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**Review of existing international and national
guidance on adaptation to climate change:
with a focus on biodiversity issues**

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**REVIEW OF EXISTING INTERNATIONAL AND NATIONAL
GUIDANCE ON ADAPTATION TO CLIMATE CHANGE:
WITH A FOCUS ON BIODIVERSITY ISSUES**

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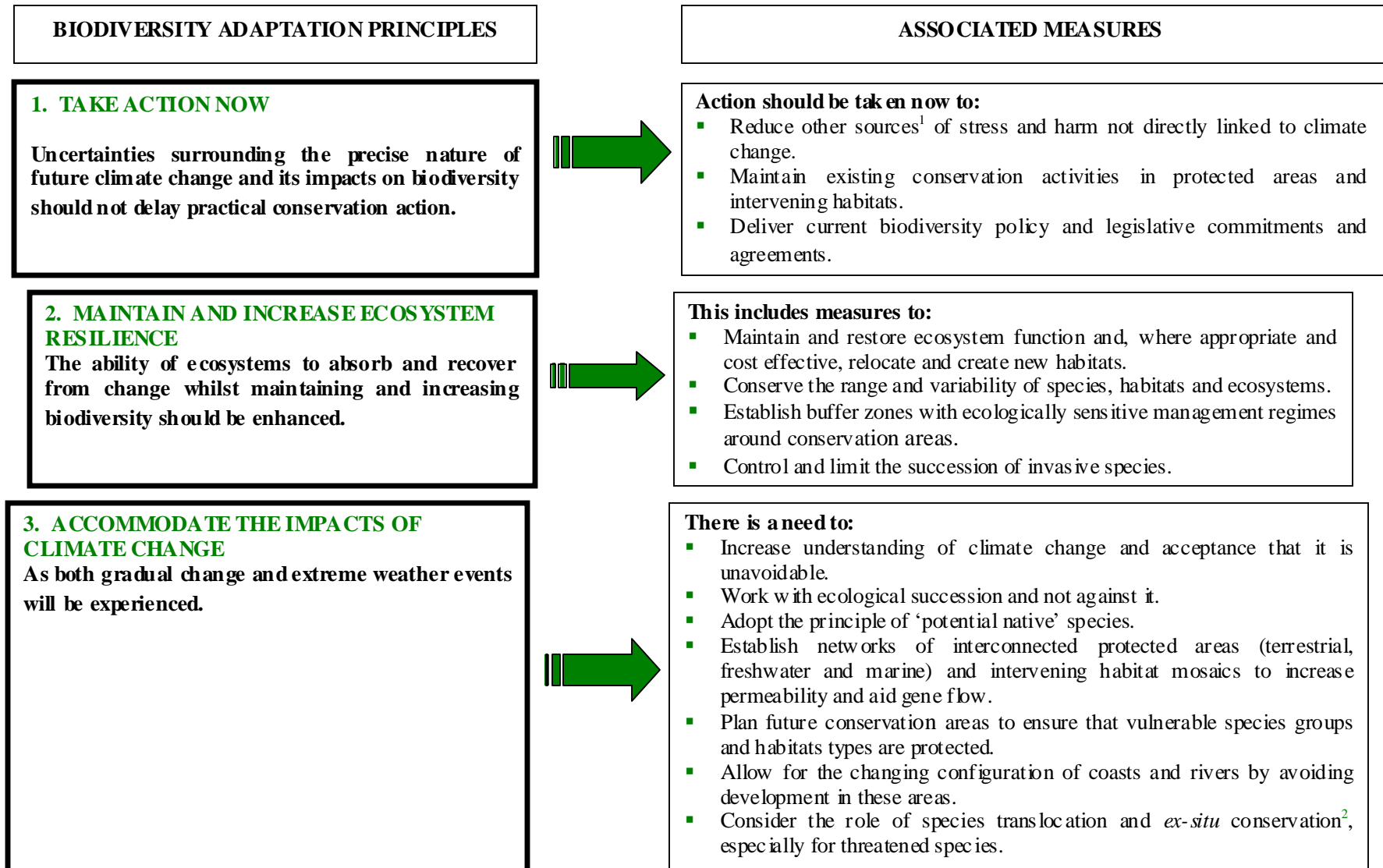
1. INTRODUCTION

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 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 purpose of this report is to provide an extensive and systematic review of published international, European and national (EU Member State) guidance on adaptation to climate change, with a focus on biodiversity and its conservation. The findings have been synthesised, key principles identified and the results presented to the Bern Convention's 'Group of Experts on Biodiversity and Climate Change' at their meeting in Strasbourg on 11 September 2008.

The key output of the review is a set of seven overarching adaptation principles for biodiversity and its conservation. These principles are 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.

2. KEY FINDINGS: ADAPTATION PRINCIPLES FOR BIODIVERSITY IN A CHANGING CLIMATE



4. FACILITATE KNOWLEDGE TRANSFER AND ACTION BETWEEN PARTNERS, SECTORS AND COUNTRIES

Successful adaptation requires that biodiversity conservation is integrated with other land and water management activities.



Action is required to:

- Strengthen existing relationships and build new partnerships.
- Ensure that policy and practice are integrated across sectors and borders³.
- Coordinate adaptation and mitigation measures to avoid mal-adaptation within and across sectors.
- Increase awareness of the benefits that biodiversity provides to society and its role in adaptation strategies across all sectors.
- Communicate best practice and exchange information on successful adaptation.

5. DEVELOP THE KNOWLEDGE/EVIDENCE BASE AND PLAN STRATEGICALLY

To effectively plan for an uncertain future, it is essential that the best available evidence is used to develop techniques that allow biodiversity to adapt.

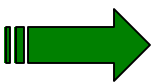


It is therefore necessary to:

- Continually review the evidence base and identify knowledge gaps and research opportunities.
- Undertake vulnerability assessments of biodiversity and associated ecosystems.
- Undertake scenario assessments and identify 'no regrets' actions.
- Pilot new approaches through demonstration projects.
- Develop 'win-win' adaptation measures and use them to build resilience and accommodate change.

6. USE ADAPTIVE CONSERVATION MANAGEMENT

Effective conservation in a changing climate will require a flexible approach.



This approach should comprise:

- Continual monitoring and re-assessment of adaptation actions as new information and research becomes available.
- Amendments to biodiversity policy, legislation and agreements to ensure that conservation objectives reflect the challenges presented by climate change.

7. MONITORING AND INDICATORS

Monitoring is a key contributor to the evidence base and, as such, existing schemes must be strengthened and new requirements incorporated.



Programmes should be set up to:

- Identify indicators to monitor the impacts of climate change on biodiversity and to assess vulnerability and adaptation.
- Continue to monitor the observed impacts of climate change on biodiversity and establish procedures to validate projections.
- Monitor the occurrence and dispersal of 'potential native' species.
- Monitor the effectiveness of adaptation measures and adaptive conservation management in maintaining and increasing ecosystem resilience and accommodating change.

¹ Examples include: pollution, fragmentation, over-harvesting, alien species, over use, tramping, international trade, urban expansion, land use change, resource over-exploitation, and inappropriate management.

² Collection of seedbanks, transportation of less mobile species.

³ Principally agriculture and forestry, but also planning, transport, energy, water and fisheries.

3. BIODIVERSITY AND CLIMATE CHANGE ADAPTATION LITERATURE REVIEW

3.1 International guidance

Secretariat of the Convention on Biological Diversity (2007). *Emerging issues for biodiversity conservation in a changing climate.*

<http://www.cbd.int/doc/publications/cbd-ts-29.pdf>

Biodiversity should be central to efforts to mitigate and adapt to climate change. The Convention on Biological Diversity is in a phase of enhanced implementation, and the Secretariat is assisting with regional and sub-regional efforts by Parties to achieve the objectives of the Convention to conserve, sustainably use, and equitably share the benefits arising from biological diversity. By striving to significantly reduce the rate of loss of biodiversity by the year 2010, we will at the same time be bolstering our own resistance to the negative effects of climate change.

This is a collection of presentations from the 12th Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice of the Convention on Biological Diversity 2–6 July 2007 in Paris, France. It considered both mitigation and adaptation and the role of biodiversity. It presents case studies on the impacts of climate change on biodiversity, the use of biodiversity in adaptation measures, avoided deforestation, land use change and forestry and the contribution of biodiversity to climate change mitigation.

Secretariat of the Convention on Biological Diversity (2006). *Guidance for promoting synergy among activities addressing biological diversity, desertification, land degradation and climate change.*

<https://www.cbd.int/doc/publications/cbd-ts-25.pdf>

The report highlights the major biological factors that contribute to ecosystem resilience under the projected impacts of global climate change, assesses the potential consequences for biodiversity of particular adaptation activities under the thematic areas of the Convention, provides methodological considerations when implementing these activities, and highlights research and knowledge gaps. The report both recognizes the potential of, and stresses the need for, synergy in the implementation of activities that interlink biodiversity conservation, mitigation of and adaptation to climate change, and land degradation and desertification in the context of the objectives of the three Rio Conventions and other relevant multilateral environmental agreements.

Section II of the report contains an assessment of the integration of biodiversity considerations in the design and implementation of adaptation activities. Section III describes some approaches, methods and tools for planning, designing and implementing adaptation activities that also include biodiversity considerations. Drawing upon the contents of the previous two sections, section IV includes key points for advice.

Secretariat of the Convention on Biological Diversity (2003). *Interlinkages between biological diversity and climate change. Advice on the integration of biodiversity considerations into the implementation of the United Nations Framework Convention on Climate Change and its Kyoto protocol.* <http://www.cbd.int/doc/publications/cbd-ts-10.pdf>

Adaptation is necessary not only for the projected changes in climate but also because climate change is already affecting many ecosystems.

Adaptation activities can have negative or positive impacts on biodiversity, but positive effects may generally be achieved through: maintaining and restoring native ecosystems; protecting and enhancing ecosystem services; actively preventing and controlling invasive alien species; managing habitats for rare, threatened, and endangered species; developing agroforestry systems at transition zones; paying attention to traditional knowledge; and monitoring results and changing management regimes accordingly. Adaptation activities can threaten biodiversity either directly—through the destruction of habitats, e.g., building sea walls, thus affecting coastal ecosystems, or indirectly—through the introduction of new species or changed management practices, e.g., mariculture or aquaculture.

Reduction of other pressures on biodiversity arising from habitat conversion, over-harvesting, pollution, and alien species invasions, constitute important climate change adaptation measures.

Since mitigation of climate change itself is a long-term endeavour, reduction of other pressures may be among the most practical options. For example, increasing the health of coral reefs, by reducing the pressures from coastal pollution and practices such as fishing with explosives and poisons, may allow them to be more resilient to increased water temperature and reduce bleaching. A major adaptation measure is to counter habitat fragmentation through the establishment of biological corridors between protected areas, particularly in forests. More generally, the establishment of a mosaic of interconnected terrestrial, freshwater and marine multiple-use reserve protected areas designed to take into account projected changes in climate, can be beneficial to biodiversity.

Conservation of biodiversity and maintenance of ecosystem structure and function are important climate change adaptation strategies because genetically-diverse populations and species-rich ecosystems have a greater potential to adapt to climate change.

While some natural pest-control, pollination, soil-stabilization, flood-control, water purification and seed-dispersal services can be replaced when damaged or destroyed by climate change, technical alternatives may be costly and therefore not feasible to apply in many situations. Therefore, conserving biodiversity (e.g., genetic diversity of food crops, trees, and livestock races) means that options are kept open to adapt human societies better to climate change. Conservation of ecotones is also an important adaptation measure. Ecotones serve as repositories of genetic diversity that may be drawn upon to rehabilitate adjacent ecoclimatic regions. As an insurance measure such approaches can be completed by ex situ conservation. This might include conventional collection and storage in gene banks as well as dynamic management of populations allowing continued adaptation through evolution to changing conditions. Promotion of on-farm conservation of crop diversity may serve a similar function.

A range of tools and processes are available to assess the economic, environmental and social implications of different climate-change-mitigation and adaptation activities.

Environmental impact assessments and strategic environmental assessments can be integrated into the design of climate change mitigation and adaptation projects and policies to assist planners, decision-makers and all stakeholders to identify and mitigate potentially harmful environmental and social impacts and enhance the likelihood of positive benefits such as carbon storage, biodiversity conservation and improved livelihoods.

IPCC (2007). *The Working Group II contribution to the IPCC Fourth Assessment Report.*

The IPCC state that: adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

And that adaptation practices refer to actual adjustments, or changes in decision environments, which might ultimately enhance resilience or reduce vulnerability to observed or expected changes in climate.

IUCN (2004). *Global action for nature in a changing climate.*

A three-stage strategic approach can guide actions to achieving ecosystem resilience to climate change:

1. Assess the vulnerability of species, habitats, and ecosystems to climate change.
2. Develop strategies for enhancing the resilience of existing habitats and ecosystems and the species they support, thereby improving their adaptive capacity.
3. Develop strategies to accommodate changes in species ranges, habitats and ecosystems demanded by climate change.

Governments and nature conservation organizations should:

- Catalyse new momentum in order to bring about a global climate change movement to make ecosystems more resilient and to accommodate change.
- Develop best practice by testing and reporting on new techniques.
- Build knowledge on the social and economic costs and benefits of relevant actions.
- Facilitate networks, exchange of information and sharing of experiences across conservation organizations, governments and other interested parties.
- Forge new partnerships both within and outside the nature conservation community to build institutional capacity and resources for improved conservation responses to climate change.

IUCN (2003). *Climate change and nature: adapting for the future.*

http://cmsdata.iucn.org/downloads/cc_nature_adapting_for_future.pdf

- Conservation strategies must deal more effectively with risks and uncertainties.
- We need to adopt an adaptive management style - adjusting our actions based on learning. This means going beyond a static management plan and moving towards a dynamic approach that tests assumptions, monitors results and adapts management actions accordingly.
- Adapting to climate change requires better use of knowledge and information.
- Adapting to climate change reinforces a focus on the delivery of ecosystem goods and services within and outside of conservation areas.
- We need to focus on managing at the level of landscapes and seascapes.
- Adapting to climate change will require building new partnerships and capacities.
- We need to communicate and raise public awareness in order for climate change adaptation to be successful.
- Adapting to climate change should start NOW, several direct actions:

Policy and planning:

1. Improve natural resource planning and management to focus on ecosystem functionality across the landscape and seascape.
2. Assess nature conservation legislation and regulation in light of the impacts of climate change.
3. Adopt policies that lessen pressures on resources, remove perverse incentives for agriculture, forests, water and fisheries, and incorporate climate change into poverty reduction strategies.
4. Develop policies for creating and restoring ecosystems.
5. Ensure compliance with existing regulations on the use of land, water and marine resources.

Capacity building and awareness:

6. Develop awareness campaigns to highlight the value that ecosystem services provide as buffers against climate variability and secure public acceptance for climate change adaptation.
7. Strengthen institutional and individual capacities within nature conservation organizations especially in developing countries for dealing with climate change.
8. Share information between governments and their agencies, NGOs, communities, and research institutions on potential and observed climate change impacts and extreme events.
9. Make resources available for investing in adaptive management especially in developing countries.
10. Develop disaster preparedness and recovery systems including forecasting, early warning and rapid response measures.

Management:

1. Include adaptation to climate change in the management objectives and strategies of conservation areas.
2. Create robustness and flexibility within conservation areas to allow for the management of ecosystems and their services in addition to species of conservation interest.
3. Enlarge conservation areas where appropriate.
4. Create and restore buffering zones and habitat mosaics around conservation areas.
5. Implement *ex-situ* conservation and translocation strategies if appropriate.

WWF (2003). *A user's manual for building resistance and resilience to climate change in natural systems*. http://assets.panda.org/downloads/buyingtime_unfe.pdf

What is resilience building in response to climate change?

Increasing the resilience of a natural system is a standard goal of conservation; intact ecosystems have more resources for withstanding stresses. Increasing the resiliency of ecosystems and plan our protected areas in response to the threat of climate change falls into three broad categories:

1. Protect adequate and appropriate space

Ecosystems with high biodiversity and those that maintain crucial structural components are thought to recover more easily from climatic disturbances. Traditional conservation methods such as creating protected areas, whether in terrestrial or marine areas, will thus have another justification in the next several decades. It will become increasingly important, however, to take into account projected impacts of climate change when designing new protected area systems, and to expand spatial scales through buffer zones and corridors to aid species migration. In particular, planners should look for climate refugia-areas that experience less change than others. Planning reserves will now require an eye for potentially dramatic future changes in protected areas; thinking about not only current but future configurations of habitats, communities, and ecosystems. Managers will need to be even more strategic, creative and flexible in designing protection strategies to address traditional land uses, existing threats, and also climate change stresses. Protecting not just space but functional groups, keystone species, climatic refugia, and multiple microhabitats within a biome to provide adequate representation is essential.

2. Limit all non-climate stresses

Climate change is not occurring in a vacuum. There are myriad stresses affecting natural systems, including habitat fragmentation, overharvest, invasive species, and pollution. A limited body of research on interactions between climate and non-climate stresses suggests synergistic responses. To support ecosystem resilience you must reduce the number of simultaneous insults faced by that ecosystem. Fortunately many stressors are more locally controllable than climate change. In a marine system this may mean establishing "no-take zones" to reduce fishing pressure and associated habitat destruction. In a freshwater system this may require limiting the concentration of toxic substances in effluent from an upstream industry. It may mean protecting alpine watersheds by limiting extraction of water by downslope agriculture and cities, or limiting harmful grazing practices in grasslands. Forests could require limiting fragmentation from road construction and logging. None of these tasks are easy, but they are approachable on a local level and they can increase the overall resilience of the system.

3. Use active adaptive management and strategy testing

Given uncertainty about the exact nature of ecosystem impacts of and responses to climate change, effective management will require a responsive and flexible approach. The success of various conservation approaches should be continually reassessed, and approaches adjusted as new information becomes available. In instances where impacts are relatively clear, active intervention to increase adaptive capacity coupled with monitoring is necessary. Such intervention may include assisted migration or reintroduction of species, non-chemical control of pest or disease outbreaks, prescribed burning or other fire management strategies to lessen the impact of increasingly severe and

frequent wildfires, controlling invasive species and decreasing nutrient-enhanced run-off into marine and freshwater ecosystems. Where extinction in the wild is inevitable, *ex situ* conservation of species via the collection of germplasm, seedbanks, gardens, aquaria or zoos can be used as an option of last resort. Regardless of the management strategy, on-going monitoring is essential to assure that actions are truly of the “do no harm” variety. Monitoring with adaptive management sets up an *in situ* experiment, providing data for modification of management strategies and allowing for exchange of results between protected areas for better strategy development world-wide.

Ramsar Convention on Wetlands (2002). COP8 DOC. 11: *Climate change and wetlands: impacts, adaptation and mitigation.*

http://www.ramsar.org/cop8/cop8_doc_11_e.htm

Adaptation options

Adaptation options and their implementation are thus strongly dependent on institutional capacity in the region or country. Specifically, institutional capacity includes both financial and human resources as well as the political will to address the adaptation options for climate change. Such political will can often be related to the national current and future socio-economic development and the current extent of the country's exposure to climate change. The potential for adaptation is more limited for developing countries, which are projected to be the most adversely affected.

Adaptation options should be considered within overall frameworks for sustainable development and should not conflict with the wise use of wetlands. However, given the inertia in some wetland species and functions, the development of adaptation options may not result in rapid responses. In addition, there is also likely to be institutional inertia. For example, implementation of management plans may be on a ten-year cycle, and that could affect the planning and implementation of adaptation options.

Monitoring of adaptation options should be considered to be an essential feature so that the overall adaptive framework, which should be responsive to the changes being observed either as a result of the adaptation measures or some other factors, can be modified as needed.

Potential adaptation options are also limited by the geomorphology of the system: the evolutionary time frame of the dynamics of the system can limit some options. For example, a coastal low-lying wetland system that is relatively young and has a dynamic substrate and channelling system has fewer adaptation options than an older and more stable system. In addition, adaptation options for wetlands subject to climate change and sea level rise have on the whole not been extensively addressed in the IPCC Third Assessment Report.

A major component of adaptation that needs further attention is assessment of the actual vulnerability of wetlands and wetland species and functions to climate change and sea level rise.

Where adaptation options have been addressed they have usually been linked to established socio-economic imperatives, such as the locations of settlements, infrastructure, and economically important production. In many cases the adaptation options include protection of the coast by physical structures, accommodation of change, retreating from vulnerable areas, or simply doing nothing. In some cases, however, it may become necessary to take active steps to protect wetlands. This could occur where large numbers of people rely directly on non-marine wetlands in the coastal zone or where the wetlands provide goods and services required by people in urban areas. Foremost amongst such services are fish products and fresh water. However, as these goods and services are often uncosted or not in the possession of powerful vested interests or otherwise influential groups, it is likely that little active intervention will occur.

In some instances, the wetland habitats could be relocated or become re-established, although it is likely that in many cases this option will be limited by major natural and infrastructural physical constraints.

The recent IPCC 2001 reports suggest a small number of generic potential adaptation options that can contribute to the conservation and sustainable use of wetlands:

- i) Design of multiple-use reserves and protected areas which incorporate corridors that would allow for migration of organisms as a response to climate change. The response of some wetland species (both animals and plants) to climate change could be a range expansion or poleward movement of the species. Some of these may be invasive species (both native and alien) and could impact on the system especially through changes in the hydrology. Adaptation options in this case would have to include truncation of potential corridors or control of invasive species to limit the expansion of more competitive native or alien species, especially into wetlands that may be small and have high endemism.
- ii) Expansion of aquaculture to relieve stress on natural fisheries, despite the fact that much past aquaculture has led to the loss of wetlands and wetland species. Such options should be implemented only if they could demonstrate a reduction in pressure on existing wetlands.
- iii) Poleward transportation of less mobile aquatic species across watershed boundaries to cooler waters.
- iv) Specific management in some ecosystems which could reduce pressures on wetlands. For example, in the wetlands in the Arctic, economic diversification could reduce the pressure on wildlife. Rotational and decreased use of marginal wetlands, especially in semi-arid areas, could reduce wetland and wetland biodiversity loss.
- v) Integration of land, water and marine area management with the aim of reducing non-climate stresses upon wetlands, for example through reduction of fragmentation of water systems, reduction of land-based pollution into marine systems such as coral reefs, or reduction of invasive species.
- vi) Use of water control structures for some wetlands, in order to enhance particular wetland functions and address water management issues, such as securing long-term water resources for wetland conservation. It is unlikely that such steps could be taken independently of other water management decisions, such as those that will affect irrigation and potable water supplies, and they should form part of integrated river basin and water resource management.
- vii) Development of 'setbacks' for coastal and estuarine wetlands, perhaps linked with moves to direct sediment to specific places.
- viii) High priority management actions in wetlands that are valuable and likely to be lost or degraded, including the implementation of wetland rehabilitation and restoration projects. Wetland creation could also be usefully undertaken, but possibly not in many cases where existing infrastructure limits both the area and processes that support particular wetland types or functions.

Other adaptation options which could benefit wetlands concern the more efficient use of natural resources and the removal of policies and financial measures that work against the maintenance, and even the creation, of wetlands.

There are likely to be negative repercussions to specific adaptation options. Examples include:

- i) The active transportation of aquatic species or "better-adapted" warm water species poleward - historical evidence suggests that this could result in the extinction of local wetland species and large changes in ecosystem processes and structure, all with economic consequences.
- ii) Interactions resulting from increased stocking and relocation of recreational and aquacultural endeavours.
- iii) Other negative effects related to secondary pressures from new hydrologic engineering structures.

There also may be co-benefits of adaptation measures. For example, the development of infrastructure against sea level rise in a low-lying coastal system could result in economic gains, although the relative expense of structures such as ports and trading centres that arise are unlikely to have been costed within the context of climate change.

Adaptation options for sector/system dependent on wetlands

Water

- Increase water-use efficiency with “demand-side” management (e.g., pricing incentives, regulations, technology standards).
- Increase water supply, or reliability of water supply, with “supply-side” management (e.g., construct new water storage and diversion infrastructure).
- Change institutional and legal framework to facilitate transfer of water among users (e.g., establish water markets).
- Reduce nutrient loadings of rivers and protect/augment streamside vegetation to offset eutrophying effects of higher water temperatures.
- Reform flood management plans to reduce downstream flood peaks; reduce paved surfaces and use vegetation to reduce storm runoff and increase water infiltration.
- Re-evaluate design criteria of dams, levees and other infrastructure for flood protection.

Food and fibre

- Change timing of planting, harvesting, and other management activities.

Coastal areas, marine fisheries

- Prevent or phase-out development in coastal areas vulnerable to erosion, inundation, and storm-surge flooding.
- Use “hard” (dikes, levees, seawalls) or “soft” (beach nourishment, dune and wetland restoration, afforestation) structures to protect coasts.
- Implement storm warning systems and evacuation plans.
- Protect and restore wetlands, estuaries, and floodplains to preserve essential habitat for fisheries.
- Modify and strengthen fisheries management institutions and policies to promote conservation of fisheries.
- Conduct research and monitoring to better support integrated management of fisheries.

Various restoration, remediation and prevention actions are currently used in wetland management, especially to address salt water intrusion or degradation of wetlands. The cost of this often long-term management action is such that it would be an unlikely option for future widespread application.

Ramsar Convention on Wetlands (1999). *Wetlands and climate change: exploring collaboration between the Convention on Wetlands (Ramsar, Iran, 1971) and the UN Framework Convention on Climate Change.*

http://www.ramsar.org/key_unfccc_bkgd.htm#2

Adaptation strategies to adverse effects

Management of natural resources is characterized by the need to *continuously* adapt to changing circumstances through a learning-by-doing approach. In this sense, adapting to a changing climate has many similarities with other aspects of natural resources management.

Adaptation in the context of climate change can be defined as a deliberate management strategy to minimize the adverse effects of climate change, to enhance the resilience of vulnerable systems, and to reduce the risk of damage to human and ecological systems from changes in climate. Wetland rehabilitation can be a viable alternative to flood control and dredging efforts designed to cope with larger and more frequent floods, possibly associated with climate change.

The vulnerability of societies to climate change, and the vulnerability of specific types of wetlands, play a decisive role in the degree to which the development of adaptation strategies is

needed. With respect to wetland and water resources, managers have given less attention, thus far, to strategies that cope with increasing variations and changes in climate. Elements of an adaptation strategy should not only involve physical alterations in the management system, but also technological and institutional changes that can deal with changing conditions.

The ability to adapt will vary from country to country depending on the available human and financial resources. Adaptive capacity is further a function of socio-economic, political and legal conditions that vary widely between countries. Due to limited human and financial resource availability poorer countries will have lower adaptive capacities to cope with the effects of climate change. They may benefit, though, from having introduced a lesser degree of alteration in their natural systems.

3.2 European guidance

Huntley (2007). *Climatic change and the conservation of European biodiversity: towards the development of adaptation strategies.*

Adaptation strategies must take account of:

- Species' spatial response to climatic change.
- The need to facilitate, rather than to hinder, gene flow through species' populations to enable the adaptive component of their response to climatic change.
- Species' individualism and the consequent impermanence of species assemblages and ecosystems.
- The vital role of protected areas in any successful adaptation strategy.
- The absolute need to render landscapes 'permeable' to species as they adjust their spatial patterns of distribution.

In order to achieve this, and to be effective, adaptation strategies must incorporate:

- Re-evaluation of the management goals of protected areas.
- The need to maintain legal protection for protected areas that in future may not support the species or ecosystems that led to their initial designation.
- A re-evaluation of the concept of a 'native' species.
- Implementation of management, of protected areas and the wider landscape, that will facilitate species' potential future range changes.
- Measures designed to minimise loss of intra-specific genetic diversity, especially that component of such diversity concentrated near the 'trailing edge' of species' European distributions.
- Measures designed to facilitate community and ecosystem changes.
- Management practices designed to facilitate ecosystem dynamic processes upon which realisation of community and ecosystem changes often depend.
- Continued protection and appropriate management of existing protected areas.
- Identification, using a 'coarse filter' approach, of gaps in the existing network of protected areas.
- Augmentation of the existing protected areas network to maximize representation of the range of combinations of environmental conditions and physical habitats, as well as to minimise the occurrence of large spatial gaps in the network.
- Implementation of appropriate management of the wider landscape and development of a landscape structure that will facilitate species' spatial responses to climatic change.
- Exploitation of buffer zones to enhance the effectiveness of protected areas.
- Development of landscapes that provide functional networks of habitat 'stepping stones' ensuring connectivity between the protected areas that will form the major nodes in these functional

networks, the ‘stepping stones’ being of varying sizes and separations and providing appropriate representation of the range of physical habitats characteristic of the landscape.

- Implementation of management of the ‘matrix’ of the wider landscape in ways that are less intensive and that favour the maintenance or enhancement of fine-scale heterogeneity.
- Exploitation of existing, and development of new, incentive schemes for landowners that promote the desired lower intensity land management, increased fine-scale heterogeneity and provision of habitat ‘stepping stones’.

In addition, adaptation strategies must recognise that continuous corridors are neither a necessary part of achieving landscape connectivity nor a viable option in most parts of Europe on the scale necessary to render them an effective response to climatic change.

Adaptation strategies also must recognise the scale mismatch between viable buffer zones and species’ potential spatial responses to climatic change; buffer zones are valuable in enhancing the effectiveness of protected areas, but offer little or nothing specifically in relation to adaptation to climatic change.

In addition to the implications outlined above for the development of adaptation strategies, such strategies also must have a number of further attributes.

In relation to species’ dynamic and individualistic responses to climatic change, adaptation strategies must also:

- Implement management of both protected areas and ‘stepping stones’ that accelerates community and ecosystem transformation.
- Implement management, especially of protected areas, that will maximize populations of rare or threatened species found therein, even in the case of sites near the ‘trailing edge’ of a species’ range where it is unlikely to persist in the longer term but where elements of the species’ intra-specific genetic diversity important to its ability to adapt to climatic change elsewhere in its range are likely to be concentrated.
- Combine and balance the foregoing requirements.
- Develop a new holistic approach to the legal framework for the protection of an overall functional network of protected areas and the associated ‘stepping stones’ required to render the landscape permeable, taking a continental scale view rather than a national focus.
- Adopt the concept of a ‘potential native’ species and provide equivalent protection for all such species.

In relation to the importance of maintaining and augmenting the existing protected area network, adaptation strategies must also:

- Address as a matter of urgency the need to amend the legal basis for the designation of many protected areas so as to ensure continuity of protection of these sites that will be vital to any successful adaptation strategy.
- Take the steps necessary to increase the extent of the protected area in order that the often conflicting management practices required to facilitate change, on the one hand, and to maximise populations of rare and threatened species, on the other, can be accommodated.
- Target increases in the extent of the protected area such that the additional area, whether in the form of extensions to existing protected areas or of additional newly designated protected areas, offers the greatest flexibility and potential for species to adjust their distributions within the landscape in response to climatic change, e.g. by adding areas that extend to the highest elevations in the local landscape, that offer a high degree of topographic diversity, that maximise the range of physical habitats represented and/or that maximise the extent of the physical habitat and ecosystem that is dominant within the landscape.

- In relation to the requirement to ensure connectivity of the protected area network through appropriate management of the wider landscape, adaptation strategies must also:
- Take the steps necessary to retain as many as possible of the remaining fragments of unaltered or semi-natural habitat in the landscape, especially of western Europe, in order that they may serve as 'stepping stones' and contribute to rendering the landscape permeable.
- Make the necessary provisions to 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.
- Ensure that the legal protection afforded to species applies wherever in the landscape that may be present, and that the default status of species is that they are protected from disturbance or destruction wherever they may occur.

European Commission (2006). *Halting the loss of biodiversity by 2010 and beyond.* http://eur-lex.europa.eu/LexUriServ/site/en/com/2006/com2006_0216en01.pdf

The European Commission's Communication "Halting the Loss of Biodiversity loss by 2010 - and Beyond: Sustaining ecosystem services for human well-being" is a commitment to prioritize biodiversity and a recognition that existing efforts need to be stepped up to achieve the goal and meet the following two commitments: to halt the loss of biodiversity by 2010 and restore natural systems, made by EU Heads of State and Government in 2001 and to significantly reduce the rate of biodiversity loss worldwide by 2010, made by world leaders in 2002.

The Communication outlines the evidence of continuing and accelerating loss of biodiversity and the related decline in ecosystem services and explains why this loss matters – acknowledging the intrinsic value of nature but stressing also the economics. A central message of the Communication is that biodiversity – at the level of ecosystems, species and genes – underpins the supply of ecosystem services for our prosperity and well-being; i.e. nature is working for us.

Attached to the Communication is an EU Action Plan to 2010 and Beyond. It identifies four key policy areas for action: 1) biodiversity in the EU, 2) the EU and global biodiversity, 3) biodiversity and climate change and 4) the knowledge base. Ten priority objectives are specified in relation to these policy areas, addressing most important habitats and species; actions in the wider countryside and marine environment; making regional development more compatible with nature; reducing impacts of invasive alien species; effective international governance; support to biodiversity in international development; reducing negative impacts of international trade; adaptation to climate change; and strengthening the knowledge base.

Eurosite (2006). *Biodiversity sites and climate change: Eurosite statement of Orleans.* http://www.eurosite-nature.org/IMG/pdf/orleans_statement_en.pdf

In adapting biodiversity conservation to address the impacts of climate change on biodiversity, Eurosite calls for:

- Early adaptation measures to increase the resilience of nature sites against the impacts of climate change; this to be achieved by developing adaptive management strategies and practical actions, and by reducing other pressures on features of interest.
- The management of nature sites additionally must accommodate the inevitable changes resulting from climate change, especially the shifting distribution and abundance of species responding to the changing locations of suitable climatic conditions.
- Nature sites to be managed as interlocking, mutually supportive networks; and as climate change and its impacts intensify, site-specific conservation objectives and management should develop across a wider geographic context.
- Conservation planning and management to be undertaken at the landscape scale, to reduce fragmentation of areas of natural and semi-natural habitat and accommodate and facilitate shifts in species' distributions.

- More land, including all areas of high conservation value as well as areas currently of lesser biodiversity value, to be managed for nature conservation.
- Advancement and sharing of knowledge and best practice with regard to climate change including: impacts on sites and species of conservation importance; site management techniques; monitoring; and the strategic development of nature sites and landscape scale approaches.
- The necessary funding and other resources required to ensure the effective functioning of nature sites to conserve biodiversity in the face of climate change to be allocated across the European Union, in recognition both of legal and moral duties to protect and conserve biodiversity and the economic and social benefits that biodiversity provides.

EEAC (2005). *Biodiversity conservation and adaptation to the impacts of climate change.*
http://www.eeac-net.org/workgroups/cont_frame10.htm

Summary

Biodiversity loss is being exacerbated by climate change and this is hindering the European Union commitment to achieving the Gothenburg target of halting the loss of biodiversity by 2010. Whilst mitigation measures to reduce greenhouse gas emissions are essential, adaptation measures are also required to minimise the risk of loss of plant and animal species. Synergies should also be developed between biodiversity conservation and adaptation and mitigation policies in other key sectors.

As we will be subject to at least 50 years of climate change that we cannot prevent, we will have to adapt to its unavoidable impacts.

Adaptation is concerned with reducing the vulnerability of human and natural systems to climate change. In biodiversity conservation, this should complement other activities to reduce pressures arising from, for example, habitat fragmentation, land use change, overharvesting, pollution, urban expansion and invasions of alien species. The ‘precautionary principle’ should be a key consideration in this context. Activities that promote adaptation of biodiversity to climate change can also contribute to its conservation and sustainable use and to sustainable land management, and vice versa. Conservation of biodiversity and maintenance of ecosystem structure and function can contribute to climate adaptation strategies by maintaining ecosystem resilience and thereby minimising vulnerability to climate change.

European Union biodiversity policy (in relation to adaptation)

The EEAC wishes to:

- A. Emphasise the importance of policy integration in key sectors, especially agriculture, forestry, fisheries, water, transport, energy, built development, rural development, economic policy, trade, human health, and regional and spatial planning, to achieve sustainable use of natural resources and reduce pressures on biodiversity (Malahide Message).
- B. Draw attention to the importance of extending conservation planning across whole landscapes, halting net loss of habitat, enhancing ecological connectivity to reduce fragmentation and recreating ecosystems on a large scale (Pan-European Biological and Landscape Diversity Strategy; Article 10, Habitats Directive).
- C. Support the establishment of a coherent network of Marine Protected Areas (Johannesburg Commitment) and take due account of biodiversity in coastal zone and marine management.
- D. Recognise the need for resilient ecological systems (terrestrial, freshwater, coastal and marine) with high quality genetic diversity, which will buffer perturbations and accommodate, or adapt to, change and to work to achieve this through application of the ecosystem approach (Decision VII/11 adopted by the 7th Conference of the Parties to the Convention on Biological Diversity 2004).

Adaptation of biodiversity conservation to climate change

Furthermore, the EEAC :

- E. Affirms the importance of assessing the observed and projected impacts of climate change on biodiversity within the context of the dynamism and functionality of ecosystems, of distinguishing between natural ecological succession and functional processes and climate-driven changes, and of adapting targets and establishing biodiversity indicators to help shape policies for biodiversity and integrate biodiversity needs into other policies.
- F. Affirms the benefits of early action to build resilience and help ecosystems adapt sustainably to climate change (this may have the added advantage of being more cost effective).
- G. Recognises the need to strengthen partnerships and capacities (governments, management agencies, practitioners and other stakeholders including scientists) for addressing climate change and adapting conservation of biodiversity to its impacts.
- H. Recognises the need to identify best practice and communicate advice and guidance on anticipating the impacts of climate change and formulating sustainable options for adapting land and water management to these changes.

3.3 National guidance

3.3.1 UK guidance relevant to biodiversity conservation

Smithers *et al.* (2008). *England Biodiversity Strategy: climate change adaptation principles.*

Five main adaptation principles are fundamental to conserving biodiversity in a time of rapid climate change:

Take practical action now - We cannot wait until the evidence demonstrates greater certainty, as delay will result in more severe impacts, fewer available options for action and increased costs of damage and intervention (Stern, 2006). Existing conservation efforts are insufficient and there is a need to act now with greater vigour to:

- Conserve existing biodiversity.
- Conserve Protected Areas and all other high quality habitats.
- Reduce sources of harm not linked to climate.
- Use existing biodiversity legislation and international agreements.

Maintain and increase ecological resilience - Increasing the resilience of species, habitats and ecosystems to the impacts of climate change, will help the widest range of biodiversity to survive and adapt. It is vital to continue and extend current efforts to:

- Conserve range and ecological variability of habitats and species.
- Maintain existing ecological networks.
- Create buffer zones around high quality habitats.
- Take prompt action to control spread of invasive species.

Accommodate change - Both gradual change and extreme weather events will shape the places where species occur. There is a need to:

- Understand change is inevitable.
- Make space for the natural development of rivers and coasts.
- Establish ecological networks through habitat restoration and creation.
- Aid gene flow.

- Consider the role of species translocation and ex-situ conservation.
- Develop the capacity of institutions and administrative arrangements to cope with change and learn from experience.
- Respond to changing conservation priorities.

Integrate action across partners and sectors - The scale of adaptation required demands that biodiversity conservation is integrated with other land-use activities. There is a need to:

- Integrate adaptation and mitigation measures.
- Integrate policy and practice across land-use sectors.
- Build and strengthen partnerships.
- Raise awareness of benefits of the natural environment to society.

Develop knowledge and plan strategically - We have to plan for the future with available information, developing techniques that will enable us to move forward with actions that we will not regret whatever the future may bring. Whilst monitoring both the impacts of climate change and the effectiveness of adaptation.

- Undertake vulnerability assessments of biodiversity and associated ecosystem goods and services without delay.
- Undertake scenario planning and implement no regrets actions.
- Pilot new approaches and monitor.
- Identify potential win-wins and ensure cross-sectoral knowledge transfer.
- Monitor actual impacts and research likely future impacts.
- Research knowledge gaps with stakeholder participation.

Natural England (2008). *Climate change policy.*

<http://naturalengland.communisis.com/naturalenglandshop/docs/NE97.pdf>

An integrated approach to climate change

Natural England believes that there is a need for an integrated approach to climate change, addressing both adaptation and mitigation in order that human responses to climate change do not exacerbate the impacts experienced. The urgent need for action to mitigate climate change fundamentally stems from the limited capacity of our natural environment and natural processes to adapt to rapid climate change. An integrated approach to climate change is essential to ensure that, in the pursuit of targets to reduce greenhouse pollution, decision makers do not lose sight of what the ultimate goal of this activity is – to secure our natural environment and the social and economic welfare it delivers for the future.

The focus of climate change policy both internationally and domestically has been on strategies to reduce greenhouse pollution. However, it is now accepted that adaptation is a critical strategy to complement pollution mitigation. This does not in any way diminish the need to maintain the urgent focus on mitigation to limit future dangerous climate change.

A national framework for action

Adaptation cuts across sectors and disciplines. Without a clear national framework for action, there is a major risk that adaptation response will at best be ad hoc, and at worst lead to conflicting outcomes.

Natural England will need to make a major contribution to the development and implementation of such a framework to ensure the development of a sustainable approach to adaptation, based on a healthy and resilient natural environment and which recognises the potential for many of the issues that would have implications for the natural environment.

A national adaptation strategy for the natural environment

A central element of any national framework would need to be an adaptation strategy for the natural environment. This would assess the risk to the natural environment and communicate the potential impacts of climate change. It would also outline key priorities for actions to help people prepare for change. A consistent and credible methodology for assessing the risk to the natural environment from climate change is needed, which can inform planning and decision-making.

Adaptation principles

Natural England believes that the following key principles are important in the development of adaptation strategies for the natural environment: conserving existing biodiversity, particularly on protected sites should be at the core of adaptation strategies; adaptation strategies need to be based on a landscape-scale approach in which protected areas are a key part; adaptation strategies should seek to build resilient natural systems and processes to accommodate climate change; adaptation strategies should be developed using the best currently available evidence; uncertainty of the nature and extent of impact of climate change and its impact on the natural environment should not be a reason to delay action which will provide benefits for the natural environment; adaptation strategies should be dynamic and be refined in light of effective monitoring of both the response of the natural environment to climate change and strategies to increase resilience; adaptation strategies should seek to reduce habitat fragmentation by increasing landscape connectivity and permeability; adaptation strategies should increase people's understanding of the impact of climate change and lead to practical action.

Policy

- Climate change adaptation strategies need to be based on a clear set of agreed principles.
- Adaptation strategies need to be developed for the most vulnerable landscapes, ecosystems and habitats.
- Adaptation strategies need to be developed through demonstration projects at a range of scales to enable learning.

Hopkins *et al.* (2007) *Conserving biodiversity in a changing climate: guidance on building capacity to adapt.*

Summary of the guiding principles on building the capacity to adapt biodiversity:

1. **Conserve existing biodiversity.** The richness of future biodiversity, in a changing world, will depend upon the diversity we conserve today:
 - i. Conserve Protected Areas and other high quality habitats. These areas will remain important because they have characteristics that will continue to favour high biodiversity: e.g., low-nutrient soils.
 - ii. Conserve range and ecological variability of habitats and species. It is impossible to predict which localities will continue to have climatic conditions suitable for a given species or habitat; by conserving the current range and variability we will reduce the probability of all localities being lost, although some losses will be inevitable.
2. **Reduce sources of harm not linked to climate.** Climate change is one of many threats to biodiversity and by reducing other sources of harm we will help natural systems maintain their biodiversity in the face of climate change.
3. **Develop ecologically resilient and varied landscapes.** By ensuring landscapes remain varied, and allowing space for physical processes to take place, we will increase their ability to retain biodiversity:
 - i. Conserve and enhance local variation within sites and habitats. Maintaining diversity in the landscape in terms of features such as vegetation structure, slope, aspect and water regime will

increase the chances that species whose current habitat becomes inhospitable will be able to spread locally into newly favourable habitat.

- ii. Make space for the natural development of rivers and coasts. Changing rainfall patterns and rising sea levels will affect our rivers and coasts. By allowing natural processes of erosion and deposition to take place we will increase the potential for wildlife to naturally adapt to these changes.
4. **Establish ecological networks through habitat protection, restoration and creation.** Some species will need to move some distance from their current locality if they are to survive climate change; creating new habitat, restoring degraded habitat, or reducing the intensity of management of some areas between existing habitat, will encourage this.
 5. **Make sound decisions based on analysis.** Adopt an evidence-based approach which recognises that biodiversity is constantly changing:
 - i. Thoroughly analyse causes of change. Not all change will be due to climate change and by thoroughly analysing the causes of change we will identify those situations where climate-change adaptation is needed.
 - ii. Respond to changing conservation priorities. Regularly review conservation targets to ensure resources are directed towards genuine conservation priorities as some species increase, others decline and habitats change in character.
 6. **Integrate adaptation and mitigation measures into conservation management, planning and practice.** When reviewing conservation management plans consider the impacts of climate change—for example more frequent summer fires and floods—and make changes as appropriate. Where they can be identified, reduce release of greenhouse gases to the atmosphere.

Hopkins *et al.* (2007) *Conserving biodiversity in a changing climate: guidance on building capacity to adapt.*

Summary of the guiding principles on building the capacity to adapt biodiversity:

7. **Conserve existing biodiversity.** The richness of future biodiversity, in a changing world, will depend upon the diversity we conserve today.
 - i. Conserve Protected Areas and other high quality habitats. These areas will remain important because they have characteristics which will continue to favour high biodiversity: e.g., low-nutrient soils.
 - ii. Conserve range and ecological variability of habitats and species. It is impossible to predict which localities will continue to have climatic conditions suitable for a given species or habitat; by conserving the current range and variability we will reduce the probability of all localities being lost, although some losses will be inevitable.
8. **Reduce sources of harm not linked to climate.** Climate change is one of many threats to biodiversity and by reducing other sources of harm we will help natural systems maintain their biodiversity in the face of climate change.
9. **Develop ecologically resilient and varied landscapes.** By ensuring landscapes remain varied, and allowing space for physical processes to take place, we will increase their ability to retain biodiversity.
 - i. Conserve and enhance local variation within sites and habitats. Maintaining diversity in the landscape in terms of features such as vegetation structure, slope, aspect and water regime will increase the chances that species whose current habitat becomes inhospitable will be able to spread locally into newly favourable habitat.
 - ii. Make space for the natural development of rivers and coasts. Changing rainfall patterns and rising sea levels will affect our rivers and coasts. By allowing natural processes of erosion and

deposition to take place we will increase the potential for wildlife to naturally adapt to these changes.

10. **Establish ecological networks through habitat protection, restoration and creation.** Some species will need to move some distance from their current locality if they are to survive climate change; creating new habitat, restoring degraded habitat, or reducing the intensity of management of some areas between existing habitat, will encourage this.

11. **Make sound decisions based on analysis.** Adopt an evidence-based approach which recognises that biodiversity is constantly changing.

- iii. Thoroughly analyse causes of change. Not all change will be due to climate change and by thoroughly analysing the causes of change we will identify those situations where climate-change adaptation is needed.
- iv. Respond to changing conservation priorities. Regularly review conservation targets to ensure resources are directed towards genuine conservation priorities as some species increase, others decline and habitats change in character.

12. **Integrate adaptation and mitigation measures into conservation management, planning and practice.** When reviewing conservation management plans consider the impacts of climate change – for example more frequent summer fires and floods – and make changes as appropriate. Where they can be identified, reduce release of greenhouse gases to the atmosphere.

Hopkins *et al.* (2007) *Conserving biodiversity in a changing climate: guidance on building capacity to adapt.*

Summary of the guiding principles on building the capacity to adapt biodiversity:

13. **Conserve existing biodiversity.** The richness of future biodiversity, in a changing world, will depend upon the diversity we conserve today.

- i. Conserve Protected Areas and other high quality habitats. These areas will remain important because they have characteristics which will continue to favour high biodiversity: e.g., low-nutrient soils.
- ii. Conserve range and ecological variability of habitats and species. It is impossible to predict which localities will continue to have climatic conditions suitable for a given species or habitat; by conserving the current range and variability we will reduce the probability of all localities being lost, although some losses will be inevitable.

14. **Reduce sources of harm not linked to climate.** Climate change is one of many threats to biodiversity and by reducing other sources of harm we will help natural systems maintain their biodiversity in the face of climate change.

15. **Develop ecologically resilient and varied landscapes.** By ensuring landscapes remain varied, and allowing space for physical processes to take place, we will increase their ability to retain biodiversity.

- i. Conserve and enhance local variation within sites and habitats. Maintaining diversity in the landscape in terms of features such as vegetation structure, slope, aspect and water regime will increase the chances that species whose current habitat becomes inhospitable will be able to spread locally into newly favourable habitat.
- ii. Make space for the natural development of rivers and coasts. Changing rainfall patterns and rising sea levels will affect our rivers and coasts. By allowing natural processes of erosion and deposition to take place we will increase the potential for wildlife to naturally adapt to these changes.

16. **Establish ecological networks through habitat protection, restoration and creation.** Some species will need to move some distance from their current locality if they are to survive climate

change; creating new habitat, restoring degraded habitat, or reducing the intensity of management of some areas between existing habitat, will encourage this.

17. **Make sound decisions based on analysis.** Adopt an evidence-based approach which recognises that biodiversity is constantly changing.

- v. Thoroughly analyse causes of change. Not all change will be due to climate change and by thoroughly analysing the causes of change we will identify those situations where climate-change adaptation is needed.
- vi. Respond to changing conservation priorities. Regularly review conservation targets to ensure resources are directed towards genuine conservation priorities as some species increase, others decline and habitats change in character.

18. **Integrate adaptation and mitigation measures into conservation management, planning and practice.** When reviewing conservation management plans consider the impacts of climate change – for example more frequent summer fires and floods – and make changes as appropriate. Where they can be identified, reduce release of greenhouse gases to the atmosphere.

Mitchell *et al.* (2007). *England Biodiversity Strategy – towards adaptation to climate change.*

The EBS climate change adaptation workstream members have identified four key principles for adaptation to climate change, aimed at reducing vulnerability and managing for uncertainty:

- Reduce direct impacts.
- Reduce indirect impacts.
- Increase resilience.
- Accommodate change.

These are generic principles and their practical application can be summarised as six measures for adaptation:

- Direct management to reduce impacts of climate change.
- Promote dispersal of species.
- Increase available habitat.
- Promote conditions for ecosystem functioning.
- Optimise sectoral responses to climate change for biodiversity.
- Continue to reduce pressures not linked to climate change.

In addition three key underpinning requirements enable these measures to be developed and implemented:

1. **Monitoring and surveillance** - of change in populations and communities and the factors that control them, is critical for:

- Understanding the response of ecosystems, habitats and species to climate change and other pressures that may exacerbate this response.
- Providing data for use in model development and testing, which will improve capacity to predict future change.
- Assessing effectiveness of policy and management responses. Monitoring is integral to an adaptive management approach: it provides the key to learning from experience and responding to emerging trends.

2. **Development of the evidence base** - it is important to improve understanding of the processes that drive change, and to develop the capacity to forecast future change.

3. Knowledge transfer and communication - specialist knowledge needs to be made available to policy makers and managers in order to inform their decision making, and researchers and other specialists need to understand what information is required to inform those decisions. Scientific concepts need to be presented in a simple, straightforward way that is accessible to the wider public.

Adaptation measures

Direct management to reduce impacts of climate change:

Specific interventions or changes in management may reduce adverse impacts of climate change on aspects of biodiversity (these can be site based operations for localised effects, or they can be applied across wider areas) by:

- Reducing competition (grazing regimes, preventing spread of competitor species or even direct removal of competitors) may allow threatened species to persist.
- Manipulating microclimate, by modifying vegetation height or canopy structure.

Promote dispersal of species:

- If species approaching their climatic limits cannot adapt to the new climate and cannot be maintained in their present locations by management, they will only survive if they move into new areas where the climate is suitable.
- Dispersal of this sort can take place at a range of scales: northwards movement between geographical regions, altitudinal movement and possibly local movement between different microclimates (such as slopes of different aspects).

Increase available habitat:

- Increasing habitat size needs to be viewed, along side promoting dispersal, as part of a 'landscape scale approach'.
- Increases in habitat area can be achieved by expanding the area occupied by existing habitat patches and by increasing the number of discrete areas of habitat.
- An important aspect of increasing area is to increase the range of soil types and topographical variations in microclimate covered by a habitat in a region.
- Restoring degraded habitats or creating new areas of habitat.

Promote conditions for ecosystem functioning:

- Nutrient and water cycling and energy transfers, as well as interactions between species, such as pollination and competition.
- Ecosystem functioning is not usually susceptible to direct intervention, but environmental conditions can sometimes be manipulated to promote particular processes.
- Biodiversity and ecosystem function are linked and protecting species from other pressures will also tend to protect some ecosystem processes.

Optimising sectoral responses to climate change for biodiversity:

- Responding to climate change is necessary in many other aspects of society as well as biodiversity conservation.
- This will require policy guidance, for example to inform the planning system, but also a process of education and knowledge transfer.

Reduce pressures not linked to climate change:

- Populations and communities already threatened by one pressure are almost always more vulnerable to others. Some of these pressures are relatively well understood, subject to less uncertainty than climate change and can be addressed more directly than climate change impacts themselves.

- Controlling one factor also reduces the impact of the other.
- Over-grazing, herbicide use, cessation of management and habitat destruction. A reduction in these types of pressure often provides quick wins.

Walmsley, C.A. & Harley, M. (2007). *Conclusions and the implications for policy and practice.*

Planning for the impacts of climate change on biodiversity requires adaptation strategies that maintain and enhance and strategies which accommodate. Such actions should seek to maintain and enhance connectivity by:

- Conserving and restoring where possible all semi-natural habitats, not just a representative sample of sites in protected areas.
- Targeting habitat creation to buffer semi-natural habitats from the negative effects of adjoining intensive land use.
- Extending the area of semi-natural habitats, especially in parts of the country where they are concentrated.
- Increasing the ability of biodiversity to move across landscapes by making intervening agricultural, forestry or urban areas more permeable and less hostile to wildlife, rather than simply linking fragmented semi-natural habitats through slim green corridors.

Underpinning principles for adaptation are:

- Protection of existing biodiversity, including protected areas and other wildlife habitat of high value
- Reduction of other sources of harm, such as pollution, inappropriate habitat management, and over-exploitation of resources (e.g. water abstraction and agricultural intensification)
- Development of ecologically resilient landscapes through establishment of ecological networks, conservation of local variability, and integration of practical adaptation measures into protected area management.

RSPB (2007). *Climate change, wildlife and adaptation: 20 tough questions, 20 rough answers.* http://www.rspb.org.uk/Images/climatechange20questions_tcm9-170121.pdf

The overall objective for the nature conservation sector in the UK must be to conserve and enhance biodiversity by enabling wildlife to survive, thrive and adapt to the conditions imposed by a changed climate. To achieve this, the Government should work to achieve:

- Resilient populations of wildlife in healthy habitats.
- A massively increased area of land managed for environmental benefits....At least 20% of land (all land protected by law for its nature value, plus a similar amount to provide buffering and linkage) should be managed with biodiversity as a core objective, in some cases alongside other activities. Outside this, all our land should deliver some environmental benefit.
- A countryside more permeable to wildlife, with key habitat features present across all farmed, forested and urban landscapes.
- Biodiversity conservation and sustainability safeguards built into the adaptation plans of other sectors.

Gregory et al. (2006). *The conservation of genetic diversity: science and policy needs in a changing world.* JNCC report no. 383.

http://www.coe.fi/user_data/jncc383_web.pdf

Principles of genetic conservation that can be communicated to policy-makers and practitioners:

- High levels of genetic diversity within populations are almost always desirable to ensure that they are genetically sustainable.

- Adaptability is correlated with diversity and should be an important driver for conservation in response to environmental change.
- Genetic diversity is broadly correlated with population size, hence conservation should seek to maintain or create large populations.
- Low levels of genetic diversity are detrimental to populations when they lead to inbreeding depression but can be of special scientific interest and may indicate ongoing evolution and speciation.
- Gene flow between populations is desirable but care may be required where small populations have been isolated for a long period and local adaptation may be swamped.
- Action to increase landscape permeability for one species may be bad for another but what is good for most species should take precedence.

Woodland Trust (2005). *Position statement: climate change.*

<http://www.woodland-trust.org.uk/campaigns/briefingsmore/climatechange.htm>

There is an urgent need to implement adaptation strategies to conserve and create landscapes that will be welcoming to wildlife in a time of rapid climate change. The urgency is because of the scale of action required and the timescale needed for habitats to develop to maturity. Such strategies have to focus on whole landscapes rather than on individual sites. Moreover by making natural systems more resilient, not only will biodiversity benefit but human society will also benefit from the 'services' which natural ecosystems provide such as flood relief, healthy soils, carbon sinks and future sequestration, water quality and renewable natural resources. Woodland, as the most widespread semi-natural habitat in the UK, is uniquely placed to act as a key component of a more sympathetic and receptive landscape for wildlife in the face of climate change.

Developing resilient natural systems in the face of climate change requires landscape scale action. Much of this is sound conservation practice that becomes even more relevant in the face of climate change. In terms of woodland and wildlife this means:

- Conserving all semi-natural habitats not just a representative sample of sites.
- Restoring all woodland and semi-natural habitats planted with non-native conifers.
- Targeting habitat creation in areas where there is greatest potential to put woodland on a sustainable footing, namely in the greatest existing concentrations of ancient or semi-natural habitats.
- Buffering semi-natural habitats from negative effects of intensive land use and extending their core area.
- Reducing the intensity of the intervening land-use practices between semi-natural habitats in order to increase the ability of biodiversity to move across landscapes; this in turn means:
 - Reducing air and water pollution.
 - Improving soil management.
 - Limiting herbicide and pesticide inputs.
- Re-establishing more gentle transitions from one habitat to another particularly at woodland edges.
- Creating more natural green space within urban environments.

Brooker and Young (2005). *Climate change and biodiversity in Europe: a review of impacts, policy responses, gaps in knowledge and barriers to the exchange of information between scientists and policy makers.*

With respect to biodiversity conservation, adaptation strategies would be designed to enable the maximum biodiversity resource to persist within the context of a changing climate. Some of these adaptations might be autonomous, i.e. systems responding to climate change without any active

management intervention. This could include species dispersal and colonisation of new areas or in situ evolutionary responses. In contrast planned adaptation involves active intervention and management, for example promotion of dispersal by the development of habitat “corridors” or the more strategic design of landscapes to facilitate the movement of species

Development of adaptation strategies for biodiversity conservation:

- Identifying those ecological systems that are most vulnerable to climate change (including semi-natural and fragmented habitats) will be a key step towards developing adaptation strategies, providing opportunities to increase resilience of ecological systems to climate change.
- The first steps toward outlining how adaptation strategies might be implemented need to be taken. We must ask how such strategies will translate in to activities “on the ground”.
- Once initial adaptation and mitigation strategies for biodiversity conservation during climate change have been formulated they should then be monitored and supplemented by the appropriate data to refine them as needed.
- The existing networks of protected areas will be a critical component of adaptation strategies. There is a need to take a more flexible and adaptive approach to management of protected areas, both in terms of improving their ecological connectivity to create a more permeable landscape and in terms of assessing their capacity to cope with the impacts of climate change.
- Development of “first-step” adaptation strategies would enable an assessment of whether existing biodiversity conservation policy is adequate to enable the activities needed to protect biodiversity during climate change. International cooperation on this issue is important in some areas, especially with respect to the dispersal of species between administrations. This poses a challenge for existing, locally determined land use and resource management planning.
- Despite the growing scientific evidence, ineffective communication and institutional inertia means that there is still a lack of policy response to climate change impacts on biodiversity. There is a need for interdisciplinary research to address the development of policies that can deliver conservation goals on a broad geographical scale and for the development of an institutional framework capable for delivering appropriate incentives for stakeholders to conserve biodiversity.

Summary of priority activities:

- Identifying vulnerable ecosystems including assessment of migratory routes.
- Research to enable the design of adaptation strategies – e.g. how do we create resilient ecosystems within a permeable landscape?
- Implementation of adaptation strategies associated with their monitoring and ongoing refinement
- Assessment of the protected areas approach within the context of climate change – how will existing areas cope and how might they be integrated into an ecological network?
- Assessment of whether existing biodiversity legislation encompasses activities needed to adapt to climate change impacts.
- Guidance on effective, shared approaches for spatial development that incorporates the likely impacts of climate change on biodiversity and integrates ecological knowledge into the planning process at different scales.

Robinson *et al.* (2005). *Climate change and migratory species.*

Adaptation to the effects of climate change is likely to require a multi-benefit ecosystem approach. Thus, it is much more likely that conservation goals will be achieved if they are part of ecosystem management with wider aims such as floodplain management, coastal protection or reducing deforestation, all of direct benefit to the inhabitants of the areas concerned, as well as to wildlife. The ecosystem management approach of the Convention on Biological Diversity provides many of the mechanisms for these potential adaptation solutions, but this approach requires the full cooperation of all the stakeholders involved, particularly, the local inhabitants.

Adaptation: Implications of climate change for the management and conservation of marine mammals, turtles, fish, cephalopods and plankton

Marine mammals - Management and conservation measures need to take into account the potential changes in range and changing requirements of marine mammals. The adverse effects on breeding habitat may be reduced by creating protected areas for the remaining habitat, if it can be identified. However, the main method for adapting to change in the wider environment will be to manage human impacts on the resources required by marine mammal species through some form of ecosystem based management.

One way to protect marine mammals would be to designate marine protected areas (a.k.a. 'no take zones') for the prey of marine mammals as well as marine mammal species. However, the ideal location of such areas is likely to change over time, and this will require different legislation than those currently used. For example, there needs to be a degree of flexibility in the establishment of protected areas for marine mammals, such as Special Areas of Conservation (SAC), to take into account the potential shift in range and needs of marine mammals with climate change.

Turtles - Protective measures for marine turtles need to include the protection of current and potential nesting beaches and minimising human induced habitat degradation, such as coastal developments. The nature of this degradation, and its impact on turtle populations, may shift with climate change, and research and conservation policies need to be flexible to adapt to such changes. Reducing the threats faced by sea turtles, such as egg harvesting, egg predation, fishing, by-catch, pollution, marine debris, boat traffic and light pollution, also need to be addressed at both global and local levels.

As for all marine species, climate change is likely to result in range shifts and distributional changes in abundance. This will result in a shifting regional focus for conservation (e.g. turtles are becoming much more frequent in UK territorial waters).

Fish - Fishing activities and fisheries management need to be able to respond to regional changes in local population abundance and distribution which may be driven by the timing of life-history events (such as spawning, migration etc.) and episodic events. The designation of marine protected areas (a.k.a. "no-take zones") for marine species will need to be flexible to take into account the potential changes in their distributions over time and space, with climate change.

However, protective and conservation measures will not be able to solve many of the problems faced by marine mammals as a result of climate change and therefore the mitigation of greenhouse gases to prevent temperature increase may be the only solution.

3.3.2 Other UK guidance

Defra (2008): Adaptation Policy Framework

<http://www.defra.gov.uk/environment/climatechange/adapt/pdf/adapting-to-climate-change.pdf>

Driven by the Department for Environment Food and Rural Affairs (Defra), the recognized key priorities for adaptation for the UK over the next 30 to 50 years are:

- Water resource management.
- Coastal and river flood defence.
- Enhanced resilience of buildings and infrastructure.
- Management of wildlife, forestry and agriculture.
- Co-ordinated approaches to planning.

The UK Government has now set up the Adapting to Climate Change (ACC) Programme, to bring together the work already being led by Government and the wider public sector on adaptation in England, and to co-ordinate and drive forward the development of the Government's work on adapting to climate change in the future

UK Climate Impacts Programme <http://www.ukcip.org.uk/index.php>

The UK Climate Impacts Programme (UKCIP) helps organisations to adapt to inevitable climate change. While it's essential to reduce future greenhouse gas emissions, the effects of past emissions will continue to be felt for decades. Since 1997 UKCIP has been working with the public, private and voluntary sectors to assess how a changing climate will affect: construction, working practices, demand for goods and services, biodiversity, service delivery and health. See annexes 1 and 2 for further detail.

UK Environment Agency's Climate Change Adaptation Strategy (2005/7)

http://www.environment-agency.gov.uk/commondata/acrobat/adaptation_strategy_2083410.pdf

The Environment Agency (EA) out a systematic approach for embedding climate change adaptation the EA's core business planning, providing a strategic framework for assessing climate risk, building adaptive capacity, identifying adaptation options and ensuring coordinated delivery. Work to date has focused on priority business areas, such as Flood Risk Management, Water Resources, Freshwater Ecology, Water Framework Directive, Waste, Land Quality and Monitoring. Examples of activity underway include:

- The next revision of National Flood Risk Assessment (NAFRA) will include new climate change science and forthcoming scenarios from the UK Climate Impacts Programme (UKCIP08).
- Revised climate change allowances in Flood Risk Appraisal guidance, incorporating regional variations.
- A map of river flows up to 2050.
- An assessment of the climate vulnerability of all Biodiversity Action Plan species.
- Project to examine how waste management sites will be affected by future climate change and how better management practices may alleviate the increased risks this poses for the environment and human health.
- Influencing the development of agri-environment schemes to include options for water efficiency, rural Sustainable Urban Drainage Systems and better soil management.

The EA Climate Change Adaptation Strategy (2008-11) builds on the previous strategy launched in 2005 and sets out a systematic approach for embedding climate change adaptation into the Environment Agency's core activities, providing a strategic framework for assessing climate risk, building adaptive capacity, identifying adaptation options and ensuring co-ordinated delivery. Key elements of the strategy include:

- All policy functions to have developed an Adaptation Action Plan by April 2009.
- Development of a Climate Change Adaptation Programme by April 2010, fully integrated with the new Corporate Strategy, also due by April 2010.
- Establishment of a Climate Change Programme Board to drive and oversee delivery.
- A rolling programme of adaptation in action case studies and projects.
- Publication of a major report in 2009 on adaptation.
- Development of an Adaptation Advocacy Plan.

3.3.3 Other national guidance

For information on other national guidance considered in compiling this report, please see Annex 1 (MACIS 2008), Annex 2 (Iglesias *et al.* 2008) and Annex 3 (Bern Convention 2008).

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Annex 1

MACIS: Minimisation of and adaptation to climate impacts on biodiversity

Extracts from WP4: *Policy options to prevent/minimise negative impacts on biodiversity*

Deliverable 4.1: Policy analysis for biodiversity under climate change, April, 2008. Review paper of relevant policy and policy trends (A&M, sectoral), current policy-related research and future scenarios across selection of MSs and at EU level and development of assessment frameworks and policy-linkage framework. Dr Jake Piper, Elizabeth Wilson.

Selection of Member State policy documents on climate change and biodiversity (Update of policy documents - Feb 26 2008)

Note that the table identifies not all climate change strategies in each country, but those strategy/policies which appear **most focussed on biodiversity**

Member State	date	Policy documents	Comment
Austria	2002	Climate Strategy 2008-12 klima:aktiv (MITIGATION) Key ministry: Federal Ministry of Agriculture, Forestry, Environment and Water Management www.lebensministerium.at ----- Regional policies and measures	http://www.accg.gv.at/ = Austrian Climate Portal Feb 08: klima:aktiv newsletter, plus klim:aktiv climate protection programme.
Bulgaria	2004	Second National Action Plan on Climate Change 2005-8	http://www.moew.government.bg/home_e.php?action=fullnews&id=44 Covers activities/policies for all economic sectors, and indication of funding
Denmark	2003	Ministry of Environment http://www.mim.dk/ and Danish EPA "Miljøstyrelsen" www.mst.dk Proposal for a Climate strategy for Denmark From 2005: Work on preparing adaptation policy and catalogue of impacts.	Concerns CO ₂ emissions, and mitigation
	2007?	----- Strategy under preparation (planned for 2007) Summary of the Danish Government's Strategy for Climate Adaptation http://glwww.mst.dk/homepage/default.asp?Sub=http://glwww.mst.dk/transportuk/01000000.htm	see update by country. Refers to nature and nature management. Mentions corridors, EIA, activities to improve resilience of nature and environment plus risk analysis and risk management. Also, maybe, "safeguarding" land for future biodiversity use? mentions "reservations in planning"

Finland	2005	National Strategy for Adaptation to Climate Change. (to 2080) (see section 2.2 for more details)	Addresses biodiversity: principles and objectives and timelines, but no locations or targets http://www.ymparisto.fi/
France	2006	National adaptation strategy for the consequences of climate change ONERC	Addresses biodiversity (cross-cutting theme) Objectives and strategies (in general terms) across sectors. No locations, timelines or targets.
	2006-7	Territorial Climate Plans (regional and local level)	Some mention of general adaptation (for heatwaves, drought, flooding) but not biodiversity.
Germany	start: 2007	German National Strategy on Adaptation to Climate Change	Work on this started 2007. The first stage will be a compilation and evaluation of existing knowledge on climate impacts across all relevant sectors and on possible adaptation measures for consultation in 2008. Nature conservation will be one of the sectors considered.
		Länder level: Some states (e.g. Baden-Württemberg, Hessen, Thüringen, Sachsen, Bayern) have completed studies on the regional impacts of climate change, including conservation concerns. In some states, adaptation strategies are also currently under development, none have been completed yet.	Two examples for studies carried out: "Impacts of climate change on water-related ecosystems", an R+D-project in Sachsen (peatland areas) which identified expected impacts and possible measures Brandenburg: research on ways to prevent impacts of increasing drought on its large-scale protected areas, especially the Spreewald Biosphere Reserve (br-spreewald@lua.brandenburg.de).
Greece		Ministry of Environment http://www.minenv.gr/4/41/e4100.html	National report on climate change "coming soon" on website (Feb 08)
Italy		Ministry of the Environment and care for biodiversity www.minambiente.it http://www.conferenzacambiamentoclimatic2007.it/site/it-IT/ lists "hotspots" for biodiversity impacts in forests Climate conference held in Rome in September 2007, by Env't Min. Conference "manifesto" makes some ref to biodiversity	Documents only on environmental sustainability, little reference to climate change (06/07) Italy's Third National Response to the Framework Convention on Climate Change (2003) deals with emissions and mitigation nothing else on website: Feb., 2008
Netherlands	2004	Nota Ruimte (5th National Policy Document on Spatial Planning)	Identifies impacts, proposes mitigation
	2006	Regional example: Noord-Holland Water Management Plan 2006-2010	Recognition of CC impacts on water (availability, flooding)

	2006	Climate strategy: between ambition and reality (Scientific council for Government Policy http://www.wrr.nl/content.jsp?objectid=3638	(English summary seen) emphasis on flooding issues
Portugal		ICN: Instituto da conservacao da natureza http://portal.icn.pt/ICNPortal/vPT/ Comissão para as Alterações Climáticas - essentially mitigation. Plan for Energy Efficiency (2007) National Strategy for Conservation of Nature and Biodiversity (2001)	Research example: SIAM project: Scenarios, impacts and adaptation measures - Project report: http://www.siam.fc.ul.pt/SIAMExecutiveSummary.pdf
Spain		National Adaptation Strategy on CC and Action Plan www.mma.es/portal/secciones/cambio_climatico/areas_tematicas/impactos_cc/pdf/pna_v3.pdf	Essentially an Action Plan for R&D, includes biodiversity
		Climate Action Plan for Andalucia 2007-2012	Mitigation programme with R&D and mention of adaptation
		Estrategia Española De Cambio Climático Y Energía Limpia Horizonte 2007- 2012 -2020	Spanish Strategy for Climate change and Clean Energy. Mitigation and adaptation measures, plus clean energy. Update to UNFCCC indicates some funding for adaptation measures.
Sweden	2002	Swedish climate policy (bill)	
UK		UKCIP (UK Climate Impacts Programme, sponsored by DEFRA) National and regional strategies for adaptation, making some reference to biodiversity. Research programme preparing technical reports. www.ukcip.org.uk Adaptation policy framework under preparation to structure roles and activities of relevant organisations - government, etc. Regional impact studies	Example of research under UKCIP: Monarch (Modelling Natural Resource Responses to Climate Change): a synthesis for biodiversity conservation Wamsley, et al. 2007 Example of regional impact assessment studies: REGIS: Regional Climate Change Impact Response Studies in East Anglia and North West England.
		A Government agency - Natural England - with responsibilities for biodiversity is preparing a campaign for a “National spatial vision” which will include spatial planning for adaptation to climate change	Managed realignment of coasts★
	2007	England Biodiversity Strategy Review for CC – available from Defra website: http://www.defra.gov.uk/wildlife-countryside/resprog/findings/ebs-climate-change.pdf	

Annex 2

Examples of adaptation strategies and actions in Europe taken from the UNFCCC SBSTA, Nairobi, 2006.

(Iglesias *et al.*, 2008 http://ec.europa.eu/agriculture/analysis/external/climate/final_en.pdf)

Adaptation action	Status
Austria	
Change of cropping patterns and agricultural management strategies.	Under development
Water-saving or more efficient irrigation techniques.	Under development
Development of new cultivars with extended growth periods, multi-stress resistance and improved water use efficiency.	Under development
Belgium	
Coastal areas: Sigma Plan for flood protection and control (including new controlled flooding zones).	Under implementation
Cyprus	
Adaptation strategies to combat water shortage.	Ongoing
Introduction of severe water restrictions on domestic and agriculture water supplies.	Under development
Implementation of irrigation programmes according to crop needs.	Under development
New and improved irrigation systems.	Under development
Finland	
National Strategy for Adaptation to Climate Change: adaptation measures identified as immediate (2005-2010), short-term (2010-2030) and long-term (2030-2080). Immediate: planning of water services, surveying of risk sites, preparation of general plans for risk sites, construction of irrigation systems for agriculture; short-term: improve preparation for exceptional situations and regional co-operation, increase discharge capacity of dams, improve dam safety and re-evaluate design discharges at major dams, restrictions on water use; long-term: adapt national plans to climate change effects and improve climate forecasting	Ongoing
Five-year research programme to support the implementation of the National Adaptation Strategy: 15 projects in forestry, agriculture, spatial planning, built environment, floods, drought and biodiversity were started in 2006.	Ongoing
France	
National observatory on climate change impacts (ONERC): collects information from research and informs policy makers (including local communities) on impacts, vulnerability and adaptation.	Ongoing since 2002
National adaptation strategy.	Published 2007
National adaptation plan.	Under development
Assessment of costs of impacts and adaptation at national level.	Under development
Germany	
KomPass: 'Competence Centre' on climate change impacts and adaptation.	Ongoing
National Adaptation Strategy.	Under development
Klimastudie Brandenburg: guidelines on improvement of landscape water balance and impacts of moderate climate change on semi-natural ecosystems, managed forests and agricultural yields.	Ongoing
INKLIM (Hesse): assessment of climate change impacts until 2012 and possible adaptation measures in different sectors, including agriculture.	Ongoing
KLARA (Baden-Wuerttemberg): assessment of climate change impacts on vulnerable sectors, including agriculture.	Completed
Hungary	

Adaptation action	Status
VAHAVA project: coordination, publication/dissemination and expert debates on climate change issues.	Under development
New Vásárhelyi Plan: emergency reservoirs along upstream and middle Tisza sections to enhance flood safety. Focus on flood control, conservation and environmental protection, ecotourism, agro-ecological farming, rural development.	Under development
Italy	
Establishment of a National Action Plan (IMELS, 1999) and a National Committee to Combat Desertification.	Ongoing
National plan for irrigation: specific funds are allocated to alleviate the effects of extreme events (including droughts).	Ongoing
Rural Development Plan: the National Strategic Plan includes specific measures for water quantitative protection, especially for “improvement of agricultural sector and forestry competitiveness” and “environmental and rural areas improvement”.	Ongoing
CLIMAGRI climate change and agriculture project: improved the knowledge of linkages between agriculture and climate change. Focus on climate change impacts, but with a view to support implementation of response measures and draw recommendations for adaptation. Sub-projects: 1. Climatic analysis and future scenarios; 2. Italian agriculture and climate change; 3. Drought, desertification and water resources management; and 4. Data dissemination and communication.	Completed 2001-2004
Latvia	
Project ASTRA: developing policies and adaptation strategies for climate change in the Baltic Sea region (2005-2007).	Ongoing
Risk management conception in agriculture (2007).	Under consideration
Malta	
Draft National Rural Development Strategy for the period 2007-2013: recognises the impact of inundation, increased risk of flooding, deterioration and erosion of soil, accelerating desertification processes, as well as damage to the landscapes, agriculture and animal husbandry operations and to natural terrestrial and marine ecosystems with loss of biodiversity. Also highlights the likelihood of future water shortages and outlines priority actions to be undertaken in order for agriculture to adapt to climate change.	Under development
PRODIM: a transnational Interreg III B-funded project to develop a comprehensive pro-active management plan to combat drought and water scarcity in drought-prone areas of the Mediterranean region, with particular reference to the islands and coastal areas.	Under implementation
Government is planning a major flood relief project for Birkirkara, which will involve the catchment of storm water coming from Mosta, Naxxar, Iklin, Attard and Balzan, its storage in galleries and its use for irrigation by farmers.	Under consideration
Netherlands	
National Spatial Adaptation Strategy to Climate Change: being developed by national government in cooperation with waterships, regional and local governments. Focuses on the effects of climate change in the Netherlands under the main themes: safety (against flooding), the environment, biodiversity and economic sectors. Strategy is stressing the need for spatial adaptation to climate change and is using leading principles in order to adapt. Also stresses the need for a transition within society (awareness into action). National government will agree the national strategy and a national adaptation agenda in 2007.	Under development

Adaptation action	Status
Agricultural sector has responsibility to cope with climate change: farmers should optimise their production process through choices about what to produce and where. Government has a supportive task to provide alternatives through science and make instruments climate proof. Adapting to changing conditions is to a large extent normal agricultural practice. Dutch farmers have been highly successful in doing so given that they have adequate technical training and financial resources.	Ongoing
Dutch government and the agricultural sector reached agreement on a state guarantee for insurance policies for damage as a result of heavy rainfall in 2004: sector no longer applies for government compensation in the case of an extreme event. Crop damage caused by heavy rainfall is now an insurable risk in the Netherlands.	Ongoing
Water managers throughout the Netherlands (Rijkswaterstaat for the large river, lake and coastal water systems and the regional Water Boards for the smaller backwater systems) are currently developing adaptation strategies: aimed at re-arranging the spatial design of the landscape to enhance its flexibility to retain and store freshwater surpluses at times of high precipitation and/or peak river discharges and, at the same time, enhancing flow capacities of the river systems to ensure their ability to cope with higher peak discharges.	Ongoing
Portugal	
National Adaptation Plan for the Water Resources Sector: integrated with the National Climate Change Adaptation Plan and the new generation of River Basin Plans.	Under consideration
Research and development efforts on climate change, climate change impacts and adaptation.	Ongoing
Several ad-hoc specific measures in the licensing, land use management and infrastructure domains that enhance the country's adaptation capacity.	Under implementation
Implementation of several new irrigation schemes, private or collective.	Under implementation
Rehabilitation of existing irrigation schemes to improve irrigation efficiency.	Under implementation
Groundwater abstraction for animal husbandry in drought conditions.	Under implementation
Portuguese National Action Programme to Combat Desertification: includes soil and water conservation; recovery of areas most threatened by desertification; research, experimentation and diffusion; ensuring that desertification is included in development policy; implantation, monitoring and assessment.	Ongoing
Romania	
National Action Plan on Climate Change (2005): highlights the need for an Action Plan on Adaptation by 2007.	Under consideration
National sectoral research programme: to assess Romanian agro-climatic potential and establish favourableness for the main crops in order to initiate a sustainable management system in the agricultural domain according current climate and climate change scenarios. Also elaboration of specialized agricultural systems with reference to climatic regions, taking into account their vulnerability to extreme events and impact on vegetal production, whilst considering changes in crop systems and structure, obtaining new genotypes with high tolerance to extreme events, annual planning and establishment of crops, including plant species and hybrids with different vegetation periods.	Under consideration
New agro-climatic mapping 'AGROCLIMA ROMANIA': identification and classification of vulnerable areas to extreme events.	Under consideration

Adaptation action	Status
Implementation of 'dry-farming' technologies in the most vulnerable areas to drought: to develop crop schemes with better limitative climate tolerance.	Under consideration
Use of wind energy for irrigation of drought vulnerable areas.	Under implementation
Attitude Code for Farmers: specialised assistance dedicated to local communities regarding the adaptation of technologies and agricultural practices to climate change. Chapter 3 contains brief description of practices, benefits and dangers. Topics include soil and land use, water management in agriculture, disease and pests.	Ongoing
ACCRETe 'Agriculture and Climate Changes: how to Reduce human Effects and Threats': assessment of climate change impacts on agriculture. Recommendations for good practice to mitigate effects of climate change, to combat drought and desertification, and on efficient water use in agriculture.	Under implementation
Climate neutral land use patterns: improve land management approaches and planning at local, regional and national scale.	Under consideration
Agro-meteorological programme: monitoring of meteorological parameters and agro-meteorological parameters for the most important crops. In-situ measurements of soil moisture and observation of phenological change. Use of simulation models for crop-weather relationships to assess the impact of climate change on yield and plant water use. Use of GIS and remote sensing to determine spatial variability of agro-meteorological parameters. Research and elaboration of case studies related to climate change impacts on agriculture and the environment. Training of agro-meteorology specialists and dissemination of information to end-users and decision makers.	Under implementation /ongoing
Code of good practice: crop rotation, dropping irrigation, feri-irrigation.	Under development
Slovenia	
Strategies for flood and drought mitigation under National Environmental Programme: determination of risk areas and regulation of land use.	Ongoing
Spain	
National Adaptation Programme to Climate Change (PNACC).	Ongoing
Coordinated research programme between national and regional governments on climate change impacts and adaptation.	Under development
Sweden	
Commission on Climate and Vulnerability: internet-based adaptation guidelines.	Published Oct 2007
United Kingdom	
Adaptation Policy Framework: co-ordination of adaptation activities across UK Government, involving comprehensive coverage of sectors; coherent approach across departments, levels of government, and wider public sector; provision of strategic direction, without duplication of existing efforts; definition of roles and responsibilities; provision of sound evidence base for decision-making; identification of threats and opportunities.	Ongoing

Adaptation action	Status
UK Climate Impacts Programme (UKCIP): set up in 1997 and funded by the UK Department for Environment, Food and Rural Affairs (Defra), UKCIP helps organisations assess how they might be affected by climate change, so they can prepare for its impact. Based at the University of Oxford, UKCIP works with stakeholders/partners and co-ordinates research - based on stakeholders' needs - on how climate change will have an impact on their activities, and ways in which they can adapt to minimise these impacts. UKCIP provides a bridge between researchers and decision-makers in government organisations and business.	Under implementation
'Preparing for a Changing Climate in Northern Ireland': the report examines the impacts of climate change and identifies the threats and opportunities together with the adaptive strategies required over 13 different sectors.	Under implementation
UK DEFRA Sustainable Agriculture Climate Change Adaptation Research Programme: to initiate preparation of alternative agriculture options and other response measures, including alternative crops, cultivation methods and pest, weed and disease controls.	Under implementation
Rural Climate Change Forum: a stakeholder forum, co-chaired by a DEFRA minister that provides advice on climate change and rural land management, including adaptation and managing the impacts of climate change.	Under implementation
Strategic review of the impacts of climate change on land management in England and Wales: conducted by the Environment Agency.	Initial review completed
Agricultural Change and Environment Observatory (ACEO): funded by DEFRA and others, it provides evidence for policy making on the range of environmental issues for agriculture. One of the aims is to look at the links between the changes observed in farming practices and observed environmental changes, including adaptation to climate change. 'Farmers' Voice' survey 2006 (part of ACEO research programme) includes a chapter on adaptations as a result of climate change.	Under implementation
Vale of Evesham Project: specifically examining the impact of an extreme weather event (heat wave of 2003) on farms in the Vale of Evesham and the measures that farmers took in response.	Under consideration.

Annex 3

Synthesis of national biodiversity adaptation activities from: Bern Convention ‘Group of Experts on Biodiversity and Climate Change’, 2008.

Albania	<p>Identification and implementation of adaptation response measures in Drini - Mati River Deltas</p> <p>Gef through the UNDP together with cost sharing from the Government of Albania have funded the project preparatory phase PDF A: "Identification and implementation of adaptation response measures in Drini _ Mati Deltas" which aims to to build adaptive capacities in the Dini - Mati River Delta areas in order to protect vulnerable ecosystems and local livelihoods.</p>
Armenia	<p>Second National Communication: single out those areas and ecosystems of Armenia, which are not included in specially protected areas, but have in their structure biodiversity species of global and/or national importance, and suggest adaptation measures aimed at those species in the form of management plans for those territories.</p>
Bulgaria	<p>No specific biodiversity adaptation activities recorded.</p>
Czech Republic	<p>In 2004 the Ministry of the Environment of the Czech Republic released National Program to Abate the Climate Change Impacts in the Czech Republic (http://www.env.cz/AIS/web-en.nsf/pages/Climate_Change).</p> <p>The program includes main policies and measures for reducing greenhouse gas emissions as well as adaptation strategy. It has been evaluated in 2007 with a special view to the assessment of the effects brought by measures implemented since 2004. The evaluation should be approved by the Government soon.</p> <p>Adaptation measures that can positively influence biodiversity: soil protection (against erosion and other land degradation), natural habitat and native species protection, supporting natural processes in ecosystems, measures against the expansion of invasive alien species or water courses restoration.</p> <p>There are two projects on adaptation to climate change in the Czech Republic taking place currently. The aim of one of them is to downscale global models to regional conditions of the Czech Republic and to elaborate concrete measures in water management, agriculture and forestry sectors. The second project addresses adaptation measures in small forest drainage areas/river basins with a special view to water management in those ecosystems. Results from these projects are expected in a 5-year term.</p>
Denmark	<p>An overall national strategy for adaptation to climate changes (“Strategi for tilpasning til klimaændringer i Danmark”) was launched by the Government in March 2008. The strategy describes a number of initiatives to be implemented by the various sectors during the next decade.</p> <p>Among the climate adaptation tools relevant in nature management the strategy emphasizes:</p> <ol style="list-style-type: none"> 1) restoration of certain river-valleys to the state of natural, extensively managed wetlands; 2) targeting the use nature protection orders, detailed planning related to the NATURA 2000 and Water framework directives, nature restoration and grant schemes in order to increase ecological connectivity in the fragmented Danish landscapes; 3) an action plan on invasive species will include analyzes of the need of efforts related to the climate changes in order to prevent negative consequences of existing or possible new invasive species.
France	<p>No English translation.</p>
Germany	<p>The project “Protected Areas in Germany under Global Change – Risks and</p>

	<p>Policy Options” is ongoing and set to run until July 2009. This project will produce among other things ecological risk assessments with regard to the conservation targets of selected protected areas in Germany and aims to formulate concrete steps towards necessary adaptations, also at the national scale. So far, methods have been developed for the modelling of habitat changes and for assessing risks to species, regionalised climate scenarios have been developed for the selected protected areas and modelling of plant and bird distributions has been undertaken. More information is available at: http://www.pik-potsdam.de/forschung/aktuelle-forschungsfelder/klimawirkung-vulnerabilitat/vme/schutzgebiete/index_html?set_language=en</p> <p>At the federal level, a National Strategy for Adaptation to Climate Change is currently being developed. The process is coordinated by the Federal Environment Ministry and the strategy is expected to be drawn up and consulted upon by the end of this year. Nature conservation will be one of the sectors considered in the strategy.</p>
Latvia	<p>A new Climate Change Adaptation Policy is under preparation.</p> <p>The Faculty of Geography and Earth Sciences of the University of Latvia as a partner was involved in the INTERREG III B project "Developing Policies & Adaptation Strategies to Climate Change in the Baltic Sea Region" (ASTRA) (2005-2007). The main objective of the project was to assess regional impacts of the ongoing global change in climate and to develop strategies and policies for climate change adaptation. www.astra-project.org</p>
Norway	<p>A Norwegian strategy for climate change adaptation will be developed as part of a five year national climate adaptation programme which started in 2007. A Norwegian follow up to the Arctic Climate Impact Assessment will be published in 2009 and will include impacts on ecosystems and biodiversity. The Directorate for Nature Management has recently published three reports on climate change and adaptation, a database on climate change effects on biodiversity and is strengthening its national monitoring of climate change impacts.</p>
Serbia	<p>No specific biodiversity adaptation activities recorded.</p>
Spain	<p>The National Plan for the Adaptation to Climate Change (NPACC) is the reference framework for the coordination of all activities related to the evaluation of impacts, vulnerability and adaptation to climate change in Spain.</p> <p>Its main objective is the integration of the adaptation to climate change in the planning strategy of, initially, fifteen sectors and systems through a series of Work Programmes. Under the first Work Program, the priority sectors and activities considered are the generation of regional climate scenarios and the evaluation of the impact of climate change in water resources, coastal areas and biodiversity.</p> <p>The Ministry of Environment started in 2006 the preparation of a project to assess the impacts of climate change on biodiversity and to make informed decisions on practical adaptation actions and measures. The main objective of the project is to assess the impacts and vulnerability of biodiversity to climate change, as well as the adaptation measures required to prevent biodiversity loss related to climate change.</p>
Sweden	<p>The Commission has analysed how the climate of Sweden may develop over the next hundred years. Important aspects that have been investigated are vulnerability to floods, landslides and storms. Terrestrial, marine and freshwater ecosystems will face great upheavals, and the loss of biodiversity may increase. The commission propose various measures to reduce vulnerability and adapt</p>

	<p>society to long-term climate change and extreme weather events. The report: http://www.sweden.gov.se/content/1/c6/09/60/02/4b04b42e.pdf</p> <p>Nordic nature management in a changing climate The Nordic Council of Ministers has made a report in 2005 that describes how the climate and nature may develop in the Nordic Region south of the Arctic Circle in the next 100 years. The report also describes how effects of climate changes can be integrated in nature conservation and management.</p>
Turkey	<p>First National Communication of Turkey on Climate Change was completed in 2006. This report contains climate change, vulnerability assessment and adaptation measures, climate change scenarios, sea level rise and coastal implications, assessment of impacts and adaptation measures (impact of climatic changes on water resources, agriculture, marine ecosystems and fisheries, terrestrial and freshwater ecosystems, wetlands, special protection areas and biodiversity)</p> <p>Biodiversity Strategy and Action Plan Preparing Project was prepared by The Ministry of Environment and Forestry (General Directorate of Nature Conservation and National Parks) and completed in 2007. Project duration was 18 months. This Action Plan contains determination and monitoring of climate change, potential future effects on biodiversity and taking measures to prevent the climate change effects on vulnerable species and ecosystems. For more information: www.bcs.gov.tr.</p>
UK	<p>The UK Climate Change Bill was introduced to Parliament in November 2007. The Bill will create a new approach to managing and responding to climate change in the UK through: setting ambitious targets, taking powers to help achieve them, strengthening the institutional framework, enhancing the UK's ability to adapt to the impact of climate change and establishing clear and regular accountability to the UK, Parliament and devolved legislatures. The Bill should become law by the end of 2008. www.defra.gov.uk/environment/climatechange/uk/legislation/index.htm</p> <p>On January 29 2008, the Scottish Government published a consultation which sets out proposals for a Scottish Climate Change Bill. The Bill is intended to create a long-term framework for the current and successive administrations in Scotland to ensure that carbon emissions are cut by 80% by 2050. www.scotland.gov.uk/Publications/2008/01/28100005/0</p>



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