



Convention on the Conservation
of European Wildlife and Natural Habitats

Standing Committee

Recommendation No. 135 (2008) of the Standing Committee, adopted on 27 November 2008, on addressing the impacts of climate change on biodiversity

The Standing Committee of the Convention on the Conservation of European Wildlife and Natural Habitats, acting under the terms of Article 14 of the Convention;
Having regard to the aims of the Convention to conserve wild flora and fauna and its natural habitats;

Recalling that Article 2 of the Convention requires Parties to take requisite measures to maintain the populations of wild flora and fauna at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic requirements;

Recalling that Article 4 of the Convention requires Parties to take appropriate measures to ensure the conservation of the habitats of wild flora and fauna species as well as of endangered natural habitats; and give particular attention to the protection of areas of importance for migratory species;

Recalling the 2003 Kyiv Resolution on Biodiversity, which includes the commitment to ‘*halt the loss of biological diversity at all levels by 2010*’, as adopted by Environment Ministers and Heads of delegation from 51 countries in the Pan-European region;

Recalling the 2004 Strasbourg Declaration on the role of the Bern Convention in the preservation of biological diversity;

Recalling the 2005 Millennium Ecosystem Assessment and its finding that “unprecedented increased efforts” are needed to achieve the 2010 biodiversity target at national, regional and global levels;

Recalling further the Belgrade Declaration from the 6th Ministerial Conference “An Environment for Europe” (10-12 October 2007), stating that the loss of biodiversity remains an environmental challenge which all governments of the UNECE region are committed to continue addressing as biodiversity decline and the loss of ecosystem services continue;

Having regard to the 4th Assessment of the Intergovernmental Panel on Climate Change (IPCC), its Synthesis Report and Summary for Policymakers, approved in November 2007;

Recognising that wild flora and fauna constitute a natural heritage of aesthetic, scientific, cultural, recreational, economic and intrinsic value that needs to be preserved and handed on to future generations;

Recognising also that climate change affects biological diversity in the territory covered by the Convention, including species, habitats and the Areas of Special Conservation Interest of the Emerald Network;

Recognising further that conserving and halting the loss of biodiversity is essential for any strategy to adapt to and mitigate climate change;

Recalling the European Strategy on Invasive Alien Species, as climate change affects the abundance and spread of invasive alien species and the vulnerability of ecosystems to invasions;

Recalling the European Strategy for the Conservation of Invertebrates and the need to apply it in a changing climate, which requires increased flexibility and effort to monitor invertebrate populations and communities;

Having regard to relevant Council of Europe's legal and policy frameworks such as the Bern Convention, the Pan-European Biological and Landscape Diversity Strategy (including its key component: the Pan-European Ecological Network), the European Landscape Convention, the European Conference of Ministers responsible for regional planning (CEMAT), and the EUR-OPA Major Hazards Agreement;

Having regard also to relevant Recommendations and Resolutions from the Council of Europe's Parliamentary Assembly and Congress of Local and Regional Authorities (such as Assembly Recommendation 1823 (2008) on 'Global warming and ecological disasters', Resolution 1406 (2004) on 'Global warming: beyond Kyoto'; and Congress Recommendations 231(2008) on 'Climate change: Building adaptive capacity of local and regional authorities', and 232 (2008) on 'Biodiversity policies for urban areas');

Recalling CBD COP Decision VIII/30 which encourages the development of rapid assessment tools for the design and implementation of biodiversity conservation and sustainable use activities which contribute to adaptation to climate change, particularly in vulnerable countries and regions;

Recalling also CBD COP Decision IX/16, which urges Parties to enhance the integration of climate change considerations related to biodiversity in their implementation of the Convention, including identifying vulnerable regions, subregions and ecosystem types; assessing the threats and likely impacts of climate change; and taking appropriate actions to address and monitor the impacts of climate change, and the impacts and opportunities from climate change mitigation and adaptation activities as they relate to biodiversity;

Recalling further CBD COP Decision IX/18 on the role that protected areas and their connectivity play in addressing climate change, and Decision IX/4 which recognises the links between climate change and the impacts of invasive alien species;

Having regard to the EC communication on "*Halting the loss of biodiversity by 2010 – and beyond. Sustaining ecosystem services for human well-being*", noting particularly its associated targets and actions related to supporting biodiversity adaptation to climate change; and the 2007 Commission Green Paper on "*Adapting to climate change in Europe – options for EU action*";

Recalling the "Message from Reunion Island" issued at the conference "The European Union and its Overseas Entities: Strategies to Counter Climate Change and Biodiversity Loss", July 2008) and the exceptional importance of the biodiversity of the EU's Overseas Countries and Territories and Outermost Regions in comparison with continental Europe, and their vulnerability to climate change;

Recognising the need to adapt conservation work to the challenges of climate change so as to minimise its impact on the species and natural habitats protected under the Convention;

Bearing in mind that uncertainties surrounding the precise nature of future climate change and its impacts on biodiversity should not delay practical conservation action;

Recognising the need to take account of the five-year Nairobi work programme (2005-2010) on impacts, vulnerability and adaptation to climate change, adopted by Parties to the UN Framework Convention on Climate Change (UNFCCC);

Recognising the need to co-operate with the Convention on Biological Diversity, the Convention on Migratory Species and its related agreements (CMS Resolution 8.13 and AEWA Resolutions 3.17 and 4.15), the Ramsar Convention on Wetlands (Resolution VIII.3 on climate change and wetlands), and the need to co-ordinate efforts regarding CBD COP Decisions VIII/30 and IX/16 on biodiversity and climate change;

Recognising the need to address the impacts of climate change on migratory birds and other migratory species and, in this respect, recalling CMS Resolution 8.13 on climate change and migratory species, which calls upon Parties to implement adaptation measures to reduce the foreseeable adverse effects of climate change on migratory species and encourages the initiation of international research projects on migratory species and their habitats in order to better understand these effects;

Recognising the particular challenge to address the impacts of climate change in the marine and coastal environment and recalling the need to co-operate with the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, as well as with other regional seas conventions in Europe (OSPAR, Baltic, Black Sea);

Recalling Recommendation No. 122 (2006) of the Standing Committee on the conservation of biological diversity in the context of climate change, adopted on 30 November 2006;

Welcoming and bearing in mind the following expert reports “*Conserving European Biodiversity in the Context of Climate Change*” by M.Usher [document CO-DBP (2005) 3 rev]; “*Climatic change and the conservation of European biodiversity: Towards the development of adaptation strategies*” by B. Huntley [document T-PVS/Inf (2007) 3]; “*Climate change and the vulnerability of Bern Convention species and habitats*”, by P.Berry [document T-PVS/Inf (2008) 6 rev]; “*Climatic change and the conservation of migratory birds in Europe: Identifying effects and conservation priorities*” by M.Ferrer, I.Newton and K.Bildstein [document T-PVS/Inf (2008) 1 rev]; “*A perspective on climate change and invasive alien species*” by L.Capdevila-Argüelles and B.Zilletti [document T-PVS/Inf (2008) 5 rev]; “*Climate Change Impacts on European Amphibians and Reptiles*” by K. Henle *et al.* [document T-PVS/Inf (2008) 11 rev]; and “*Review of existing international and national guidance on adaptation to climate change with a focus on biodiversity issues*” by M. Harley and N. Hodgson [document T-PVS/Inf (2008) 12 rev];

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

1. Address and communicate, as a matter of urgency, the impacts of climate change on biological diversity and its conservation;
 2. Raise awareness of the link between biodiversity and climate and emphasise the large potential for synergies when addressing biodiversity loss and climate change in an integrated manner, including socio-economic effects;
 3. Encourage the elaboration of climate change adaptation activities for biodiversity, taking account of the suggested measures listed in the guidance set out in the Appendix to the present Recommendation; and
 4. Continue to engage in the development of further guidance to implement the Convention.
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APPENDIX

Guidance

This guidance draws on the expert reports commissioned by the Council of Europe and discussed by the Group of Experts on Biodiversity and Climate Change at its meetings in 2007-2008. The conclusions and recommended actions provided stem from six separate expert reports and discussions by the Group of Experts, which should be completed and updated in the future, and including potential revision of the current recommendations as well as additional recommendations for other groups of species.

Measures that may be considered as appropriate for addressing the impacts of climate change on biodiversity, for the purposes of the application of the Convention, are listed for consideration by Contracting Parties. These measures are offered as examples of action that may be taken by authorities at all levels of governance to address this issue. Other complementary measures may be identified by governments as equally appropriate to their particular circumstances and concerns.

The effects of climate change on ecosystems are complex. The impacts of a changing climate on the species and habitats protected by the Bern Convention may differ widely, depending on the species and the interactions with other species and/or their habitats, as well as according to location. The effects that climate change adaptation measures in other sectors can have on species and habitats should also be considered in order to avoid further unforeseen impacts.

I. Vulnerability to climate change

Vulnerability, as defined by the Intergovernmental Panel on Climate Change (IPCC), incorporates the concepts of exposure, sensitivity and adaptation, and it is usually a combination of these that lead to vulnerability. Species are already vulnerable to decreases in their abundance and range but on a short-time scale (1-10 years), climate change will increasingly contribute to longer-term stresses and exacerbate the current drivers of biodiversity loss. Climate change is not an isolated factor, and an integrated approach is needed in order to understand how interacting factors contribute to vulnerability.

There is abundant evidence from observations and monitoring that climate change is already impacting species and habitats, and, for some, this is leading to increased vulnerability. There is little direct information on the attribution of sources of this vulnerability but the majority of the observed responses are consistent with those expected from climate change.

Most of the very limited evidence for the potential impacts of climate change on Bern Convention species and habitats is inferential and based on monitoring and observations of responses to current climate change, expert knowledge and modelled projections. A picture of species' vulnerability can begin to be drawn, but this information base needs to be further developed, as the nature of the threatened status of many species suggests that climate change will only compound the situation.

This section includes proposed actions and measures based on the work done so far under the Bern Convention (see reports "*Climate change and the vulnerability of Bern Convention species and habitats*", by P. Berry; "*Climatic change and the conservation of migratory birds in Europe: Identifying effects and conservation priorities*" by M. Ferrer, I. Newton and K. Bildstein, and "*Climate Change Impacts on European Amphibians and Reptiles*" by K. Henle *et al.*).

Proposed actions¹:

1. There is a need for action in all sensitive areas in Europe, including South Eastern Europe, the Mediterranean and central European regions, but there is urgency to address the impacts of climate change on the species and habitats of those areas consistently projected as being most vulnerable in Europe: the Arctic (including parts of Scandinavia and Greenland); mountain regions; coastal zones (including the Baltic and parts of the Mediterranean); and island habitats and wetlands in areas increasingly threatened by drought. The terrestrial ecosystems considered especially affected by climate change (and found in Europe) are: tundra, boreal forest, mountain and Mediterranean-type ecosystems, salt marshes and sea-ice biomes, and the Arctic region.
2. Given the threatened status of many species included in the Bern Convention, and their level of endemism and rarity, take measures to build up population numbers.
3. Further develop and improve the information base on the vulnerability of Bern Convention species and habitats based on all the components of vulnerability (i.e. exposure, sensitivity and adaptive capacity).
4. As mitigation and adaptation are both aimed at reducing vulnerability to climate change, consider adaptation strategies to reduce species loss, and assess mitigation activities and measures in terms of their potential to contribute to or reduce vulnerability of species and habitats.
5. Take care that adaptation and mitigation measures conform with biological diversity conservation principles. Bear in mind that adaptation strategies may favour certain species or groups of species over others. Take an integrated, cross-sectoral approach to assess responses to climate change, as mitigation and adaptation activities in other sectors can have either positive or negative effects on biodiversity.
6. Focus attention on the potentially more vulnerable Bern Convention species regarding climate change (preliminary analysis based on available information from modelling)*. These lists are not comprehensive, but focus on some species already identified as potentially threatened by climate change in the report by P. Berry “*Climate change and the vulnerability of Bern Convention species and habitats*”:
 - Mammals: *Lynx pardina*, (Iberian lynx); *Microtus tatricus* (Tatra vole) and *Myomimus roachi* (Mouse-tailed dormouse); *M. roachii*; *Myotis dasycneme* (Pond bat); *Monachus monachus* (Mediterranean monk seal); Saimaa ringed seal (*Phoca hispida saimensis*).
 - Birds: The greatest reduction in bird species richness is projected to occur in southern and central Europe. Most affected species: *Anthus berthelotii* (Berthelot's pipit); *Chersophilus duponti* (Dupont's lark) and *Bucanetes githagineus* (Trumpeter Finch) ; *Apus caffer* (white-rumped swift), *Phoenicopterus ruber* (greater flamingo) and *Calidris alba* (sanderling); *Acrocephalus paludicola* (aquatic warbler), pintail (*Anas acuta*) and meadow pipit (*Anthus pratensis*). Northern species are generally vulnerable and birds such as marsh warbler (*Acrocephalus palustris*) could be vulnerable in the southern and western parts of their range.
 - Reptiles: *Lepidochelys kempii* (Kemp's Ridley Sea turtle), *Dermochelys coriacea* (Leatherback turtle) and *Eretmochelys imbricata* (Hawksbill turtle); *Gallotia simonyi* (Hierro)

¹ These recommended actions are drawn from the report by P. Berry “Climate change and the vulnerability of Bern Convention species and habitats”, document T-PVS/Inf (2008) 6 rev.

* Even though climate change has not been used as a criterion for the listing of species, if other threats are present then it is possible that the species will be vulnerable to climate change too, especially if it is in a vulnerable region or if there is other supporting evidence in the form of modelling results and/or additional components of vulnerability present.

lizard, Canary Islands endemic). For *Vipera ursinii* (Meadow viper), if it is able to disperse it could expand its range, but otherwise it could contract.

- **Amphibians:** Particularly vulnerable in the Iberian peninsula. Of the species modelled, both *Alytes obstetricans* (Midwife toad) and *Bufo calamita* (Natterjack toad) are vulnerable to climate change.
 - **Insects:** It is thought that Southern European species may remain less affected as they are better adapted to very high temperatures as well as rapid changes in temperature.
 - **Fish:** One of the most vulnerable species is the *Romanichthys valsanicola*; the European sturgeon (*Acipenser sturio*) has also been identified.
 - **Vascular plants:** No evidence of responses to current changes or sources of vulnerability have been found for Bern Convention vascular plants, but species such as *Pulsatilla patens* (Pasqueflower), *Apium repens* (Creeping marshwort) and *Cypripedium calceolus* (Lady's slipper) could be vulnerable in southern parts of their range in Europe. Particularly vulnerable species will be those with long life cycles and/or slow dispersal, as well as some isolated species (Arctic, alpine, island, coastal..).
7. Identify and address with urgency other non-climate threats to vulnerable species to enhance their adaptive capacity.

Migratory birds

Migratory birds can be influenced by a changing climate in three different geographic locations: their breeding grounds, their wintering areas, and their migration routes. We can expect that migrants will suffer greater storm-induced losses, which could cause noticeable reductions in populations regardless of other climate changes.

The breeding ranges of some European birds are already shifting north, as individuals withdraw from southern portions of their ranges, while others spread north at the northern limits of their ranges. A particular concern involving range shifts is the loss of mountain-top and high latitude breeders, which may disappear from much of their range, as global warming reduces the extent of specific high-mountain and high latitude habitats.

Proposed actions²:

8. Establish a functional network of watch sites or “watchtowers” to monitor changes in bird behaviour and assess bird-population trends in Europe.
9. Establish a set of focal species whose populations and behaviour should be monitored because of their relationships with more-difficult-to-follow but critical biological variables. In particular, seabirds, wetland birds, diurnal birds of prey or raptors, other soaring birds, and several widespread and long-term studied songbirds should be monitored.
10. Undertake studies in southern Europe, where many migratory birds over-winter, and where many others pass through while migrating between European breeding grounds and African wintering areas.

Amphibians and reptiles

There is mounting empirical evidence that climate change is already having various impacts on different aspects of the ecology of organisms, including amphibians and reptiles. Long-term

² These recommended actions are drawn from the report by M. Ferrer, I. Newton and K. Bildstein “Climatic change and the conservation of migratory birds in Europe: Identifying effects and conservation priorities”, document T-PVS/Inf (2008) 1 rev.

studies on European amphibians and reptiles show already a tendency to earlier breeding in many species. Also, the decline of some species have been linked to changed climatic conditions.

Amphibians and reptiles critically depend on temperature and water. While reptiles have developed adaptations to cope with water scarcity, all European amphibians require moist habitats and, with few exceptions, open water for reproduction. Species will become threatened by climate change particularly in regions where water and humid habitats are already scarce and expected to become even drier. As wetland habitats disappear, aquatic and semi-aquatic species will suffer declines.

The main response of species to climate change is either a range shift or in-situ adaptation by evolutionary change. Apart from marine turtles, reptiles and amphibians have a too low dispersal capacity to follow the expected rapid changes, especially in the highly fragmented European landscapes. In-situ adaptation requires large populations – beyond the size of most amphibian and reptile populations in modern landscapes. Climate envelope modelling and the assessment of the climate sensitivity of amphibians and reptiles clearly show that climate change impacts will considerably differ among species and regions. Overall, amphibians are expected to suffer more than reptiles based on their adaptation to harsh environments.

Proposed actions³:

11. Take early action on the following species, expected to be most affected, including through species-specific climate change mitigation plans:

- Amphibians from dry Mediterranean regions (especially in Spain, Western France, and Italy), and amphibians requiring cool environments;
- For reptiles, projected losses are also highest in areas with high temperatures and major reductions in precipitation (Spain, Italy, the Balkans, and Greece);
- Island endemics, such as *Alytes muletensis* (Balearic Mid-wife Toad), the lizards *Algyroides fitzingeri* (Pygmy Algyroides), *Lacerta bedriagae* (Bedriaga's Rock Lizard), *Podarcis tiliguerta* (Tyrrhenian Wall Lizard), and *Gallotia simonyi* (El Hierro Giant Lizard), and the snake *Macrovipera schweizeri* (Cyclade Blunt-nosed Viper) are predicted to become the most affected species, together with *Phyllodactylus europaeus* (European Leaf-toed gecko);
- In Central and Northern Europe, early breeding amphibian, i.e., primarily brown frogs (*Rana arvalis*, *Rana dalmatina*, *Rana temporaria*) and the common toad (*Bufo bufo*) may be placed at increasing risk due to late frosts, less snow cover, and warmer winter temperatures.

12. Highly sensitive species should be monitored as indicators of climate change.

13. Facilitate in-situ adaptation and natural range shifts by redoubling efforts to maintain or restore large intact habitats and large-scale connectivity.

14. Countries with breeding populations of sea turtles and endemic island taxa potentially threatened by sea level rise should gather data and undertake studies to improve knowledge on climate change impacts on endemic island species.

15. Mediterranean countries should assess the reduction of permanent wetlands and rivers by the combined effects of land use and climate change to better understand impacts on amphibian species.

16. Further research should be undertaken on the potential impacts of climate change on amphibian and reptile species.

³ These recommended actions are drawn from the report by K. Henle et al “Climate Change Impacts on European Amphibians and Reptiles”, document T-PVS/Inf (2008) 11 rev.

II. Adaptation strategies

Climate change is an important determinant of the distribution and functioning of natural systems, with species, habitats and ecosystems having been modified repeatedly throughout geological time. Today, changes in land use and management are resulting in the degradation of semi-natural habitats, declines in traditional agricultural and forest management on which many species depend, and now large-scale land abandonment. It is likely that these changes will be further exacerbated by climate change. Projections suggest that between one fifth and one third of European species will be at increased risk of extinction if global mean temperatures rise more than 2 to 3 °C above pre-industrial levels. A combination of climate change and other drivers of change will reduce the adaptive capacity (and resilience) of many species and habitats, and will have potentially serious consequences for the delivery of ecosystem services that are the cornerstone of human existence and well-being. Robust mitigation and adaptation policies are clearly needed in order to address the impacts of climate change on biodiversity.

The following seven overarching adaptation principles for biodiversity and its conservation derived from pre-existing guidance, are linked with more detailed measures, and should be considered when developing adaptation strategies and actions to conserve species, habitats and ecosystems, and the services that they provide. The concepts underpinning these principles are also equally relevant to other sectors and could be further developed within and across sectors as a standard for universal application, and they should be considered when devising adaptation activities at all levels⁴:

1. Take action now: As uncertainties surrounding the precise nature of future climate change and its impacts on biodiversity should not delay practical conservation action.

Proposed actions:

- a. Enhance existing biodiversity conservation activities in protected areas and intervening habitats.
 - b. Deliver on current biodiversity policy and legislative commitments and agreements.
 - c. Reduce other sources of stress and harm not directly linked to climate change.
 - d. Develop further biodiversity policy, legislation and agreements to ensure that conservation objectives reflect the challenges presented by climate change.
2. Maintain and increase ecosystem resilience: In order to improve the ability of ecosystems to mitigate the effects of climate change whilst maintaining and increasing biodiversity.

Proposed actions:

- a. Maintain and restore ecosystem structure and function and, where appropriate and cost effective, relocate and create new habitats.
 - b. Conserve the range and variability of species, habitats and ecosystems.
 - c. Establish buffer zones with ecologically sensitive management regimes around conservation areas.
 - d. Prevent the introduction and control the spread of invasive species.
 - e. Develop actions to increase resilience and communicate those actions.
3. Accommodate the impacts of climate change: As both gradual change and extreme weather events will be experienced.

⁴ These recommended actions are drawn from the report by M. Harley and N. Hodgson “Review of existing international and national guidance on adaptation to climate change with a focus on biodiversity issues”, document T-PVS/Inf (2008) 12 rev.

Proposed actions

- a. Increase understanding of the specific effects of climate change on biodiversity, develop adaptive strategies based on sound ecological research and undertake risk management planning to take account of unpredictable effects.
 - b. Work with ecological principles when accommodating to climate change impacts.
 - c. Establish networks of interconnected protected areas (terrestrial, freshwater and marine) and intervening habitat mosaics to increase permeability and aid gene flow.
 - d. Plan future conservation areas to ensure that vulnerable species groups and habitats types are protected.
 - e. Allow for the changing configuration of coasts and rivers by avoiding development in these areas.
 - f. Consider the role of species translocation and *ex-situ* conservation, especially for threatened species.
4. Facilitate knowledge transfer and action between partners, sectors, the general public, and authorities at all levels, including Conventions: As successful adaptation requires biodiversity conservation to be integrated with other land and water management activities.

Proposed actions:

- a. Strengthen existing relationships and build new partnerships, including across Conventions.
 - b. Ensure that policy and practice are integrated across sectors and borders.
 - c. Co-ordinate adaptation and mitigation measures to avoid mal-adaptation for the environment and biodiversity within and across sectors.
 - d. Increase awareness of the benefits that biodiversity provides to society and its role in adaptation strategies across all sectors.
 - e. Communicate best practice and exchange information on successful adaptation.
 - f. Communicate and engage the wider public to promote concerns on biodiversity and face the challenges of climate change.
5. Develop the knowledge/evidence base and plan strategically: It is essential that the best available evidence is used to develop techniques that allow biodiversity to adapt.

Proposed actions:

- a. Continually review the evidence base and identify knowledge gaps and research opportunities.
 - b. Develop research on biodiversity and climate change to enhance a comprehensive understanding of the impacts of climate change at the community/ecosystem level which will provide a better analysis of the consequences regarding species, and with a biogeographical vision, both at short and long time-scales.
 - c. Undertake vulnerability assessments of biodiversity and associated ecosystems.
 - d. Undertake scenario assessments and identify 'no regrets' actions.
 - e. Pilot new approaches through demonstration projects.
 - f. Develop 'win-win' adaptation measures and use them to build resilience and accommodate change.
6. Monitor and use indicators: As monitoring is a key contributor to the evidence base and, as such, existing schemes must be strengthened and new requirements incorporated

Proposed actions:

- a. Identify indicators to monitor the impacts of climate change on biodiversity and to assess vulnerability and adaptation.

- b. Continue to monitor the observed impacts of climate change on biodiversity and establish procedures to validate projections to direct or develop conservation objectives, including where appropriate through the development of community-based monitoring programmes.
 - c. Monitor the effectiveness of adaptation measures and adaptive conservation management in maintaining and increasing ecosystem resilience and accommodating change.
7. Use adaptive conservation management: As effective conservation in a changing climate will require a flexible approach based on learning from direct experiences.

Proposed actions:

- a. Undertake continual monitoring and re-assessment of adaptation actions as new information and research becomes available.
- b. Develop and communicate adaptive management actions to increase both ecosystem resilience and accommodation to the impacts of climate change.

III. Cross-cutting issues

Invasive species

Biological invasions are a problem likely to increase under climate change. The risk posed by invasive species under climate change conditions is, in general, underestimated because models and scenarios, mainly focused on native biodiversity, have poorly explored the issue. IAS and climate change are considered two of the five main threats to biodiversity, and therefore the two operating together could be expected to produce extreme outcomes. Current biotic changes caused by invasive species could further interact with climate change, increasing ecosystems' vulnerability and therefore the risk of new invasions.

While tools to fight invasive species already exist, countries' concern is still scarce and action is urgent. It is difficult to predict how climate change will affect invasive processes per se as well as in combination with other factors of global change (biotic changes, land use changes, etc.). Climate change could alter the structure and composition of native communities and, as a consequence, the way in which an ecosystem functions, increasing the risk of biological invasion: maintaining high biodiversity communities is expected to reduce susceptibility to invasives. Climate change is also likely to increase the potential distribution and abundance of invasive species, further enlarging areas at risk of invasion, and threatening the viability of current management strategies against invasive species.

Proposed actions⁵:

- 17. Improve information on the biology of invasive species and how their populations respond to climate change.
- 18. Condition any intentional introduction of alien species on exhaustive risk analysis processes which include considerations related to climate change. Also, risk analysis on pathway and vectors should take into account potential interactions with climate change to prevent unintentional introductions.
- 19. Consider the effects of altered climate and atmospheric chemistry when undertaking risk analysis for biotic invaders.
- 20. Step up research on biological invasions linked to climate changes, including on: (i) the influence of dispersal, propagule pressure and species interactions; (ii) the populations' ability to adapt, and the scales over which climate will change and living systems will respond; (iii) the

⁵ These recommended actions are drawn from the report by L. Capdevila-Argüelles and B. Zilletti "A perspective on climate change and invasive alien species", document T-PVS/Inf (2008) 5 rev.

synergistic effects between climate and other anthropogenic variables that are likely to exacerbate the abundance and impact of invasive species; and (iv) predictive models.

Protected areas and landscape scale conservation

Protected areas have long been one of the cornerstones of conservation policy, and they have a vital role in biodiversity adaptation strategies to climatic change. Protected areas are likely to become of even greater importance as they often harbour the best quality habitats for many species. It will therefore be necessary to take account of climate change in the planning and management of protected areas to achieve successful strategies for biodiversity conservation in the face of climatic change.

Networks of protected areas should be embedded within a high-quality landscape conservation approach to provide permeability and connectivity to assist species adjust their spatial distributions, through the provision of habitat ‘stepping stones’ and other tools. Protected areas alone will not be sufficient to ensure adequate protection of habitats and species. It will be critical to ensure the continued protection and appropriate management of existing protected areas which, to be effective, should need to be complemented by appropriate management and structure of the wider landscape, as otherwise many species will be unable to achieve the responses to climatic change that are essential to their long-term survival.

Proposed actions:

21. Consider the extent and location of protected areas to provide flexibility and potential for species to adjust their distributions within the landscape in response to climatic change. Consider buffer zones as a valuable tool for enhancing the effectiveness of protected areas.
22. Develop permeable landscapes that provide functional networks of habitat ‘stepping stones’ of various sizes and separations linking protected areas, to help species’ adaptation to climate change.
23. Take the necessary steps to retain as many as possible of the remaining fragments of unaltered or semi-natural habitat in the landscape in order that they may serve as ‘stepping stones’ and contribute to rendering the landscape permeable, and encourage the creation of habitat ‘stepping stones’ in landscapes where past land management practice has led to the absence of sufficient suitable patches of unaltered or semi-natural habitat that may be managed for this purpose.
