IMPACTS AND OPPORTUNITIES OF A CHANGING CLIMATE ON HAMPSHIRE'S BIODIVERSITY

Evidence to the Hampshire Commission of Inquiry on Climate Change

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Introduction

The natural environment is fundamental to quality of life in Hampshire. The benefits of biodiversity are well documented in the County Council's *Corporate Biodiversity Action Plan*[1] and include health and well being, recreation, education and support to the economy.

The pattern of habitats and species seen in Hampshire today is the result of the interaction between climate, soil and human activity. In the past Hampshire, as elsewhere in the UK, has suffered a large loss of biodiversity to development, agriculture and forestry. Our climate is now changing and we are now entering a new and significant phase of stress on the natural environment.

Despite uncertainties there is substantial evidence predicting the future influence of climate change on biodiversity. Indeed there is evidence that ecological change is already occurring. Later this month DEFRA will be launching a major report on biodiversity and climate change as part of the England Biodiversity Strategy[2].

It is essential that we plan now for this change, and through the development of policy and practice, assist biodiversity to be resilient to adverse change. We also need to embrace and nurture change that is acceptable and beneficial.

The biodiversity of Hampshire

Hampshire is extremely rich in wildlife. The county embraces a remarkable diversity of habitats unparalleled in the South East – from ancient woodlands and wildflower meadows, lowland heathlands and chalk streams, to river valleys and coastal habitats. The New Forest is the largest area of semi-wilderness left in lowland England.

Habitats of priority concern for nature conservation have been identified in the UK Biodiversity Action Plan and a programme of conservation effort has been cascaded from the national to local level. The priority habitats in Hampshire are listed in Annex 1.

Hampshire has the greatest diversity of species of any county in England. Reasons for this include: the merging of two climatic zones; the county's situation on the coast; the broad extent and stability of a considerable range of habitats; and the New Forest.

Full descriptions of the habitats and species of Hampshire can be found in the *Biodiversity Action Plan for Hampshire*[3,4]. A review of the state of biodiversity in Hampshire, identifying changes in the last ten years and future challenges

and opportunities is included in the report *The State of Hampshire's Biodiversity*[5]. Both reports have been published by Hampshire County Council on behalf of the Hampshire Biodiversity Partnership.

Designations

Over 23% of Hampshire is designated for its nature conservation importance. Britain's most valuable wildlife habitats – Sites of Special Scientific Interest (SSSIs) are legally protected and cover 14.5% of the County, twice the national average. Many of these areas are also important internationally and have added protection through European law. (Special Protection Areas, Special Areas of Conservation, Ramsar sites). A further 8.7 % of Hampshire is covered by county Sites of Importance for Nature Conservation (SINCs), identified by the County Council in partnership with other local authorities, Natural England and the Hampshire Wildlife Trust. Even outside all of these specially recognised areas much of Hampshire's rural landscape and many urban areas are rich in biodiversity. (See Annex 1 for map of designated sites)

PART 1 IMPACTS OF CLIMATE CHANGE ON BIODIVERSITY

1.1 Types of impact

Climate change will have a wide range of impacts on Hampshire's biodiversity. Habitats will change and species will be displaced from current locations and change their distributions. Impacts will be **negative**, but some changes will be benign. Climate change will also offer **opportunities** for biodiversity – we have already welcomed the arrival of the little egret from the continent to our shores.

Influences on biodiversity will be **direct**, for example loss of saltmarsh to sea level rise. Other influences will be **indirect**, resulting from changes in activities such as agriculture in response to climate change.

It should also be noted that the negative impacts of climate change on biodiversity can be **exacerbated** by other activity, for example water abstraction or loss of habitat to development. Avoidance of exacerbating factors is a fundamental requirement of any strategy to minimise the adverse affects of climate change on biodiversity.

Gathering the evidence

The evidence of direct impacts of climate change on biodiversity comes from a variety of sources including modelling studies.

One of the largest modelling programmes is MONARCH, undertaken under the Climate Change Impacts Programme[6,7]. This project has used computer modelling to map the current suitable climate space in the UK for 400 individual species and has estimated (over time and under differing climate change scenarios) the likely change in geographical area suitable for each species. The study is showing how the climate space for individual species could

contract, expand or shift as climate changes. (Annex 2 provides an example of maps produced by MONARCH showing predicted changes in species distribution)

BRANCH (Biodiversity Requires Adaptation in Northwest Europe under a Changing Climate) is a three-year, multi-partner, multi-project programme aiming to raise awareness of climate change and identify spatial planning response to climate change. Natural England is the lead partner, bringing together partners in South East England (including Hampshire County Council) the Netherlands and France. BRANCH has used the modelling work undertaken by Monarch to raise awareness and has helped facilitate case studies, including coastal studies in Hampshire, to demonstrate impacts.

The Hampshire Biodiversity Information Centre, based within Hampshire County Council, has worked with Monarch to develop mapping of the implications of climate change on heathland and chalk downland in Hampshire.

Extensive mapping of the effect of sea level rise on Hampshire's coast has been undertaken by a variety of projects in partnership with Hampshire County Council.

The Forestry Commission have also undertaken modelling of potential change in woodland composition in the UK under varying climate change scenarios[8].

1.2 Direct impacts of climate change on biodiversity

Potential changes to habitats and species in Hampshire under a changing climate include:

- Loss (extinction) of species
- Arrival of species not currently found in Hampshire
- Change in populations and distribution of species
- Changes in extent and distribution of habitat
- Changes to species composition and structure of habitats

Set out below are brief summaries of some predicted changes to selected habitats and species in Hampshire. This brief synopsis shows that the main adverse implications are for rivers, wetlands and the coast.

1.2.1 Lowland heath - Overall in Great Britain heathland is likely to remain stable, but in the South East wet heath is expected to dry out and change to dry heath or acid grassland. Specific wetland species, such as marsh gentian will suffer. There is likely to be an increased incidence of fires on Hampshire's heathland. Some heathland species will gain - the European protected bird Dartford warbler, on the north of its range in Hampshire, is expected to increase.

1.2.2 Hedgerows - Hedgerows are likely to be little affected, but increase in summer drought could stress certain species such as beech.

1.2.3 Chalk grassland – The vegetation composition of this habitat will change, but the precise change is uncertain and will depend on local conditions. Deep rooted flowering plants could increase under drought, but increase in temperature and rain in the winter may favour competitive grasses

at the expense of flowering plants. Bryophyte communities relying on humidity may be lost.

Increases in butterflies such as Adonis blue are expected, but ability to spread will be limited because of fragmentation of this habitat. Summer drought could reduce invertebrate communities.

1.2.4 Lowland wet grassland - Wet meadows will be subject to drought and lower water tables. This will adversely affect bird populations.

1.2.5 Woodland - Effects on woodlands are mixed and uncertain. There is prediction of stress on beech which is drought sensitive. Studies show that ash may replace beech under a low emission scenario and oak replace beech under a high emission scenario. Nevertheless there will always be beech woodland due to variation in local conditions and ash or oak as replacement species will be valuable for biodiversity. Wet alder woodland is under most threat, along with its invertebrate specialists.

There are likely to be subtle changes to woodland composition through changing competitive advantage amongst both trees and ground vegetation. But far more serious is the threat of pests and disease which will become more prevalent under a changing climate (see 1.2.9).

Increase in the severity of storms may result in wind-throw within woodland, but resulting woodland gaps and dead wood are good for biodiversity. Studies of woodlands damaged in the 1987 storms in South East England have shown a significant increase in biodiversity by 2001.

1.2.6 Rivers, wetlands and water bodies - Winter rainfall is predicted to increase and summer rainfall decrease. These changes will potentially alter flow regimes of streams and rivers with the potential for more frequent winter flooding and summer drought. Less summer rain, higher temperatures and increased evapo-transpiration will lead to increased frequency of drought and, with likely increased demand for water abstraction, river flows are likely to be reduced and river-side habitat will dry out.

Increase in water temperature may affect some species. For example, warming of water, low flows and siltation will affect upstream migration and spawning of salmon. Low flows may concentrate nutrients and lead to eutrophication, and riverbeds may become scoured through flash winter floods.

The drying of floodplains in the summer will adversely affect breeding wader populations which are already depleted, for example in the Avon Valley. Surface waters and grazing marsh ditches may dry out. Fen meadows will change in character and mires and bogs in the New Forest may be lost through repeated drying out.

Ponds and small water bodies are likely to dry out affecting species such as great crested newt and the common frog. Algal blooms on water bodies will

increase. There will also be an increased risk of pollution to water bodies through runoff from agricultural land.

1.2.7 Coast - The most definite and visible affect of climate change on Hampshire's biodiversity is the loss of coastal and esturine habitat as a result of sea level rise. Sea levels have been rising for some time due to the sinking of land in the Southern England, but this is now exacerbated by sea level rise as a result of climate change.

Rising sea levels and increased frequency of storms will squeeze low-lying saltmarsh and mudflats against hard sea defences, thus reducing their extent. These habitats are designated for their international importance. It is estimated that if sea defences are maintained in Hampshire up to 830hectares of coastal habitat may be lost over the next 100 years. These dynamic habitats will only be maintained if sea defences are re-aligned to allow landward migration. Options for doing this are limited by urban land and land of existing nature conservation importance such as saline lagoons and grazing marsh.

Loss of mudflat and saltmarsh will reduce the area available for internationally important populations of wintering birds such as dunlin, grey plover knot and godwit. Breeding waders such as redshank and curlew will also be affected. Wildfowl such as brent geese and wigeon may also be affected if eel grass beds on which they are dependant are destroyed by increased wave action. Rising sea levels is also a concern for nesting terns, as their nest will be prone to flooding during high water events.

Invertebrates

The overall trend for invertebrates is likely to be an increase in biodiversity. Invertebrate communities will change, but the current most valuable areas for wildlife are still likely to be the most important in the future.

Butterflies and other invertebrates such as dragonflies are showing substantial expansions of their range northwards, but sedentary or specialist species may be unable to spread in a fragmented landscape.

Two rare butterflies, the Adonis blue and silver-spotted skipper, have extended their range in Hampshire over the last ten years. The clouded yellow butterfly, formerly regarded as a summer migrant from Europe, is now a UK resident as a result of milder winters. The small red damselfly is a continental species now established in Hampshire as a direct result of climate change. The wasp spider once confined to the Hampshire coast is now present throughout the county.

Birds

Of particular concern are the impacts on breeding waders as Hampshire's river valleys become drier and the impacts on coastal birds as a result of loss of habitat to sea level rise.

Some species from further south may colonise Hampshire if climate and habitat conditions become favourable to them. Examples include great reed warbler, black kite and cattle egret. Populations of Dartford Warbler will grow and move northwards as they are less restricted by cold winters.

Numbers of brent geese wintering in Hampshire are likely to fall as the birds remain closer to their northerly breeding grounds and no longer fly so far south

Milder winters may allow more invertebrates to remain active and thus provide food for birds. However, parasites will be less likely killed off by frosts, resulting in increased parasite burdens.

Ground-nesting species are vulnerable to prolonged periods of wet weather or particularly heavy rainfall, which can result in flooding of nests or chilling of young chicks. Increased incidence of such weather in spring and early summer could have negative impacts on species such as skylark, lapwing and grey partridge.

1.2.8 Phenology

Phenology, the science of recording natural regularly occurring events, is demonstrating how climate change is affecting our wildlife. We are all aware for example that leaf bud and flowering of plants is occurring earlier in the year than it used to. Phenological change can have severe and widespread consequences for wildlife since species are interdependent. For example, blue and great tits are already showing population declines as the timing of their nesting has moved out-of-step with the peak availability of caterpillars

Some migrants are arriving earlier (e.g. swallows arriving 1 week earlier than in the 1970s). Whilst this may be beneficial for some species that are able to rear more than one brood in a season, it has implications for others whose breeding is timed to coincide with peak food availability. Migrants such as pied flycatcher and wood warbler are no longer able to time their breeding with the maximum availability of key food sources.

Research on Hampshire's butterflies has shown that whereas in the late 1980's around 15 species would emerge before the end of April, by the late 1990s this figure had risen to about 18-20 species. The exceptionally mild winter and warm spring of 2007 has resulted in an unprecedented early emergence with at least 26 species recorded before end April. The same shifts have also been noted for many moths and various other insects including beetles and bees. Such dramatic shifts will have knock-on effects for the whole food chain, especially insect- eating birds and bats.

Unless species are able to simultaneously adapt and synchronise this could have serious consequences. Some of the specialist species may struggle with the pace of change. Little can be done to help avoid this type of change.

1.2.9 Pests and disease

Milder, wetter winters and warmer summers may lead to conditions that favour pests and diseases. The harlequin ladybird, a pest species first recorded in Britain in 2004, is a voracious predator on native ladybirds and other insects and is now established in Hampshire. The long-term implications of this are unknown.

Woodland faces a variety of threats. Soil bourne pathogens can be promoted by fluctuating water tables. Defoliating moths and beetles may become more prevalent. Deer populations may increase, increasing the damage to the regeneration of woodland.

The increase in pests and disease is likely to be a problem for agriculture. Any increased spraying of pesticides and herbicides to combat this will have knock-on effects on wildlife.

1.3 Indirect effects of climate change on biodiversity

1.3.1 Agriculture

Effects on biodiversity of changes to agriculture in response to climate change are uncertain, but likely to be very significant. The type of crops grown in Hampshire will change as will the extent of certain crop types. This will be in response to change in the suitability of growing conditions and the stimulus to grow bio-fuel for the mitigation of climate change. Effects on biodiversity will depend on the type of crop grown, the area in which the crop is grown and the agricultural practice by which the crop is grown.

More flower crops such as lavender and sunflower can be expected. Wheat and oilseed rape may be favoured as energy crops, although wheat growing may move away from Hampshire as conditions become too hot and dry for cereals to grow without irrigation.

Maize may increase which would be negative for wildlife since it has few associated invertebrates and it grows too high ground nesting birds such as skylark. Maize also requires considerable agro- chemical inputs. River valleys have been traditionally favoured for growing maize. Late harvesting exposes bare soil as winter rains arrive and this has been linked to soil erosion and siltation which affects riverine biodiversity.

Autumn planting of winter crops is likely to increase to take advantage of warmer winters and avoid summer drought. This would be detrimental for many birds, including ground nesting lapwings and skylarks that need open fields for their nests in spring. Autumn planting would also reduce availability of winter stuble, important for wintering birds such as finches and buntings.

Farmers often try to plough before ground nesting birds start to build their nests in spring. With wetter winters preventing early ploughing and birds nesting earlier because of warmer temperatures, ploughing without disturbing nesting birds will become more difficult.

The growing season may extend to allow double or even triple cropping. This could cause disturbance to breeding birds. It will also involve more applications of pesticide and herbicide with knock-on effects on invertebrates and wildlife.

Pests are likely to increase as a result of warmer winters resulting in increased applications of pesticides. The warm wet winter of 1989/90 resulted in a large increase in aphids and a fall in yield of wheat and barley.

Overall farmers will be under pressure to intensify their farming as the climate warms. It is difficult to predict how market forces may operate, but changes could be quick and have far reaching consequences.

1.3.2 Bio energy crops

Interest in bio-energy crops stems principally from a desire to reduce greenhouse gas emissions. Biomass includes various different types of fuel and energy generation including fuel for vehicles (such as biodiesel and bioethanol) and wood fuel used for heating or in combined heat and power plants.

The principal crops involved are:

- wheat for conversion to bioethanol
- oilseed rape for biodiesel
- elephant grass (miscanthus) harvested and burnt as a fuel source
- short-rotation coppice.

In Hampshire, the principal crops are likely to be wheat and oilseed rape as they are well established as arable crops in the county. New crops such as elephant grass and short-rotation coppice are likely to have less appeal as they need to be grown in proximity to a power plant to minimise transportation costs.

Growth of energy crops will have the same effects typical of other intensive agriculture prompted by climate change. For example, modern varieties of oilseed rape and maize particularly require intensive use of agro-chemicals. Miscanthus has little proven benefit for wildlife.

Short-rotation willow coppice has been found to support higher numbers of birds than surrounding arable and grassland and a wider variety of plants and invertebrates. However short-rotation coppice is likely to have limited application in Hampshire. It would be restricted to river valleys where conditions are appropriate and the limited availability of water in catchments will also limit its adoption. Conversion to short-rotation coppice from arable replaces the annual cycle that provides stubble and open ground for birds.

1.3.3 Forestry

Forestry will have to respond to the influences of climate change on trees and woodland. Choice of species for planting will be guided by an understanding of those trees most suited to the evolving climate, both in terms of productivity and resistance to pest and disease.

Choice of species may include non-UK species more suited to continental climates. However, planting of non-native species in certain locations,

particularly ancient semi-natural woodland, would be detrimental to biodiversity.

1.3.4 Wood fuel

With more woodland than any other county in the South East, Hampshire is well placed to contribute to the provision of renewable energy in the form of wood fuel.

In March this year the Biodiversity Minister launched the *Woodfuel Strategy For England*[9]. This aims to boost the wood fuel market with an extra 2m tonnes of wood per year by 2020, saving 4000,000 tonnes of carbon annually, which is equivalent to taking 550,000 cars off the road.

As well as cutting carbon and producing renewable energy, wood fuel has the potential to benefit biodiversity by helping to reverse the long-term decline in woodland management, a situation that the County Council in partnership with the Forestry Commission has been addressing through support to the coppice industry.

The wood fuel industry also has the potential to support the management of other habitats in Hampshire, for example the use of scrub and woodland material removed to restore open heathland.

1.4 The benefits of biodiversity in a changing climate

1.4.1 Amelioration of urban climate

Promotion of the concept of green infrastructure in towns and cities is gaining momentum. Hampshire County Council and others promoted the recognition of green infrastructure in the South East Plan and it is now included within the Plan's biodiversity policies.

Green infrastructure comprises open space, street trees, vegetation on buildings (green roofs), sustainable urban drainage and green links with surrounding areas, meeting the needs of wildlife, recreation, health and the economy. Biodiversity is central to the concept of green infrastructure.

Green infrastructure within urban areas has the potential to considerably benefit urban living conditions under climate change. Greenspace in urban areas provides areas for rainwater to infiltrate into the ground and so reduce surface run-off. It creates cooler microclimates through evapo-transpiration and shading, and it absorbs air pollution. Under a high emissions scenario the temperature of woodland has been calculated to be some 13.9 C cooler than that of a town centre. Under a changing climate gardens and brownfield sites take on added importance in both ameliorating climate and providing habitats for biodiversity.

However, in some locations, trees and green space will come under increasing stress from climate change. Innovative ways of maintaining water in urban areas to maintain the health of trees and green space will be required.

Planting of vegetation on buildings (green roofs and walls) is a long standing practice in continental Europe and has gained widespread acceptance in the UK over the last ten years[10] Green roofs are proven to:

- absorb storm water run-off
- reduce the heat island effect
- cool buildings in summer
- insulate building in winter
- cut energy consumption
- absorb pollutants and improve air quality

There are good examples of innovation in green infrastructure and the current preparation of a green infrastructure strategy for South Hampshire has the potential to demonstrate good practice.

1.4.2 Flood control

The increased amount and intensity of winter rainfall over short periods is increasing the risk of flooding. Natural habitat such as wetlands and woodland have the potential to soak up water and mitigate flooding. Biodiversity has an important role to play in catchment and floodplain management schemes, and also local flood alleviation schemes.

PART 2 ADDRESSING THE IMPACTS OF CLIMATE CHANGE ON BIODIVERSITY

2.1 Action, risk and uncertainty

The importance of helping biodiversity to adapt to climate change should not be underestimated. Threats to biodiversity of the type and scale identified in this report are threats to quality of life, biological products and ecosystem functions.

The influence of climate change on biodiversity was discussed at the Hampshire Biodiversity Partnership conference, '*Biodiversity in Hampshire: achieving a sustainable future'*, held in November 2006. Following the conference, the Partnership has made a commitment to produce a supplement to the Biodiversity Action Plan for Hampshire to take account of climate change.

While some impacts of climate change on biodiversity are certain, there is uncertainty about extent and timescales of climate change and the levels and type of response of biodiversity. There are also gaps in ecological

understanding. Climate change and its influence on biodiversity is a dynamic situation. This suggests the following requirements:

- Application of risk assessment to determine appropriate levels of policy and action and embodiment of the precautionary principle
- Ensuring ' no regrets' adaptation measures – they would be justified under all plausible future scenarios and continue to be worthwhile irrespective of the nature of future climate
- The need for flexibility in climate change strategies
- The requirement for continued research, modelling and testing
- Monitoring of biological effects and success of adaptive measures
- Management of ecological data to underpin adaptation strategies

2.2 Spatial planning

Because impacts are diverse and uncertain and because they involve change in space suitable for wildlife and wildlife movement the following adaptation principles are fundamental:

Key adaptation principles

- Maintain existing habitats, both within and outside designated areas
- Reduce fragmentation of habitat and isolation of species
- Promote dispersal of species
- Maintain ecosystem functions
- Reduce and avoid pressures on biodiversity not linked to climate change, but which act cumulatively and exacerbate impacts
- Maximise resilience of habitats through appropriate management and maintain suitability of sites as receptors for species
- Safeguard land for replacement and evolution of habitat
- Restore and re-create habitat

The above principles are long standing tenets of nature conservation and are of increased importance under a changing climate. Action in accordance with the above principles is the best and most widely applicable insurance policy against the increasing, yet uncertain, impacts of climate change on biodiversity.

Spatial planning is of fundamental importance for enabling habitats and species to survive in a changing climate. A more consistent approach is required to protect, enhance, and create areas and conditions for biodiversity. This includes maintenance of ecological 'corridors' and ecological networks to form a permeable landscape of sufficient connectivity and density to facilitate and allow dispersal and adaptation.

The network of Sites of Importance for Nature Conservation (SINCs) in Hampshire forms a good basis for this connected landscape (see map in Annex 1). The identification of SINCs and the programme of support for their management led by Hampshire County Council, is increasingly important as the Hampshire countryside has to adapt to climate change.

The Hampshire Biodiversity Information Centre (HBIC) within the County Council is undertaking mapping that will assist spatial planning in response to climate change. HBIC has already mapped areas of opportunity for the recreation of heathland and chalk downland in Hampshire and there is a programme for mapping areas of opportunity for other habitats including wetland[11]. Together with the comprehensive mapping of existing habitats and designations held by HBIC, opportunity mapping will be used to underpin climate change adaptation strategies that need to take into account of the key adaptation principles listed above. The comprehensive mapping will support consideration of biodiversity within forward planning and development control, the targeting of agri-environment schemes, the development of green infrastructure (such as that being developed in South Hampshire) and the piloting of land management frameworks in Hampshire, all of which have a role in assisting biodiversity to adapt to climate change.

The draft Planning Policy Statement on Climate Change[12] identifies the role of planning in assisting biodiversity. The South East Plan includes a policy statement on climate change and biodiversity and promotes the concept of opportunity mapping for biodiversity. Allocations within plans need to be sensitive to safeguarding future land for biodiversity in addition to safeguarding existing valuable areas.

The above key adaptation principles need to be reflected in Local Development Documents and other spatial plans and strategies and these need proofing for their consideration of climate change and biodiversity. Although consideration of climate change has not been formally introduced into the requirements of Strategic Environmental Assessment of plans, Environment Impact Assessment and Appropriate Assessment of plans and projects under the Habitat Regulations, these assessments undertaken in Hampshire need to include full recognition of the influence of climate change on biodiversity.

Guidance is also required to ensure planning applications and development control decisions take full account of the need to assist biodiversity to adapt to climate change.

2.3 Strategic planning for key sectors

2.3.1 Coast

The Solent Coastal Habitat Management Plan (CHAMP)[13] produced in 2003 offers a long term view of sea level rise and its effect on internationally

important habitats and species and this is informing the preparation of the North Solent Shoreline Management Plan.

The multi-partner Solent Dynamic Coastline Project has been investigating the potential to create habitat by managed retreat to compensate for the forecasted loss of habitat, with the ultimate aim of a phased plan of implementation. Good integration of the range of plans and strategies concerning the coast is essential.

With its considerable coastal land holding, it is important for the County Council to continue to review impacts on its own land, which has commenced through its Key Area Working Groups, and to review the potential to assist with managed retreat.

Areas of internationally important habitat designated under the European Habitats Directive will be lost to sea level rise. Adjacent areas, not currently designated, will gain importance, particularly under managed retreat. Provisions of the Directive are rigidly applied to land within current site boundaries and the Directive will therefore need amending to respond to dynamic change.

The dynamics of migrating European bird populations is complex. Any displacement of birds that may occur in the Solent requires an understanding of bird dynamics including their use of other areas in the UK and Europe and any change to these areas under climatic influence. Co-operation between member states will be required to secure the favourable status of European bird populations.

2.3.2 Water

The Environment Agency Southern Region has published a *Strategic Overview of Climate Change, April 2007*[14]*.* This identifies biodiversity, along with water resources and flood risk, as the priority areas of the Agency's work impacted by climate change.

A catchment-scale approach is central to reducing climate change impacts on rivers and wetlands. River Basin Management Plans being prepared under the provisions of the European Water Framework Directive will be key for addressing the impacts of climate change. The Plans are intended to raise the ecological status of water bodies and to assist with flood management. Through adopting an ecosystem approach, River Basin Management Plans have the potential for a detailed and comprehensive approach to dealing with climate change and biodiversity. These plans are to be in draft by the end of 2008, with any significant water management measures to be identified by the end of 2007. River Basin Management Plans will be informed by both Catchment Abstraction Management Strategies and Catchment Flood Management Plans.

2.3.3 Forestry

A clear strategy for UK forestry in the face of climate change is required. Any change to forestry in response to climate change, for example the planting of non-native tree species more suited to the changing climate, needs to respect current policy for the conservation of ancient semi-natural woodland which is of particular importance for biodiversity.

Implementation of the new *Woodfuel Strategy for England* needs to be promoted in the South East through partnership co-operation. Wood fuel schemes should be accompanied by detailed environmental assessments to ensure that they are sensitive to biodiversity and that potential gains for biodiversity are realised.

The *England Woodland Grant Scheme* or associated guidance may need revising to promote adaptation to climate change.

2.3.4 Agriculture

The response of the agricultural industry to climate change has widespread implications for biodiversity. This will require a combination of intervention, control, incentives and good practice guidance.

Agri-environment schemes, of which the Environmental Stewardship Scheme is particularly important, need to incorporate measures that directly assist biodiversity to adapt to climate change.

The condition of agricultural land is critical in determining the dispersal of species across the landscape. Agri-environment schemes and support measures could therefore be targeted to increase connectivity and maximise robustness within particular geographical areas. This will benefit from the comprehensive mapping produced by HBIC mentioned earlier.

2.4 Site management

Sites of nature conservation importance require specific management to maintain their value for wildlife. If sites are under favourable management this will increase their resilience to adverse impacts of climate change. However, management decisions will become more complex. There will be a need to balance the feasibility of maintaining current interest with the benefits that would accrue by adapting site management to accommodate ecological change. It would be useful to produce a guide which provides a framework for decision making to assist the management of sites under a changing climate.

Undesignated sites and amenity open space can help biodiversity adapt to climate change. These can serve as stepping stones or refuges for species dispersal and they also have local value. Alteration of their management can make them more suitable for wildlife. For example, letting grass grow a little longer and maintaining a matrix of scrub within grassland will provide

invaluable cooler and moister micro-climates for heat and drought sensitive species.

The County Council is currently piloting the cutting of selected areas of grass within school grounds at 10cm height rather than close cropping. This can be performed efficiently at no extra cost during routine maintenance. This will allow for flowering of plants and provide a refuge for invertebrates. It will increase the capacity of school grounds to provide children with contact with nature and support environmental education. Under climate change this management will maintain and encourage wildlife interest in school grounds by providing valuable areas in contrast to parched swards. This adjustment of management could be applied to parks, road verges and other land.

2.5 Conclusion

This report has identified a wide range of effects of climate change on biodiversity, both direct and indirect. Underlying much of the anticipated change is uncertainty.

One of the most significant policies to maximise robustness against adverse effects is to maintain and develop a well managed network of habitat across the county to facilitate species dispersal and adaptation. It is also essential to avoid action that exacerbates the negative effects of climate change on biodiversity or which reduces the ability of biodiversity to adapt in the future.

Helping biodiversity adapt to climate change requires forward planning. Specific policy development and sector responses are required and provisions need to be built into a wide range of plans and strategies. This will require partnership and collaborative effort.

Part 3 of this report sets out **recommendations** to help this process, all of which are relevant to Hampshire County Council.

PART 3 RECOMMENDATIONS

Adaptation principles

1. Maximise conditions to allow biodiversity to adapt to climate change by ensuring a permeable landscape of sufficient habitat connectivity and quality to facilitate species dispersal and adaptation.

2. Adopt the following adaptation principles within development plans and other spatial plans and land management strategies:

    - Maintain existing habitats, both within and outside designated sites
    - Reduce fragmentation of habitat and isolation of species
    - Promote dispersal of species
    - Maintain ecosystem functions
    - Maximise resilience of habitats through appropriate management and maintain suitability of sites as receptors for species
    - Safeguard land for replacement and evolution of habitat
    - Restore and recreate habitat

3. Reduce and avoid pressures on biodiversity not caused by climate change, but which act cumulatively and exacerbate impacts of climate change.

Spatial planning

4. Map areas of opportunity for enhancement of biodiversity and ecological networks to support integration of the above adaptation principles into spatial plans and strategies including:

    development plans
    targeting of agr-environment schemes
    development of green infrastructure
    land management frameworks
    River Basin Management Plans

5. Establish policies for climate change and biodiversity within Local Development Documents and ensure LDDs are proofed for their consideration of climate change and biodiversity

6. Give greater recognition to the protection and management of non-designated land to assist biodiversity to adapt to climate change, including its dispersal.

7. Introduce policies to safeguard land with biodiversity enhancement / adaptation potential.

8. Ensure that influences of climate change on biodiversity are considered when undertaking Environmental Impact Assessment, Strategic Environmental Assessments and Appropriate Assessments.

9. Produce guidance to assist forward planning and development control to take account of biodiversity adaptation to climate change.

10. Develop adaptive measures for biodiversity within land management strategies such as AONB Management Plans and plans and strategies for the New Forest National Park.

Biodiversity in urban areas and its amelioration of urban climate

11. Promote the benefits offered by biodiversity for ameliorating climate within urban areas.

12. Promote the planning and implementation of green infrastructure within development and demonstrate good practice through the green infrastructure strategy for South Hampshire.

13. Review the potential of gardens and brown field land to assist the adaptation of biodiversity and the amelioration of urban climate.

14. Promote design of ‘green buildings’.

15. Integrate use of and provision for biodiversity within local flood control.

Coast

16. Continue to develop strategies for coastal re-alignment and review and develop strategies for managing biodiversity on County Council coastal land holdings.

17. Collaborate nationally and internationally to further understand the dynamics of migrating birds and habitat availability to ensure robustness of the international Natura 2000 network of sites.

18. Promote the adjustment of EU Directives to recognise that international interest will not confine itself to current designated site boundaries.

19. Produce a biodiversity and climate change action plan for the Hampshire coast.

Water, agriculture and forestry

20. Take full opportunity to plan for biodiversity adaptation within River Basin Management Plans.

21. Ensure integration of plans eg. development plans and River Basin Management Plans.

22. Ensure forestry and agriculture policy and practice in response to climate change do not compromise biodiversity.

23. Promote wood fuel initiatives and ensure they are sensitive to, and enhance, biodiversity.

24. Review provisions of agri-environment and forestry support schemes and adjust to promote biodiversity adaptation to climate change.

Site management

25. Produce guidance, including a framework for decision making, to assist management of designated sites / nature reserves under a changing climate.

26. Review the opportunity to adjust management of un-designated / amenity land to favour biodiversity eg. grass cutting regimes.

Plans and partnerships

27. Promote the preparation of local authority and agency climate change action plans which take account of biodiversity.

28. Promote partnership working on climate change through the Hampshire Biodiversity Partnership.

29. Liaise at regional, national and European levels on climate change and biodiversity and participate in joint projects where relevant to Hampshire.

Data and information

30. Ensure robust data on biodiversity to underpin adaptation strategies.

Responding to uncertainty

31. To take account of nature's dynamic response to climate change and because of uncertainty of impacts, the following principles need to be adopted:

    - Apply risk assessment to determine appropriate levels of policy and action, and embody the precautionary principle within this
    - Ensure 'no regrets' adaptation measures – they would be justified under all plausible future scenarios and continue to be worthwhile irrespective of the nature of future climate
    - Provide flexibility within climate change strategies
    - Continue research, modelling and testing of the influence of climate change on biodiversity
    - Monitor the effects and success of adaptation strategies

Sources of information

1. *Conserving Nature for the Community* – Corporate Biodiversity Action Plan, Hampshire County Council 2005

2. *England Biodiversity Strategy – Towards Adaptation to Climate Change*, DEFRA in press

3. *Biodiversity Action Plan for Hampshire*: Volume One, Hampshire County Council 1998

4. *Biodiversity Action Plan for Hampshire*: Volume Two, Hampshire County Council 2000- 2005

5. *The State of Hampshire's Biodiversity*, Hampshire Biodiversity Partnership 2006

6. *Climate Change and Nature Conservation in Britain and Ireland (MONARCH – Modelling Natural Resource Responses to Climate Change),* UKCIP 2001

7. *Climate Change and Nature Conservation in the UK and Ireland: Modelling Natural Resource Responses to Climate Change, MONARCH 2*, UKCIP 2005

8. *Climate Change and British Woodland*, Forestry Commission 2005

9. *A Woodfuel Strategy for England*, Forestry Commission 2007

10. *Building Green*, London Ecology Unit 1990

11. *Habitat Suitability Modelling for Calcareous Grassland in Hampshire*, Hampshire Biodiversity Information Centre, 2006

12. *Draft Planning Policy Statement: Planning and Climate Change (Supplement to PPS1)*, DCLG 2006

13. *The Solent Coastal Habitat Management Plan*, DEFRA et al 2003

14. *Southern Region Climate Change Strategic Overview*, Environment Agency 2006

15. *The Habitats Directive, Coastal Habitats and Climate Change – Case Studies from the South Coast of the UK,* Tyndall Centre for Climate Change Research, 2007

16. *Climate Change and UK Nature Conservation*, DETR 2000

17. *Spatial Planning for Biodiversity in our Changing Climate*, English Nature 2006

18. Rising to the Challenge – Impacts of Climate Change in the South East, UK Climate Change Impacts Programme 1999

Useful websites

UK Climate Impacts programme (UKCIP) www.UKCIP.org.uk

MONARCH (Modelling Natural Resource Responses to Climate Change)
www.eci.ox.ac.uk/biodiversity/monarch.html

Branch (Biodiversity Requires Adaptation in North West Europe under a Changing Climate)
www.branchproject.org

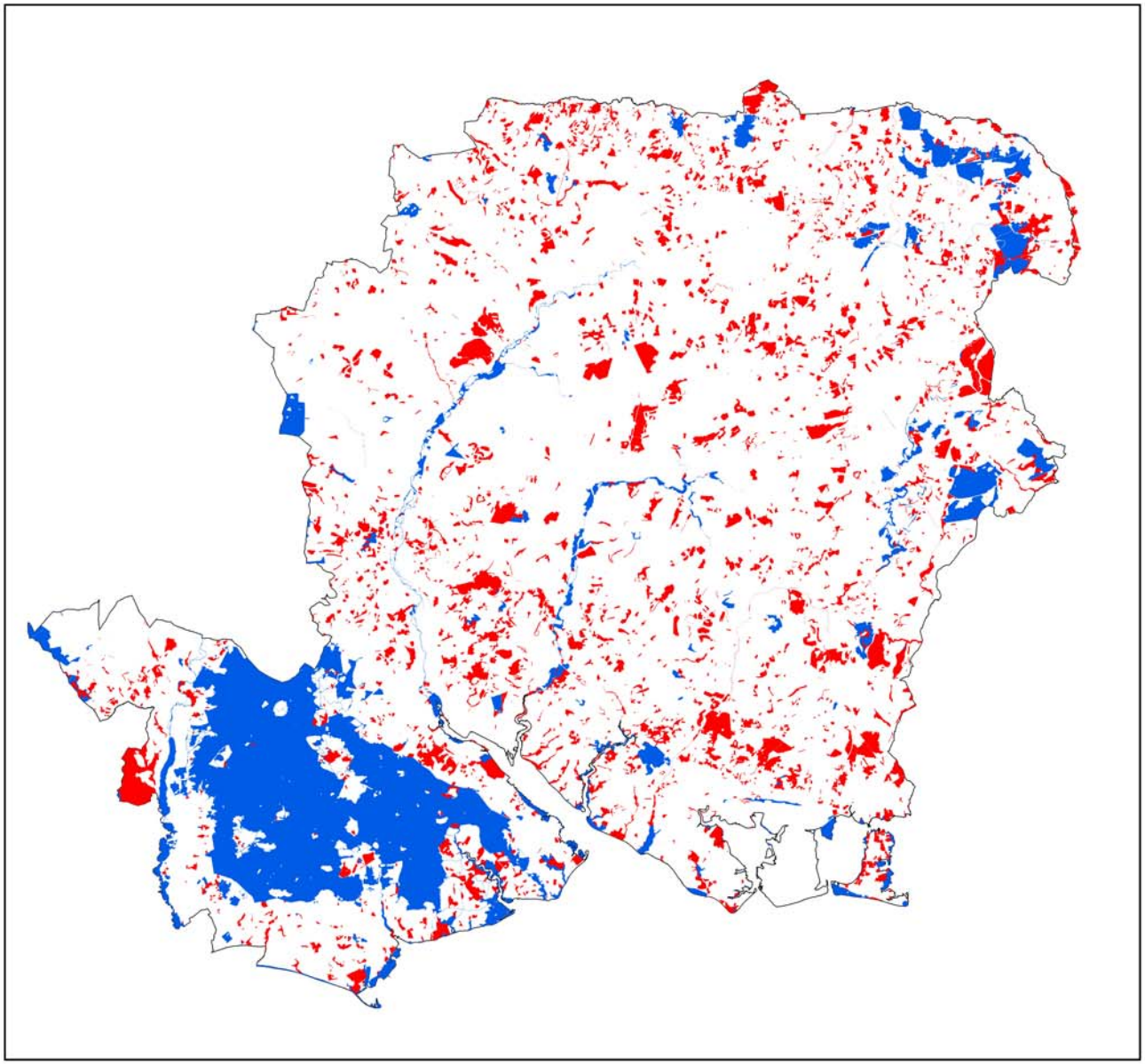
Annex 1

Priority habitats and designated nature conservation sites in Hampshire

(Extracts from the *Corporate Biodiversity Action Plan*, HCC 2005[1])

Priority Habitats in Hampshire *	Area (hectares)	% Hampshire	% of UK Habitat
Ancient Semi-natural Woodland	16,687	4.3	5.1
Pasture Woodland / Parkland	6,000	1.6	25.0
Hedgerows	14,995	u	u
Arable Field Margins	u	u	u
Neutral Grassland	2,327	0.6	c20.0
Lowland Calcareous Grassland	2,049	0.5	c5.0
Lowland Wet Grassland	2,000	0.5	u
Heathland, Acid Grassland and Bog	13,971	3.6	c28.0
Fen, Carr, Marsh, Swamp, Reedbeds	618	0.2	u
Standing Open Water (under-estimate – not all ponds have been mapped)	1,300	0.3	u
Chalk Streams	187 km	u	u
Canals	28 km	u	0.5
Coastal (maritime cliffs, shingle, saltmarsh, coastal grazing marsh, sand dunes, mudflats/eelgrass beds, saline lagoons)	8,071	2.1	u
Road Verges	20 km	u	u
* figures based on best available data from Hampshire Biodiversity Information Centre 2004 and *Biodiversity Action Plan for Hampshire : Volume One* 1998 u = unavailable			

Nature Conservation Sites in Hampshire *	Number of sites in Hampshire	Area (hectares)	% of Hampshire	Number of sites owned by Hampshire County Council
Sites of Special Scientific Interest (SSSIs) 78% of SSSIs in Hampshire are also designated for their international importance (candidate Special Areas of Conservation (cSACs), Special Protection Areas (SPAs) and Ramsar Sites)	112	55,878	14.5%	25 (2015 ha) includes 5 National Nature Reserves
Sites of Importance for Nature Conservation (SINCs) Nationally important habitats such as ancient woodland, chalk downland and heathland	3,549	33,541	8.7%	201 (c. 800 ha)
Total		89,419	23.2%	
* compiled by the Hampshire Biodiversity Information Centre 2004				



Nature conservation sites in Hampshire

County (Sites of Importance for Nature Conservation – SINCs)

International (SPA, SAC, Ramsar sites) and National (SSSI)

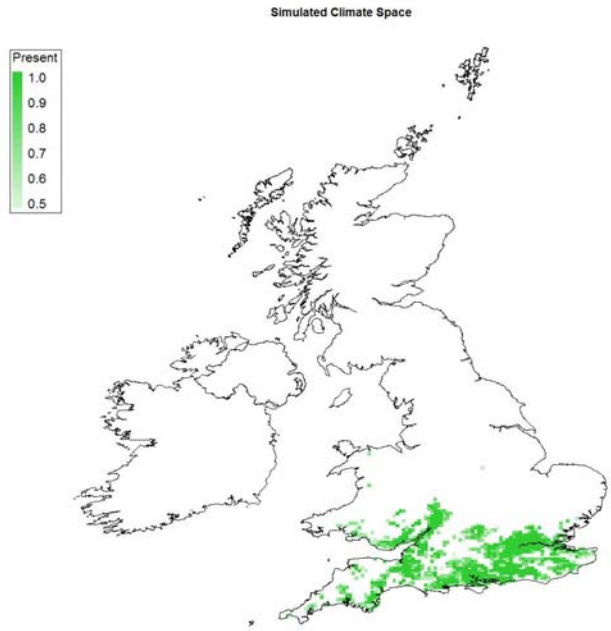
Hbic
Hampshire Biodiversity Information Centre

Hampshire County Council

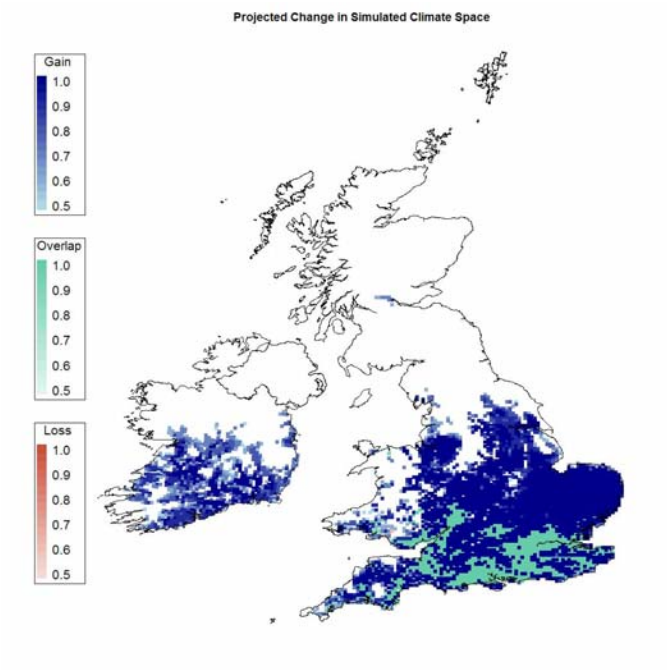
Annex 2

An example of climate space mapping produced by MONARCH

Potential suitable climate space for the Adonis blue butterfly

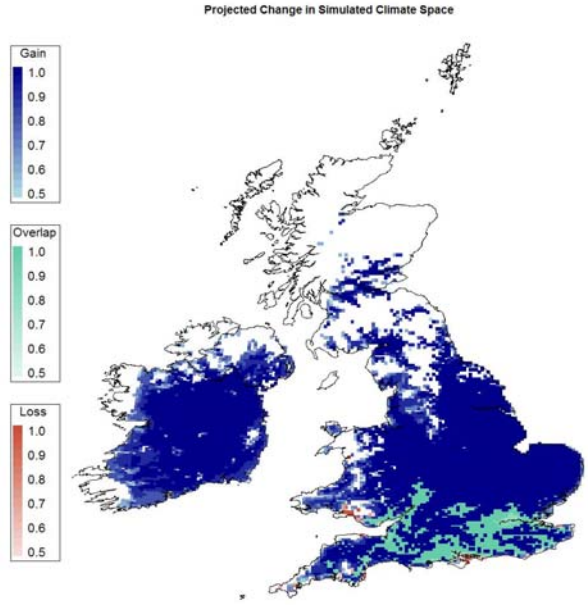


Current

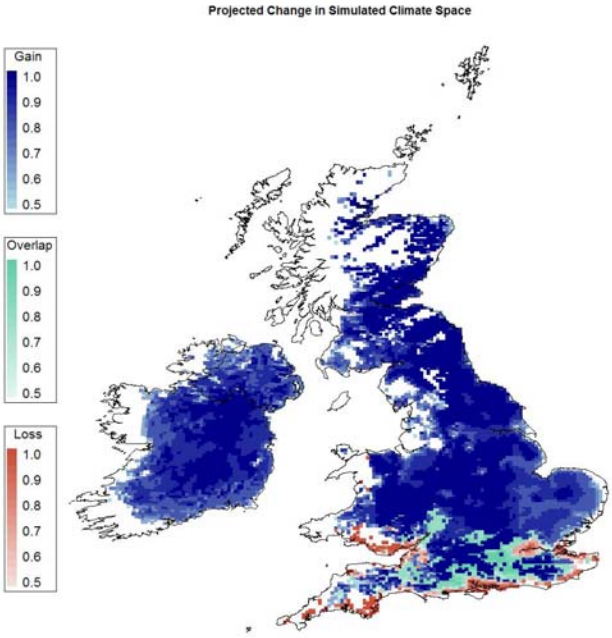


2020s high scenario

Potential suitable climate space for the Adonis blue butterfly



2050s high scenario



2080s high scenario