

Adapting to Climate Change in the North York Moors National Park

Assessment of Risks and Opportunities

North York Moors National Park Authority

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Introduction

Hotter summers, wetter winters, more storms and sea level rise are some of the changes in our climate that are predicted to take place over the coming decades. Whilst seeking to reduce the causes of climate change is clearly important, it is also necessary to acknowledge that some changes will happen, and that these need to be planned for.

The Climate Change Act 2008 has introduced a statutory requirement on many public authorities to report on the measures they are taking to address the likely impacts of these changes. English National Park Authorities have been invited by DEFRA to report voluntarily, and have collectively committed to doing so. This report forms the response of the North York Moors National Park Authority.

The North York Moors National Park

The North York Moors National Park was designated in 1952. It covers 1,436 square kilometres and at its heart is the largest continuous expanse of heather moorland in England. The Park also contains other important and scenic landscapes such as woodlands and farmland as well as 42km of Heritage Coast. It supports many important habitats and species of international and national importance. The built heritage makes an important contribution to the fabric of the Park; there are over 3,000 listed buildings and over 800 scheduled monuments. Importantly the Park is also a living, working environment, home to around 25,000 people.

The National Park Authority

The National Park Authority is the main organisation charged with delivering the National Park purposes, as set out in the 1995 Environment Act:

- To conserve and enhance the natural beauty, wildlife and cultural heritage of the area;
- To promote opportunities for the understanding and enjoyment of the Park's special qualities by the public.

The Act also places a duty on National Park Authorities in pursuing the two purposes "to seek to foster the economic and social well being of local communities."

However, the Authority cannot do this alone and much of the work is carried out in partnership with other organisations, communities and land owners.

National Park Management Plan

The National Park Authority is required to produce a Management Plan which sets out the strategic direction for achieving National Park purposes. The Management Plan sets out the vision for the Park and identifies the 'special qualities' that distinguish the Park from other

places. The Management Plan is currently being reviewed and will set the framework for the future of the Park over the next 15 years. The new Plan is proposed to be published in March 2012.

The assessment of climate change risks and opportunities has been undertaken alongside the review of the National Park Management Plan. This has enabled the predicted effects to be considered at the strategic level and the Plan identifies, at the broad level, policies to address these. These policies will be taken forward through the National Park Authority's Business Plan as well as the plans and strategies of other organisations and through our partnership working and bilateral agreements.

Scope of Adaptation Reporting

The purpose of this exercise is to assess what effects the projected changes to the climate may have on the National Park (its environment, its people and its activities) and also on the operation of the National Park Authority. The assessment also involves identifying what actions are already being undertaken or could be undertaken in the future, but does not form a detailed action plan – actions will arise from the delivery of the Management Plan as explained above.

Climate Change Impacts on the North York Moors National Park

It is generally accepted that the climate will change and that we will see hotter drier summers and warmer wetter winters, along with increasingly stormy weather and sea level rise. The degree of changes depends upon the amount of future greenhouse gas emissions. However due to the time it takes for the climate to be affected we can be certain that past emissions will have an effect over the next 30 years.

The most up to date projection of future changes to the climate are contained in the UK Climate Projections 2009 (UKCP09). The projections are based upon a range of possibilities based on different scenarios, and are not predictions of precisely how it is expected the climate will change. The projections consider low, medium and high emissions scenarios to provide a range of projections for the 2020s, 2050s and 2080s in relation to summer temperature, summer rainfall, winter temperature and winter rainfall.

It is considered appropriate to use the medium emissions scenarios in line with common practice. For the purposes of this qualitative assessment of risks and opportunities it is considered that the difference between the low, medium and high emissions scenarios are not particularly significant. The medium scenario projections for the Yorkshire and Humber region are set out below:

Hotter drier summers

Timescale	Increase in average summer temperature is...			Change in average summer rainfall is...		
	very unlikely to be less than:	most likely to be:	very unlikely to be more than:	very unlikely to be less than:	most likely to be:	very unlikely to be more than:
2020s	0.5°C	1.3°C	2.3°C	-24%	-8%	+10%
2050s	1.1°C	2.3°C	3.9°C	-36%	-19%	+1%
2080s	1.7°C	3.3°C	5.4°C	-44%	-23%	0%

Warmer, wetter winters

Timescale	Increase in average winter temperature is...			Change in average winter rainfall is...		
	very unlikely to be less than:	most likely to be:	very unlikely to be more than:	very unlikely to be less than:	most likely to be:	very unlikely to be more than:
2020s	0.6°C	1.3°C	2.1°C	-3%	+4%	+13%
2050s	1.1°C	2.2°C	3.4°C	+1%	+11%	+24%
2080s	1.6°C	3.0°C	4.6°C	+2%	+15%	+33%

Projections for sea level rise are made in relation to points around the UK's coastline. It is considered that the coastline of the National Park would fall somewhere between the projections for London and Edinburgh:

Timescale	London (cm)			Edinburgh (cm)		
	High	Med	Low	High	Med	Low
2020s	11.5	9.7	8.2	7.5	5.7	4.3
2050s	25.8	21.8	18.4	18.0	13.9	10.5
2080s	43.3	36.3	30.5	31.4	24.4	18.6

It is also considered that more extreme weather events, such as storms and flooding, will become more prevalent.

Methodology

Developing the spreadsheet

The National Park Authorities have worked together, via the Climate Change Working Group, to produce a common methodology for assessing the risks and opportunities associated with climate change.

A spreadsheet has been developed to facilitate a standard risk assessment approach to be undertaken. The spreadsheet is based around seven themes that are common to all National Parks, these are:

- landscape;
- biodiversity;
- historic environment;
- farming and land management;
- access, recreation and tourism;
- community, culture and economy; and
- National Park Authority business continuity.

Within each theme there are a number of 'areas of potential impact', for example flora, fauna and habitat under the biodiversity theme.

Potential consequences to the Park or the Authority resulting from changes to the climate are scored in terms of both their likelihood and the degree of impact, using the scoring matrix below. It is important to recognise that climate change may have positive consequences for the Park as well as negative.

Risk	-5 Catastrophic	-5	-10	-15	-20	-25
	-4 Major	-4	-8	-12	-16	-20
	-3 Moderate	-3	-6	-9	-12	-15
	-2 Minor	-2	-4	-6	-8	-10
	-1 Slight	-1	-2	-3	-4	-5
	0 No Change	0	0	0	0	0
Opportunity	1 Slight	1	2	3	4	5
	2 Minor	2	4	6	8	10
	3 Moderate	3	6	9	12	15
	4 Major	4	8	12	16	20
	5 Fantastic	5	10	15	20	25
		Rare	Unlikely	Possible	Likely	Almost certain
		1	2	3	4	5
		Likelihood				

The spreadsheet also enables current and potential actions to be identified in relation to each possible effect.

Evaluating the impacts

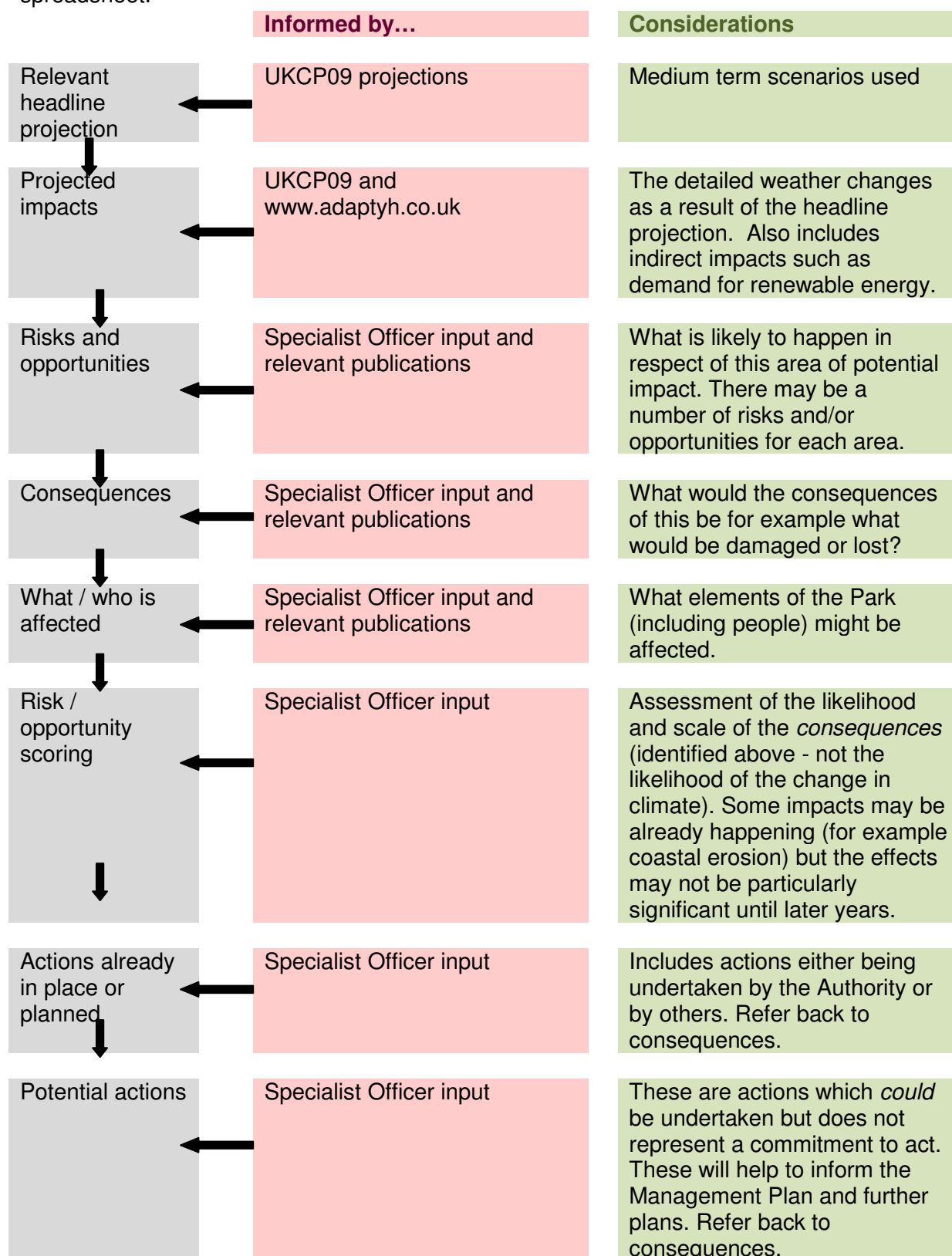
Completing the spreadsheet involves, for each 'area of potential impact', an assessment of how the projected climate changes may impact and what the consequences and significance of this may be. The scale of any potential opportunity or threat has been considered in terms of its significance to the Park as a whole, particularly in relation to the special qualities and achieving National Park purposes. Therefore, whilst an impact may be very significant to the subject affected (for example a storm damaged building) the significance for the Park may be relatively minor. Consideration has been given to cumulative effects over time.

Completion of the spreadsheet has involved internal discussions with specialist Officers who have an in depth knowledge of their subject area, in relation to: ecology, landscape, the built heritage, archaeology, farming, recreation and access and the operation of the National Park Authority.

Reference has also been made to a number of publications and resources, as set out below:

- UK Climate Impacts Programme and the UKCP09 projections, available at <http://ukclimateprojections.defra.gov.uk>
- Climate Change Mitigation and Adaptation in National Parks (English National Park Authorities Association)
- North York Moors National Park Local Climate Impacts Profile (AECOM, 2010)
- Yorkshire and Humber Climate Change Adaptation online resource <http://www.adaptyh.co.uk/>
- Climate Change and the National Park (Report to North York Moors National Park Authority, September 2005)
- Climate Change and the Historic Environment (English Heritage)
- North York Moors Recreation and Access Strategy (North York Moors National Park Authority, 2008)
- North York Moors Local Biodiversity Action Plan (North York Moors National Park Authority)
- River Tyne to Flamborough Head Shoreline Management Plan 2 (North East Coastal Authorities Group, 2007)
- Environment Agency Catchment Flood Management Plans for the Rivers Esk, Derwent and Ouse.
- Combating Climate Change – A Role for UK Forests – An Assessment of the Potential Impacts of the UK's Trees and Woodlands to Mitigate and Adapt to Climate Change (Sir David Read, 2009)

The diagram below shows how the assessments have been undertaken for each part of the spreadsheet.



It may not be possible, feasible or even desirable to take action in relation to some of the consequences identified, and actions have only been identified where it is considered these are appropriate.

Climate Change Risks and Opportunities

The tables overleaf shows the predicted risks and opportunities as identified by the completion of the spreadsheet (for the purposes of this report this does not contain all of the information entered onto the spreadsheet). It is important to acknowledge that these are *possibilities*, it is not the intention, nor is it necessarily possible, to try to state what *will* happen.

In summary, it is considered that the main impacts of climate change on the North York Moors National Park are likely to be:

- Flooding of infrastructure (buildings, roads, footpaths) and habitats, having relatively short term but potentially fairly significant consequences, including the financial impact of repair works and loss of business;
- Drought, affecting flora and fauna and also productivity, although real effects may not be seen until later in the century;
- Changes to the coastline as a result of a combination of sea level rise, increased rainfall and increased storminess;
- Increased risk of fire on the moorland. Whilst this may occur infrequently, the impact could be catastrophic;
- Cumulative effects of a number of changes to conditions for agricultural production may lead to different types and/or new ways of managing crops and stock in the future;
- Cumulative effects of a number of changes to conditions for biodiversity may result in loss of some species and an increase / introduction of other, potentially threatening, species;
- Changing composition of native woodland, including tree species and ground flora, and economic implications in relation to timber production;
- Increased occurrences of disease affecting wildlife, trees, crops and livestock.

Some potential effects may lead to both positive and negative impacts, such as an increasing number of visitors.

Far fewer opportunities than risks have been identified, but these relate to increasing potential for visitors, fewer problems associated with snowy weather and improved conditions for some species.

Theme: Landscape

Relevant headline projection	Projected impacts (Direct (D) and/or Indirect (ID))	Risks and opportunities	Consequences	Short Term Risk	Medium Term Risk	Long Term Risk	Actions
				2020s	2050s	2080s	
Geology and landform							
Hotter, dryer summers	Dryer weather (D)	Land becomes dry and vulnerable to slippage during subsequent rainy weather	Loss of land on slopes and along the coast	-5	-10	-15	Slowing the Flow project. Potential actions could include further catchment management measures
	Warmer, wetter winters	Increased amount of rainfall (D)	Soil erosion, particularly when following previous dry spells, resulting in exposure of geological landforms	Impact on landscape character	-2	-3	-8
		Increased amount of vegetation	Loss of visibility of historic landscape features	-4	-6	-12	
More extreme weather events	Increased frequency and severity of flooding (D)	Scouring of river banks	Change to landform alongside rivers	-4	-6	-9	Potential actions could include remedial works following flooding, where appropriate
Sea level rise	Coastal erosion (D)	Erosion of parts of the coast, particularly around Robin Hood's Bay and Saltwick Nab, and to a lesser extent along the rest of the coastline	Change to coastal landscape	-10	-15	-20	As set out in Shoreline Management Plan 2, coastal defences to be maintained to protect some communities
Soils and vegetation							
Hotter, dryer	Drought (D)	Moorland will become dry	Increased fire risk and	-8	-16	-16	Large areas of moorland are covered by Fire

summers			increased severity of fires, with peat burning as well as vegetation				Management Plans. Potential actions could include greater availability of fire fighting equipment, restrictions on burning, restrictions on access and changes to moorland management.
		Lack of moisture to support vegetation	Reduced levels of vegetation or change to type of vegetation	-4	-12	-16	
		Erosion of peat and other soils, particularly when followed by rainy weather	Loss of vegetation	-4	-12	-16	Restoration and re-vegetation of peat bogs.
Warmer, wetter winters	Increased rainfall (D)	Erosion of peat and other soils, particularly following dry spells	Eroding of the moorland and loss of peat to support moorland vegetation	-4	-9	-16	Measures to retain water on the moorland such as grip blocking and heather bales
	Warmer weather (D)	Increased occurrences of, and new types of, pests and diseases	Loss of native plants	-9	-12	-16	Actions may depend upon specific disease outbreaks
More extreme weather events	Storms (D)	Peat erosion	Eroding of the moorland and loss of peat to support moorland vegetation	-6	-12	-16	Measures to retain water on the moorland such as drain blocking and re-vegetating bare ground
	Rain storms (D)	Erosion of soils in steep valleys	Eroding of the narrow moorland dales	-4	-9	-16	Measures to retain water on the moorland such as drain blocking and re-vegetating bare ground
	Increased frequency and severity of flooding (D)	Flooding of narrow valleys and lowland landscapes	Soil erosion and loss of vegetation	-12	-16	-20	Slowing the Flow project. Potential actions could include further catchment management measures

Sea level rise	Coastal erosion (D)	Loss of and/or change to parts of the coast	Change to the character of the coast	-10	-15	-20	Shoreline Management Plan 2 seeks to maintain defences around some settlements, but for the open coastline it is likely that erosion will continue
	Permanent flooding of existing intertidal areas (D)	Loss of or changes to intertidal vegetation, such as kelp beds	Change to the character of the coast	-4	-6	-9	
All of the above	Range of effects on biodiversity (ID)	Changes to protect biodiversity including buffering and improving connectivity	Indirect improvements to the landscape	4	9	16	Positive outcome
Tree cover							
Hotter, dryer summers	Warmer summers (D)	Climate suited to new species of tree such as eucalyptus	Forests and woodlands look different in the landscape	-4	-9	-16	Potential actions could include to consider planting new species and use of Ecological Site Classification(matching species to sites)
		Climate not suited to trees which are sensitive to drought	Loss of drought sensitive species such as ash	-4	-9	-12	Potential actions could include to consider planting new species and use of Ecological Site Classification(matching species to sites)
		Increased numbers of pests and diseases	Loss of or damage to native species	-4	-6	-12	
Warmer, wetter winters	Warmer winters (D)	Increased tree growth	Trees intruding into other landscape areas	-3	-6	-9	
		Climate suited to new species of tree such as eucalyptus	Forests and woodlands look different in the landscape	-4	-9	-16	Potential actions could include to consider planting new species and use of Ecological Site Classification(matching species to sites)

	Warmer weather (D)	Potential for more pests and diseases such as Phytophthora (in association with drought, longer growing season and increase in deadwood from storm damage)	Loss or damage to trees	-9	-12	-16	Actions may depend upon specific disease outbreaks
More extreme weather events	Increased frequency and severity of storms (D)	Direct impact of storms on trees and woodlands	Loss of and damage to trees and woodlands	-4	-6	-8	The need for action may depend upon individual circumstances
Sea level rise	No impacts identified			0	0	0	
All of the above	All impacts	Increased tree cover is needed (as a response to the effects of climate change and to sequester carbon)	More woodland is planted	6	9	12	Positive outcome
		Short rotation forestry is favoured (for example for woodfuel)	Trees do not mature, landscape features younger trees	-4	-6	-9	
Land use							
Hotter, dryer summers	Drought (D)	Increasingly competing demands for water use	Need for more reservoirs resulting in visual impact upon the landscape	-4	-9	-12	Potential actions could include promotion of water conservation measures and storage of water in winter.
	Warmer summers (D)	Increase in growing season and changes to crops grown	Changes to the appearance of arable landscapes	-4	-9	-12	
Warmer, wetter winters	No impacts identified			0	0	0	
More extreme weather events	Increased frequency and severity of flooding (D)	Demand for flood defences	Negative impact of flood defences on landscape, particularly in settlements	-4	-4	-6	Local Development Framework

Sea level rise	Coastal erosion (in combination with increased stormy weather) (D)	Need to relocate paths, roads and buildings inland	Visual impact of relocated paths, roads and buildings	-6	-9	-16	Local Development Framework (where planning permission is required)
All of the above	Increased demand for renewable energy (ID)	Pressure for more wind turbines, both within and outside the Park	Wind turbines detracting from the landscape	-6	-9	-16	Local Development Framework and Renewable Energy Supplementary Planning Document. Potential actions could include Article 4 in response to proposed changes to the General Permitted Development Order
		Pressure for more hydro power	Hydro power developments detracting from the landscape	-4	-6	-6	Local Development Framework and Renewable Energy Supplementary Planning Document
		Pressure for more wood fuel	More woodland is planted	6	9	12	Potential actions could include promotion of good practice in woodland management
			Short rotation forestry is favoured resulting in the landscape featuring younger trees	1	-4	-12	
		Pressure for more energy crops	Introduction of new species to the landscape	-4	-9	-12	

Theme: Biodiversity

Relevant headline projection	Projected impacts (Direct (D) and/or Indirect (ID))	Risks and opportunities	Consequences	Short Term Risk	Medium Term Risk	Long Term Risk	Actions
				2020s	2050s	2080s	
Flora (plants)							
Hotter, dryer summers	Warmer weather (D)	Growing conditions adversely affected for species favouring a cooler climate	Decrease in northerly growing species such as dwarf cornel and bog rosemary which are currently at their southern extremity	-4	-9	-16	Monitoring of dwarf cornel and bog rosemary. Management of dwarf cornel through cutting of bilberry. Habitat network mapping has been undertaken in part of the Park to identify potential areas where networks could be improved.
		Growing conditions improved for species favouring a warmer climate	Increase in species favouring a warmer climate such as bracken	-4	-9	-16	Moorland management to reduce area of bracken. Habitat network mapping has been undertaken in part of the Park to identify potential areas where networks could be improved.
			Increase in species favouring a warmer climate such as some limestone grassland species and rare arable plants	4	6	12	Habitat network mapping has been undertaken in part of the Park to identify potential areas where networks could be improved.

		Increased numbers of people using rights of way and open access land	Trampling of flora	-4	-6	-6	Promotion of the "Moors Message"
		Increased number of instances of pests and diseases such as Phytophthora	Decline in and loss of existing species	-9	-12	-16	Potential actions could include increasing the number of species monitored.
	Drought (D)	Insufficient water to support plant life	Loss of flora, particularly wetland species	-6	-12	-16	
		Increased frequency and extent of wildfires	Loss of flora, particularly in woodlands and moorlands	-8	-12	-16	Fire Management Plans are in place for most estates. Promotion of the "Moors Message". Potential actions could include greater availability of fire fighting equipment, restrictions on burning, restrictions on access and changes to moorland management.
Warmer, wetter winters	Longer growing season and earlier onset of spring (ID)	Change in distribution and balance of species	More vigorous species, such as bracken and some grasses, become more widespread whilst less dominant species, such as many wildflowers, decline	-4	-12	-20	Potential actions could include increasing the number of species monitored.
	Increased levels of ground water (D)	Over saturation of ground supporting flora	Loss of plants which are not able to survive in waterlogged conditions	-2	-9	-12	
	Warmer weather (D)	Increased number of instances of pests and diseases such as Phytophthora	Decline in and loss of existing species	-9	-12	-16	Potential actions could include increasing the number of species monitored.
More extreme weather events	Increased frequency and severity of storms (D)	Wind damage to trees in exposed locations	Loss of or damage to trees, and damage to woodlands from subsequent inappropriate repair work such as ground disturbance	-2	-9	-12	Potential actions could include promoting good practice in woodland management.

	Coastal erosion (coupled with increased winter rainfall (D))	Increased erosion of soft cliffs	Loss of plants on soft cliffs, but also increased opportunities for open ground plants to colonise	-5	-5	-5	The policy of Shoreline Management Plan 2 is to allow natural processes along the undeveloped parts of the coast
	Increased frequency and severity of flooding (D)	Flooding of habitats	Loss of and damage to flora, particularly in narrow valleys and along river corridors	-6	-9	-12	Slowing the Flow project. Potential actions could include further catchment management measures
		Scouring alongside river banks and erosion of peatlands	Loss of flora on river banks and in peatlands	-8	-12	-16	Slowing the Flow project. Potential actions could include further catchment management measures
Sea level rise	Flooding of coastal area (D)	Flooding of rocky shore and intertidal habitats	Loss of or changes to flora	-6	-9	-12	
Fauna (animals)							
Hotter, dryer summers	Drought (D)	Lack of water to support populations	Aquatic animals such as white-clawed cray fish may be stranded. Others such as water voles may be more susceptible to predators if their habitat is reduced	-6	-9	-12	Water voles, Duke of Burgundy butterflies and merlins are monitored and their habitats are managed. Potential actions could include increasing the number of species monitored.
		Living conditions affected for species favouring a cooler climate	Decrease in species favouring a cooler climate	-4	-9	-16	Merlins are monitored and their habitats are managed. Potential actions could include increasing the number of species monitored.
	Warmer weather (D)	Living conditions improved for species favouring a warmer climate	Increase in species favouring a warmer climate such as Duke of Burgundy butterfly. Increase in sea temperatures enable southern intertidal species to thrive.	4	9	16	Duke of Burgundy butterflies are monitored and their habitat is managed. Potential actions could include increasing the number of species monitored.
		Increased number of instances of pests and diseases	Loss of or decline in species	-9	-12	-16	Potential actions could include increasing the number of species monitored.

Warmer, wetter winters	Wetter conditions (D)	Living conditions improved for species favouring wetter conditions	Increase in species favouring a wetter climate such as craneflies, with knock-on benefits for golden plover and grouse	4	9	16	Potential actions could include increasing the number of species monitored.
		Increase in grass growth	Grass swamping food of species such as Duke of Burgundy butterfly and habitat of species such as lapwings.	-4	-9	-16	Duke of Burgundy are monitored and their habitat is managed. Potential actions could include increasing the number of species monitored.
		Living conditions affected for species favouring a drier climate	Decline in species favouring drier conditions	-4	-9	-16	Potential actions could include increasing the number of species monitored.
		Living conditions improved for species favouring a warmer climate	Increase in species favouring wetter conditions	4	9	16	Potential actions could include increasing the number of species monitored.
	Fewer snowy days (D)	Fewer occasions when food is unavailable	Less loss of fauna due to inability to find food in winter months	4	6	6	Positive outcome
		Loss of camouflage for stoats	Stoats vulnerable to predators	-2	-4	-6	
	Warmer weather (D)	Increased number of instances of pests and diseases	Loss of or decline in species	-9	-12	-16	Potential actions could include increasing the number of species monitored.
More extreme weather events	Increased frequency and severity of flooding (D)	Flooding of habitats occupied by fauna	Loss of and injury to fauna, particularly fauna occupying narrow valleys and river corridors, loss of burrows, e.g. water voles	-9	-12	-12	Slowing the Flow project. Potential actions could include further catchment management measures
		Scouring of habitats along river banks	Loss of and injury to riparian species, e.g. white-clawed crayfish	-6	-9	-12	Slowing the Flow project. Potential actions could include further catchment management measures
		Need for flood defences	Direct damage to species such as water voles and freshwater pearl mussel	-2	-4	-4	Slowing the Flow project. Potential actions could include further

							catchment management measures
	Increased frequency and severity of storms (D)	Direct impact of storms on fauna, such as falling trees and debris	Loss of and injury to fauna and loss of habitat for e.g. tree-roosting bats	-8	-12	-16	The need for action may depend upon individual circumstances
		Silt stirred up in rivers	Damage to habitat of aquatic animals such as fresh water pearl mussel	-4	-6	-8	River Esk Fresh Water Pearl Mussel and Salmon Recovery project
		Some species not able to cope with rainstorms and cold	Harm to species at certain stages in their life cycle such as merlin and wader chicks	-4	-6	-8	The need for action may depend upon individual circumstances
		Direct damage to trees	Damage to trees may provide new habitats for smaller species	4	4	6	Positive outcome
		Erosion of soft cliffs	Loss of invertebrates	-6	-6	-6	The policy of Shoreline Management Plan 2 is to allow natural processes along the undeveloped parts of the coast
			Provision of soft ground is beneficial for flies and mining bees	4	6	9	Positive outcome
Sea level rise	Flooding of coastal area (D)	Flood defences are required	Loss of habitat and disturbance to species	-6	-9	-12	Local Development Framework
Habitats (including protected areas)							
Hotter, dryer summers	Drought (D)	Lack of water to support vegetation and habitats	Decreasing populations, habitat loss or damage	-6	-12	-16	Moorland grip blocking. Slowing the Flow project.
		Lack of water for trees	Loss of trees with high water demand, particularly open grown mature and veteran trees and young trees	-4	-9	-16	Planting open grown trees which will adapt to future climatic conditions.

			Extinction of some tree types or trees associated with small, isolated patches of woodland	-2	-4	-9	Restoration of Plantation on Ancient Woodland Sites. Potential actions could include tree planting to facilitate habitat network development and more species diversity.
		Lower water levels in rivers and streams	Loss of habitat for animals living in the water such as white-clawed crayfish	-4	-9	-12	Moorland grip blocking. Slowing the Flow project, to even out river flows
		Greater frequency and severity of moorland fires	Loss of moorland habitat	-12	-16	-20	Fire Management Plans are in place for most estates. Promotion of the "Moors Message". Potential actions could include greater availability of fire fighting equipment, restrictions on burning, restrictions on access and changes to moorland management.
	Warmer weather (D)	Grass growing earlier	Loss of habitat for some ground nesting birds	-4	-6	-8	The need for action may depend upon individual circumstances
Warmer, wetter winters	Wetter conditions (D)	Waterlogging of habitats	Changed composition to habitats and growth of inappropriate species, such as soft rush	-6	-9	-12	Potential actions could include increasing the number of species monitored.
	Warmer weather (D)	Trees start to grow earlier in the spring	Increased chance of frost damage	-2	-4	-9	Potential actions could include consideration of planting trees that can better withstand changed conditions.
More extreme weather events	Storms (D)	Coastal erosion	Damage to coastal habitats and soft cliffs	-9	-12	-15	Shoreline Management Plan 2 seeks to maintain defences around some settlements, but for the open coastline it is likely that erosion will continue
	Flooding (D)	Scouring of habitats	Loss of or damage to habitat	-9	-12	-15	Slowing the Flow project. Potential actions could include further catchment management measures
		Flood water inundates habitats	Loss of or damage to habitat	-6	-8	-10	Slowing the Flow project. Potential actions could include further catchment management measures

Sea level rise	Rising sea levels (D)	Submersion of habitats	Loss of or damage to rocky shore habitats	-3	-9	-12	
		Flood defences are required to protect communities	Loss of or disturbance of habitat	-6	-9	-9	Shoreline Management Plan 2 seeks to maintain defences around some settlements, but for the open coastline it is likely that erosion will continue
		Undercutting of soft cliffs	Loss of soft cliffs	-6	-9	-16	Shoreline Management Plan 2 seeks to maintain defences around some settlements, but for the open coastline it is likely that erosion will continue
Other							
Hotter, dryer summers	Drought (D)	Drier and eroding peat bogs	Less carbon stored in peat bogs	-3	-9	-12	Restoration and re-vegetation of peat bogs by Yorkshire Peat Partnership. Grip and gully blocking.
Warmer, wetter winters	Heavy rainfall (D)	Rain scours through cracks caused by dry weather	Less carbon stored in peat bogs	-3	-9	-12	Restoration and re-vegetation of peat bogs by Yorkshire Peat Partnership. Grip and gully blocking.
More extreme weather events	No impacts identified			0	0	0	
Sea level rise	No impacts identified			0	0	0	

Theme: Historic Environment

Relevant headline projection	Projected impacts (Direct (D) and/or Indirect (ID))	Risks and opportunities	Consequences	Short Term Risk	Medium Term Risk	Long Term Risk	Actions
				2020s	2050s	2080s	
Built Heritage							
Hotter, dryer summers	Less rain in summer (D)	Reduced levels of moisture in buildings (D)	Heightened risk of ground subsidence affecting structure of historic buildings and structures	-2	-6	-6	NPA historic buildings grants (for Buildings at Risk)
Warmer, wetter winters	Increased amount and duration of rain (D)	Increased potential for rain and groundwater intrusion into historic buildings	Damage to historic buildings caused by damp and mould or direct water intrusion.	-6	-8	-10	NPA historic buildings grants (for Buildings at Risk)
			Visual impacts arising from the need for additional rainwater goods to divert water away from buildings	-2	-4	-6	Local Development Framework (where Planning or Listed Building Consent is required)
	Warmer weather (D)	Increased number and severity of cases of infestations such as woodworm	Damage to parts of historic buildings, and potentially to the structure	-6	-8	-10	NPA historic buildings grants (for Buildings at Risk)
		Increased levels of humidity in buildings	Condensation in historic buildings leading to problems of damp and mould	-6	-8	-10	NPA historic buildings grants (for Buildings at Risk)
	Prolonged rainfall (D)	Pressure for flood defences	Damage to conservation areas, historic settlements and/or historic buildings or their settings	-3	-6	-9	NPA historic buildings grants (for Buildings at Risk)

	Reduction in the number of days experiencing sub-zero temperatures (D)	Reduced number of occurrences of freeze/thaw affecting historic buildings	Fewer instances of cold weather damage to historic buildings (such as eroded stonework and damage to rainwater goods)	2	6	8	Positive outcome which requires no action
More extreme weather events	Increase in frequency and severity of flooding events (D)	Flooding of historic buildings and settlements	Loss of or damage to historic buildings and structures, damage to historic settlements. Also leads to difficulties in insuring historic buildings against future flooding events	-9	-16	-20	Slowing the Flow project. Potential actions could include further catchment management measures
			Need for flood mitigation features on buildings could have a visual impact upon historic buildings	-2	-6	-8	Slowing the Flow project. Potential actions could include further catchment management measures
		Pressure for flood defences	Damage to conservation areas, historic settlements and/or historic buildings or their settings	-3	-6	-9	Local Development Framework (where Planning or Listed Building Consent is required)
	Increase in frequency and occurrences of stormy weather (D)	Coastal erosion	Loss of historic buildings/parts of historic settlements on the coastline such as in Staithes (Cowbar), Port Mulgrave and Robin Hood's Bay	-1	-6	-20	Shoreline Management Plan 2 provides protection for some coastal settlements/properties
		Direct damage to historic buildings and structures	Loss of or damage to historic buildings and structures	-4	-12	-16	

		Pressure for replacement of damaged or old rainwater goods with 'modern' ones	Inappropriate rainwater goods on historic buildings	-4	-9	-9	NPA historic buildings grants (for Buildings at Risk)
Sea level rise	In combination with increased stormy weather, may lead to coastal erosion (D)	Loss of parts of the coast	Loss of historic buildings/parts of historic settlements on the coastline such as in Staithes (Cowbar), Port Mulgrave and Robin Hood's Bay	-1	-6	-20	Shoreline Management Plan 2 provides protection for some coastal settlements/properties
		Pressure for flood defences	Impact upon setting of historic buildings and settlements	-4	-6	-12	Shoreline Management Plan 2 provides protection for some coastal settlements/properties. Local Development Framework
All of the above	Increased demand for renewable energy (ID)	Renewable energy installations developed in, or in the setting of, historic buildings and settlements	Negative visual impact upon historic buildings and settlements	-8	-12	-16	Renewable Energy Supplementary Planning Document
	Requirements for energy efficiency measures (ID)	Installation of inappropriate energy efficiency measures such as insulation and double glazing into historic buildings	Inappropriate energy efficiency measures may damage historic buildings	-9	-16	-16	English Heritage guidance on use of appropriate materials for undertaking energy efficiency measures. Potential measures could include grant schemes to fund the difference between inappropriate and appropriate energy efficiency measures and promotion of English Heritage guidance.
	Longer growing season (ID)	Changed requirements for agricultural buildings	No longer a need for some traditional agricultural buildings	-2	-4	-6	

			New uses for traditional agricultural buildings	2	4	6	Local Development Framework and Design Guide Supplementary Planning Document
Archaeological Assets							
Hotter, dryer summers	Drought (D)	Increased risk of moorland fires	Damage to archaeological remains in moorland areas	-8	-12	-16	Warnings of risks of fires on the moors. Controlled burning. Actions to address damage depend upon the case and needs to be weighed up against the need to also re-vegetate. Potential actions could include ensuring that all Estates have sufficient Fire Management Plans which identify and locate key historic environment sites
			Exposure of previously unknown remains	8	12	16	Action in relation to the discovery of new assets is set on a case by case basis.
		Movement of cliffs as soil becomes drier	Damage to important archaeological assets	-4	-9	-12	Action in relation to the discovery of new assets is set on a case by case basis.
		Vegetated areas become drier	Parch marks and crop marks become visible, identifying previously unknown buried assets	2	9	12	Action in relation to the discovery of new assets is set on a case by case basis.
	Changes to growing conditions (ID)	New forms of vegetation planted in areas containing archaeological assets	Reduced visibility of archaeological assets and fewer opportunities to understand archaeological assets. Asset may require more direct management.	-2	-6	-12	The need for action may depend upon individual circumstances. The need for action may depend upon individual circumstances.
Warmer, wetter winters	Increased amount and duration of rain (D)	Erosion of important archaeological sites	Loss of or damage to important archaeological assets	-3	-9	-12	Action in relation to the discovery of new assets is set on a case by case basis. The need for action may depend upon individual circumstances

			Potential to uncover previously unknown archaeological assets	2	6	6	Action in relation to the discovery of new assets is set on a case by case basis.
		Ground used by livestock becomes particularly waterlogged	Damage to or loss of archaeological assets, particularly earthworks	-2	-6	-9	Action in relation to the discovery of new assets is set on a case by case basis. The need for action may depend upon individual circumstances
		Ground used by those using open access land or rights of way becomes particularly waterlogged	Damage to or loss of archaeological assets, particularly earthworks	-1	-4	-6	Action in relation to the discovery of new assets is set on a case by case basis. The need for action may depend upon individual circumstances
More extreme weather events	Increase in frequency and severity of flooding events (D)	Erosion of important archaeological sites	Loss of or damage to important archaeological assets	-3	-9	-12	Action in relation to the discovery of new assets is set on a case by case basis. The need for action may depend upon individual circumstances
			Potential to uncover previously unknown archaeological assets	2	6	6	Action in relation to the discovery of new assets is set on a case by case basis.
		Changed land management measures to store more water on the moorland	Small scale damage and disturbance to moorland archaeology	1	-2	-2	Action in relation to the discovery of new assets is set on a case by case basis. The need for action may depend upon individual circumstances
	Coastal erosion (D)	Cliff falls	Damage to archaeological assets at the cliff foot	-8	-12	-16	Potential actions could include up to date surveys of all vulnerable coastal sites
			Gradual loss of cliff top archaeological assets	-8	-12	-16	Potential actions could include up to date surveys of all vulnerable coastal sites
			Cliff falls may reveal previously unknown assets	3	6	9	Action in relation to the discovery of new assets is set on a case by case basis.

		Hard or soft coastal defence measures implemented in areas containing important archaeological assets	Loss of or damage to archaeological assets along the coast	-6	-9	-9	Shoreline Management Plan 2 seeks to maintain existing defences rather than develop new ones
Sea level rise	Flooding of coastal areas (D)	Flooding of archaeological assets on the coastline	Loss of coastal archaeological assets	-6	-9	-12	Potential actions could include up to date surveys of all vulnerable coastal sites
		New areas subject to tidal processes	Uncovering of previously unknown archaeological assets	2	4	6	Action in relation to the discovery of new assets is set on a case by case basis.
All of the above	Increased demand for renewable energy (ID)	Planting of energy crops in areas where archaeological assets exist	Archaeological assets are obscured and there are fewer opportunities to understand archaeological assets	-2	-6	-9	
			Archaeology is damaged by ploughing	-1	-2	-6	Action in relation to the discovery of new assets is set on a case by case basis.
		Installation of ground source heat pumps in places where archaeological assets exist	Loss of or damage to archaeological assets	-3	-6	-9	Renewable Energy Supplementary Planning Document
Historic landscapes, parks and gardens							
Hotter, dryer summers	Changes to growing conditions (ID)	Introduction of new forms of vegetation	Negative visual impact on the historic landscape	-4	-9	-16	
Warmer, wetter winters	Changes to growing conditions (ID)	Introduction of new forms of vegetation	Negative visual impact on the historic landscape	-4	-9	-16	
More extreme weather events	Increased frequency and severity of storms (D)	Stormy weather damaging trees and other important landscape features	Loss of or damage to features within historic landscapes, parks and gardens	-3	-9	-12	Potential actions could include to consider planting new tree species

	Increased frequency and severity of storms (D)	Flood waters may damage important features in landscapes, parks and gardens	Loss of or damage to features within historic landscapes, parks and gardens	-3	-9	-12	Slowing the Flow project. Potential actions could include further catchment management measures
Sea level rise	In combination with increased stormy weather, may lead to coastal erosion (D)	Loss of parts of the coast	Changes to the coastal landscape and seascape	-10	-15	-20	Shoreline Management Plan 2 seeks to maintain existing defences rather than develop new ones
All of the above	Increased demand for renewable energy (ID)	Development of renewable energy in or close to historic settlements, parks and gardens	Negative visual impact upon historic landscapes, parks and gardens and their settings	-6	-12	-16	Renewable Energy Supplementary Planning Document
		Planting of energy crops	Negative visual impact upon historic landscapes	-2	-9	-12	
		Increased planting of trees for woodfuel	Appropriate planting could have positive impacts on the landscape	4	6	8	Positive outcome

Theme: Access, Recreation and Tourism

Relevant headline projection	Projected impacts (Direct (D) and/or Indirect (ID))	Risks and opportunities	Consequences	Short Term Risk	Medium Term Risk	Long Term Risk	Actions
				2020s	2050s	2080s	
Access (rights of way and open access land)							
Hotter, dryer summers	Improved weather conditions and longer summer season (D)	Increased numbers of people using rights of way and open access land.	Damage and erosion to rights of way and open access land	-6	-9	-9	Potential actions could include increased levels of maintenance
			Increased levels of walking / recreation	8	12	12	Positive outcome
	Drought (D)	Increased risk of fire	Parts of the National Park become unusable or unsafe	-4	-9	-12	Additional roadside cutting in vulnerable areas, tighter protocol with North Yorkshire Moors Railway, provision of early warning service, Fire Plans for most estates, techniques for rapid moorland recovery, promotion of the "Moors Message".
							Potential actions could include greater availability of fire fighting equipment, restrictions on burning, restrictions on access, changes to moorland management.
Warmer, wetter winters	Warmer weather (D)	Increased numbers of people using rights of way and open access land	Damage and erosion to rights of way and open access land	-6	-9	-9	Potential actions could include increased levels of maintenance
			Increased levels of walking / recreation	8	12	12	Positive outcome
	Wetter weather (D)	Fewer people using rights of way and open access land	Conservation of environment which could have been disturbed	6	9	9	Positive outcome
			Lower levels of walking / recreation	-4	-6	-6	Promotion of opportunities for walking in the Park
		Waterlogged ground	Rights of way and open access land are unusable or more easily eroded.	-4	-9	-12	Improved drainage. Installation of impermeable surfaces.

	Longer growing season (D)	Vegetation growth is greater and intrudes onto footpaths	Rights of way are unusable - users divert to easier routes	-6	-9	-12	More frequent cutting. Potential actions could include increased levels of maintenance.
			Visitors stay away from the Park due to poor publicity in relation to flooding, with knock-on effects for the local economy	-9	-12	-16	Potential actions could include quick response to repair damage and positive publicity.
Sea level rise	Coastal erosion and permanent flooding of beaches (D)	Loss of coastal rights of way	Rights of way become unusable or difficult to use.	-3	-6	-8	Moving path agreements, fixed routes with wider margin, setting back the line of cliff paths. Potential actions could include legislative change to make it easier for legal routes to move in response to the coastline moving.
Recreation (visitor facilities and activities)							
Hotter, dryer summers	Improved weather conditions (D)	Demand for more visitor accommodation	Visual impacts of additional accommodation	-2	-3	-3	Local Development Framework
			Increased spending in local businesses	4	9	9	Positive outcome which requires no action
	Drought (D)	Increased occurrences of moorland fires resulting in people being detracted from visiting the Park	Reduced spending in local businesses	-4	-6	-6	Work with Fire Liaison Panel to assess and plan best response to increased fire risk. Potential actions could include greater availability of fire fighting equipment, restrictions on burning, restrictions on access, changes to moorland management and positive publicity
Warmer, wetter winters	Wetter weather (D)	Fewer visitor come to the Park	Reduced levels of visitors at facilities and attractions	-6	-6	-9	Provide all weather facility such as the Moors Centre. Positive publicity
More extreme weather events	Increased frequency and severity of flooding (D)	Flooding of visitor attractions and facilities	Fewer days when facilities and attractions are open resulting in reduced visitor spending	-6	-9	-12	Slowing the Flow project. Potential actions could include designing facilities to withstand flooding events and further catchment management measures.

		Negative publicity	Fewer visitors annually	-6	-9	-12	Slowing the Flow project. Potential actions could include designing facilities to withstand flooding events and further catchment management measures.
			Fewer visitors to the Park resulting in reduced disturbance to the environment	6	9	9	Positive outcome
	Coastal erosion (D)	Loss of parts of Cleveland Way	Cleveland Way becomes difficult to use, resulting in fewer people using it	-6	-8	-10	Negotiating wider paths on the Cleveland Way, moveable path agreements. Potential actions could include re-routing of Cleveland Way and legislative change to make it easier for legal routes to move.
	Increasing frequency of storms (D)	Disruption to outdoor events	Visitors may not go to event due to threat of or actual disruption	-6	-9	-12	Positive publicity
Sea level rise	Flooding of coastal areas (D)	Flooding of natural and historic coastal attractions, and impeded access along the coast	Fewer visitors annually, therefore reduced spending in the local economy	-4	-6	-8	Positive publicity once attraction or access routes are re-opened
Visitor usage and numbers							
Hotter, dryer summers	Improved summer weather (D)	Increased number of visitors	Increased spending in local businesses	8	12	16	Positive outcome which requires no action
			More disturbance to natural environments and congestion and disturbance in communities (increased conflict between users)	-6	-9	-12	Promotion of alternatives to the private car. Potential actions could include careful management and promotion of the Park and designing facilities to accommodate different levels of use.
	Drought (D)	Increasingly competing demands for water	Lack of water for visitor facilities, accommodation etc	-6	-9	-12	Potential actions could include promotion of water conservation measures and storage of water in winter.

Warmer, wetter winters	Warmer winters (D)	Increased numbers of visitors using visitor attractions and local facilities	Increased spending in attractions and local economy	6	9	12	Positive outcome which requires no action
	Wetter winters (D)	Fewer visitors using visitor attractions and local facilities	Increased spending in attractions and local economy	-6	-9	-12	Promotion of attractions and facilities
More extreme weather events	Increased occurrence and severity of storms (D)	Negative publicity for the Park	Fewer visitors to the Park, less spending in local businesses	-6	-9	-12	Potential actions could include positive publicity
			Fewer visitors to the Park, less disturbance of the natural environment	6	9	12	Positive outcome
		Damage to roads and bridges	Visitors unable to get into and around the Park	-8	-12	-16	Potential actions could include positive publicity once roads and bridges are repaired
		Trees and debris obstructing roads	Visitors unable to get into and around the Park	-6	-9	-12	Action would depend upon individual circumstances
Sea level rise	Overtopping of coastal defences	Temporary flooding of access roads	Visitors stay away from the Park	-4	-9	-16	Potential actions could include positive publicity once roads are re-opened

Theme: Farming and Land Management

Relevant headline projection	Projected impacts (Direct (D) and/or Indirect (ID))	Risks and opportunities	Consequences	Short Term Risk	Medium Term Risk	Long Term Risk	Actions
				2020s	2050s	2080s	
Soils							
Hotter, dryer summers	Drought (D)	Loss of moisture in soils	Reduced crop yields and requirements for more water use for growing crops	-8	-12	-16	Potential actions could include promotion of water conservation measures
		Loss of soil through wind erosion	Reduced crop yields	-2	-6	-9	Promotion of Soil Management Plans through Higher Level Schemes
		Increased potential for wildfires on the moorland	Loss of moorland vegetation and peat soils	-10	-15	-20	Large areas of moorland are covered by Fire Management Plans. Potential actions could include greater availability of fire fighting equipment, restrictions on burning, restrictions on access and changes to moorland management.
Warmer, wetter winters	Increased rainfall (D)	Waterlogging of soils	Reduced crop yields	-6	-9	-12	
	Increased temperatures (D)	Extended growing season	Increased crop yields and opportunities to grow new crops	8	12	16	Positive outcome which requires no action
More extreme weather events	Increased frequency and severity of flooding events (D)	Soil erosion	Loss of soils therefore fewer crops	-4	-9	-16	
			Siltation in water courses	-4	-9	-12	Slowing the Flow project. Potential actions could include further catchment management measures
Sea level rise	Coastal erosion (D)	Loss of coastal soils	Reduced area of agricultural land	-6	-12	-20	Shoreline Management Plan 2 seeks to maintain defences around some settlements, but for the open coastline it is likely that erosion will continue
Livestock and introduced game management							

Hotter, dryer summers	Hotter weather (D)	Conditions too hot for livestock	Illness in livestock, need for shelter/shade	-6	-9	-12	Planting of trees, woodlands and wood pasture
		Increased occurrences of, and new types of, pests and diseases such as Blue Tongue	Loss of livestock and restrictions on livestock movement	-12	-12	-16	Actions may depend upon specific disease outbreaks
	Longer warm season (D)	Changes to timing of moving sheep between upland and lowland, and to lambing	Changes to farmers' working	-4	-6	-8	
		Extended grazing season	Improved productivity of livestock and reduced need for supplementary food	4	6	12	Positive outcome which requires no action
	Drought (D)	Reduced drinking water available for livestock	Dehydrated livestock, need to store water, increasingly competing demands for water	-4	-9	-16	Potential actions could include promotion of water conservation measures
		Reduced water levels to support feedstock	Need to bring in alternative feed supplies	-2	-6	-6	Potential actions could include promotion of water conservation measures
Warmer, wetter winters	Wetter conditions (D)	Waterlogged ground	Unsatisfactory conditions for livestock, need for more shelter	-4	-6	-8	
	Warmer weather (D)	Increased occurrences of, and new types of, pests and diseases such as Blue Tongue	Loss of livestock and restrictions on livestock movement	-12	-12	-16	Actions may depend upon specific disease outbreaks
	Fewer snowy days (D)	Fewer occasions where feedstock is inaccessible and reduced risk of snow related incidents	Improved living conditions for livestock	2	6	8	Positive outcome which requires no action
More extreme weather events	Increased frequency and severity of storms (D)	Distress and injury to animals	Loss of livestock. Additional shelter required	-4	-9	-9	
		Damage to farm buildings	Temporary loss of buildings and financial cost of repairing buildings	-4	-9	-9	

	Increased frequency and severity of flooding events (D)	Flooding of grazing land and farm buildings, particularly in lowland areas	Injury to and loss of livestock.	-9	-12	-20	Slowing the Flow project. Potential actions could include further catchment management measures
Sea level rise				0	0	0	
Crop management							
Hotter, dryer summers	Drought (D)	Increased need for irrigation	Increasingly competing demands for water	-3	-9	-12	Potential actions could include promotion of water conservation measures
		Lack of water to support crops	Lower crop yields	-6	-12	-16	Potential actions could include promotion of water conservation measures
		Wind scour of soil leading to soil erosion	Soil quality diminishes leading to fewer crops	-2	-6	-12	Promotion of Soil Management Plans through Higher Level Schemes
	Increased temperatures (D)	Extended growing season	Increased crop yields and opportunities to grow new crops	2	6	12	Positive outcome which requires no action
		Increased occurrences of, and new types of, pests and diseases	Crops lost to pests and diseases	-12	-12	-16	Actions may depend upon specific disease outbreaks
	Warmer weather (D)	Opportunities to grow new crops	New crops become viable	2	6	12	Positive outcome which requires no action
Warmer, wetter winters	Wetter conditions (D)	Waterlogged ground	Conditions not favourable for crops resulting in lower crop yields	-6	-9	-12	
			Difficulties in using machinery	-4	-6	-8	
	Warmer winters (D)	Increased occurrences of, and new types of, pests and diseases	Crops lost to pests and diseases	-12	-12	-16	Actions may depend upon specific disease outbreaks
	Fewer occurrences of frost (D)	Crops not damaged by frost	Increased crop yields	2	6	8	Positive outcome which requires no action
	Increased temperatures (D)	Extended growing season	Increased crop yields and opportunities to grow new crops	2	6	12	Positive outcome which requires no action

More extreme weather events	Increased frequency and severity of flooding events (D)	Flooding of crops	Loss of crops	-9	-16	-20	Slowing the Flow project. Potential actions could include further catchment management measures
		Soil erosion	Soil quality diminishes leading to fewer crops	-4	-9	-16	Slowing the Flow project. Potential actions could include further catchment management measures
		Disruption of access to farm land	Unable to complete tasks such as sowing and harvesting	-4	-6	-6	Slowing the Flow project. Potential actions could include further catchment management measures
	Increase frequency and severity of flooding events (D)	Damage to farm buildings	Temporary loss of buildings and financial cost of repairing buildings	-4	-9	-9	
Sea level rise	Coastal erosion (D)	Loss of coastal land	Reduced area of agricultural land	-5	-10	-15	The policy of Shoreline Management Plan 2 is to allow natural processes along the undeveloped parts of the coast
All of the above	Increased demand for energy crops (ID)	New markets for energy crops	Diversification opportunities for farmers	4	9	16	Potential actions could include supporting the wood fuel market, for example through the National Park Authority's Sustainable Development Fund and promoting good practice in woodland management.
		Increased use of farming land for energy crops	Less land for food crops and livestock farming	-2	-9	-16	
Forests and woodlands							
Hotter, dryer summers	Drier conditions (D)	Climate suited to new species of tree such as eucalyptus, whilst some existing trees may not adapt well	Forests and woodlands look different in the landscape	-2	-6	-12	Potential actions could include to consider planting new species and use of Ecological Site Classification (matching species to sites)
			Timber producing species such as Sitka spruce may become less productive or uneconomic	-1	-6	-9	Potential actions could include to consider planting new species and use of Ecological Site Classification (matching species to sites)
		Forest fires	Loss of trees / woodlands / forests	-4	-12	-12	Potential actions could include the creation of fire breaks

Warmer, wetter winters	Warmer weather (D)	Climate suited to new species of tree such as eucalyptus	Forests and woodlands look different in the landscape	-2	-6	-12	Potential actions could include to consider planting new species and use of Ecological Site Classification (matching species to sites)
	Warmer and wetter weather (D)	Potential for more pests and diseases such as Phytophthora (in association with drought, longer growing season and increase in deadwood from storm damage)	Loss or damage to trees	-9	-12	-16	Actions may depend upon specific disease outbreaks
	Wetter conditions (D)	Reduction in rooting depth	Trees are not supported in windy conditions and may be more liable to wind blow	-2	-6	-9	
More extreme weather events	Increased frequency and severity of storms (D)	Trees, woodlands and hedgerows directly impacted by storms	Loss of or damage to trees and potential damage to nearby properties	-6	-9	-12	
	Increased frequency and severity of flooding events (D)	Flooding of woodlands and areas containing individual trees	Loss of or damage to trees	-9	-12	-15	Slowing the Flow project. Potential actions could include further catchment management measures
		Erosion of gills and slopes	Loss of trees	-4	-6	-6	Slowing the Flow project. Potential actions could include further catchment management measures
Sea level rise	No impacts identified			0	0	0	
All projections	Increased demand for woodfuel (ID)	New markets for timber and wood products	Improved economic viability of woodlands, demand for more woodlands	3	12	16	Promoting new woodland establishment and management/restoration of existing woodlands to facilitate a wider range of woodland management practices. Replanting and restocking woodland with species more suited to provision of woodfuel. Potential actions could include supporting the wood fuel market, for example through National Park Authority's Sustainable Development Fund and promoting good practice in woodland management.

	All impacts (D)	Increased ecological isolation, especially for some already small and isolated woodlands	Loss of trees and other woodland species	-6	-9	-16	New woodland planting and restoration of Plantation on Ancient Woodland Sites
		Difficulties in maintaining access to woods for management, for example through flooding or waterlogging of tracks, Obstructions due to windthrow	Inability to manage woodlands appropriately	-4	-9	-12	The need for action may depend upon individual circumstances
Water resources							
Hotter, dryer summers	Drought (D)	Lower water levels throughout the Park	Increasingly competing demands for water from all users - farming, residents, businesses, water companies, wildlife	-3	-12	-16	Potential actions could include the promotion of water conservation measures and storage of water in winter.
		Stagnation of water bodies	Risk of pollution in water bodies	-3	-6	-9	
Warmer, wetter winters	Increased rainfall (D)	Increased water levels throughout the Park	Sufficient water available for competing demands. Need for more storage for summer months.	3	9	12	Potential actions could include storage of winter rainfall.
More extreme weather events	Increased frequency and severity of flooding events (D)	Soil and debris entering water courses	Polluted water not of sufficient quality to support wildlife	-3	-9	-12	Slowing the Flow project. Potential actions could include further catchment management measures
Sea level rise	No impacts identified			0	0	0	
Coastal land							
Hotter, dryer summers	No impacts identified			0	0	0	
Warmer, wetter winters	Increased rainfall (D)	Loss of soils from cliff top fields via drainage over cliff top	Valuable tillage and arable soils lost, with associated financial impact for farmers	-2	-4	-6	
More extreme weather events	Increased frequency and severity of storms (D)	Coastal erosion	Loss of coastal land	-10	-15	-20	Shoreline Management Plan 2 seeks to maintain defences around some settlements, but for the open coastline it is likely that erosion will continue

Sea level rise	Seas encroaching upon cliffs (D)	Increase in coastal erosion	Loss of coastal land	-10	-15	-20	Shoreline Management Plan 2 seeks to maintain defences around some settlements, but for the open coastline it is likely that erosion will continue
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Theme: Community, Culture and Economy

Relevant headline projection	Projected impacts (Direct (D) and/or Indirect (ID))	Risks and opportunities	Consequences	Short Term Risk	Medium Term Risk	Long Term Risk	Actions
				2020s	2050s	2080s	
Housing - existing and new development							
Hotter, dryer summers	Warmer weather (D)	Higher interior building temperatures	Demand for air conditioning units. Potential for visual impact from air conditioning units and new designs. Associated increases in energy use resulting from air conditioning systems.	-1	-6	-8	Local Development Framework (where Planning or Listed Building Consent is required)
			Design of new development to facilitate cooling, e.g. use of trees for shading	-2	-3	-3	Design Guide Supplementary Planning Document
	Increased demand for use of garden spaces and additions such as conservatories, patios and sheds	Increased intrusion of domestic goods into the landscape	-4	-6	-9	Local Development Framework (where Planning or Listed Building Consent is required)	
	Less rain in summer (D)	Reduced levels of moisture in buildings	Heightened risk of ground subsidence affecting structure of houses. Resultant demand to fell trees.	-2	-6	-6	

Warmer, wetter winters	Fewer snowy and frosty days (D)	Fewer incidences of snow or frost damage to houses	Reduced need to repair houses and associated impacts upon insurance costs	2	6	8	Positive outcome which requires no action
	Increased amount of rainfall (D)	Opportunities for water storage	Water storage facilities have a visual impact on buildings	-1	-4	-6	Local Development Framework (where Planning or Listed Building Consent is required)
			Less demand for scarce water resources in the summer	2	2	6	Positive outcome which requires no action
More extreme weather events	Increased frequency and severity of flooding (D)	Houses and communities at risk of flooding, including Lealholm, Danby, Helmsley, Thornton-le-Dale, West Ayton,	Loss of or damage to property. Risk to people. Insurance costs	-12	-16	-20	Various actions identified in Catchment Flood Management Plans including reducing run-off from the moors, restoring natural storage, localised resilience measures for individual houses. Slowing the Flow project. Potential actions could include further catchment management measures
	Increased frequency and severity of storms (D)	Houses damaged by strong winds	Residents must repair their houses. Increased insurance costs	-6	-9	-12	
		Pressure to remove trees considered to be dangerous	Loss of trees	-1	-2	-3	
Sea level rise	Coastal erosion (D)	Potential loss of properties at Staithes (Cowbar), Port Mulgrave, Runswick Bay, Robin Hood's Bay and Boulby Village	Loss of or damage to property. Risk to people.	-5	-15	-20	Shoreline Management Plan 2 provides protection for some coastal settlements/properties
Local economy							

Hotter, dryer summers	Improved summer weather (D)	Increased number of visitors	Increased spending in local businesses	8	12	16	Positive outcome which requires no action
Warmer, wetter winters	Warmer winters (D)	Increased numbers of visitors using visitor attractions and local facilities	Increased spending in attractions and local economy	8	12	16	Positive outcome which requires no action
	Wetter winters (D)	Fewer visitors using visitor attractions and local facilities	Decreased spending in attractions and local economy	-8	-12	-16	Promotion of visitor attractions
More extreme weather events	Increased frequency and severity of flooding (D)	Flooding to local businesses	Reduced income, insurance costs	-12	-16	-20	Slowing the Flow project. Potential actions could include further catchment management measures
		People not able to get to local businesses	Reduced spending	-12	-16	-20	Slowing the Flow project. Potential actions could include further catchment management measures
	Increased frequency and severity of storms (D)	Damage to business properties	Costs of repair and increased insurance costs	-2	-4	-6	
Sea level rise	No impacts identified			0	0	0	
Community life							
Hotter, dryer summers	More sunny days (D)	More opportunities for community events	Improved interaction between the community	4	6	6	Positive outcome which requires no action
		More need for shade	Increased tree planting	1	4	6	Positive outcome

	Drought (D)	Increasingly competing demands for water	Domestic water shortages and hosepipe bans	-6	-9	-16	Potential actions could include promotion of water conservation measures. Storage of water in winter.
Warmer, wetter winters	No impacts identified			0	0	0	
More extreme weather events	Increased frequency and severity of flooding (D)	Flooding of settlements	Damage to community facilities such as shops, pubs and village halls	-12	-16	-20	Slowing the Flow project. Potential actions could include further catchment management measures
	Increased frequency and severity of storms (D)	Damage to buildings directly or through falling trees or debris	Damage to community facilities such as shops, pubs and village halls	-12	-16	-20	
Sea level rise	Coastal squeeze (less intertidal area) (D)	Shorter tide intervals	Coastal safety issues - potential danger for people	-2	-6	-16	
Renewable energy							
Hotter, dryer summers	More sunny days (D)	Increased opportunity for solar water and PV panels	Increased use of renewable energy resulting in cheaper energy costs	9	12	15	Promote appropriate renewable energy through Sustainable Development Fund and Renewable Energy Supplementary Planning Document
			Negative impact on the landscape	-6	-9	-16	Local Development Framework and Renewable Energy Supplementary Planning Document. Potential actions could include Article 4 in response to proposed changes to the General Permitted Development Order
Warmer, wetter winters	Wetter winters (D)	Increased amount of water in rivers	Increased potential for hydro renewable energy	3	9	12	Promote appropriate renewable energy through Sustainable Development Fund and Renewable Energy Supplementary Planning Document
	More sunny days (D)	Increased opportunity for solar water and PV panels	Increased use of renewable energy resulting in cheaper energy costs	9	12	15	Promote appropriate renewable energy through Sustainable Development Fund and Renewable Energy Supplementary Planning Document

			Negative impact on the landscape	-6	-9	-16	Local Development Framework and Renewable Energy Supplementary Planning Document. Potential actions could include Article 4 in response to proposed changes to the General Permitted Development Order
More extreme weather events	Windier conditions (D)	Potential for offshore turbines to generate more energy	Increasing demand for offshore turbines	-6	-9	-12	
				4	6	8	Positive outcome which requires no action
	Greater tidal swell for seabed turbines	Increasing demand for seabed turbines	-2	-4	-6		
Sea level rise	No impacts identified			0	0	0	
Transport							
Hotter, dryer summers	Warmer weather (D)	Increasing numbers of people visiting the Park and using the road network	Increase in vehicle numbers and need for associated infrastructure such as car parking and signage. Impact on air quality through greater carbon emissions	-2	-9	-12	Promote alternatives to car travel
Warmer, wetter winters	Fewer snowy days (D)	Fewer instances where residents are unable to use roads	Improved access to services	2	6	8	Positive outcome which requires no action
	Wetter weather (D)	Drainage problems on roads e.g. blocked gullies	Dangerous road conditions	-2	-6	-6	The need for action may depend upon individual circumstances
More extreme weather events	Increased occurrence and severity of flooding events (D)	Damage to roads and bridges	Residents and visitors unable to get around the Park	-6	-9	-12	Potential actions could include positive publicity once roads and bridges are re-opened
		Road closures	Residents and visitors unable to get around the Park	-6	-9	-12	Potential actions could include positive publicity once roads are re-opened

	Increased occurrence and severity of storms (D)	Trees and debris obstructing roads	Residents unable to get around the Park	-6	-9	-12	The need for action may depend upon individual circumstances
Sea level rise	Coastal erosion	Loss of Whitby - Sandsend road	Need for new road, would probably need to be in the Park	-2	-6	-20	Shoreline Management Plan 2 sets the basis for investigation of further options

Theme: National Park Authority Business Continuity

Relevant headline projection	Projected impacts (Direct (D) and/or Indirect (ID))	Risks and opportunities	Consequences	Short Term Risk	Medium Term Risk	Long Term Risk	Actions
				2020s	2050s	2080s	
NPA property and estates							
Hotter, dryer summers	Warmer weather (D)	Need for air conditioning and ventilation, particularly for IT equipment	Financial cost, alterations to buildings	-1	-2	-3	Business Continuity Plan
	Drought (D)	Increased risk of fire	Loss and damage to land and buildings	-6	-9	-12	Fire Management Plans
Warmer, wetter winters	Increased rainfall (D)	Water damage to properties	More frequent maintenance required on buildings	-3	-4	-5	Potential actions could include flood protection at Spout House
	Warmer winters (D)	Reduced requirements for heating	Financial savings, CO ₂ savings	2	3	4	Positive outcome which requires no action
More extreme weather events	Increased frequency and severity of storms (D)	Properties are damaged	Disrupted service provision	-2	-3	-4	Actions may depend upon specific instances of flooding
			Repair work required, associated insurance costs	-2	-3	-4	Actions may depend upon specific instances of flooding
	Increased frequency and severity of flooding (D)	Properties are flooded	Disrupted service provision	-1	-3	-4	Actions may depend upon specific instances of storm damage
			Repair work required, associated insurance costs	-1	-3	-4	Actions may depend upon specific instances of storm damage
Sea level rise	No impacts identified			0	0	0	
Working							
Hotter, dryer summers	Heat waves (D)	Increased absenteeism in staff	Disruption to work	-1	-4	-6	

	Warmer weather (D)	Risk of sunburn or heat related illness for staff working outside	Disruption to work	-2	-4	-6	Provision of suncream for staff
Warmer, wetter winters	Fewer snowy days (D)	Fewer occasions when roads are impassable	Fewer staff snow days, fewer occasions when work on the ground is unable to take place	2	6	8	Positive outcome which requires no action
More extreme weather events	Increased frequency and severity of flooding (D)	Flooding of roads and land	Staff unable to get to work. Staff unable to carry out work or to get around the Park.	-6	-8	-10	Potential actions could include improvements to IT to enable remote access
Sea level rise	No impacts identified			0	0	0	

Current Actions

There are already a range of actions in place which, either directly or indirectly, will help to address some of the potential impacts of climate change. These include:

- The Slowing the Flow Project. This is aiming to reduce flooding of communities along the Pickering Beck (both inside and outside of the Park) through measures including the creation of dams using woody debris, blocking moorland drains and tree planting. A similar project is to be put in place above Great Ayton;
- Ensuring that new infrastructure, such as bridges, is more resilient to flooding;
- Fire management plans covering large areas of the moorland;
- Developing climate change resilience at the landscape scale by targeting conservation work, such as tree planting, at habitat network development;
- Provision of all weather visitor facilities, for example the Moors National Park Centre;
- Management and monitoring of habitats for certain species of flora and fauna, such as dwarf cornel and water voles;
- Restoration and re-vegetation of peat bogs.

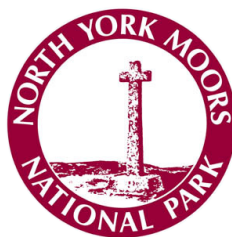
Actions are not necessarily carried out only by the National Park Authority but often in partnership with other organisations, communities and landowners / land managers.

Taking it forward

Potential actions have been identified where it is considered that this is useful. However, in relation to some potential consequences, such as changes to the growing season or the impacts of storm damage, it is particularly difficult to identify action when it is not clear exactly what the impacts might be, whether there is anything that can be done to mitigate any impacts and whether this would be desirable. For many of the potential impacts, monitoring of changes to see how these emerge will be beneficial.

Where positive impacts have been identified actions may not be necessary, although it may be wise to monitor any changes and to seek to influence or support the positive change where appropriate.

The assessment of the consequences arising from the effects of climate change has been undertaken alongside the review of the National Park Management Plan. This has enabled the risks and opportunities to be considered as part of production of the new Plan which will set the strategic framework for action to address these. Reference back to this risk assessment will help in taking forward these strategic policies through other plans and strategies and action on the ground.



North York Moors National Park Authority

The Old Vicarage

Bondgate

Helmsley

York

YO62 5BP

Tel: 01439 770657

www.northyorkmoors.org.uk