makes clear that the predominant response of species to larger magnitude and relatively rapid climatic changes has been to shift their distributions, or 'migrate' (Huntley & Webb, 1989), so as to continue to occupy

those regions offering the climatic conditions to which they are adapted, as Good (1931) long-ago argued was to be expected.

It is now clear from numerous studies that species are exhibiting at least some of these six types of response to the climatic changes of the recent past. At least more mobile species groups are generally showing range shifts in the expected directions (Hickling *et al.*, 2006; Chen *et al.*, 2011). Species are also showing changes in relative abundance, with resulting shifts in community composition, that are consistent with the direction of climatic change (Devictor *et al.*, 2008). In addition, behavioural changes are relatively widespread, especially phenological changes (Parmesan & Yohe, 2003; Schwartz *et al.*, 2006; Visser *et al.*, 2006; Altwegg *et al.*, 2012), but also changes in migratory behaviour of some birds (Berthold *et al.*, 1992; Lock & Cook, 1998) that are at least in part attributable to climatic change.

There is only limited evidence, however, that some species may have shown adaptive genetic responses to climatic change. Furthermore, in general any adaptation is seen only locally and has not resulted in species occupying climatic conditions in which they were not previously found in some part of their range. On the contrary there is considerable evidence from the Quaternary record that species' climatic niches are conserved through major climatic changes (Huntley *et al.*, 1989). The IPCC concluded in its Fifth Assessment Report that "*there are few observational studies of rapid evolution and difficulties in detection and attribution, so there is only **medium confidence** that some species have responded to recent changes in climate through genetic adaptations, and insufficient evidence to determine if this is a widespread phenomenon (thus **low confidence** for detection and attribution across all species)*" (Settele *et al.*, 2014) (*Slide 17*).

There is also as yet only very limited evidence of extinctions that can be attributed to climatic change, principally because a variety of other stressors is almost always also present (Settele *et al.*, 2014); the Golden Toad (*Bufo periglene*s) (Pounds *et al.*, 1999; Pounds *et al.*, 2006) remains perhaps the most persuasive example, although even in this case other contributory factors cannot be excluded (*Slide 18*). That projected rapid large magnitude climatic changes are likely to place large numbers of species at increased risk of extinction (Thomas *et al.*, 2004) is, however, generally accepted. Indeed the IPCC Fifth Assessment Report concludes, with **high confidence**, that "*A large fraction of terrestrial and freshwater species face increased extinction risk under projected climate change during and beyond the 21st century, especially as climate change interacts with other pressures, such as habitat modification, overexploitation, pollution, and invasive species*" (IPCC, 2014).

As a final point it is important to emphasise that the evidence, not only from the palaeoecological record (Davis, 1983; Huntley & Birks, 1983) but also from experimental studies (Chapin & Shaver, 1985), is very clear that species respond individualistically to climatic changes (Huntley, 1991), and that, as a result, communities disaggregate and re-form as climatic conditions change (Graham & Grimm, 1990; Huntley, 1996). Furthermore, it also is apparent that novel or no-analogue climatic conditions result in the assembly of novel or no-analogue communities (Graham *et al.*, 1996; Graham, 1997; Williams *et al.*, 2001). As Richard West wrote as long ago as 1964, "*past communities (and so also conditions of climate?) are not necessarily in existence today*", leading him to conclude that "*our present plant communities have no long history ... but are merely temporary aggregations under given conditions of climate, other environmental factors, and historical factors*" (West (1964) quoted in Huntley (1996)) (*Slide 19*). Thus we should expect that species will respond individualistically to recent and projected future climatic changes, and that as a result communities and ecosystems that have been present in the past are in many cases unlikely to be present under future changed conditions.

WHY BIODIVERSITY MATTERS

Having reminded ourselves of the nature of the problem that we face, of how we expect species and communities to respond, and of the potential for a large number of species to face increased extinction risk, and thus of a substantial loss of global biodiversity, we need now to consider why we seek to conserve biodiversity – why does biodiversity matter? what is its value?

I do not intend to dwell on this issue, because the reason that we are all here is that we have already recognised that biodiversity is important and that steps need to be taken to ensure its conservation. However, the international context for thinking about and framing this issue has fundamentally shifted in emphasis over recent years, and certainly since this group was established, and it is relevant to consider this at least briefly.

Key to this shift has been the recognition, firstly, of the value to human society of a range of ecosystem services upon which our well-being is dependent (Costanza *et al.*, 1997), a development then taken up by the Millennium Ecosystem Assessment (Hassan *et al.*, 2005), and secondly, that biodiversity is key to the capacity of ecosystems to deliver multiple services (Hector & Bagchi, 2007). In addition, the greater resilience of more diverse communities (e.g. Finger & Buchmann, 2015; Pedro *et al.*, 2015) and of more diverse landscapes (Schippers *et al.*, 2015), and the greater productivity, and hence carbon sequestration potential, of more diverse communities (Tilman *et al.*, 2001; Lambers *et al.*, 2004; Reich *et al.*, 2004), have also provided evidence of the inherent value of biodiversity.

Against this background, the UN Convention on Biodiversity in its Strategic Plan for 2011–20 (https://www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-EN.pdf) places considerable emphasis upon the value to human society of ecosystem services and hence of biodiversity as an essential underpinning to the continued delivery of multiple services, especially in the face of climatic change. This is reflected in both The Vision: "*By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining* ***ecosystem services****, sustaining a healthy planet and delivering benefits essential for all people.*" (*Slide 20*) and The Mission: "*Take effective and urgent action to halt the loss of biodiversity in order to ensure that by 2020* ***ecosystems are resilient and continue to provide essential services****, thereby securing the planet's variety of life, and contributing to human well-being, and poverty eradication. To ensure this, pressures on biodiversity are reduced, ecosystems are restored, biological resources are sustainably used and benefits arising out of utilization of genetic resources are shared in a fair and equitable manner; adequate financial resources are provided, capacities are enhanced, biodiversity issues and values mainstreamed, appropriate policies are effectively implemented, and decision-making is based on sound science and the precautionary approach.*" (my emphasis) (*Slide 21*).

Key components of the international response to this new emphasis have been the recognition of the potential value of 'green infrastructure' and the essential need to embed considerations relating to the conservation, or restoration, of functional ecosystems, and hence of biodiversity, in all areas of human endeavour. It has also come to be widely recognised that functional ecosystems, and their biodiversity, can and should play key roles in both climatic change adaptation and mitigation strategies; indeed often a 'green infrastructure' strategy to address these issues can be a more economically viable option than more traditional engineering solutions. These issues are now embedded in the policies and legislation of many countries, including many of the parties to the Bern Convention.

Notwithstanding this new emphasis upon the role of biodiversity in relation to sustaining ecosystem services, in the context of climatic change we must not overlook the important role that biodiversity plays in the resilience of ecosystems to extreme climatic events, the frequency of which is expected to increase as a result of climatic change. Biodiversity will also play a vital role in enabling adaptation of ecological systems to the novel climatic conditions that are projected to become widespread, or even dominant in some regions, as anthropogenic climatic changes unfold during the course of the present century and beyond.

Biodiversity also has other intrinsic values, both as a reservoir of as yet untapped potential natural resources, and through its aesthetic and cultural values that make extremely important contributions to the quality of life of humankind.

WHAT NEEDS TO BE DONE

Biodiversity then faces enormous challenges as a consequence of climatic change, as well as the numerous other human activities that have potentially negative impacts, but at the same time there are now

new and important opportunities as a result of the recognition of the value of ecosystem services and of 'green infrastructure', including its potential role in climatic change adaptation and mitigation. Given this context, what should those of us concerned with the conservation of biodiversity be doing?

The answer by-and-large is that we should continue vigorously to pursue the implementation of the recommendations previously made by this Group.

In my 2012 assessment of the implementation of this Group's recommendations (Huntley, 2012) I synthesised the many recommendations made by the Group over the period of its activities into a set of ten recommended actions (Table 1) (*Slide 22*), although these were not presented in any kind of priority order. In the concluding section of my report I also presented a set of sixteen specific and three general recommendations in the light of what I had found with respect to the implementation by the Parties of the Group's previous recommendations. The Secretariat presented to the Group's meeting in 2012 a set of eight draft recommendations (*Slide 23*) and five instructions (*Slide 24*), derived in large part by summarising those made in my report; these draft recommendations were subsequently adopted and became Recommendation No. 159 (2012) of the Standing Committee, adopted on 30 November 2012, on the effective implementation of guidance for Parties on biodiversity and climate change. As with the Group's earlier recommendations, these are as relevant now, in my view, as they were when they were made, and are presented in Table 2 below as a reminder. Furthermore, my 2012 recommendations and Recommendation No. 159 also embedded the need to inform policy-makers about the potential win–win solutions offered by ecosystem approaches when developing strategies for climatic change adaptation or mitigation across all sectors. What was most obviously missing at that time, however, was any explicit mention of ecosystem services and of the value of biodiversity in relation to the future maintenance of these services as climate changes. Given the wider context, emphasising the need to inform policy-makers and the public about this issue, and thus of the wider value of biodiversity conservation measures, is something that should be considered in any revision or updating of the Group's recommendations.

The other thing that perhaps has been missing from the Group's recommendations, and that thus may have contributed to the disappointingly low level of practical actions by the Parties, is a 'recipe' for the implementation of the key actions necessary. An example of the kind of 'decision support' tool that can help provide such a recipe was presented by Shoo *et al*. (2013) and is illustrated below (Figure 1) (*Slide 25*). It is also relevant to note the development in recent years of the concept of 'climate-smart' approaches to biodiversity conservation (Hansen *et al.*, 2010) and of guidance as to how to adopt such an approach (see e.g. National Wildlife Federation, 2013). In the latter document the approach advocated is summarised in a useful figure(Figure 2) (*Slide 26*). If we are not already doing so, then in future we should certainly apply such a climate-smart approach to all of our biodiversity conservation planning and activities.

Table 1: Synthesis of recommended actions

1. **Target as a priority the most vulnerable regions/ecosystems** – the Arctic (sea-ice, tundra and boreal forest), mountains, coastal zones, islands, wetlands in areas of increasing drought. Improve knowledge of potential losses of such vulnerable habitats from the combined effects of climatic change and changing land use. Take steps to minimise other pressures on these habitats and regions that are most vulnerable to climatic change.
2. **Enhance the adaptive capacity of vulnerable species** (rare/endemic/threatened). Take steps to increase their populations; identify and urgently address threats, other than climatic change, to these species; develop climatic change adaptation/mitigation plans, especially for those species identified as most vulnerable to climatic change.
3. **Improve knowledge of species and habitats of special concern** (including Bern Convention species/habitats, endemics, sea-turtles, amphibians and reptiles), especially of their vulnerability to climatic change. Simulate potential impacts using species' distribution models, enabling a focus upon those identified as most vulnerable to climatic change. Update or develop conservation statements and, where necessary, recovery plans for all threatened species, incorporating climatic change impacts. Incorporate climatic change vulnerability into the assessment of threatened status when compiling 'Red Books/Lists'.

4. **Improve knowledge and understanding of the role of wildfire** in ecosystem dynamics. Assess the vulnerability of ecosystems to changes in wildfire frequency as a result of climatic change, land-use changes and human settlement patterns. Include the role of fire in all assessments of the vulnerability of species, ecosystems and habitats. Assess the vulnerability of protected area networks to wildfire and take this into account when developing strategies for their management and/or enhancement.

5. **Improve knowledge of introduced alien species**, especially those widely cultivated as horticultural subjects. Assess how their populations are likely to respond to climatic change and hence which of them are potentially invasive. Monitor, assess and control intentional new introductions of alien species not already present, taking into account potential impacts of climatic change and/or enhanced atmospheric CO_2 concentrations upon their potential to become invasive.

6. **Implement monitoring** of *inter alia* species' population trends, species behaviour, including phenology, and climatic change impacts upon protected areas. Select focal species as targets for monitoring on the basis that they are highly sensitive potential indicators of climatic change impacts, or else that they respond to critical biologically-relevant variables that themselves are difficult to monitor. Target monitoring to critical areas (e.g. southern Europe is important for many migratory birds).

7. **Maintain or restore intact ecosystems**. Ensure existing protected areas are managed appropriately so as to maximize their health and resilience; increase the extent of protected areas, implement buffer zones and increase connectivity by developing permeable landscapes that provide functional networks of habitat 'stepping stones' of various sizes and separations linking protected areas, thus facilitating both local adaptation and range shifts. Retain as many as possible of remaining fragments of unaltered or semi-natural habitats; create new patches of habitat where past land management has led to their absence from the present landscape; maintain and, where appropriate, increase habitat heterogeneity; take steps to increase ecosystem resilience, not only to progressive climatic change but also to extreme weather events; use a variety of mechanisms, including easements, set-aside, incentive-based schemes, local conservation strategies and public and private collaboration for conservation, to achieve these goals.

8. **Implement adaptive management practices and strategies**. Use monitoring results to inform adaptive management; improve understanding and knowledge of the practical application and effectiveness of alternative management practices; take a long-term view (20 – 50 years) when developing protected area management plans. **Act now** – do not allow uncertainties about the precise nature of future climatic changes to be an excuse for delays in taking practical conservation actions.

9. **Adopt holistic approaches to adaptation and mitigation**. Development of species' and/or habitat conservation and/or recovery plans should take an holistic view, not only across different taxonomic groups and ecosystems, but also trans-nationally and across sectors other than the biodiversity conservation sector. Adaptation strategies should aim to reduce species losses whilst mitigation measures should contribute to reducing species and/or habitat vulnerability. Steps should be taken to facilitate knowledge transfer between partners, stakeholders, including the general public, and sectors.

10. **Consider assisted colonisation and/or *ex situ* conservation** for species unlikely to achieve necessary range shifts. Evaluate potential risks and benefits, considering both target species and potential 'receiving' sites/ecosystems. Assess coverage and quality of existing *ex situ* conservation measures (e.g. seed banks, botanical garden collections); take steps to enhance these where necessary, ensuring propagules are preserved of Bern Convention and other threatened plant species.

Table 2: Recommendation No. 159

Recommends Contracting Parties to the Convention and invites Observer States to:

1. Urgently implement the practical conservation measures that have been recommended by the Group of Experts and encourage appropriate national bodies involved in nature conservation to adopt and use them as resources permit; urgent action should more particularly focus on implementing adaptive management practices and strategies, enhancing the adaptive capacity of vulnerable species (rare/endemic/threatened), minimising pressures and threats on species and habitats that are most vulnerable to climate change, and implementing monitoring of, *inter alia;* species' population trends, species behaviour, including phenology, and climate change impacts upon critical areas;
2. Take further steps to develop ecological networks, to promote and enhance the permeability of landscapes generally, and also enhance their protected areas networks, as appropriate, by increasing the extent of existing sites, designating new sites and establishing buffer zones, and ensuring they are sustainably and adaptively managed;
3. Take an appropriately long-term view, based on adaptive management methodologies, when formulating management plans and strategies for protected areas management;
4. Adopt, as appropriate, a more holistic approach when formulating strategies and plans for ecological networks or protected areas, and when developing conservation or recovery plans for individual species. In particular, encourage the general adoption of the examples of good practice reported, especially by Switzerland and Ukraine, with respect to taking into account their international context when planning ecological networks, and to developing networks and protected areas in partnership with their neighbours;
5. Adopt measures that encourage biodiversity conservation to be embedded across other sectors and taken into account when formulating policies or strategies for those sectors, also by informing policy-makers across the Parties about the opportunities for win–win solutions, for instance through the development and use of ecosystem-based approaches, when developing strategies for adaptation to climate change by their sector as well as for mitigation measures;
6. Undertake knowledge transfer activities using existing mechanisms, to encourage awareness by other stakeholders and the general public of the challenges posed and opportunities presented by climate change when considering biodiversity conservation, including its links to other sectors and the opportunities for win–win solutions;
7. Take account of the potential increased risk of wildfires as a result of climate change and embed, as appropriate, mitigation measures for consideration of this risk into protected area management plans;
8. Adopt the good practice, identified in the case of the United Kingdom, of implementing measures for the assessment of introductions that include assessment of the impacts of projected climate changes on species' invasion potential;

Further instructs the Bern Convention Group of Experts on biodiversity and climate change to:

1. Take all necessary steps to ensure that the importance of the issue of climate change on biodiversity, and understanding the role of biodiversity in adapting to and mitigating the effects of climate change is well recognised by all Contracting Parties;
2. Promote awareness among Contracting Parties of the examples of good practice identified and urge their implementation;
3. Ensure that those persons preparing reports from Parties for the Group of Experts are fully informed about relevant activities, for example monitoring activities, being undertaken in their country, thus avoiding spurious identification of gaps in the activities of that Party or of priorities for new actions by the Party;
4. Assess the potential for introduced species already present in the national territory of Contracting Parties to become invasive under future climate conditions, in close co-operation with the Group of Experts on Invasive Alien Species, and using information and methodologies developed in other *fora*, where appropriate;
5. Inform the Standing Committee on the progress made in the implementation of this Recommendation.

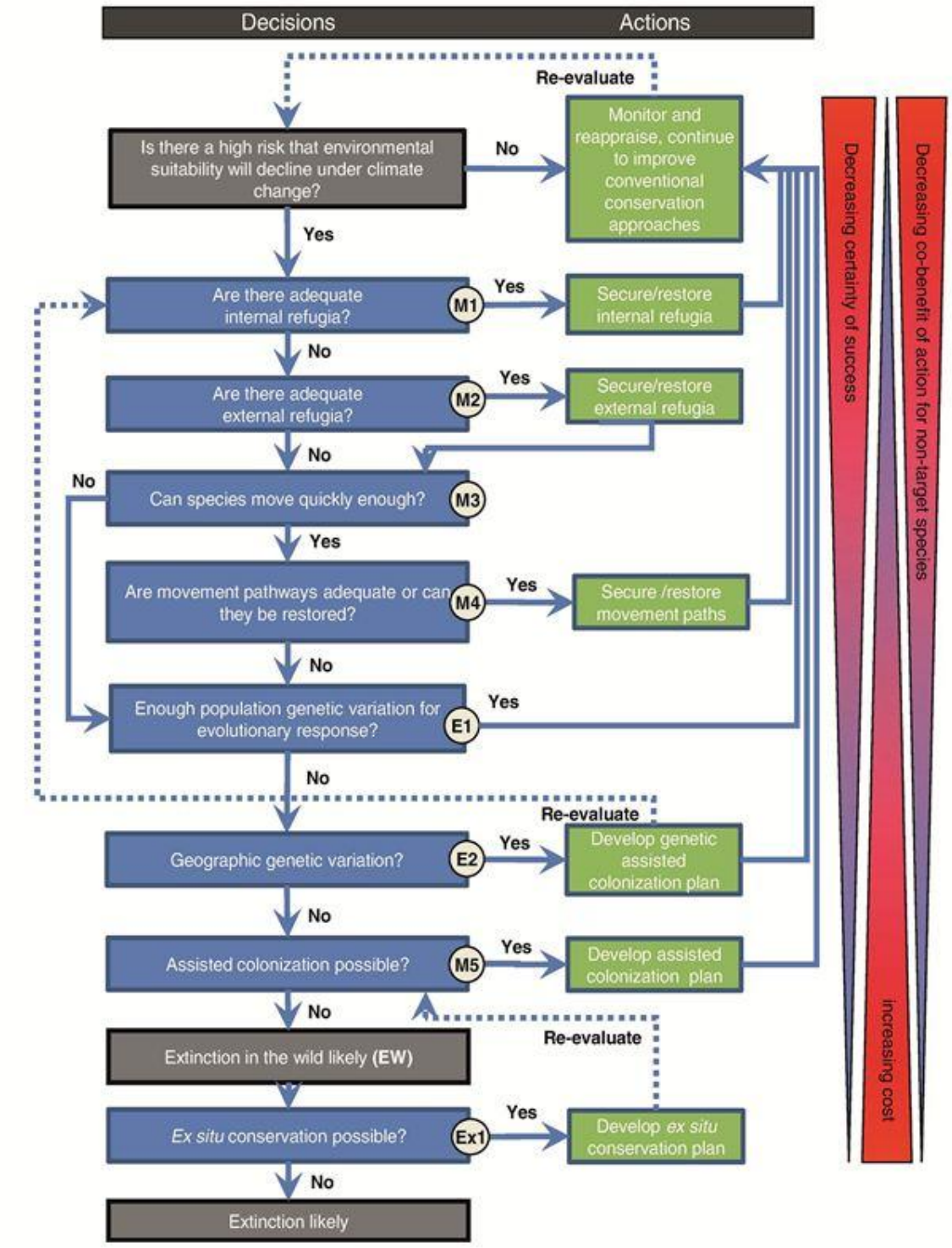

Figure 1: Decision framework for management actions

Decision framework for management actions focused on ameliorating impacts of climate change on wild species. 'M' is used to identify movement options for species, while 'E' and 'Ex' concern evolutionary and *ex situ* options respectively (Figure 1 of Shoo *et al.*, 2013).

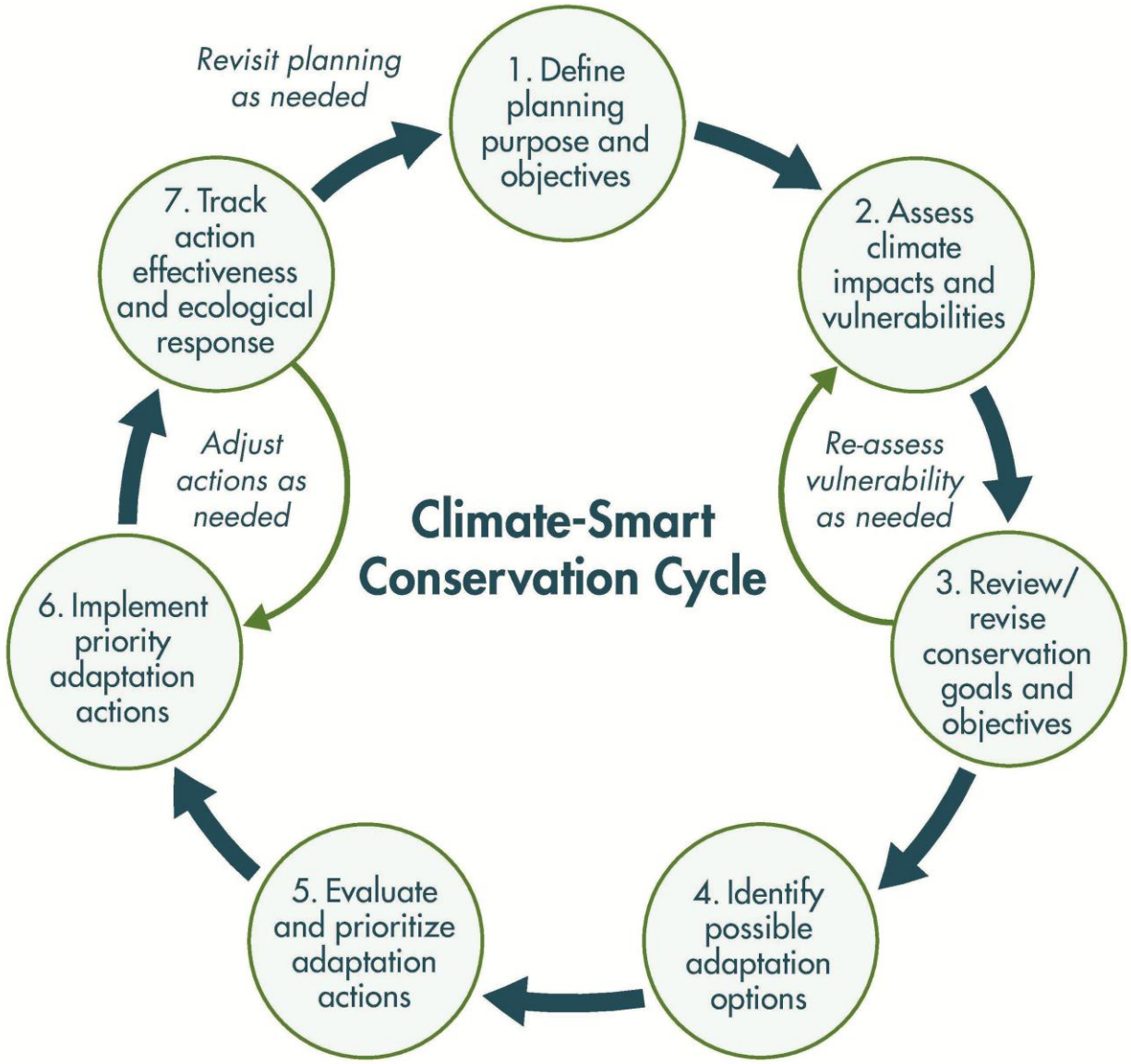

Figure 2: The climate-smart conservation cycle:

The climate-smart conservation cycle as presented by the National Wildlife Federation in their brief guidance document (National Wildlife Federation, 2013).

Another area in which progress has been made since the Group last considered its recommendations is in the provision of guidance as to how to perform assessments of species vulnerability to climatic change, one of the areas upon which the IUCN Climate Change Specialist Group has, for example, focused (see Pacifici *et al.*, 2015). That Group has also discussed the extent to which the IUCN Red-listing Criteria and processes are able adequately to capture threats to species arising from climatic change. In this context there have been several published studies examining the extent to which the

IUCN Red-listing Criteria are able to identify species at risk of extinction as a consequence of climatic change, and, in particular, whether and in what circumstances they can provide sufficient warning for effective measures to be put in place to prevent extinctions (Akcakaya *et al.*, 2014; Keith *et al.*, 2014; Stanton *et al.*, 2015). Amongst the important conclusions to-date from this research, the following are pertinent to note: identifying species at risk with a sufficient lead time to take adequate action requires more frequent assessments than typically are being made; species at risk are more likely to be identified early if all criteria are used; and implementation of conservation actions as soon as a species is listed as Vulnerable is often necessary to avoid extinctions, 50% of which in one study occurred within 20 years of the species being raised to Critically Endangered (*Slide 27*).

Notwithstanding all of the foregoing, however, the key thing that needs to be done is urgently to implement the various recommendations for practical action that have been made. As I emphasised in 2012 (Huntley, 2012), and as others have recognised, many of these actions do not require any new policies or legislation, they simply require a recognition by government agencies, NGOs and especially the conservation practitioners responsible for on the ground management, of the need to consider climatic change when designing strategies and management plans, and of the urgency of this need and of the need to implement such 'climate-smart' actions.

WHAT IS BEING DONE

The foregoing might be taken to imply that nothing is yet being done, and clearly that is very far from the truth. As I identified in 2012, some of the Parties had already taken action with respect to more than half, or even most of the ten summary recommendations and some failed to report relevant actions that had been taken; on the other hand, almost half of the Parties who reported their progress in 2011 or 2012 had taken action with respect to three or fewer of the ten. The progress reports submitted by 17 Parties in June 2014 suggest that this pattern has not fundamentally changed over the intervening two years.

On the positive side, most Parties recognise the need to take actions and to put in place legislative or other frameworks to facilitate or enable such actions, and many report progress towards the emplacement of such legislation or other tools. There also continue to be excellent examples of good practice, as exemplified by those highlighted in 2012 (Huntley, 2012).

Where there is much less progress, however, is in the implementation of practical actions, the urgency of many of which becomes greater with every passing year. Once again, there are shining examples of good practice, with some Parties having made great strides with respect to at least some of the key actions that are needed (e.g. the development of connected and functional ecological networks that will facilitate the responses of species to climatic change, increases in the extent of protected areas, implementation of monitoring both of the impacts of climatic change and of the effectiveness of conservation measures, assessments of the vulnerability of species to climatic change). On the other hand, there are few examples of the implementation of several of the key actions needed (e.g. increasing the permeability of the intensively-managed landscapes that dominate many parts of Europe, taking steps to minimise other pressures on and threats to species identified as most vulnerable to climatic change, taking steps to increase the populations of vulnerable species).

Nonetheless, the conclusion remains, as I wrote three years ago, that "*there is a very real danger that too little will be done too late*" (Huntley, 2012). That is not to say that strenuous efforts are not being made by many in the field of biodiversity conservation who recognise and are highly committed to the need for urgent action, but simply that more still needs to be done, and done very soon, if the present critical situation is adequately to be addressed. This requires actions by more than the committed few; all governments need to take the steps needed to honour the international commitments into which they have entered – all of the Council of Europe (CoE) countries, for example, as well as most of those listed as observers, are parties to the UN Convention on Biodiversity (CBD), although six of the CoE countries are not yet listed as signatories to the CBD (https://www.cbd.int/information/parties.shtml#tab=0 , accessed 16th April, 2015).

PRIORITIES FOR THE FUTURE

What then are the priorities for the future? Perhaps obviously, the top priority is to take steps to achieve the wider and more complete implementation of the Group's past recommendations, especially those in Recommendation No. 159, and in particular those practical actions that will facilitate the ability of species to respond to climatic change. Especially important are those actions that are necessary to enable species to achieve the range shifts that are expected to be of fundamental importance and that are well-documented already to be taking place, albeit not at a sufficient rate to match the rate of climatic change (e.g. Devictor *et al.*, 2008) and often severely hindered by habitat loss and/or by the impermeability of the wider landscape (e.g. Warren *et al.*, 2001). To this end, the Group might wish to consider the development of clear 'recipes' and/or 'decision support tools' (*Slide 28*), or the adoption of published examples of these, with the aim of assisting those seeking to implement its numerous recommendations by providing simple guides as to the steps required for such implementations. It is likely that at least some Parties will already have developed for themselves such recipes and tools and thus the sharing of best practice in this respect is strongly recommended.

Alongside such actions that are designed to benefit all species, a second parallel priority is to complete assessments of the vulnerability of species to climatic change (*Slide 29*). Whilst the Bern Convention species are an obvious group with which to start, and the exposure of seasonally migrant species to the consequences of climatic changes in their breeding, non-breeding and stopover/staging areas is likely to increase their vulnerability, making them also an obvious priority group, it is unsafe to assume that even species that are at present widespread and/or relatively abundant are not threatened by climatic change. Thus, as assessments of the vulnerability of the priority groups of species, including rare and range-restricted species, notably endemics and biome-restricted species, those already identified as threatened as a consequence of other pressures, and migrants, are completed, the focus should expand to include less rare and more widespread species. Such assessments, furthermore, should be made co-operatively by the Parties, taking into account the overall range and population of each species, thus ensuring that an holistic rather than a parochial view is taken when assessing priorities. As was pointed out long ago, Boreal species that reach their southern limit within a country such as the United Kingdom may be assessed as highly vulnerable to climatic change in that country, whereas across Europe as a whole they are not amongst the most vulnerable species (Huntley, 1995). Expending valuable conservation resources on such species in the United Kingdom is thus inappropriate; such resources would better be spent upon efforts to improve the status of species that have, or may in future have, a larger proportion of their European range and population in the United Kingdom. Thus, without such, at least Europe-wide, vulnerability assessments, it will not be possible to target to best effect the inevitably limited resources available for biodiversity conservation.

A third priority (*Slide 30*) is to take steps to ensure that adaptive management practices are adopted and implemented for all protected areas, and that the management plans for such areas take into account and respond to the expected consequences of climatic change and the need to facilitate the responses of species. Once again, this is an area where good practice already is established in the case of some Parties and the sharing of best practice is strongly urged.

The fourth priority I would suggest is the need to promote the research necessary to underpin the development of more permeable landscapes. The need to render the wider landscapes of Europe more permeable, thus facilitating species' range shifts, has long been recognised, and various suggestions have been put forward as to how this might be achieved. Unfortunately there is as yet no clear consensus as to the size and separation of habitat patches that will be most effective. Furthermore, it is likely that this will differ according to the size and dispersal characteristics of species. A useful starting point would be for the Group to undertake a review of the published research on this topic (*Slide 31*), linked to evidence of the extent to which the impermeability of the wider landscape is limiting species' responses.

A fifth priority is the development of common approaches to monitoring, both of species and of the effectiveness of conservation measures undertaken. In some areas such common approaches to

monitoring species are already well-established and provide extremely valuable data (e.g. Pan-European Common Bird monitoring Scheme, http://www.ebcc.info/pecbm.html ; Butterfly monitoring, organised by Butterfly Conservation Europe, http://www.bc-europe.eu/index.php?id=339), but these remain exceptions. This Group could seek to encourage both the wider uptake of such established schemes amongst the Parties and the development of parallel schemes for other taxonomic groups (*Slide 32*). The Group could also seek to ensure the adoption of well-established and common approaches to the monitoring of target species to assess the effectiveness of conservation measures.

Finally, given the international context, a sixth priority might be an assessment by the Group of the importance of biodiversity in Europe in relation to the capacity of European ecosystems to adapt to climatic change (*Slide 33*), thus ensuring their continuing capacity to deliver the necessary level of ecosystem services upon which human society in Europe depends. Linked to this should be an assessment of the value of 'green infrastructure' solutions when addressing both adaptation to climatic change and measures designed to mitigate climatic change. The results of the assessment must be communicated to the Parties who should be encouraged to take them into account when formulating policy and planning adaptation and mitigation measures.

In conclusion then, to summarise, I suggest that the Group consider six priority areas for its activities in the near future:

- Develop or adopt clear 'recipes' and/or 'decision support tools' that will provide simple guidelines to be followed by those in the Parties seeking to implement the Group's recommendations; where Parties have already developed such tools, share best practice.
- Complete assessments of the vulnerability of species to climatic change, focusing initially upon rare and range-restricted species, notably endemics and biome-restricted species, those already identified as threatened as a consequence of other pressures, and migrants; take an holistic, range-wide view of species when assessing their vulnerability, rather than a parochial national view of the species as it occurs within the territory of an individual Party.
- Ensure that adaptive management is implemented for all protected areas, and that management plans take into account climatic change and the need to facilitate species' responses; where good practice has already been implemented by some Parties, share best practice.
- Undertake a review of published research on how to render the wider landscape more permeable, and of evidence of the extent to which impermeability of the wider landscape is limiting species' responses to climatic change. develop appropriate recommendations for action based on the outcome of the review.
- Take steps to encourage the wider uptake by the Parties of established monitoring schemes, the development of such schemes for a wider range of taxonomic groups, and the adoption by the Parties of well-established and common approaches to the monitoring of target species to assess the effectiveness of conservation measures.
- Assess the importance of biodiversity for the capacity of European ecosystems to adapt to climatic change and to continue to deliver the ecosystem services upon which human society depends. Assess also the value of 'green infrastructure' solutions when addressing both adaptation to climatic change and measures designed to mitigate climatic change. Ensure that the Parties are aware of the results of this assessment and encourage them to act accordingly when formulating policy.

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