Ministry of Defence

Embedding climate resilience in land use & management

Practitioner Guide 03/12

Sustainable Development

Document Aim:

This Practitioner Guide aims to raise awareness of the potential climatic risks and opportunities (including signposting documents) that should be considered as part of existing MOD estate planning and management tools and procedures to develop mitigation and adaptation measures that will sustain military capability.

Document Synopsis:

This document outlines the climate-related risks and opportunities on a number of inter-related themes likely to affect MOD land use and management activities and acts as a signposting document to existing UK guidance.

Document Information	
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Related Documents

MOD Sustainability and Environmental Appraisal Handbook Section 7 CIRAM	JSP 892 Risk Management
MOD Climate Change Strategy 2012	JSP 435 Defence Estate Management
MOD Departmental Adaptation Plan 2011	JSP 418 Leaflet 1 Environmental Management Systems
MOD Sustainable Development Strategy	JSP 362 Section 3 Countryside and Conservation
PG 01/12 Building a climate resilient estate	DIO Business Continuity Strategy (to be published)
PG 05/10 Integrated Rural Management Plans	Strategic Risk Assessment for Infrastructure Climate Resilience (to be published)
Embedding climate resilience in health and safety management (to be published)	Strategic Flood Risk Assessment for Infrastructure Resilience (to be published)

Contents

Legend

Illustrative Examples Generic examples have been used to illustrate the recommended approach within the guidance. These examples have been drawn from real MOD projects to aid their interpretation.	

1. INTRODUCTION

1.1. Under the Climate Change Act 2010, the UK Government has produced a UK wide Climate Change Risk Assessment (UK CCRA). The CCRA has assessed the main projected threats and opportunities arising from changes in the UK climate over the short, medium and long-term. Priority areas for action include the natural environment and understanding the ways that land use and management can lead to increased resilience to climate change including flood reduction e.g. how moors can decrease the amount and speed of runoff.

1.2. Changes in climate and extreme weather events are likely to bring a wide range of challenges for MOD land use and management, including increased risk of fires, increased issues with pest and weed control and increased damage due to more intense and frequent precipitation events. There will also be a greater need to ensure sustainable land management practices are applied to the MOD estate to minimise vulnerability to climatic risks and maximise ecosystems services functionality.

How to use this guidance:

1.3. This PG supports Practitioner Guidance 01/12 Building a Climate Resilient Estate, and applies to all MOD sites with green and open spaces, whether or not have a Climate Impacts Risk Assessment (CIRAM). It aims to raise awareness of the potential climatic risks and mitigation and adaptation opportunities (including signposting documents) related to a series of interrelated themes, including:

a. Landscape;

b. Nature Conservation and Biodiversity;

c. Forestry;

d. Historic Environment;

e. Weed, pest and disease control;

f. Management of wild deer;

g. Access and recreation;

h. Fire;

i. Agriculture; and

j. Land quality.

1.4. In this PG, taking each theme in turn, the risks and impacts are identified together with the potential implications for MOD. Each section provides a series of management measures together with signposts to supporting documentation.

1.5. This PG also supports the UK National Adaptation Programme (NAP) and other relevant EU and UK Government's initiatives. It is based on UK policy and research but the risk areas identified may be applicable to overseas.

2. UK NATIONAL ADAPTATION PROGRAMME (NAP)

2.1. The UK Adaptation Sub-Committee (ASC) identified as two of the five priority areas for the Government to focus on in preparing the UK National Adaptation Programme (NAP):

a. Land use planning – locating properties, infrastructure and green spaces strategically so that the causes and consequences of climate change are minimised;

b. Natural resources – managing natural resources sustainably by using water more efficiently, setting up ecological networks and habitat bridges so that the species can adapt and move and making space for water along rivers and the coast

2.2. The NAP will set out how the Government will deal with the priority risks and opportunities identified in the CCRA.

2.3. NAP areas for action include:

a. Built environment and infrastructure, including increasing the resilience of the built historic environment and supporting green infrastructure;

b. Business resilience;

c. Health and Wellbeing and Local Resilience, including managing the risks arising from heatwaves and vector borne diseases;

d. Agriculture and forestry resilience whilst making a positive contribution to ecosystem services including understanding opportunities for forestry creation that will increase the resilience of landscapes and adaptation through ecosystem services; and

e. Natural environment resilience, with the following areas of actions:

1) Adapting to key water risks such as environmental low flows and water quality through catchment based approaches;

2) Adapting to key biodiversity risks through action to increase the resilience of landscapes and habitats;

3) Embedding ecosystem service based approaches to adaptation into wider adaptive action; and

4) Adapting to key coastal and marine risks by improving the integration between marine and land management approaches to adaptation.

2.4. MOD is required to contribute to the NAP, and as a major landowner, contribute to increasing the resilience of the Natural Environment.

3. OTHER RELEVANT EU AND UK POLICIES

3.1. There is increasing interest in UK and EU policy in understanding the ways that land use and management can lead to increased resilience to climate change including working with natural processes and ecosystem services.

3.2. The EU Water Framework Directive (WFD) and the Floods Directive aim to ensure that Member States enhance the efficiency of ecosystems in managing water quality and boosting water storage capacity. In the UK, Catchment Flood Management Plans and River Basin Management Plans are the mechanisms to deliver these requirements. See also JSP 362 Leaflet 8 Flood and Water Management.

3.3. The UK Government and the UK National Ecosystem Assessment recognise the value of well-functioning ecosystems and landscapes and the need to capture this value in decision making in order to increase resilience to climate risks and provide a variety of benefits and services, including (but not limited):

a. Military training resource;

b. Water storage and purification, e.g. uplands, peatlands;

c. Flood protection e.g. trees in catchment areas, peatlands;

d. Storm surge protection, e.g. saltmarshes;

e. Carbon sequestrations, e.g. forests, wetlands and grasslands;

f. Bioenergy e.g. biomass;

g. Climate regulation e.g. trees helping to regulate temperatures;

h. Provision of food, water and clean air, etc.

3.4. England Natural Environment White Paper, Wales Natural Environment Framework, and Scotland's Climate Change Adaptation Framework for Biodiversity & Ecosystems Services, highlight the importance of ecosystem services and habitat connectivity and propose integrated management approaches as the mechanism to manage the environment taking into account the risks from climate change and the value of ecosystem services.

3.5. UK central Government and Devolved Administrations (DA) policy on how woodlands and trees can help increasing resilience to the impacts of climate change is reflected at *Combating Climate Change – A Role for UK Forests* Section 4 Adaptation, Scottish Government Forests and Forestry Sector Action Plan and Rural priorities for sustainable flood management, Wales' forestry strategy and The Climate Change Strategy for Wales.

3.6. Partnership working is also a key principle in delivering the UK Gov climate resilience agenda and assisting MOD in increasing the resilience of the estate see PG 01/12 Building a Climate Resilient Estate and example at Box 1. There is an expectation from MOD in participating in local and regional resilience projects where applicable e.g. Holcombe Moor River Basin Management Plan.

4. MOD APPROACH

4.1. It is MOD policy to manage the estate in a sustainable and integrated way. Existing MOD land use planning and management tools and procedures will need to consider climatic risks and opportunities likely to affect the estate, and the management options to increase resilience and maximise benefits, including (as appropriate):

a. Estate Strategic initiatives and plans e.g. Estate Development Plans (EDPs), SDSR, BOP ;

b. Strategic Environmental Assessments (SEA);

c. Environmental Impact Assessments (EIA);

d. Sustainability Appraisals (SA);

e. Investment Appraisals;

f. Integrated Estate Management Plans (IEMP);

g. Environmental Management Systems (EMS);

h. Integrated Rural Management Plans (IRMPs);

i. Sites of Special Scientific Interest (SSSIs) management etc.

5. LANDSCAPE

Summary of climate-related impacts

5.1. Climate changes have been affecting the character and ecological and historic features of landscapes in a number of ways e.g. soil erosion, changes to the plant species characteristic of the landscape and direct damage from more frequent and extreme events including wildfires, drought and heavy precipitation. For example, according to Countryside Council for Wales (CCW), observations in Wales suggest that certain species are already moving to higher ground and that there may be significant changes in the biodiversity and landscape of the Welsh uplands. Loss of key upland plant species and degradation of the habitats due to extreme events can result in increased flooding of the lowland areas.

5.2. Creating resilient landscapes including landscape / habitat connectivity will become increasingly important to support the resilience of the natural environment (including water management).

Potential implications for MOD

5.3. The risks arising from climate change could increase the resources needed for maintaining the character of the landscape and safeguard significant landscape and military training features, see example at Box 1.

5.4. Potential training restrictions may be applied, especially if statutory protected ecological and historic features are affected by overtraining on climate distress areas (see sections 3, 4 &5).

5.5. Diverse and well connected landscapes can absorb and respond to changes and provide multiple benefits including water storage, flood protection and sustaining biodiversity, therefore helping MOD and neighbouring communities and ecosystems to increase resilience to climate variability and change.

Managing potential risks and opportunities

5.6. Existing management processes, e.g. IRMP can be used to identify potential climatic risks to the character of the landscape and management actions to minimise their impact. The IRMP process also provides an opportunity for partnership working with stakeholders to share best practice.

5.7. Existing mechanisms such as MOD Service Provider reactive maintenance reports can be used to monitor and further understand the risks of inclement weather and ensure that important landscape features are maintained.

5.8. Identify opportunities to enhance habitat connectivity through ecological networks and multifunctional and varied landscapes, e.g. use EIA and SA processes for new developments to identify opportunities to increase green and blue infrastructure such as urban greenspace and water storage areas.

5.9. Taking a precautionary and risk-based approach to development in floodplains and other high climate risk areas.

5.10. Working in partnership with others including tenant farmers, local communities and statutory bodies will increase the ability to manage potential risks and opportunities, see

Box 1. For example, Scottish Natural Heritage has established green network partnerships such as the Glasgow and Clyde Valley Green Network to promote the development of green networks across Scotland, aiming to provide a mechanism for species migration and adaptation and improve the resilience of landscapes to climate change.

Other signposting documents

5.11. The Countryside Agency and Scottish Natural Heritage (SNH) paper on Climate change and natural forces – the consequences for landscape character provides guidance for England and Scotland on the risks, impacts and responses that could be used to address the challenges. It also provides detail on how climate can be incorporated into landscape assessments and how these assessments can be used to increase landscape resilience to climate change.

5.12. The Landscape Institute Position Statement Landscape Architecture and the Challenge of climate change highlights the importance of landscape design towards climate change mitigation and adaptation, including case studies in the UK.

5.13. Natural England (NE) Green Infrastructure Guidance provides detail on how landscape design and green infrastructure can be established to deliver multiple environmental functions, and to play a key part in adapting to and mitigating climate change.

Box 1 Storm damage to DTE North

During 3 days (7-9 Jan 2005), storm damage in the DTE North caused more damage than 50 years of troops training. Flooding and windblown trees temporarily closed the estate e.g. River Lune at Halton reached nine feet above normal height of the water mark.

Roofs were torn from buildings and some structures were demolished or rendered unusable. An estimated 10,000 trees were uprooted or snapped changing the landscape. Key training facilities were lost and military training programmes had to be adapted to cope with the loss of woodland cover.

Scordale Valley at Warcop was particularly affected by the storm, and this was the second time, in the period Dec 03 – Jan 05, that the valley was affected by an extreme flood event previously considered a “once in a life time flood”. Heavy precipitation caused flash flooding that changed the route of the beck through the range danger area and caused serious damage in the landscape including trees, tracks (see photo) and archaeological sites. The financial costs were estimated at £0.5m.

Due to MOD’s statutory obligations and commitments to maintain and protect designated areas and monuments, coupled with training requirements and MOD undertaking to assist tenants, and provide safe public access, Scordale Valley could not be left as it stood after the storm. As the site had previously been restored after the Dec 03 storm in partnership with Natural England, English Heritage and the Environment Agency, after the second storm the statutory bodies were cautious about restoration works and it was agreed to consider the entire watercourse from “tip to toe”. A stakeholder management board was set up and overseen by Eden Rivers Trust, who acquired the services of an eminent scientist from Durham University.

After some 12 months of field work and debate, a holistic management plan was agreed for the whole watercourse. This involves stock removal, bank side planting, the removal of old flood defences and the construction of new ones. To make the plan work, all stakeholders and locals will have to sign up to it. It will lead to a change; to the landscape particularly that of Scordale, but more interestingly to farming practices lower down stream. Working with stakeholders and local residents has been central to this project.

6. NATURE CONSERVATION AND BIODIVERSITY

Summary of climate-related impacts

6.1. Climate variability and change has been affecting natural systems in England, Wales, Scotland and Northern Ireland[1] in various ways, including:

a. Changes in the timing of seasonal events (e.g. reproduction) leading to a loss of availability of food and other resources upon which species depend;

b. Changes in suitable climatic conditions for individual species leading to changes in their abundance and distribution/range, migration patterns and changes to the composition of plant and animal communities. For example, since the mid-1980s, trends in the distributions of several wading bird species that spend the winter on UK estuaries indicate that these have been shifting (see Figure 1) from the west to the eastern estuaries as mean winter temperatures have increased[2]. Trends on species moving to higher latitudes and altitude have also been observed;

c. Loss of space/habitats as conditions change e.g. drying up of wetlands, and loss of species in them;

d. Increases in invasive species and increased frequency in outbreaks of pests and diseases (see section 9);

e. Direct damage from more frequent and intense extreme weather events e.g. fires (see section 12), droughts;

f. Exacerbating existing pressures on biodiversity due to development, unsustainable land management practices, habitat destruction and pollution;

g. Changes in ecosystems processes and degradation of ecosystem functioning, for example drier and eroded peatlands are more vulnerable to fire, therefore increasing the risk of fire. The ability of ecosystems to provide services is determined by the interaction of their chemical composition, physical integrity/condition and the structure and activity of biodiversity, therefore any changes to any of these elements will have an impact on ecosystem functioning.

6.2. The UK CCRA Biodiversity and Ecosystem Services report identifies that coastal zone, upland and wetland habitats, which are generally high-value areas, are particularly sensitive to change. In particular peatlands (including blanket bog) and saltmarshes are at risk. Other habitats vulnerable to climate change include lowland heathland and machair. Habitats and species at either the southern end or lower altitudinal limit of their climate range are also vulnerable e.g. specialist montane species such as Norwegian mugwort *Artemisia norvegica*, icy rock moss *Andreaea frigida* and alpine lady-fern *Athyrium distentifolium*.

6.3. Habitat and landscape fragmentation across the UK is likely to prevent many species from adapting as climatic conditions change. See Annex A for a list of species likely to be vulnerable to climate change.

6.4. These changes and risks could lead to significant loss of biodiversity in important nature conservation areas, and add further pressures to maintain these sites. For example, upland birds are at risk, with potential further restrictions on upland SPAs to minimise human disturbance.

[1] See UK CCRA http://www.defra.gov.uk/environment/climate/government/risk-assessment/ reports for English regions, Wales, Scotland and NI respectively at the bottom of the page

[2] JNCC Biodiversity and Climate Change – a summary of impacts for the UK

Potential implications for MOD

6.5. Loss of training resource, for instance:

a. Damaged and degraded areas may not be fit or safe for training;

b. Training restrictions may be put in place due to MOD's statutory obligations and commitments to maintain and protect designated areas and protected species to manage/minimise some of the risks.

6.6. Increased repair and management costs of affected areas.

6.7. Increased management issues with invasive species and pest and diseases (see section 9).

6.8. Loss of ecosystem services. For example at Shoeburyness, there are areas where saltmarshes provide protection against coastal flooding. As the saltmarshes are lost (due to sea level rise and coastal squeeze) they need to be replaced by the establishment with armour stone to continue to protect the site against coastal flooding and wave action.

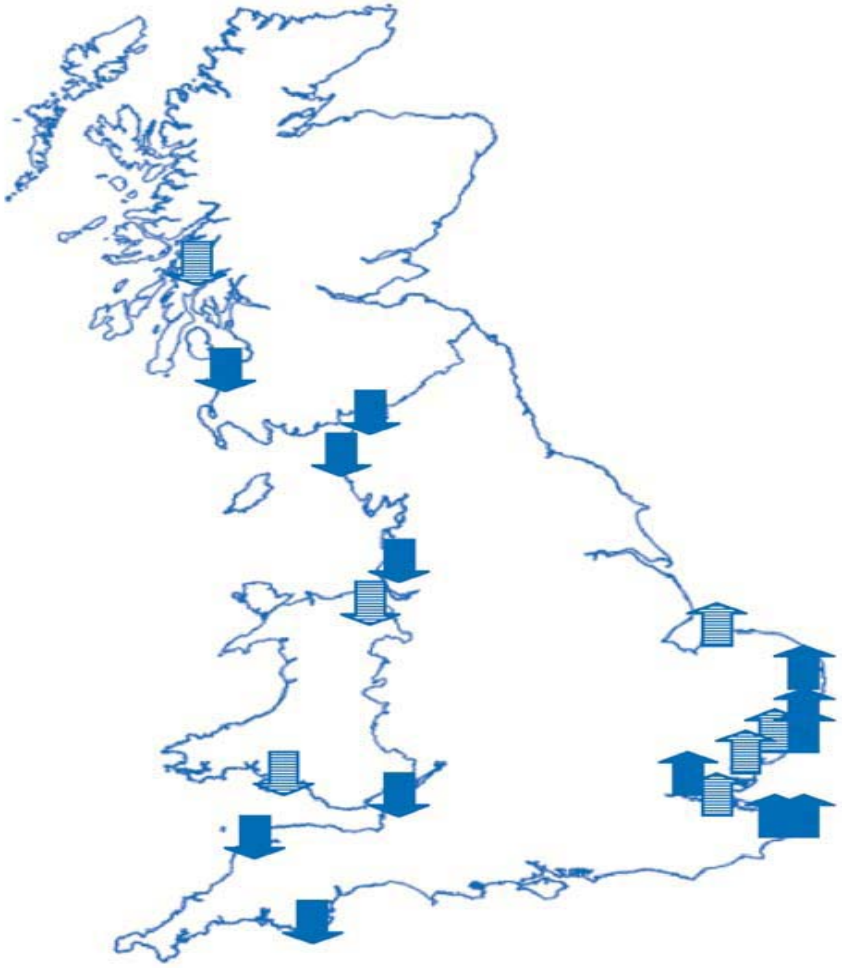

Figure 1 As the distribution of wader bird species in Britain change with climate change, the numbers of some species at some British SPAs are dropping below the thresholds upon which the designations are based. The map shows changes in Common Ringed Plover Charadrius hiaticula numbers on Britain's SPAs designated for the species (Austin *et al*. 2004). Upward- and downward-pointing arrows indicate SPAs where numbers increased and decreased between 1994-95 and 1999-2000, respectively; filled and hatched arrows indicate changes of 50% and 25% in smoothed numbers during that period, respectively. Source JNCC

Managing potential risks and opportunities

6.9. MOD establishments should consider climate change risks and opportunities as part of short-term and long-term land use planning, development and management of their sites, including:

a. Identify which species and habitats are most at risk at the establishment, and potential management options for the future (consider advice from Scottish Natural Heritage (SNH) climate change approach and action plan and England Biodiversity Strategy (EBS) Adaptation Principles on how to manage potential risks and take advantage of any opportunities);

b. Identify opportunities to maintain, enhance and restore ecosystem services e.g. natural carbon sinks such as bogs (bogs of good habitat status peat formation rate is about 0.8 mm/yr which is equivalent to a carbon accumulation rate of about 0.5% tonnes of carbon/hectare/year whilst peat formation rate falls to 0.1 mm/yr in bogs with poor habitat status);

c. Identify options for habitat connectivity e.g. as part of new developments and plan for green and blue infrastructure in order to optimise benefits (e.g. local flood risk management) and provide corridors that will increase habitat and biodiversity resilience to climate change;

d. Identify opportunities for partnership working with statutory bodies and others. For instance, Dartmoor Mires Project brings together MOD, the Environment Agency, Natural England, South West Water, Dartmoor National Park Authority, the Duchy of Cornwall and RSPB to restore Dartmoor's blanket bog aiming to improve the ability of the peat habitat to provide clean water supply, absorb heavy rainfall and absorb carbon (preventing the release of around three million tonnes of carbon dioxide and lock up new carbon stores of around 4,500 tonnes per year; DECC 2009 carbon prices = £50/tonne);

e. Consider changes in the underlying environmental conditions, such as hydrology. For example, the management of wetland sites will need to develop further measures to combat increased risk of dryness;

f. Design flexibility into plans and decisions. PG 01/12 Building a Climate Resilient Estate provides more detail on adaptive management strategies.

Other signposting documents

6.10. For an overall background on UK nature conservation climatic risks see JNCC Second Report by the United Kingdom under Article 17 on the implementation of the Habitats Directive.

6.11. For further information on how to build resilience of nature conservation resources to climate risks see Defra principles for biodiversity adaptation in Conserving Biodiversity in a changing climate (for terrestrial biodiversity) and England Biodiversity Strategy (EBS).

6.12. Specific advice for wetlands can be found at Fen Management Handbook and the Wetland Vision Climate Change Assessment tool.

6.13. CCW Climate Vulnerability Assessment of Designated Sites provides an initial evaluation of how climate change may impact upon the ability to achieve favourable condition on designated sites, and seeks to identify those sites where adapting to climate change of managing ecosystems services will be most important.

6.14. The forthcoming NE habitat vulnerability assessment will provide a high level indication of the relative vulnerability of BAP habitats to climate change across England, and identifies areas where intervention can potentially have the biggest impact in increasing resilience to the changing climate. This assessment will aim to inform prioritisation of adaptation actions and assist in the development of adaptation strategies. NE and partners are also planning to publish a Biodiversity and Ecosystems Adaptation Manual within 2012-13. This will provide practical advice for site managers and those working to develop a landscape approach to wildlife management.

6.15. The Defra Ecosystem Knowledge Network provides tools and guidance that help to apply an ecosystems approach to land use and planning, including guide to valuing ecosystem services.

7. FORESTRY

Summary of climate-related impacts

7.1. Increased frequency and intensity of extreme weather events including droughts, flooding and wind have been affecting tree stability (depending on the species). Changes in the incidence and frequency of pests and diseases have also been observed (see section 9) e.g. *Phytophthora ramorum* is already an issue in SW England and Wales where statutory plant health notices have been served.

7.2. The UK CCRA for the Forestry Sector has identified that the risk of drought, flooding (waterlogging) and pests and diseases are likely to increase significantly and are highlighted as priority climate related risks for the forestry sector. Fire risk is also identified as a priority risk likely to increase (see section 9), but there are still gaps in understanding the potential frequency and scale of events at a national scale.

7.3. The risk and frequency of landslips in forests is also projected to increase in Scotland and likely to increase in Wales, a particular concern in both regions as many forests are in areas of steep topography.

7.4. Current climate projections do not project significant increases in wind speeds. However as tree health is affected by other climate stresses their vulnerability to wind throw will increase.

7.5. Increased risk of wild herbivores affecting the health of woodlands is also projected to increase (See sections 8).

7.6. Changes to the extent, composition and structure of woodlands can limit the goods and services that they provide.

Potential implications for MOD

7.7. Increased tree instability and risk of damage to the forested estate could lead to:

a. Increased windblown trees on the forested estate which could cause disruptions to training activities and increases in costs e.g. from the removal of windblown trees. For example from FY 04-05 to FY 08-09 there were at least 84 recorded incidents of windblown trees on the training estate. These were in their majority incidents below 5k thus the contractor did not charge MOD extra for the removal of these. However, this could be a major issue in the future;

b. Increased risk of landslides on hillsides and embankments, creating health and safety hazards, damage and obstructions to roads/tracks within the MOD and increasing repairing costs e.g. Glen Douglas munitions road in Scotland;

c. Exacerbating coastal erosion issues e.g. perimeter of RAF Kinloss;

d. Increased forest fire risk (see section 12) with direct damage on the MOD estate, potential training disruption and risk of impacts to/from outside the wire e.g. Sandhurst (2004) and Thursley Common (2006) forest fires within the wire caused significant disruption outside the wire including damage to power lines and closure of A roads. Fires have also occurred in West Moors plantation which is adjacent to West Moors Defence Fuels Group presenting risks to the establishment.

7.8. Increasing the resilience and cover of trees and woodlands will help build resilience in other areas e.g. managing temperatures, surface water and air quality in urban areas and managing water resources and reducing flood risk in rural areas.

Managing potential risks and opportunities

7.9. Targeted forestry management and woodland creation can help minimise the risks and their effects and take advantage of the opportunities, including:

a. Increasing the diversity of planting material and growing new species, e.g. incorporate drought resistance together with waterlogging tolerant varieties;

b. Increasing the mixture of species to enhance resilience to pest and disease attack;

c. Plant/manage trees on steep slopes and cliffs in ways that reduce the impact of heavy or prolonged rainfall preventing soil erosion and/or slope failure;

d. Manage stands to reduce the risk of wind damage, e.g. thinning regimes;

e. Have contingency plans in place to deal with extreme events such as damaging drought, fire and pest and disease outbreak, etc;

f. Establish/manage woodlands and trees to aid biodiversity adaptation, overheating issues, drainage and flood management e.g. coppicing can improve resilience to drought, etc.

7.10. MOD is already working in partnership with the Woodland Trust to explore opportunities for woodland creation around the MOD estate aiming to provide nil cost woodlands for training whilst feeding into climate change mitigation targets for wider government. Forest Design Plans and Forest Management Plans will take into account current and future climate risks to ensure that woodlands will be able to absorb and respond to climate variability and change; hence capable of sustaining future military training and helping towards UK adaptation.

7.11. The latest climate change projections [currently UK Climate Projections 2009 (UKCP09)] should be considered when planning which tree species to plant, whilst meeting biodiversity objectives. Guidance developed by the Forestry Commission (FC) and Forest Research provides advice on tree species suitability taking into account future climatic changes (includes regional suitability maps) and possible adaptation measures for England, Scotland and Wales.

7.12. Woodland creation should be given consideration on a site-by-site basis to ensure the impacts of establishing woodland are fully understood. It is also important that the appropriate species of trees are planted in the right location e.g. aiming to increase resilience to wind and/or reduce the risk of flooding and soil erosion whilst making a contribution to carbon reduction targets.

7.13. Further opportunities for increasing woodland and tree cover on the MOD estate (including urban establishments) could be identified as part of the SA and IRMPs processes.

Other signposting documents

7.14. For further information about how projected climate changes may affect UK forests and possible adaptation management actions see UK Forestry Standard Guidelines for Forests and Climate Change, Forestry Commission Information Note Climate Change and British Woodland, Forestry Commission Research Note Climate Change: impacts

and adaptation in England's woodlands and Forestry Commission woodland management and climate change web pages.

7.15. For detail on the woodlands' role in managing water quality and quantity see Woodland Trust publication Woodland actions for biodiversity and their role in water management.

7.16. For detail on the benefits of urban trees and woodland see Woodland Trust report Best value in managing urban green space the Right Trees for a Changing Climate web pages.

8. HISTORIC ENVIRONMENT

Summary of climate-related impacts

8.1. Changes in temperature and moisture and more frequent droughts, heavy precipitation events and wind storms can affect the condition of historic assets including:

a. Buried archaeology e.g. due to changes in water table levels and soil chemistry;

b. Historic buildings e.g. due to changes in humidity cycles, rising damp and thermal stress;

c. Foundations of walls may be affected by extreme cycles of wetting and drying with risk to important vernacular walls within the landscape;

d. Parks and gardens e.g. due to more frequent and intense droughts; and

e. Coastal historic assets may be at risk of coastal erosion etc.

Potential implications for MOD

8.2. MOD has responsibility for historic assets and the increasing risk of these being damaged due to increasing frequency and intensity of extreme weather events could bring increasing maintenance costs, health and safety and reputational risks for the Department.

Managing potential risks and opportunities

8.3. It is important that historic assets at risk are identified and monitored where possible to better understand the implications for the MOD and management actions that could help towards building climatic resilience.

8.4. Planning and management of historic assets should consider JSP 362 Leaflet 12 which includes MOD policy on climate change mitigation and adaptation for historic assets.

Figure 2 Fort George barracks in the image, are at risk of coastal erosion

Other signposting documents

8.5. For further detail on the potential risks likely to affect MOD historic assets see English Heritage publications Climate change and the Historic Environment and Conservation Bulletin 57 which also provides tips about how to anticipate the impacts and learning to adapt.

9. WEED, PEST AND DISEASE CONTROL

Summary of climate-related impacts

9.1. The incidence and spread of certain weeds, pests, pathogens and parasites is affected by weather and climate, some may become less of a problem but others are likely to become more common, for instance:

a. Temperature increases allows some pests to reproduce more quickly e.g. aphids, rodents;

b. Warmer summers with increased rainfall intensity and milder winter temperatures favour mosquito development and extend the biting season of some species;

c. Rises in sea levels and storm surges could eliminate some mosquito sites and create new ones where there is inundation of salt-water;

d. Increased risk of flooding may lead to rodents to being displaced bringing them into closer contact with humans (e.g. into buildings);

e. Climate projections suggest that housefly and blowfly populations could increase substantially in the UK;

f. Warmer climate will expand the range/population of some non-native and invasive species including boar, grey squirrel, edible dormouse, rhododendron, laurel, Japanese knotweed and Himalayan balsam;

g. Climate projections also indicate that a number of pests and diseases affecting tree health are likely to expand their range and become more common as a result of warmer winters such as defoliating moths, green spruce aphid and fungal pathogen *Phytophthora ramorum* (sudden oak death);

h. Historic assets are also at risk of biological attack of organic materials by insects, moulds, fungi, and invasive species such as termites as numbers may increase with climate changes;

i. Exotic diseases spreading onto the UK. There have been over 14 exotic disease outbreaks in the last 10 years including foot and mouth (see Figure 1), bird flu and bluetongue;

j. Spread of vector-borne diseases (e.g. those carried by midges and ticks such as bluetongue and Schmallenger virus);

k. Increased incidence of certain pathogens and parasites e.g. liver fluke, etc.

9.2. The costs of animal disease outbreaks in the UK range from £2 million (minor) to over £3 million (major outbreak).

Potential implications for MOD

9.3. Loss of access to training resource e.g. foot and mouth outbreaks.

9.4. Increased management and maintenance costs.

9.5. With increased frequency and intensity of extreme weather events, it is anticipated that it will be more difficult to apply pesticides and biocides effectively with implications for maintenance activities.

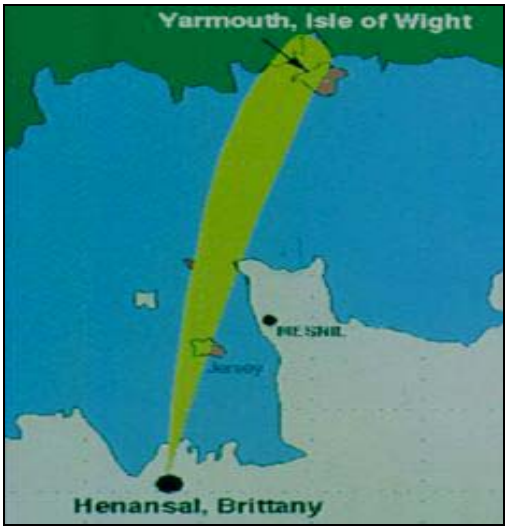

Figure 3 In 1981 Foot and Mouth Disease spread from Brittany to the UK. The wind carried the vector 150 miles and crossed Jersey causing one case of the disease locally. On the mainland, 400 animals had to be slaughtered and animal movement in Hampshire and the Isle of Wight was restricted. Source: Jersey Government

Managing potential risks and opportunities

9.6. The management of pests, weeds and infectious animal diseases should consider MOD policy JSP 362 Chapter 9 and Chapter 10 respectively. Existing control procedures should take into account that the risks of pest, weeds and diseases spreading are likely to increase.

9.7. MOD establishments follow specific instructions issued by Defra regarding the management of pests, weeds and diseases. However it is important that MOD establishments identify the potential risks and update estate and business continuity management plans and procedures to minimise the risks and prevent the spread of pests, weeds and diseases on the MOD estate.

9.8. Monitoring and surveillance activities could assist in identifying and managing the risks e.g. of wild animals casualties; sight of pests encountered by the users of the establishment.

Other signposting documents

9.9. For further detail on the potential animal diseases risks see Foresight report on the *Effects of Climate Change on Infectious Diseases of Animals*, and Defra web pages http://ww2.defra.gov.uk/food-farm/animals/diseases/.

9.10. The Deer Initiative has developed practice guides raising awareness of Lyme disease, and describing Bovine Tuberculosis and Foot and Mouth in deer.

9.11. For detail on pests and invasive species affecting tree health see Climate change: impacts and adaptation on England's Woodlands (box 4 in the document) and Forestry Commission website.

10. MANAGEMENT OF WILD DEER

Summary of climate-related impacts

10.1. According to Natural Environment Research Council, Forest Research, SNH and the Royal Society for the Protection of Birds RSPB, increasing average temperatures and especially warmer winters can increase the abundance and/or distribution of deer species resident in the UK. In particular increased red deer numbers have been associated with warmer springs as calves are born earlier and heavier and are more able to survive the winters which have become milder.

10.2. SNH and the Scottish Government have identified that unsustainable deer populations disrupt vegetation on peaty soils and lead to soil erosion and loss of carbon. Deer grazing levels can also prevent woodland from establishing or regenerating and so stop carbon from being captured in timber and woodland soils.

10.3. Deer can carry infectious animal diseases such as liver flukes and foot and mouth, and provide the vector in which certain virus can over-winter such as bluetongue. According to Parliamentary Office of Science and Technology Postnote 325 the potential for deer to transmit these diseases to livestock depends on the species of deer and the disease in question. For example, fallow deer pose the greatest risk of disease transmission because they graze in pasture and congregate in feeding sites.

Potential implications for MOD

10.4. The risk of increasing deer populations are likely to add further pressures to MOD statutory obligations to undertake sustainable management of wild deer populations, and the damage these can cause on the estate.

Managing potential risks and opportunities

10.5. The management of deer should consider MOD JSP 362 Leaflet 5 which provides information on MOD policy on sustainable deer management. However, establishments currently managing deer populations should consider whether there is a risk for deer species to increase in numbers, especially due to increased likelihood of higher average winter temperatures.

10.6. Defence Deer Management (DDM) managers already monitor deer populations within the MOD estate. DDM census of deer should be used to identify deer population trends as the climate changes.

10.7. Deer management plans and the IRMP process provide an opportunity to consider these issues and identify whether the establishment may be at risk from unsustainable numbers of deer.

Other signposting documents

10.8. The Deer Initiative web pages provide information on the status on wild deer in the UK and their impacts including those associated with climatic changes.

11. ACCESS AND RECREATION

Summary of climate-related impacts

11.1. Changes in climate can alter the manner in which the general public use the countryside for recreation. For example, it can be anticipated that countryside visitor numbers increase during warmer weather. This can result in increased pressures on the natural environment including: overcrowding, soil erosion, disturbance to wildlife, rubbish tipping, and increased fire risk (see section 12).

11.2. As conditions become less comfortable in urban areas on hot summer days, it is likely that the number of visitors will increase in waterside and woodland locations with increased risk of overcrowding as people seek cooler, shadier places in the warmer months. Visitor numbers are also likely to increase during spring and autumn. Coastal sites are particularly popular during heatwaves.

11.3. Summer drought will lead to a reduction in suitable locations that facilitate water based recreation at a period where demand for such activities will be at its greatest. This may result in user conflict through overcrowding and have detrimental impacts on lake and river ecology. A decrease in water quality (due to reduced dilution of pollutants) and an increase in algal blooms may also have health and safety consequences.

11.4. Increased intensity of rainfall throughout the seasons is likely to increase channelling and gullying on footpaths and other rights of way, leading to more rapid erosion. This issue is well documented at sites such as the Lake District and Snowdonia National Park.

11.5. Extreme sports such as mountain biking, white water canoeing, hill scrambling, rock climbing, caving and mine exploration and paragliding are becoming increasingly popular. Whilst the training estate has a limited capacity for some of these activities the rugged terrain of many DTE sites makes them popular for mountain biking.

11.6. Technological developments are allowing users to pursue their pastime all year round in all weather conditions and, in some cases, at any point in the day. Mountain biking in particular is becoming a 24 hour pastime that can reach into increasingly wider areas of the estate and should be carefully managed.

11.7. It is foreseeable that erosion of formal and informal trails is likely to be exacerbated by a combination of increased rainfall intensity and fewer, but more enthusiastic recreational users.

11.8. Coastal erosion can affect the provision and safety of coastal public access (e.g. Thorney Island) and has implications for the delivery of access under the Marine and Coastal Access Act 2009.

Potential implications for MOD

11.9. A number of potential negative impacts can be identified as a consequence of the increase in use of DTE as a recreational open space by the public including:

a. Increased visitor numbers in areas of DTE that lack effective visitor management will significantly affect the capacity to deliver effective military training.

b. Intensification of visitor use in popular areas may exacerbate existing issues with litter, noise, pollution (e.g. DTE SE 's bill for clearing 'fly-tipping' in the Home Counties training areas runs close to £100,000 per year);

c. Increased visitor pressures will place a greater strain on resources due to the rise in estate maintenance costs, increased man hours, etc.

d. Increased use of water bodies and navigable waterways, causing user conflict, overcrowding and increased erosion of banks;

e. Surface erosion leading to increased run-off and sedimentation of rivers and lakes;

f. Increased disturbance to sensitive conservation habitats and species;

g. Increased fire risk particularly on heathland areas, with consequences for health and safety and potential need to close areas to manage the risk.

11.10. Under the Marine and Coastal Access Act 2009 the English Coastal route will be established, using provision under the National Parks and Access to the Countryside Act 1949. Additional powers will be given to enable the route to be moved inland as the coast changes through the incorporation of spreading room. The 2009 Act and the resulting Coastal Access Scheme call this provision 'roll back', which means that where existing paths erode into the sea, a replacement route can be quickly put in place.

11.11. DIO is undertaking an internal review of public access at all coastal sites in England. The review will investigate the feasibility of improving access to the coast where this is compatible with defence requirements.

Managing potential risks and opportunities

11.12. DTE establishments should identify areas at risk of increasing visitor numbers and manage these areas accordingly. Management options may be highly site specific or warrant standardisation across the whole of the DTE.

11.13. Partnership working with national and local interests groups can provide management solutions, help raise awareness of potential issues and potentially mitigate impacts.

Other signposting documents

11.14. For further information see DIO Access and Recreation website, Natural England access advice and the Countryside Code pages for further information.

11.15. For an example on how others are managing visitor pressure see New Forest National Park Recreational Pressure Monitoring Strategy.

Figure 4 Coastal Path at Thorney Island which is at risk of coastal erosion; during stormy weather the path has to be closed to the public due to H&S reasons

12. FIRE

Summary of climate-related impacts

12.1. Fire Interdisciplinary Research on Ecosystem Services (FIRES) identified that about 1,600 grassland fires have occurred in a normal year in England and Wales between 1996-2004 whilst over 4,000 have occurred in drought years (1995 & 2003).

12.2. Wildfires are increasing in frequency and severity in the UK. Increased likelihood of drier and hotter weather episodes is likely to exacerbate existing fire risk. For a 1°C and a 2°C increases in future temperatures, a 17-28% and a 34-56% (respectively) increase in the number of outdoor fires in England and Wales is predicted to occur annually.

12.3. Increased numbers of the public accessing the countryside during warmer weather (see Section 11) are likely to exacerbate fire risk.

12.4. Key habitats more sensitive to fire include woodlands, grassland, and heathlands. Fires on these areas can damage their ecology, historic and landscape value, exacerbate rates of erosion and have a detrimental effect on water quality.

12.5. The risk of fire is particularly high on heathland areas (including peatlands e.g. blanket bog) due to the type of soils where they occur, their high vulnerability to drought and their vegetation which is very resinous and flammable e.g. Apr 2003 during which every county with upland / moorland heathland suffered some damage due to fires. The worst hit areas were the Peak District (several fires affecting about 2800 ha) and Dartmoor (1500 ha in a single fire).There is also a risk of damage resulting in bare peat, which can lead to loss of stored carbon and uncontrolled water run-off. Fires in peatlands are difficult to extinguish and could have significant environmental damage and impacts on their ability to store carbon e.g. Fylingdales Moor Fire Sept 2003.

12.6. Increased risk of wildfires affecting critical infrastructure and creating resilience issues (see examples at 12.8).

Potential implications for MOD

12.7. Increased risk of military training causing fires. Management processes for dealing with these, in particular in heathland and grassland areas, may have to be more robust in the future.

12.8. Increased risk of farming burning activities to get out of control e.g. a recent fire caused by a farmer burning the moorland at Otterburn ranges got out of control due to the high dryness of the vegetation. Management processes for dealing with these may have to be more robust in the future.

12.9. Wildfires on the MOD estate could cause long lasting damage to training assets, including nature conservation and historically important assets and associated reputational issues and repairing costs. For instance, total restoration costs due to Fylingdales Moor Fire Sept 2003 were £235,000.

12.10. Potential for training restrictions to training activities in high risk areas during high risk season.

12.11. Wildfires within the MOD estate can also have impacts outside the wire with additional risks and reputational issues, for example wildfires in Ash and Pirbright ranges due to arson have previously impacted on the resilience of the South East region (see also para 7.7d):

a. Ash Ranges (1999), 300 ha of heathland affected, caused temporary closure of the Waterloo to Alton Train Line and local A-roads during the four-day incident;

b. Pirbright Ranges (2003) fire, 800 ha affected, closed local A-roads, lead to the evacuation of military homes and concerns about Farnborough Airport flight path.

Managing potential risks and opportunities

12.12. Establishments should identify locations where a fire is likely to break out and develop a fire risk plan accordingly.

12.13. Partnership working with Local Wildfire Groups can assist to manage wildfire issues, including prevention activities and providing effective responses when wildfires occur. For example MOD is working in partnership with the South East of England Regional Wildfire Group and the Home Counties Operational Wildfire Group, and this should help manage arson issues in the area.

12.14. There are also opportunities to investigate the Met Office Fire Severity Index (FSI) which provides an assessment of the current day's fire severity (and a forecast for the following 5 days) for England and Wales. This index is used by Natural England and landowners / managers to manage fire restrictions on open access land, but it is also a useful tool that can aid decision making to prevent fires starting e.g. inform open fire checks for vulnerable areas. Similar information is also available for Scotland.

Other signposting documents

12.15. The Urban Heaths Life Project Best Practice Guide for Fire Risk Assessment and Management provides guidance on fire risk assessment and management techniques.

Figure 5 Wildfires on the UK, 18 April 2003. Red dots mark the location of active fires detected by the MODIS satellite. Smoke plumes from large moorland fires can be seen. (NASA/University of Maryland)

13. AGRICULTURE

Summary of climate-related impacts

13.1. Agriculture depends directly on climate and whilst some aspects of climate change such as longer growing seasons and warmer temperatures may bring benefits (e.g. longer growing seasons), there will also be a range of adverse impacts, including reduced water availability and more frequent extreme weather, increased loss of carbon from agricultural soils and increased run-off and soil erosion. Further detail on the risks and opportunities can be found at the CCRA Agriculture report.

Potential implications for MOD

13.2. MOD tenanted farm land may no longer be suitable for farming.

13.3. Increased risk of pollution and soil erosion and potential management issues (e.g. if pollution reaches SSSIs).

13.4. MOD farm land could help towards habitat connectivity and be used/managed to increase resilience in other areas e.g. for winter water storage.

Managing potential risks and opportunities

13.5. As part of tenancy agreements MOD should encourage tenant farmers to adopt appropriate sustainable farming practices, and understand the practices, technologies and policies that can help their farms to adapt whilst increasing the resilience of the estate to the risks that a changing climate may bring. See signposting documents.

13.6. Key priorities in the NAP include embedding adaptation in CAP reform, and rewarding farmers, foresters and land managers for delivery of ecosystem services which aid adaptation. CCW anticipates that Common Agriculture Policy (CAP) reform, agri-environment schemes like Tir Gofal and management practices will help shape agricultural systems so that they can absorb the effects of climate change. For example, CCW through the Glastir scheme aims to develop more links between habitats by habitat restoration and creation.

Other signposting documents

13.7. Defra Farming Advisory Service, Farming futures and Farming for a better climate websites contain advice on farming and climate change mitigation and adaptation including factsheets and leaflet with practical advice. The Scottish Climate Change Impacts Partnership pages on agriculture also provide a good summary of the key impacts and adaptation opportunities.

13.8. Other publications providing information about how the agricultural sector can help the UK to reduce greenhouse gas emissions and increase resilience to climate impacts include Climate Change, Agriculture and Land Management.

13.9. Scotland Adaptation Framework Agriculture Sector Action Plan covers the risks and actions to be taken for adapting farming in Scotland.

13.10. Natural England has published various Technical Information Notes to help farmers and advisers to integrate climate change mitigation and adaptation with other agri-environment objectives. Examples include TIN107 Environmental Stewardship and climate change mitigation (also mentions adaptation) TIN093: Shelter woods to prevent wind erosion, TIN098: Protecting water from agricultural run-off: an introduction, TIN109 Arable reversion and climate change case study, and TIN108 Planning for climate change adaptation case study.

14. LAND QUALITY (POLLUTION, PREVENTION AND CONTROL)

Summary of climate-related impacts

14.1. Changes in climate variables and in particular extreme weather events can affect the mobility of soil contaminants and change the source-pathway-receptor model and create/exacerbate land quality pollution prevention and control issues.

Potential implications for MOD

14.2. There may be consequences for standards in management of contaminated land areas and land remediation processes e.g. increased temperatures may increase the risk of remediation schemes failing, extreme floods may create the pathway by which pollution causes off-site contamination.

14.3. Other pollution control issues may arise, e.g. from the flooding of interceptors and fuel/explosive storage areas.

Managing potential risks and opportunities

14.4. Establishments Land Quality Assessments (LQAs) and Land Condition Files (LCFs) assist in the management of land contamination risks at site level. However, LQAs and LCFs should identify the short, medium and long term climatic risks likely to affect the source-pathway-receptor model and remediation techniques. The relevant establishment management plans and procedures should be updated accordingly e.g. H&S, EMS and Business Continuity / Resilience Plans.

14.5. EMS should also be used to monitor whether climatic risks increase the risk of pollution.

Other signposting documents

14.6. The FC document Climate change, Pollutant linkage and Brownfield regeneration provides a summary of the potential risk and advice on risk management strategies.

14.7. The EA technical information for projects and land contamination includes guidance on adapting to climate change and land quality. It provides a general overview of the risk for soil and water quality; highlights the importance of considering climate change impacts when assessing the risks from land contamination and includes advice on how to factor climate change into risk assessments.

Summary of UK species (spp.) likely to be vulnerable to climate change

Please note:

1. **This list has been drafted by MOD Climate Resilience Focal Point (DIO StratPol-SD Energy1b1) by pulling together information to date from the UK Climate Impacts Programme (MONARCH project), UK Biodiversity Action Plans, Joint Nature Conservation Committee, Defra, BTO and SEPA on how climate change is likely to negatively affect different species in the UK;**
2. **This list is not exhaustive, but it gives an indication of spp. that might be at risk due to climate changes;**
3. **Known spp. of Lichens, Cnidaria, Fish, Marine turtles, Whales, Dolphins and Porpoises also vulnerable to climate change have not been included in this list;**
4. **There are still a number of gaps in current knowledge and data about how spp. will adapt and whether there will be the suitable climate space and food for them;**
5. **Depending on the specie and location, there are likely to be other factors affecting decline.**

Birds	• Arctic skua (BAP); • Scottish crossbill (BAP); • Ring ouzel (BAP); • Bittern (BAP); • Aquatic warbler (BAP); • Skylark (BAP); • Common Scoter (BAP); • Black Grouse (BAP); • Capercaillie (BAP); • Song Thrush (BAP); • Puffin; • Kittiwake; • Arctic tern; • Ptarmigan; • Snow buntings; • Whooper swans; • Greenshanks; • Dotterels; and • Golden plover. • SPAs issues - Wintering populations of several species of waders occurring in internationally important numbers in the UK have shifted from the western to eastern estuaries in response to increasing mean winter temperatures (e.g. Curlew; Oystercatcher; Dunlin; Ringed plover). However, in the long term, populations of some wader species may decline considerably in the future and may lead to a situation where Britain no longer holds internationally important populations of species including: - Ringed plover; - Sanderling; - Purple sandpiper; - Ruddy turnstone.
Reptiles	• Sand lizard and Smooth snakes (BAP and European protection) – both spp. are at the edge of their ranges in the UK and confined to very specific habitat, in

	future may be able to survive in a much broader range of habitats in an altered climate. However, in practice the fragmented nature of the natural landscape in the UK may prevent migration to alternative habitats. Conversely, the increase in hot weather and droughts may result in an increased impact of arson attacks on the sites to which they are confined. Similarly, milder winters might negatively affect body condition and survival.
Amphibians	• Great crested newt (BAP and European protection); • Natterjack toad (BAP and European protection); • Pool frog (BAP).
Mammals	• Grey seals (due to loss of breeding areas); • Bat spp. reaching their Northerly limit: - Greater horseshoe bat (BAP); - Bechstein's bat (BAP); - Lesser horseshoe bat (BAP); - Noctule bat (BAP); - Brown long-eared bat (BAP); - Soprano pipistrelle bat (BAP); - Barbastelle bat (BAP), might gain climate space northerly by the 2020s and 2050s this but could partially offset by losses in southern England by the 2080s.
Insects	• Mountain ringlet (BAP); • Silver-studded blue butterfly (BAP); • Bright wave moth (BAP); • Marsh Fritillary (BAP & SAC) - climate is unlikely to be a critical factor. However, without landscape scale habitat restoration and management, the Biodiversity Action Plan target to halt range decline and maintain or expand key populations will probably not be met. • Stag beetle (BAP) might gain climate space northerly by the 2020s and 2050s this but could partially offset by losses in southern England by the 2080s; • Carabid species (ground beetles) have shown numbers increasing in the south-east but decreasing elsewhere; • Craneflies, which are a key food source for a wide range of upland birds (decline likely to have wide implications).
Molluscs	• Narrow-mouthed whorl snail (BAP & SAC)
Plants	• Shore dock (BAP) – climate change is a current factor affecting decline; • Climate change might affect decline due to sea level rise, erosion or coastal defences affecting suitable habitats of: - Early gentian (BAP); - Fen orchid (BAP); and - Petalwort (BAP). • Other plants likely to loss climate space include: - Norwegian mugwort (BAP); - Twinflower (BAP); - Oblong (BAP); and - Woodsia (BAP). • Some plants might gain climate space northerly by the 2020s and 2050s this but could partially offset by losses in southern England by the 2080s including:

	- Cornflower (BAP); - Floating water plantain (BAP); - Tower mustard (BAP); - Cut-grass (BAP). • Arctic-alpine plant species in mountain-top environments also at risk, including: - Trailing azalea; - Dwarf willow; - Stiff sedge; - Starry saxifrage.