New Forest National Park

Climate Change Risks and Opportunities Assessment

November 2025

NEW FOREST NATIONAL PARK

COMMUNITY FUND

Wild New Forest

maploom

Summary

Climate change is increasingly viewed as the greatest long-term threat to biodiversity and the natural environment, both globally and locally in the New Forest. At a local level, Met Office projections suggest a continuation of trends observed over the last two decades, with hotter drier summers, milder wetter winters, rising sea levels, and more frequent episodes of extreme weather leading to increased risks of drought, flooding, and wildfire. In the last four years alone, the New Forest has experienced record summer temperatures (2022), the wettest winter on record (2023/24), and one of the driest and hottest spring/summer periods on record (2025). These changes are impacting the management and use of the National Park by people, and the associated ecosystem services and benefits that the New Forest provides.

This report, commissioned by the New Forest National Park Authority, assesses climate change risks and opportunities for the New Forest National Park. It forms a contribution to the YouCAN project, which is funded by the National Lottery Community Fund.

The report focuses on the natural environment and the special qualities that distinguish the New Forest from other parts of lowland England, and that underpin the conservation designations and landscape character that provide the unique sense of place that is the New Forest National Park.

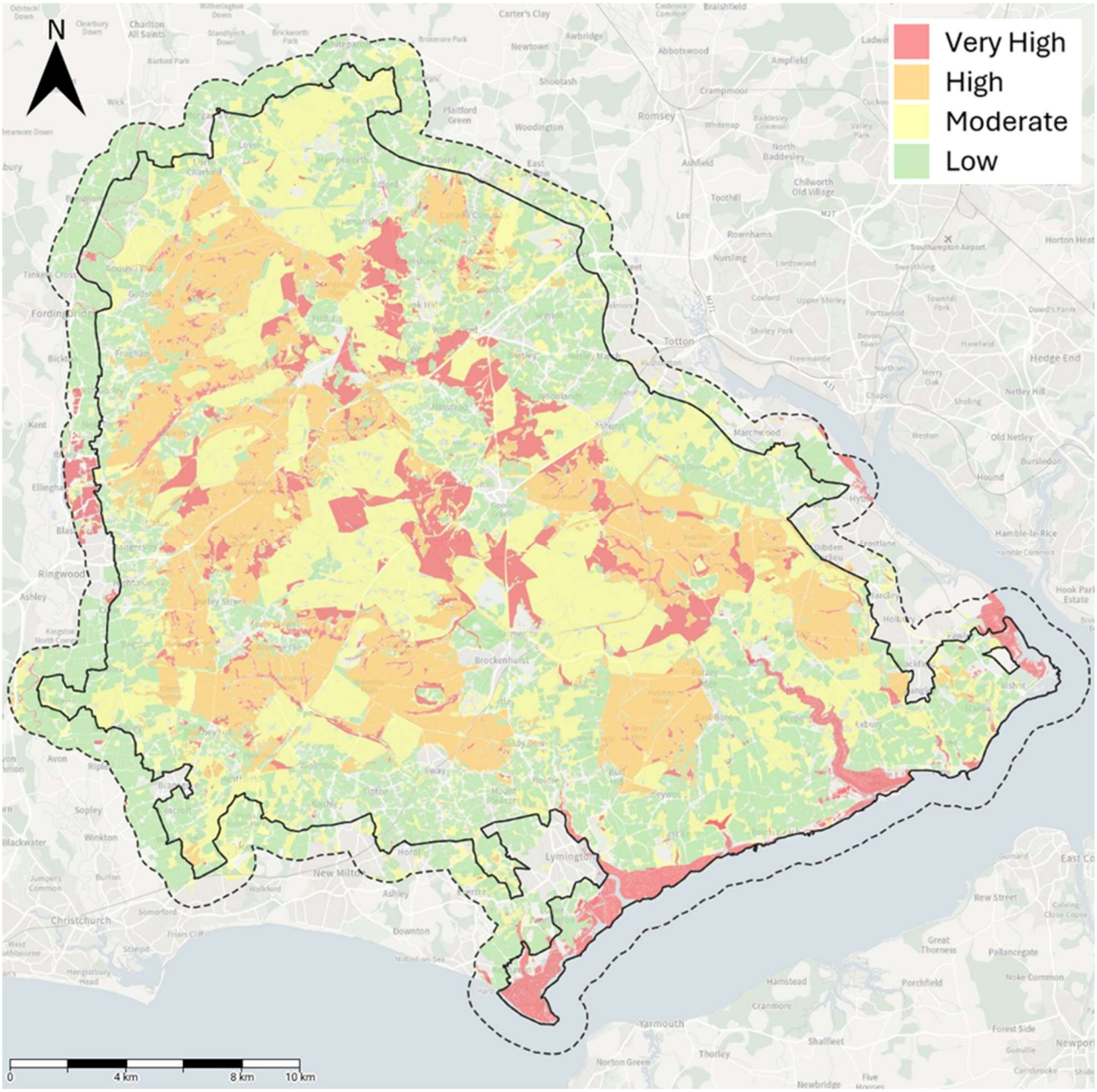
The assessment uses land-cover mapping, coupled with an assessment of habitat sensitivity to climate and consideration of adaptive capacity, to produce a series of maps showing the spatial distribution and magnitude of risk across the landscape. Key points from the habitat assessment are:

- More than one-third (37%) of the New Forest National Park is at high or very high risk of habitat loss or damage due to climate change. This includes freshwater and wetland habitats that are highly sensitive to changes in precipitation and temperature, coastal habitats that are unable to naturally migrate in response to sea-level rise, unique ancient pasture woodlands featuring a high proportion of drought sensitive Beech and heathland habitats that are vulnerable to wildfire.
- Measures to mitigate the impacts of climate change on freshwater and wetland habitats are largely the same as those needed to improve ecological status, i.e. more effectively protecting habitats from pollution, restoring natural flow/hydrology wherever possible, retaining or increasing shade and natural features within channels, and creating new ponds and freshwater features to increase resilience and connectivity.
- Sea-level rise is a major socio-ecological challenge for the New Forest, for which anticipation and planning are essential, involving active engagement with statutory processes. Coastal ecosystems, some of which are already highly degraded, deliver a multitude of ecosystem services. Nature-based solutions have the potential to play an important role in maintaining and enhancing these services in the long term.
- Both wet and dry heathlands require active management coupled with restoration to reduce fragmentation and isolation, mitigate wildfire risk, and restore hydrology to maximise resilience to climate change.
- Risks to woodland habitats vary depending on a range of factors including species type and provenance, soil conditions and setting, stand size, and exposure to aggravating pressures. As noted above pasture woodlands have been rated as very high risk due to the relative importance of Beech in New Forest pasture woodlands, their sensitivity to drought and the very low adaptive capacity of these habitats due to the relatively slower rate of natural regeneration within grazed woodlands compared to ungrazed woodlands. Other woodland

types (riverine and bog, managed broadleaf and conifer) have been grouped as moderate risk. Some of the commonest tree species are poorly adapted to cope with changing hydro-meteorological regimes and/or the pressure of new and existing pests and diseases. Both natural regeneration and the use of seed and saplings of species with southern provenance are strategies that are expected to increase woodland resilience to climate change. Woodland creation opportunities provide an important pathway to increase connectivity and size of wooded areas which also increases climate resilience.

- Climate change risks to the natural environment are amplified, in nearly all cases, by the presence of other pressures such as fragmentation, pollution and agricultural intensification. Reducing these pressures will increase the resilience of the New Forest landscape and biodiversity to climate change.
- Highly modified grasslands deliver some of the lowest biodiversity and ecosystem service values of the New Forest landscape - there are numerous opportunities to increase the contribution of these grasslands to climate resilience through improving soil health, restoring hydrology and water features, and reducing intensity of use to allow more habitat heterogeneity (hedges, edges, field margins).
- In all cases, improved monitoring will be vital to understand how these habitats are responding locally to climate change, and to inform appropriate iterative management.

The map below shows the spatial distribution of climate risk for New Forest habitats, based on land-cover data and a combined habitat sensitivity and adaptive capacity rating.



The table below summarises the spatial extents of the different risk classes.

Risk Rating	Ha	% of National Park Area	Land cover classes
Very High	6,286	13%	Freshwater, Coastal and estuarine habitats and Old Growth Pasture Woodland
High	12,055	24%	Peat bogs, valley mires and heathland
Moderate	17,054	34%	Riverine and bog woodland, other woodland, soils
Low	14,135	29%	Acid grasslands and Agriculture, Horticulture and Modified Grassland

Alongside the habitat assessment, which forms the core of this study, a review of climate risks to 1) species, 2) pests and diseases, 3) natural capital and ecosystem services, 4) heritage, 5) landscape, and 6) the special qualities of the New Forest have been completed. For species, the key points are:

- The New Forest is increasingly recognised for its exceptional species diversity, which includes an estimated total of over 20,000 species of animal, plant, and fungus. In the UK, climate change is already the second most important driver of change in terrestrial and freshwater species abundance and distribution, behind (primarily agricultural) land-use change.
- Species responses to climate change can generally be considered as changes in 1) distribution, 2) phenology and behaviour, 3) physiological and/or genetic evolution, and 4) (ecological) network interactions. Distribution and phenology are the most easily observed and widely researched.
- Climate change creates dispersal / expansion opportunities for multiple New Forest species groups, with the potential to improve biodiversity in other regions. Dispersal success depends on many factors including existing population size, dispersal capabilities, availability of habitat and food, and the pathways and barriers (e.g. verges, roads) associated with movement.
- There is likely to be a continuing increase in the number of new species of southern provenance arriving naturally, and increased survival of anthropogenically-assisted invasive non-native species.
- There is potential for loss of species that cannot tolerate the new climatic envelope of the New Forest, including tree and plant species that may lead to changes to the visual landscape. However, variations in microclimate can significantly exceed the projected magnitude of climate change, highlighting the importance of habitat heterogeneity and potential for habitat refugia to provide a buffer to climate change at very local levels, offering opportunities for species to persist beyond macroclimatic thresholds.
- The impact of range shifts on ecological networks is poorly understood but has the potential to impact ecosystem function and associated ecosystem services.

Key points from the remaining sections are:

- Pest, pathogen, and disease risks to people, animals, and plants are all increasing in response to climate change and will continue to increase in the future. This includes vector-borne diseases transmitted by ticks and mosquitos, fungal pathogens, and mobile insect pests. Increased monitoring and awareness are vital to inform early intervention.
- Biodiversity underpins the ecological condition and quality of ecosystems that together form the natural capital of the New Forest, that directly benefits people through delivery of a diverse range of ecosystem services. There is a high risk that these services will be modified by climate change, but also a wide range of opportunities to enhance natural capital whilst also increasing climate resilience and delivering adaptation. Mobilising public and private finance to support natural capital investment is an increasingly important opportunity for the New Forest.
- Climate change increases the risk of damage and destruction of heritage assets through mechanisms such as coastal erosion, water damage, subsidence, vegetation growth, fungal decay, and extreme event impacts. These will increasingly force a reconsideration of how some heritage assets are managed and maintained; in some situations, full or partial loss or extensive adaptation will be necessary. This may increase the potential for conflict within the planning system as sympathetic adaptation may not always be viable.
- Beyond risks to physical heritage assets, climate change has potential positive and negative impacts on cultural heritage including the local commoning community. Although climate change will likely increase costs of livestock management, the landscape-scale conservation grazing provided by commoner's livestock will be increasingly recognised as an essential tool for climate resilience, including vegetation management to reduce wildfire risk.

The New Forest is special because much of the landscape has been protected from the land-use intensification of past decades. Going forwards, a combination of legal protection, active commoning, and conservation-informed forestry will help to sustain a high-quality and diverse mosaic of habitats. However, current evidence is unclear as to whether overall New Forest biodiversity and ecosystem services will increase, as is likely to be the case in the short term, or decline, which remains a significant risk in the longer term. Much will depend on how effectively the collective interests of New Forest landowners, residents, and visitors can be aligned to address the needs of habitats and species, and how willing people are to support and implement change.

As well as risks, climate change also creates opportunities. The New Forest is one of the most biodiverse landscapes in the UK, loved by many, with a rich cultural heritage, strong local communities, and a historic and thriving practice of biological observing and recording. Climate change provides a shared challenge and opportunity to leverage the strengths of the New Forest to rebuild human connection with the natural environment, to understand and learn from change, to innovate, to show national leadership and to learn from and share solutions, approaches, successes and failures to support the collective challenge of increasing resilience and adapting to climate change.

The study outlines 13 opportunities that are grouped into six themes: **Lead, Learn, Enable, Protect, Manage, Restore & Create**. These opportunities are summarised as O1-13 in the table below.

Lead	**O1**	**Link climate mitigation and adaptation with nature, and mainstream into decision-making, policy, and the planning process via the Local Plan** • Define what climate adaptation means for the New Forest • Centralise climate change adaptation as a core operational activity in the next iteration of the New Forest Partnership Plan and set out mitigation and adaptation ambitions and guidance in the Local Plan • Develop a theory of change showing how activities and outputs align to deliver climate resilience • Identify and manage conflicting requirements • Review and revise (where needed) organisational structures, interest groups, and co-operation and collaboration mechanisms
	O2	**Build a strategic narrative linking climate change with nature, people, and the New Forest, and align messaging across public sector bodies and NGO's** • Clear messaging about climate change is essential and a prerequisite for mobilising action; this needs to be driven by a strategic narrative that clearly links climate change with biodiversity, wellbeing, and the local environment • Topical and engaging stories are needed to show what is happening and why it is happening, alongside information and practical guidance to show how individual and community actions make a difference
	O3	**Monitor climate change risk and impacts, track and report actions and progress** • Establish a New Forest climate adaptation monitoring programme, with clear objectives, accountability, and open reporting • Adaptation measures have significant potential to ignite activism and resistance, especially where short-term losses or costs are necessary to tackle longer-term needs. These need to be identified and strategies formulated with partners to address potential conflict, including development of a robust evidence base to inform debate and decision making

Learn	**O4**	**Expand and appropriately target research and monitoring efforts to provide the evidence needed to inform adaptation** • Support and strengthen the communities of people, organisations, and landowners/managers working with the aligned interest of sustaining and enhancing the resilience of the New Forest and its exceptional biodiversity for the long term • Increase accessibility to biological recording and conservation volunteering for a wider range of people; support with high quality information such as up-to-date, open-access habitat mapping and high quality, authoritative guidance. Support the regional and national systems that validate, curate and make biological records available for use • Learn from and contribute to research and monitoring efforts, and the development of best practices both within and beyond the New Forest; regionally, nationally, and internationally • Support climate-driven species dispersal by working with 'receiving' landowners, people, and organisations to share habitat management advice and improve connectivity, and develop evidence for adaptation and understanding of success factors and impacts
	O5	**Strengthen efforts to share data and knowledge across the community and between disciplines** • Climate change is disrupting land management practices that have been established over decades of experience. The rate at which climate change is taking place constrains the time available for experiential learning and potentially leads to an ongoing process of continually shifting goalposts. Opportunities that support knowledge exchange and accelerate community learning become far more important under these evolving conditions and require the integration of knowledge across multiple different practitioner and specialist groups
Enable	**O6**	**Motivate action by increasing public awareness and understanding of climate change as the most important driver of current and future environmental change in the New Forest National Park** • The most consistent indicator of concern for the environment, and the uptake of pro-environmental behaviours, is an individual's connection to nature. Pro-environmental behaviours and pro-nature-conservation behaviours are distinct, and form two types of human behaviours that need to be thought of differently. Pro-conservation behaviours are driven by the type of interactions people have with nature; the things people do are more important than the time spent • Recreational and tourist use of the New Forest provide opportunities to increase both pro-environment and pro-conservation behaviour through informed design of activities, places, and initiatives • The New Forest provides a living, dynamic showcase of environmental change and species responses to climate change across all the main species groups and lowland habitats in the UK. Many of these changes, such as those seen in plant, amphibian, and bird phenology, and in new species arrivals and changes in abundance, can be easily observed with minimal guidance in the forest or back garden. Encouraging and supporting activities that involve observing, recording, and sharing these changes provides a pathway to

		increase nature connectedness and encourage pro-social, pro-environment, and pro-conservation behaviours
	O7	**Support landowners and land managers to increase climate and biodiversity positive land management and use** • Land management is key to climate adaptation. More than 50% of the New Forest National Park is privately owned with minimal limitations or constraints on how this land is managed • Supporting management practices on privately (or publicly managed) land that include climate-friendly and biodiversity-positive approaches is essential
	O8	**Facilitate mobilisation of private finance and business investment in nature that supports New Forest species and landscape** • At a national level, there is recognition that UK Government funding is not sufficient to deliver nature recovery. The New Forest has unique attributes that need to be more effectively leveraged to mobilise private finance in support of climate resilience, nature restoration, and ecosystem service provision
Protect	**O9**	**Reduce non-climate pressures and directly protect the most sensitive or vulnerable habitats** • 97% of the land cover mapped within the New Forest for this report has been rated as moderately to very highly sensitive to climate change, with habitats that are compromised by altered hydrology or coastal squeeze at the highest end of this spectrum. With some exceptions, highly functioning ecosystems are more capable of adapting to climate change than degraded human-modified systems • Restoration of natural function, management of habitats to improve condition, and reducing or eliminating other pressures, all help habitats to adapt to climate change by increasing their natural capacity to respond • Climate change increases the urgency with which non-climate pressures need to be addressed, and may drive new requirements for management interventions
	O10	**Increase focus on habitat heterogeneity and maintaining climate refugia for species most at risk from climate change, provide guidance for landowners and managers** • Local variations in microclimate that habitat heterogeneity provides can greatly exceed the magnitude of climate change expected over the next 75 years and provide critical refugia for species that are sensitive to macroclimatic conditions • Explicit consideration of climate refugia / habitat heterogeneity in habitat management is essential to help retain climate sensitive species within the New Forest and reduce risks of disruption to food webs or other network interactions and dependencies from species losses • With the exception of invasive non-native species, new species arrivals need to be monitored and where appropriate encouraged / supported through suitable habitat management
Manage	**O11**	**Explore the opportunities for adaptive management or other decision-making frameworks that integrate climate change at a landscape scale** • Effectively tackling climate change requires co-operation beyond landowner or land manager boundaries

		• Tools are increasingly being developed and improved to support landscape-scale decision making under climate change; examples include adaptive management, and the Resist Accept Direct (RAD) framework • These types of tools provide opportunities to help facilitate multi-landowner co-operation to increase habitat resilience across the New Forest landscape
Restore & Create	**O12**	**Restore and create habitats to increase resilience and connectivity within the New Forest National Park, and support forest-friendly changes in land use that deliver climate and biodiversity benefits** • Increasing the quality and size of protected areas has a positive impact on species dispersal, persistence, and adaptation • Working with Local Nature Recovery Strategies, alongside local and regional landowners and managers, action is needed to continue to ensure effective management of habitats, alongside restoration and creation where possible, focusing on supporting natural processes, and improving habitat quality, extent, and connectivity
	O13	**Improve habitat quality and connectivity beyond the boundaries of the New Forest National Park** • Changes in species distributions are increasingly likely in response to climate change, with potential benefits to species populations • Successful range expansion depends on habitat availability, quality, connectivity, and on existing species population size and health • Understanding range expansions and working with organisations and landowners in the receiving areas provide opportunities to support range expansions

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Acknowledgements

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1 Introduction

This report provides a baseline assessment of the climate change risks and opportunities facing the New Forest National Park. The work was commissioned by the New Forest National Park Authority (NPA) as part of the YouCAN project, funded by the National Lottery Community Fund.

The New Forest National Park (referred to in this report as the New Forest) is an extraordinary place for nature. This is primarily because it has survived, for the most part, the dramatic changes in land use seen across the UK since WW2. The diverse landscape of the New Forest supports nationally and internationally important assemblages of wildlife and provides ecosystem services to millions of people. This includes around 35,000 residents living within the National Park, almost 1 million residents 'on the doorstep' and c. 3 million annual day visits by tourists and holiday makers from further afield[1].

The primary aim of this work is to improve understanding of how the changing local climate will impact the New Forest and identify opportunities that arise in response to climate change. The focus is firmly on the natural environment, as it is primarily this characteristic which distinguishes the New Forest from other areas of lowland England and underpins its various conservation designations and the landscape character that provides the unique sense of place that is the New Forest.

As guardians of a national park, the New Forest National Park Authority (NPA) has statutory purposes and socio-economic responsibilities as specified in the Environment Act of 1995:

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

Working in partnership with other organisations it is also the Authority's duty to seek to foster the economic and social well-being of the local communities within the National Park.

The NPA sum this up as: **Protect – Enjoy – Prosper**

As of December 2023, under the new Protected Landscapes Duty, Government departments, public bodies, statutory undertakers (such as utility companies) and persons holding public office must now 'seek to further' these statutory purposes.[2]

A second aim of this study is to inform the development of the next iteration of the New Forest National Park Partnership Plan (due in 2027).

This section, **Section 1,** sets out the methodology used in this study and the climate change context.

Section 2 assesses the risks of climate change considering the New Forest purposes.

Section 3 identifies climate change opportunities for the New Forest.

[1] Based on the Liley et al. 2019, visitor survey data, using total estimated day visits per annum of ~15 million
[2] See UK Government guidance and Campaign for National Parks (CNP) explainer

1.1 Approach

The study has been guided by the approach defined in ISO 14091:2021[3] using the conceptual framework for risk illustrated in Figure 1. Definitions for the terms used are provided below.

Risk is used to describe the potential for *adverse* consequences.

Climate Hazard refers to projected changes to the climate in response to greenhouse gas emissions; the data used for this assessment are discussed in section 1.2.

Exposure refers to the presence of an asset, habitat, or species in a location that could be adversely affected, i.e. reflecting how many and/or how much is potentially impacted by the risk. This is assumed to be uniform across the New Forest. In reality there are significant differences in climate depending on the scale considered (i.e. cm to km), including the marine/coastal influence and topographic variation. The future climate projections used in this study are km scale and therefore these variations have been assumed to be negligible. Alongside spatial variability, exposure also has temporal variability. This is illustrated clearly in the work of Wilson and Pescott (2023), Figure 2, which shows the increasing effect of climate change over time and variation in exposure across the UK. The New Forest is within the region with the greatest exposure.

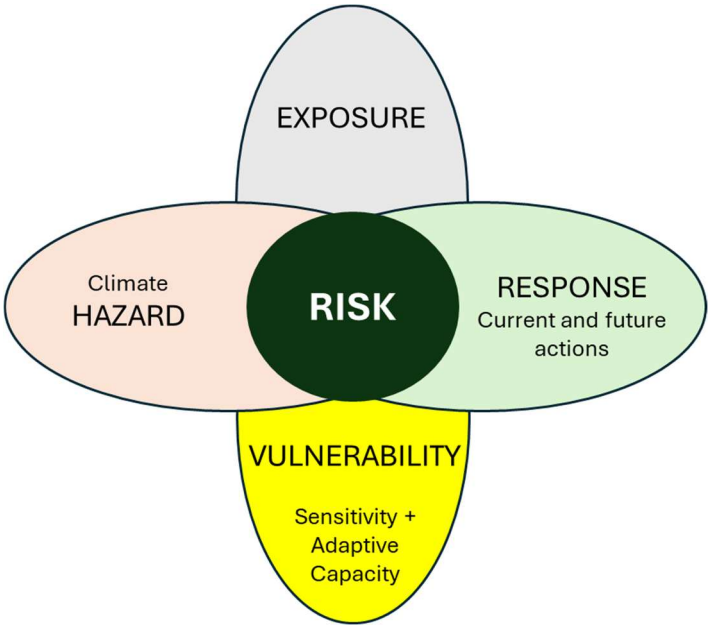


Figure 1: Conceptual Framework for Risk based on the approach used in IPCC AR5.

[3] Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment

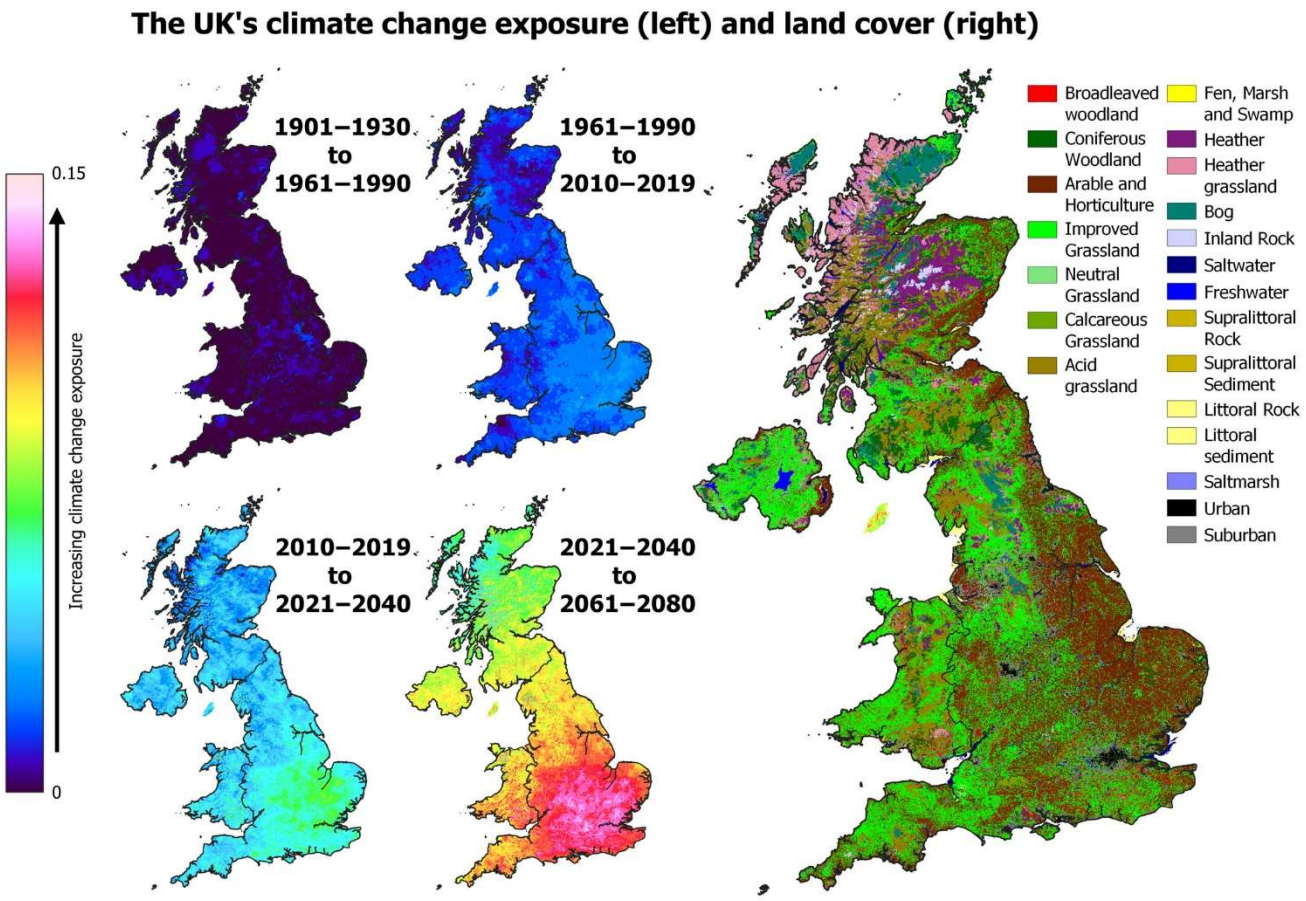


Figure 2: Spatial differences in climate change exposure across the UK (left), UK landcover map (right) (Wilson and Pescott, 2023).

Response acknowledges that the natural environment of the New Forest is a managed landscape and that the type of management in place now, and potential changes to management in the future, have an impact on and can mitigate climate risk.

Vulnerability is an assessment of the sensitivity of a particular asset, habitat, or species to climate change and its adaptive capacity, where **Sensitivity** is used to mean the degree to which a system is affected, positively or negatively, by climate change and **Adaptive Capacity** is used to describe the ability of a system to adjust to potential damage; this might be to limit that damage, take advantage of opportunities, or otherwise cope with the consequences of climate change. Adaptive capacity is used here to reflect either inherent properties or associated human actions carried out in response to, or in anticipation of, changes in climate.

Resilience is another term used throughout this report. It is defined as the ability of a system to absorb disturbances while retaining the same basic functions; a resilient system has capacity to adapt to stress and change.

Opportunity refers to potential actions that could be taken to reduce risk.

1.1.1 Scope

The risk assessment covers habitats and those characteristics of the New Forest National Park that are particularly connected to habitats i.e. heritage, landscape, the special qualities of the National Park, pest and disease risks, and risks to natural capital and ecosystem services. A section on species risks has been included, although within the scope of this study the detail is limited. There is much

more work that needs to be done to understand how species assemblages and their interactions are being influenced by climate change, and how they might continue to change in the future.

The work has been drawn together using academic and other literature, supplemented by local knowledge and experience where possible. The consultation process has been non-exhaustive. Drawing on wider perspectives and experience from those who live, work, and visit the New Forest is an essential ongoing task in the process of mitigating climate risk and adapting to climate change.

The risk assessment approach varies by topic. Habitats form the core of the risk assessment and the most substantive section of the report. The main aim has been to establish how vulnerable the New Forest habitats are to climate change and where the greatest vulnerabilities are (spatially). Habitats have been given a risk rating based on a combination of their sensitivity to climate change and adaptive capacity, with the results geospatially mapped. For the remaining topics the sections provide summary information of current understanding of climate risks and impacts from a New Forest perspective. Apart from pest and disease risks these have not been assigned risk ratings.

All the assessments have been made considering a medium emissions scenario (RCP 4.5[4]), the projected consequences of which are described in Section 1.2. Under a lower emissions scenario the impacts are likely to be reduced, whereas higher emissions will lead to more rapid and extreme changes to the climate making it harder for the natural environment to adapt. No attempt has been made to map impacts to different emissions scenarios or time steps at this stage. For the scopes assessed, in all cases risks increase as emissions increase, and in all cases both risk and uncertainty increase over time.

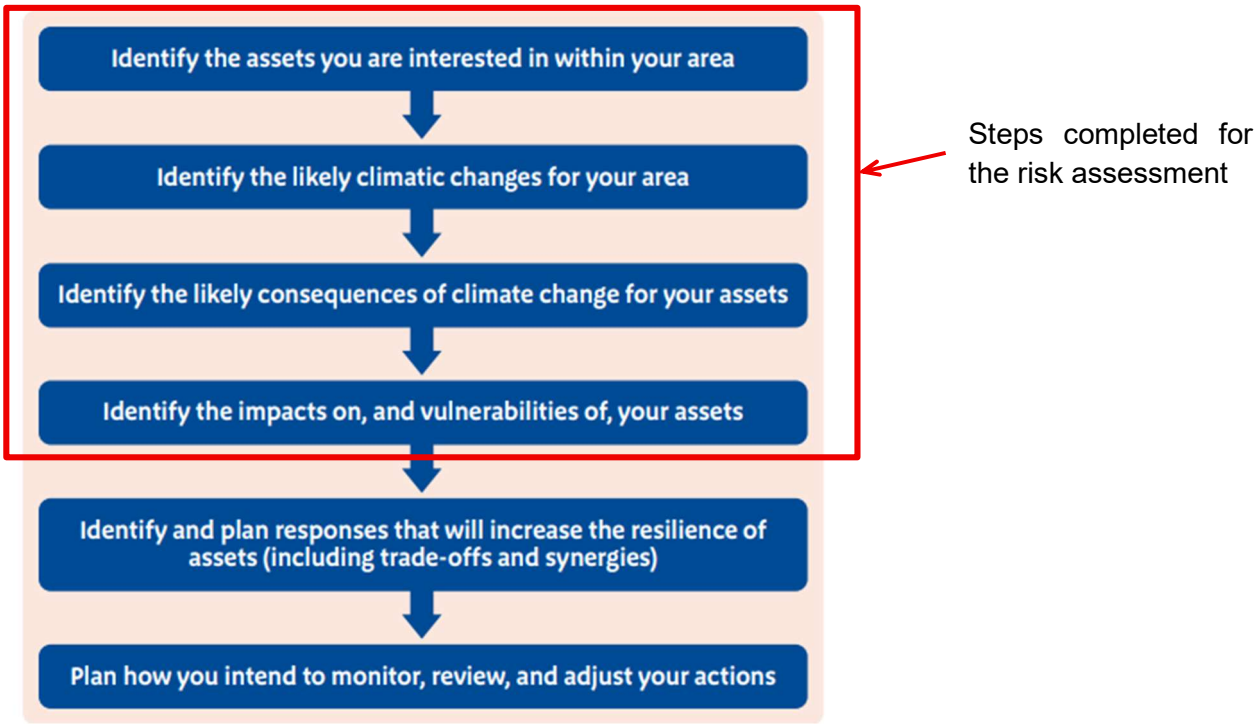


Figure 3: Natural England's Landscape Scale Climate Change Assessment Methodology Flow Chart showing the steps completed in this assessment.

[4] RCP's (Representative Concentration Pathways) are sets of assumptions about the economic, social, and physical changes to our environment that will influence climate change. Each RCP pathway represents a plausible future that results in a different level of global warming relative to the pre-industrial era (taken as 1850 – 1900).

Geospatial data and mapping

A variety of geospatial data have been used to inform the risk assessment. Spatial extents of priority assets (habitats, agriculture, and historical sites) have been defined using readily available GIS datasets. Where possible, a single dataset was used to maximise consistency.

By mapping asset extent, it is possible to see *where* the current stock of assets is located throughout the New Forest National Park, and by understanding the vulnerability of these assets to climate change impacts, *where* the areas at risk are and *where* action needs to be taken.

The datasets used are:

- Priority Habitat Inventory (Natural England)
- Ancient Woodland Extent (Natural England)
- National Forest Inventory (Forest Research)
- Heritage assets (Historic England)

Several features of interest were either not available as GIS datasets or were only available as a low-resolution layer, missing detail and smaller features. To address this, some features of interest have been extracted from the Ordnance Survey's highest resolution data via the OS Maps API under the NPA PSGA licence. These features include:

- Springs, water courses, drains, conduits and standing water, ponds
- Agricultural land and glasshouses

Further processing has been implemented to enhance the OS features with data from the Priority Habitat Inventory layer, which enabled the separation of arable land from pasture.

Several other sources have been used to provide additional information and context, such as:

- Soils (British Geological Survey)
- Peaty soils (Natural England)
- Terrain and tree canopy (Environment Agency)
- Legal and administration boundaries (Forestry Commission, NPA)

Flood risk was identified using:

- Flood Zones (Environment Agency) – climate change flood risk layer.

It was not possible to define spatial extents from existing GIS data for:

- Peat Bogs and Valley Mires
- Riverine and Bog Woodland

All datasets have been cropped to an extent based on the New Forest National Park boundary with a 1km buffer zone applied. This allowed for the visualisation of connectivity of the selected assets outside the National Park and calculations both inside the National Park and within the buffer zone. Data have also been segmented based on other extents of interest (e.g. open forest, Crown Lands etc) for additional calculation of area statistics.

Mapping and geospatial analysis was undertaken in Maploom® and provided as an interactive platform for the project: https://nf-ccra.maploom.com

1.2 Past, Present, and Future Climate

The term climate is used to mean average weather, typically looked at over a period of 30 years.

There is now unequivocal evidence that climate change is increasing average temperatures, driving sea level rise, and making extreme weather such as heatwaves and heavy rainfall more likely in the UK. In 2024, annual global average temperatures exceeded 1.5°C above pre-industrial levels for the first time.[5]

Global greenhouse gas emissions continue to increase[6], on a trajectory that suggests global average warming will reach 2°C in the next 25 years, with the possibility of significant further warming by the end of the century (see footnote 5). The implications are that the New Forest will face more unpredictable conditions, with higher year-round temperatures, more frequent extreme heat and drought conditions, and more intense rainfall leading to increased flood risks. The risks of exceeding 'safe limits' are growing.

In July 2022, Met Office records show that southeast England reached a record temperature of 40.2°C, resulting in ~3000 heat-related deaths and an unprecedented number of wildfires. The preceding winter and subsequent summer of 2022 received significantly less than the usual levels of rainfall, leading to extensive drought. Attribution studies show that these extremely hot and dry conditions were made 10 times more likely as a result of climate change.[7] In the New Forest, sections of the Highland Water dried up for the first time in living memory.

Beginning almost immediately after this hot dry period, England experienced the wettest 18 months on record. The plots in Figure 4 show how different the temperatures and precipitation rates were during the summer of 2022 and winter of 2024 compared to the average. The images in Figure 5 illustrate some of the impacts of these conditions in the New Forest.

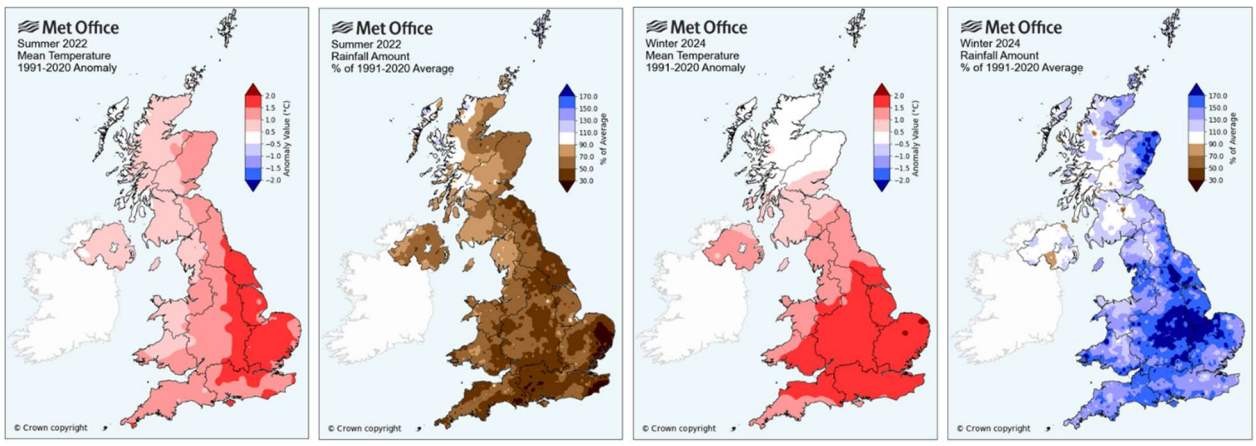


Figure 4: Met Office plots showing the hot dry summer of 2022 (left) and warm wet winter of 2023/2024 (right)[8].

[5] https://www.theccc.org.uk/publication/progress-in-adapting-to-climate-change-2025/
[6] https://gml.noaa.gov/ccgg/trends/mlo.html
[7] https://www.carbonbrief.org/climate-change-made-2022s-uk-heatwave-at-least-10-times-more-likely/
[8] https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-actual-and-anomaly-maps

Figure 5: Images, left to right, Beech leaf fall in the August 2022 drought (Busketts Wood), fallen tree on a New Forest Road (Bolderwood), grazing lawn inundated during flood (Longwater Lawn).

The UK Met Office, UK Climate Change Committee and Intergovernmental Panel on Climate Change (IPCC) AR6 Synthesis report provide detailed authoritative information on climate change.

The next section provides a short overview of past and future projected climate of the New Forest extracted from the Met Office UKCP18 User Interface, Climate Data Portal and the Local Authority Climate Service. A more detailed assessment is provided in Report 1: New Forest Climate (Jan 2025).

Table 1 (below) shows **average** annual and seasonal temperatures and rainfall in the New Forest over the past 40 years, alongside projected changes to these averages in the future covering four different time intervals through to 2100[1].

The future projections are probabilistic (i.e. behind these data are a full a range of potential outcomes with an associated probability of occurrence). Representative Concentration Pathways (RCP's) provide projected temperature changes under different emission scenarios; there are three commonly used scenarios:

- **RCP 2.6** represents a future with strong global action on climate change resulting in a median global temperature increase of c.1.6°C by 2081.
- **RCP 4.5** is a medium emissions scenario that results in a best estimate median temperature change of 2.4°C by 2081.
- **RCP 8.5** is a high emissions scenario that results in a best estimate median temperature change of 4.3°C by 2081.

The values shown in black are the median (central) result for the intermediate emissions pathway (RCP4.5). The values in grey are the median results for a low (RCP2.5) and high emission scenario (RCP 8.5).

For context, the WMO report that the 2024 global average temperature was about 1.55°C above pre-industrial levels, and the past ten years (2015 – 2024) are the ten warmest years on record.

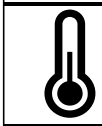
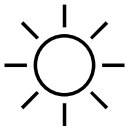
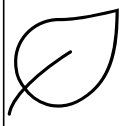
		Baseline	Recent Past	+5 years	+25 years	+55 years	+75 years
		1981 - 2000	2001 - 2020	2030	2050	2080	2100
	**Temperature**	°C	°C	°C change	°C change	°C change	°C change
	Annual Average	**10.2**	**10.9**	+0.9	+1.3	+2.2	+3.0
				0.9 to 1.0	1.3 to 1.8	1.4 to 3.5	1.5 to 5.0
	Spring Average	**9**	**9.7**	+0.6	+1.0	+1.7	+2.2
				0.6 to 0.7	0.9 to 1.3	1.0 to 2.7	1.1 to 3.6
	Spring Maximum	**13.5**	**14.5**	+0.7	+1.0	+1.7	+2.2
				0.7 to 0.8	1.0 to 1.4	1.1 to 2.8	1.1 to 3.8
	Summer Average	**16**	**16.5**	+1.2	+1.9	+3.1	+4.4
				1.2 to 1.5	1.9 to 2.6	2.0 to 5.0	2.4 to 7.2
	Summer Maximum	**21**	**21.5**	+1.4	+2.1	+3.5	+4.9
				1.4 to 1.7	2.1 to 2.8	2.3 to 5.6	2.8 to 8.0
	Autumn Average	**10.9**	**11.6**	+0.9	+1.5	+2.4	+3.0
				0.9 to 1.1	1.4 to 2.0	1.5 to 3.8	1.5 to 5.2
	Autumn Maximum	**14.9**	**15.7**	+1.1	+1.6	+2.5	+3.0
				1.1 to 1.3	1.5 to 2.1	1.6 to 4.0	1.6 to 5.3
	Winter Average	**4.9**	**5.5**	+0.8	+1.3	+1.8	+2.3
				0.8 to 0.9	1.1 to 1.6	1.1 to 2.9	1.1 to 4.0
	Winter Maximum	**8.1**	**8.8**	+0.8	+1.2	+1.7	+2.1
				0.8 to 0.9	1.0 to 1.6	1.1 to 2.8	1.0 to 3.7
	Precipitation	mm	mm	% change	% change	% change	% change
	Annual Average	**880.2**	**899.4**	+1	+0	+1	-1
				0 to 1	0 t 0	0 to 1	0 to -1
	Spring Average	**178.6**	**174.8**	-2	-2	-7	-8
				-2 to -3	-1 to -3	-5 to -8	-5 to -9
	Summer Average	**154.2**	**182.8**	-13	-20	-29	-43
				-13 to -17	-20 to -24	-22 to -41	-30 to -59
	Autumn Average	**283.8**	**268.5**	+2.3	+2.7	+5.6	+8.1
				1 to 2	2 to 3	5 to 6	8 to 9
	Winter Average	**257.4**	**274.6**	+9.1	+10.2	+16.9	+19.5
				9 to 10	10 to 13	11 to 26	11 to 33

Table 1: Past and future climate projections for the New Forest National Park (based on 25km resolution data). The grey numbers shown are the median (central) results for a low (RCP2.5) and high emission scenario (RCP 8.5). Future projections are relative to the average of the period 1981 to 2000.

Table 1 clearly shows the headline trends: higher average temperatures for all seasons, drier springs and summers, and wetter autumns and winters. Importantly, overall precipitation is not expected to vary significantly.

It is important to interpret these data within the context of UK weather patterns. UK rainfall patterns are not uniform and vary on seasonal and regional scales; these will continue to vary in the future. Natural variation means that some cold winters, some dry winters, some cool summers, and some wet summers will still occur. Analysis by the Met Office shows that while the projections show a clear

shift to higher probabilities of drier summers, they also suggest that the likelihood of individual wet summers reduces only slightly (Maisey, 2019).

For other climate variables, the UK Climate Projections (UKCP18) suggest the following for the New Forest region:

- Negligible change to windspeeds (within +/- 0.5m/s to 2080's)
- An increase in the magnitude, frequency, and duration of heatwaves and drought conditions
- An increase in the intensity of rainfall (~25% increase in summer and autumn)

The implications of hotter, drier summers are an increase in the magnitude and duration of wildfire conditions, especially in central and eastern southern England (including the New Forest).

Alongside temperature, the other clearest signal of climate change is sea-level rise, and an ongoing increase to mean sea level at the coast. The projected increases in sea level for the New Forest coast are shown in *Table 2*.

Time Step	2030	2050	2080	2090's
RCP	cm	cm	cm	cm
2.6	+18 *+12 to +24*	+27 *+19 to +38*	+40 *+26 to +60*	+44 *+29 to +68*
4.5	+18 *+13 to +24*	+29 *+21 to +41*	+47 *+32 to +70*	+53 *+36 to +80*
8.5	+20 *+15 to +26*	+35 *+25 to +47*	+64 *+44 to +91*	+75 *+51 to +108*

Table 2: Change in sea level with reference to 1981 – 2000 baseline (cm) (spatial average calculated as the mean of all grid boxes along the coastal boundary of the NFDC Local Authority area). The upper value shows the central projection; the range is provided in grey italics underneath.

Both increases in average temperatures and changing concentrations of CO_2 in the atmosphere have implications for plant growth. Growing degree days are a metric of the number of days above a threshold temperature (5.5°C) used to indicate when conditions promote growth in the natural environment. *Table 3* shows how the growing degree day indicator increases with different thresholds of warming, alongside frost days and very hot days (>25°C). The implications for plants of increasing CO_2 concentrations have not been discussed in any detail in this report.

Warming relative to pre-industrial levels	Growing Degree Days[9]	Frost Days	Approximate number of days with a maximum daily temperature > 25°C
Historic (baseline)	2008 (1981-2000)	47 (1981-2000)	~ 14 days
1.5°C of warming	2336 (+16%)	34 (-28%)	~ 30 days
2.0°C of warming	2498 (+24%)	29 (-38%)	~ 38 days
4.0°C of warming	3062 (+52%)	13 (-72%)	~ 70 days

Table 3: Projected changes in annual growing degree days, frost days, and number of days exceeding 25°C for the New Forest region.

The impact of shifting averages on extreme events

Alongside changes to average conditions, analysis of UKCP18 data show an increase in the frequency and intensity of extremes. An extreme weather event is one that is rare at a particular place and time of year, with unusual characteristics in terms of magnitude, location, timing, or extent.[10] These events are above or below a threshold near the upper or lower (tail) ends of the range of observed values in a specific region. Even if a weather or climate event is not statistically extreme, there are cases where an event, an accumulative series of events, or a specific combination of events can lead to extreme conditions or impacts (e.g. a simultaneous high tide, storm surge, and heavy or prolonged precipitation leading to extensive flooding).

It is predicted that as the climate continues to change the New Forest will be subject to climate hazards and extremes of different frequency, severity, and duration. UKCP18 results highlight that from the 2050s onwards, higher emissions scenarios are projected to lead to greater increases in extreme weather and sea level and that the severity of extremes is projected to increase with global warming. It is also important to note, however, that unprecedented extremes will continue to occur in the future as a result of natural variability.

There is an increasing risk of passing climate 'tipping points' as global warming progresses. Tipping points are thresholds in the earth system that, if crossed, lead to large, accelerating, and potentially irreversible changes to our current climate - examples include changes to ocean circulation or loss of major Antarctic ice sheets. The impacts of crossing these tipping points are not included in the climate projections and remain poorly understood. As a consequence, there is a residual risk of rapid changes in climate outside the envelope of scenarios currently modelled by the UKCP18 suite of climate projections.

[9] Growing Degree Days indicate if conditions are suitable for plant growth. A Growing Degree Day (GDD) is a day in which the average temperature is above 5.5°C. It is the number of degrees above this threshold that counts as a Growing Degree Day. E.g. if the average temperature for a specific day is 6°C, this would contribute 0.5 Growing Degree Days to the annual sum, an average temperature of 10.5°C would contribute 5 Growing Degree Days.
[10] https://wmo.int/topics/extreme-weather

2 Climate Change Risks

2.1 Habitats

The New Forest consists of an inter-connected mosaic of habitats including extensive heaths and grasslands (wet and dry), valley mires and bogs, ancient pasture woodlands, and forestry inclosures. The interior contains a network of rivers, streams, and ponds, while the 26 miles of coastline feature shingle beaches, saltmarshes, lagoons, and mudflats.

Residential and commercial developments within the New Forest range from single dwellings and small urban centres to large private estates which include land managed for farming, shooting, and fishing. Interactive versions of maps in this report are available here: https://nf-ccra.maploom.com/

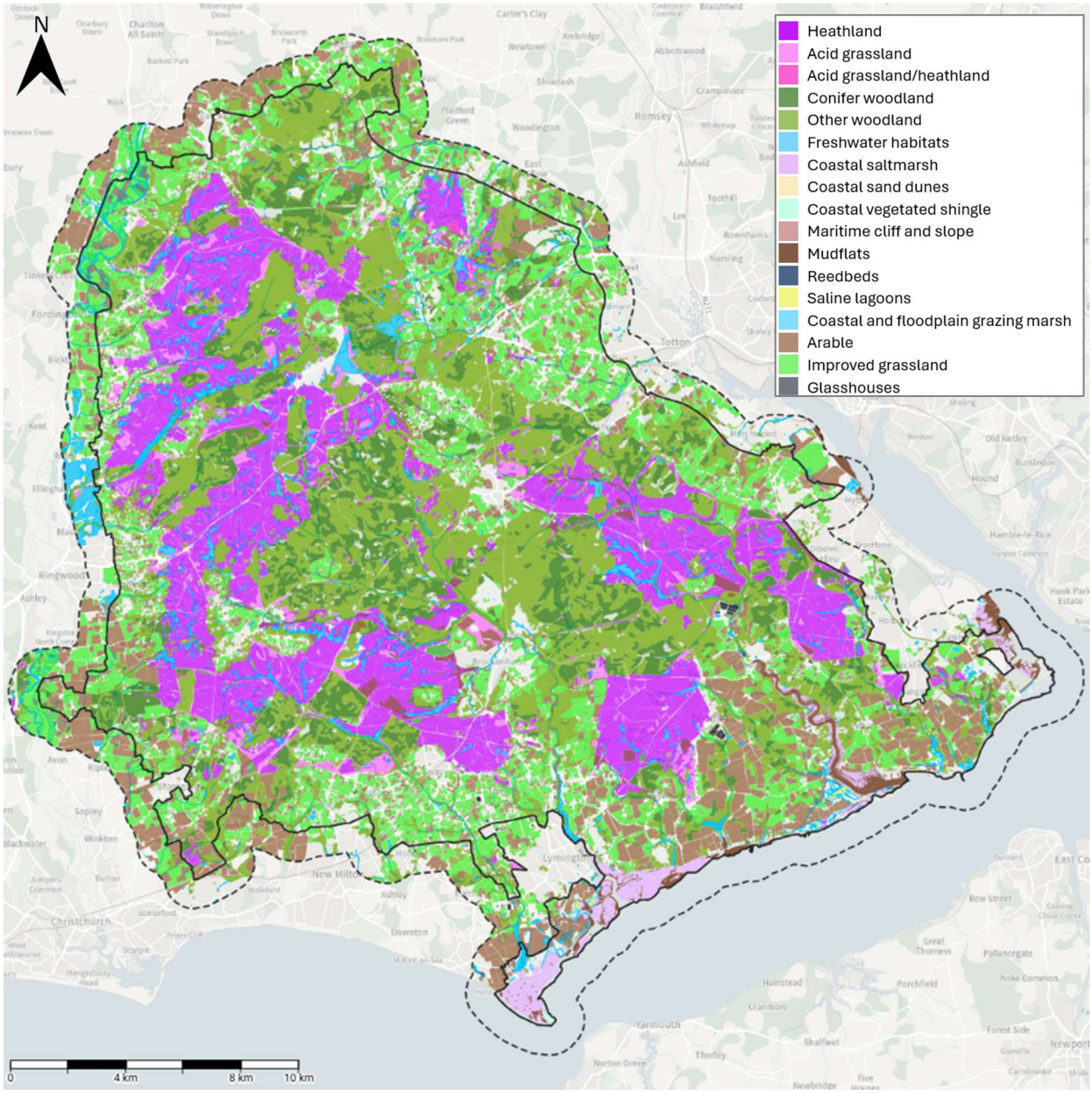


Figure 6: Habitat map of the New Forest showing the National Park boundary (solid black line) with a 1km buffer (dotted black line).

2.1.1 Methodology

For the purposes of this assessment, New Forest habitats have been grouped as listed below. In practice, each habitat represents a spectrum of different features or vegetation communities that are dynamic and transitional and encompass within them significant spatial variation.

- Freshwater
- Peat Bogs and Valley Mires
- Coastal and Estuarine
- Heathland
- Acid Grassland
- Woodland, split into old growth pasture, riverine and bog, and other types of woodland
- Agriculture, Horticulture and Modified Grassland
- Soils

Table 4 and *Table 5* below show the criteria used to rate sensitivity and adaptive capacity of habitats. Combined (multiplied) these results give overall risk of habitat modification in response to climate change, as shown in *Table 6*. The assessment is subjective, reflecting published evidence and local experience; these should be modified if new information or understanding becomes available.

Rating	Sensitivity	
1	Very Low	Existence of habitat is determined by high levels of human manipulation or factors such as grazing or geology. Climate has a minor influence.
2	Low	Habitat is expected to be resilient to projected changes in climate.
3	Moderate	Habitat is sensitive to climatic or hydrological conditions but expected to be resilient to projected changes in climate with some minor modifications in composition.
4	High	Habitat is highly sensitive to climatic or hydrological conditions and likely to undergo significant change in response to projected changes in climate.
5	Very High	Habitat presence is dependent on specific climatic or hydrological conditions which projections indicate are likely to change.

Table 4: Sensitivity Scoring Criteria

Rating	Adaptive Capacity	
1	Very High	Habitat can adapt naturally without assistance or is under high levels of management that can be proactively modified to support adaptation at the pace required to keep up with climate change.
2	High	Habitat can adapt naturally with some human assistance; adaptation timeframes are short (e.g. can vary annually) and can maintain pace with climate change.
3	Moderate	Habitat has some capacity to adapt naturally and/or can be proactively supported to adapt (relatively less than 'high' and more than 'low').
4	Low	Habitat has limited natural ability to respond to projected changes in climate and/or limited scope for human aided adaptation, timeframes for adaptation are likely to exceed those needed to keep pace with climate change.
5	Very Low	Habitat has minimal ability to adapt naturally and/or management options are very limited (practically, or due to legal protections or other factors), adaptation timeframes exceed the rate needed to adapt to climate change.

Table 5: Adaptive Capacity Scoring Criteria

Sensitivity	Adaptive Capacity	Sensitivity x Adaptive Capacity = Risk
Very Low (1)	Very High (1)	Very Low <5
Low (2)	High (2)	Low 5 -> 9
Moderate (3)	Moderate (3)	Moderate 10 -> 14
High (4)	Low (4)	High 15 -> 19
Very High (5)	Very Low (5)	Very High 20+

Table 6: Risk Rating

Each habitat section includes an overall risk rating and map, a brief summary outlining the rationale for the ratings given, context, more detailed discussion of potential climate impacts, and a short summary of adaptation and mitigation response options identified in the literature. These are expanded and discussed in the context of the New Forest in Section 3 (Opportunities).

A higher level of detail is provided for those habitats that are deemed to be at high or very high risk.

The review has drawn extensively from the key references shown below. Additional sources are individually referenced.

- UK 3rd Climate Change Assessment (CCRA3) and supporting technical reports (2021). Note CCRA4 is currently underway, due for publication in 2026.
- Natural England and RSPB, 2019. Climate Change Adaptation Manual - Evidence to support nature conservation in a changing climate, 2nd Edition. Natural England, York, UK, and the 2023 update (see Staddon, 2023).
- Living with Environmental Change (LWIC): archive of publications and reports.

2.1.2 Summary of habitat results

provides a summary of the risk assessment results for each habitat class. This is followed by three maps which present the results (excluding the soils class) in a visual format, with tables summarising spatial extents for each result.

Table 7: Summary of results from habitat assessment showing sensitivity, adaptive capacity, and risk.

Habitats	Sensitivity to Climate Change	Adaptive Capacity	Risk Assessment	*Score*	Rationale
Freshwater Habitats	Very High	Very Low	Very High	*25*	High dependence on precipitation, sensitivity to °C, exposure to multiple stressors that are amplified by temperature and volume of water
Coastal and Estuarine Habitats	Very High	Low	Very High	*20*	Habitats constrained in their ability to respond to sea level rise (sediment supply limited/risk of coastal squeeze) therefore high potential for habitat loss
Old Growth Pasture Woodland	High	Very Low	Very High	*20*	Beech has high drought sensitivity and forms a significant and important proportion of these woodlands. Habitats are fragmented; high grazing pressure prevents regeneration. Limited interventions possible due to protections.
Peat Bogs and Valley Mires	High	Low	High	*16*	Sensitive to changes in the quality, quantity & seasonal availability of water. Supports specialist species with narrow hydrological requirements and limited dispersal opportunities
Heathland	High	Low	High	*16*	Under modified conditions, depending on precipitation outcomes there is potential for heaths to become drier or wetter, with associated composition changes (including to associated peaty soils). Dry heaths are highly combustible, at increasing risk of wildfires.
Riverine and Bog Woodland	Moderate	Low	Moderate	*12*	Sensitive to precipitation. Anticipate some changes in species due to combined impacts of milder, wetter winters and hotter drier summers (trees, ground flora and associated vertebrates/invertebrates), very low natural regeneration but some ability to influence water flow through landscape hence low (not very low) adaptive capacity
Soils	High	Moderate	Moderate	*12*	Temperature and precipitation are key drivers of multiple soil processes influencing soil health, soils have some adaptive capacity however agricultural and other soils impacted by compaction, loss of organic matter or other manipulation are likely to have reduced adaptive capacity. Exposed soils are at risk of increased erosion from extreme drought and high intensity rainfall.
Other Woodland	Moderate	Low	Moderate	*12*	Increased temperatures are extending the growing season but also create favourable conditions for new pests and diseases to thrive. Extreme and unseasonal weather increase stress and mortality rates. Increasingly, suitability of species will change.
Acid Grassland	Low	Moderate	Low	*6*	The main risk is drought; community composition may shift to favour southern temperate and mediterranean species.

Habitats	Sensitivity to Climate Change	Adaptive Capacity	Risk Assessment	*Score*	Rationale
Agriculture, Horticulture and Modified Grassland	Moderate	High	Low	*6*	Activities supported under this category are dependent on water and sensitive to temperature but as they are highly managed adaptive capacity is high, and overall risk is low

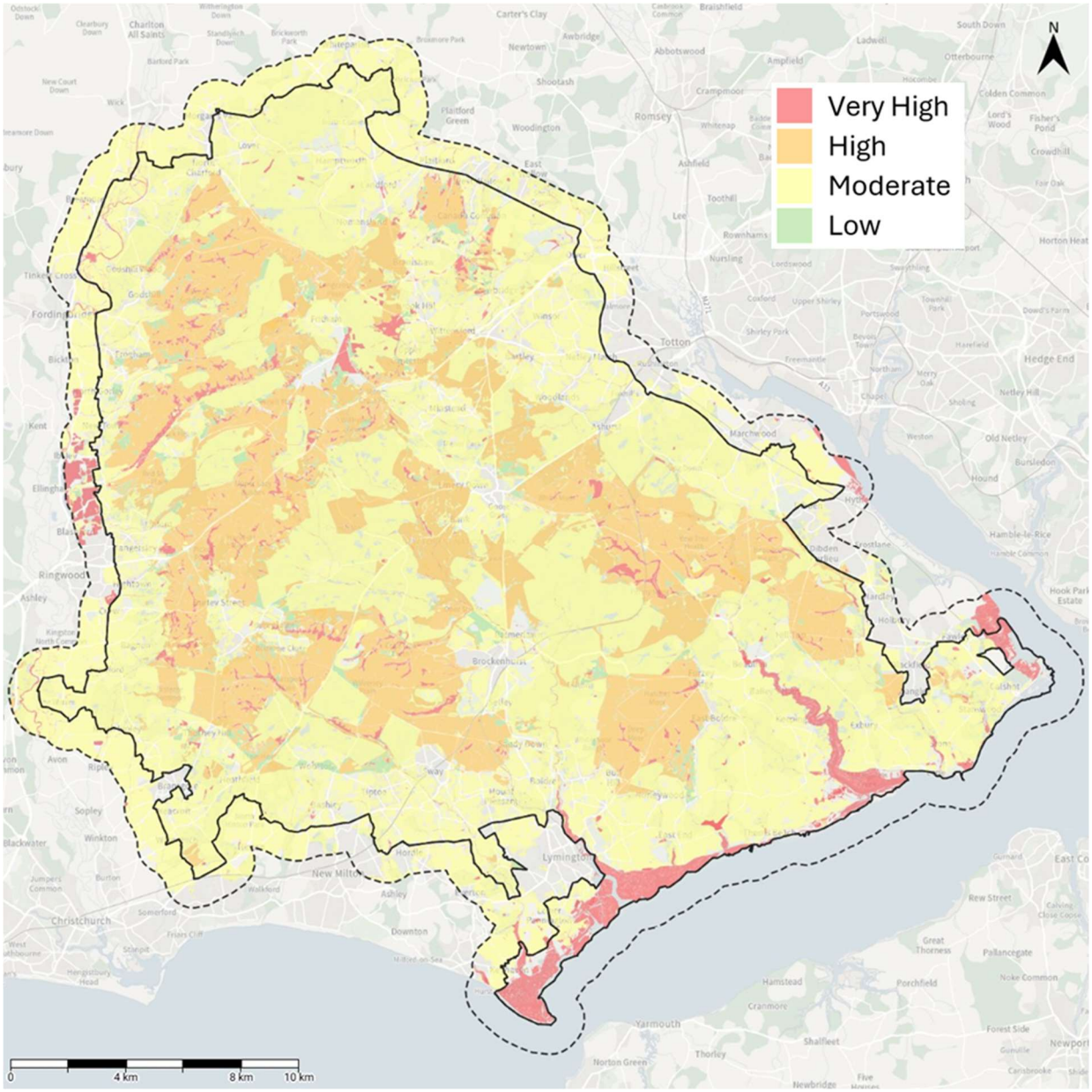


Figure 7: Map showing results of the climate sensitivity assessment for the New Forest based on habitat classes.

Sensitivity Rating	Ha	% of National Park Area	Land cover classes
Very High	2,840	6%	Coastal, freshwater and estuarine
High	15,501	31%	Old Growth Pasture Woodland, peat bogs, valley mires and heathland, soils
Moderate	29,942	60%	Other woodland types, land used for Agriculture, Horticulture and Modified Grassland
Low	1,234	2%	Acid grasslands
Total	49,516	100%	

Table 8: Summary of the spatial extents and classes in the sensitivity assessment

Figure 7 above shows the spatial distribution of the climate sensitivity assessment based on land cover data and the results shown in *Table 7*.

Freshwater, coastal and estuarine habitats are the most sensitive (very high), driven by the combined effects of rising temperature, lower spring and summer precipitation, and higher drought risks. Coastal habitats are impacted by sea level rise and coastal squeeze.

Wetland bogs, mires, heathland and old growth pasture woodland habitats have been rated high due to their dependence on precipitation and sensitivity to sustained periods of higher temperatures. Old growth pasture woodlands are extremely scarce habitats that are unique to the New Forest. They feature Beech as a major component, are highly fragmented and are under high grazing pressure which prevents natural regeneration.

Riverine and bog woodland alongside other woodland habitat types have been rated as moderate sensitivity, reflecting an understanding that woodlands will certainly survive in this region (notwithstanding a catastrophic disease outbreak), albeit with some changes in species. This rating masks considerable variation in sensitivity between different tree species - some such as Beech are highly sensitive (see e.g. Martinez del Castillo et al., 2022) whereas others, such as Pedunculate Oak are more resilient. There are also variations in sensitivity depending on the type of woodland, with riverine woodland potentially more resilient and woodland on free-draining and more exposed sandier soils potentially less so (depending on which species are located in those areas). Agriculture, horticulture, and modified grasslands have been rated as moderate as these are all highly modified by management, yet also sensitive to temperature and water availability.

Acid grasslands have been rated as least sensitive to the projected changes in climate for this region.

Soils are not shown on the map but have been rated as high sensitivity. Temperature and precipitation are key drivers of multiple soil processes influencing soil health. Physical impacts include increased risk of soil erosion from higher temperatures and repeated cycles of drought and flooding. Drier soils lose structural and water retention capacities. Higher intensity and increased winter precipitation increases the loss of soil nutrients and risk of run-off and erosion of soil into watercourses. Wetter winters increase the duration during which soils are saturated increasing susceptibility to compaction.

Sensitivity of any habitat to climate change may be amplified or moderated depending on the capacity of a habitat (whether naturally or in response to changes in management) to adapt. Figure 8 (below) shows the spatial distribution of the adaptive capacity assessment based on land-cover data and the results shown in *Table 7*.

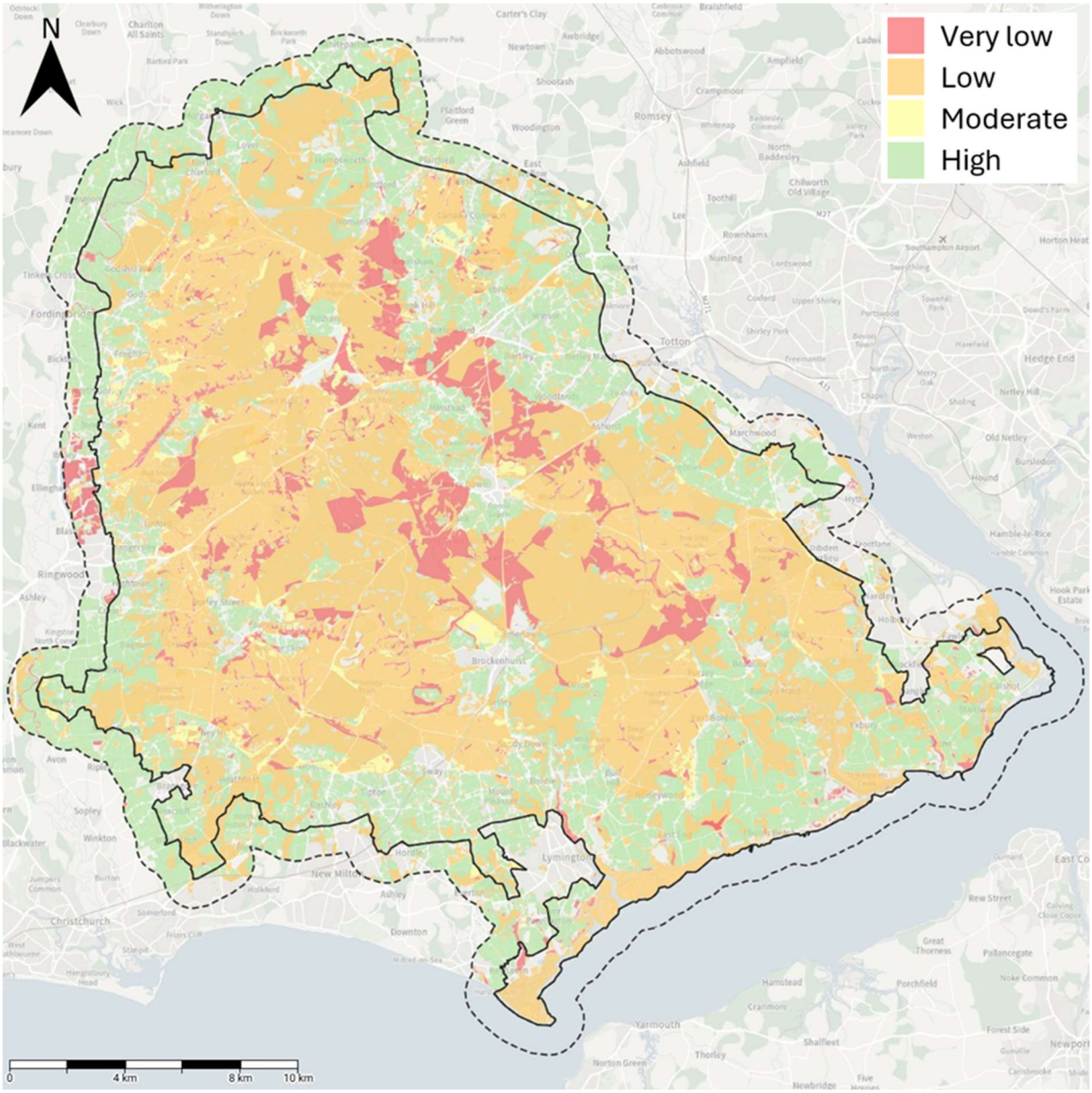


Figure 8: Map showing results of the adaptive capacity assessment for the New Forest based on habitat classes.

Adaptive Capacity Rating	Ha	% of National Park Area	Land cover classes
Very Low	5,142	10%	Freshwater habitats and Old Growth Pasture Woodland
Low	30,245	61%	Coastal and estuarine habitats, Peat bogs, valley mires and heathland, riverine and bog woodland and other woodland
Moderate	1,409	3%	Soils and acid grassland
High	12,713	26%	Agriculture, Horticulture and Modified Grassland
Total	49,509	100%	

Table 9: Summary of the spatial extents and classes in the adaptive capacity assessment

Two habitats have been rated as having very low adaptive capacity; these are freshwater habitats and old growth pasture woodland. Freshwater habitats have an extremely limited ability to adapt to changes in water volume and precipitation, which can exceed behavioural or survival thresholds of some species. Although flow rates and temperatures vary under 'normal' conditions, the magnitude of temperature and volume changes that are anticipated in the New Forest region have the potential to exceed the thresholds of multiple species. Old growth pasture woodlands have been rated as very low due to their fragmentation, very low regeneration success, lifespan and high levels of protection limiting intervention options.

Peat bogs, mires, heathlands, coastal habitats, and all other woodland types have been rated as having low adaptive capacity. This reflects the time taken for these habitats to regenerate (especially some tree species), and their ability to maintain their current composition under a modified climatic regime (including higher sea levels).

Soils and acid grassland have been classed as moderate for adaptive capacity based on an understanding that they are more resilient to climate change than the more water-sensitive types. Confidence in the assessment for soil is low due to a lack of published evidence.

Agriculture, horticulture, and modified grasslands have been rated as having the highest adaptive capacity as they are strongly influenced by human management and can be modified more easily than the more highly protected areas.

The spatial extents of the risk classes within the National Park boundary are shown in *Table 10* below. Figure 9 shows the spatial distribution of climate risk for New Forest habitats based on land cover datasets and a combined sensitivity / adaptability rating.

Risk Rating	Ha	% of National Park Area	Land cover classes
Very High	6,286	13%	Freshwater, Coastal and estuarine habitats and Old Growth Pasture Woodland
High	12,055	24%	Peat bogs, valley mires and heathland
Moderate	17,054	34%	Riverine and bog woodland, other woodland, soils
Low	14,135	29%	Acid grasslands and Agriculture, Horticulture and Modified Grassland
Total	49,530	100%	

Table 10: Summary of the spatial extents of the different risk classes.

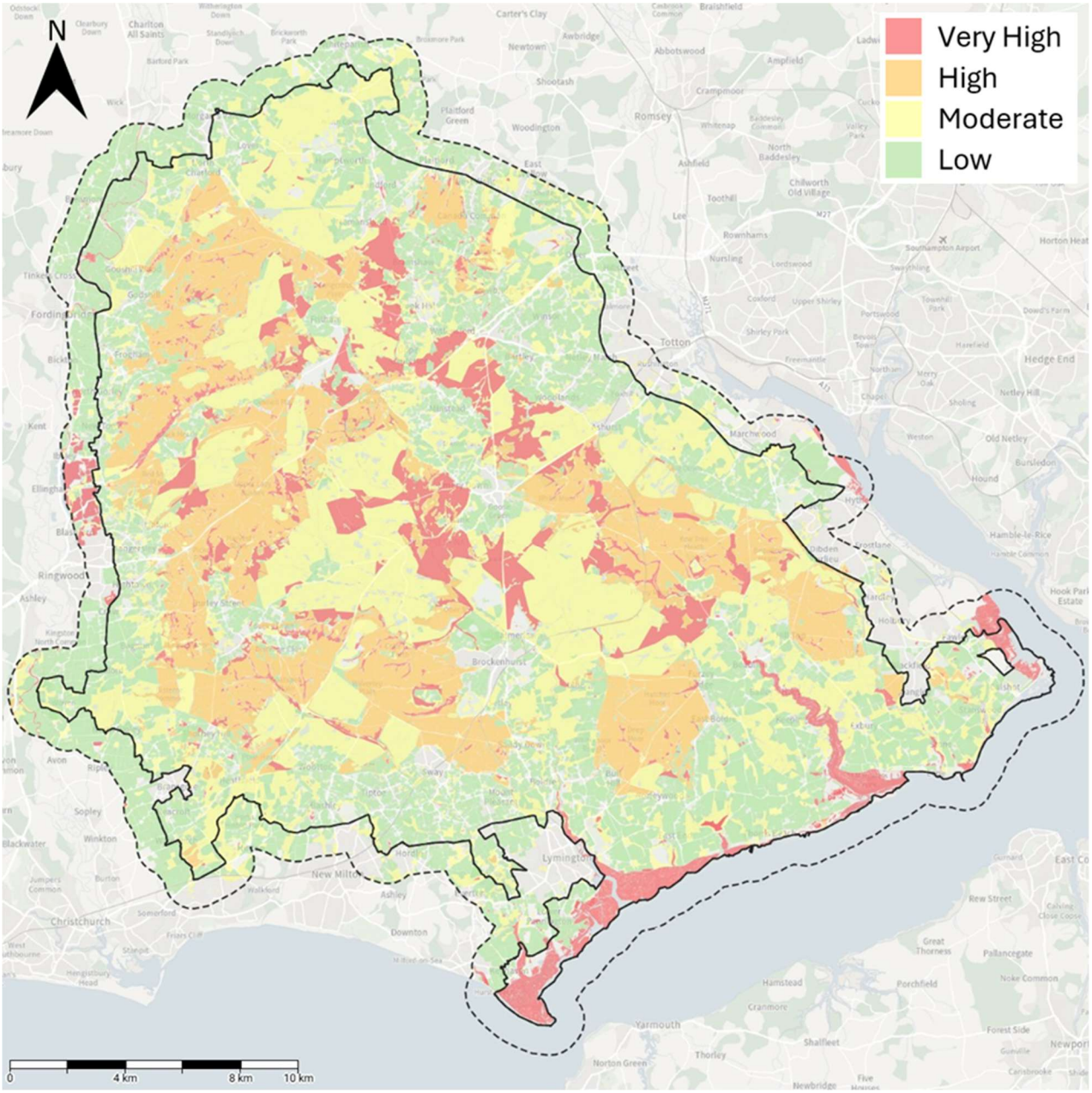


Figure 9: Map showing the spatial distribution of climate risk for New Forest habitats, based on land-cover data and a combined sensitivity / adaptability rating.

2.1.3 Freshwater Habitats

The New Forest contains over 1000 ponds and an abundance of streams that feed into several rivers, which drain into the Solent, the River Avon, and the River Test; the quality and quantity of these freshwater habitats makes the New Forest one of the best Important Freshwater Areas in the UK.

Sensitivity to Climate Change	Adaptive Capacity	Risk Rating	Confidence
Very High	Very Low	Very High	High

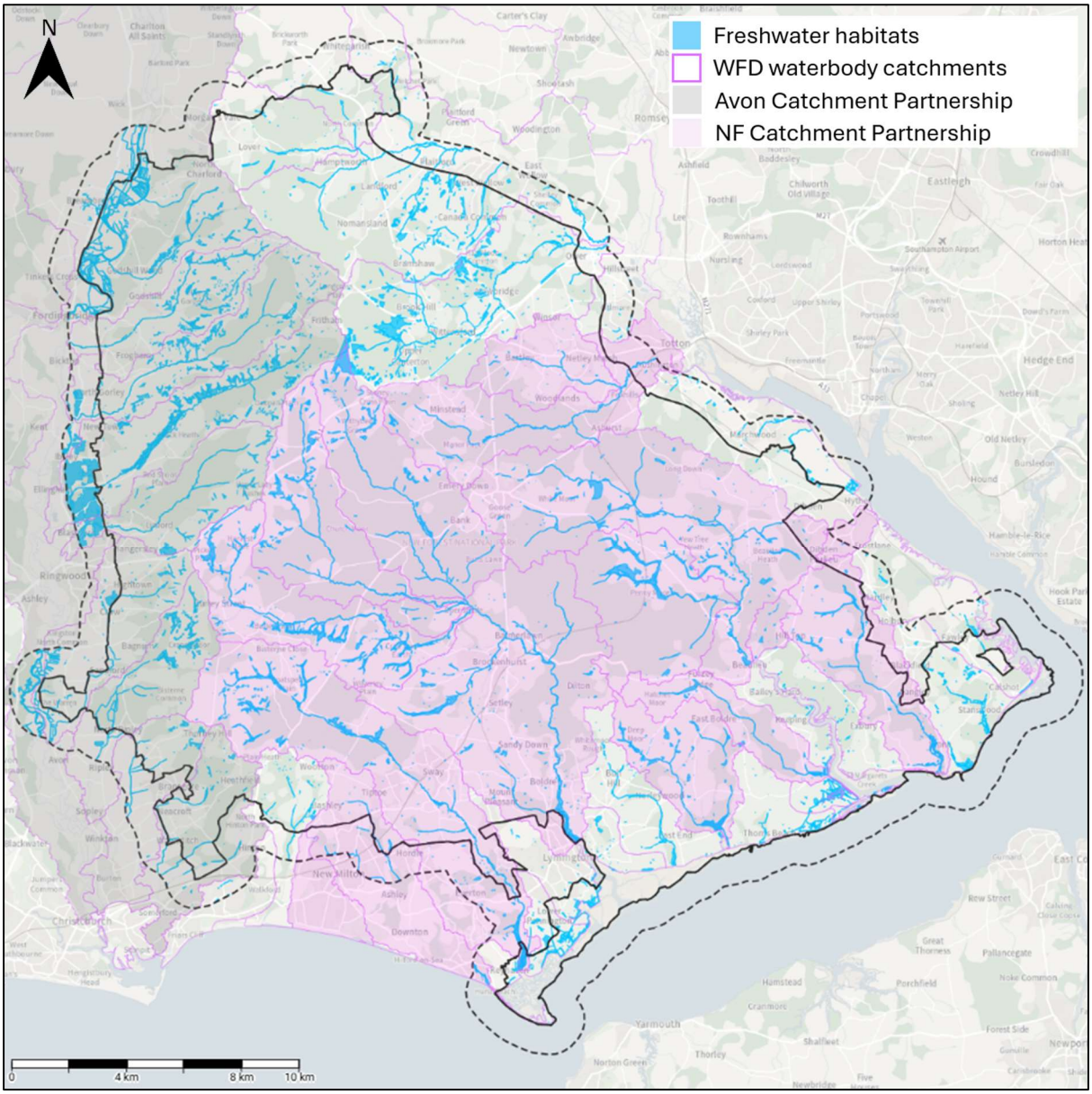


Figure 10: Map showing freshwater habitats and catchments. Sources: Ordnance Survey MasterMap (Standing Water and Water courses), Environment Agency Catchments.

Summary

- The volume and temperature of water available within freshwater habitats is of fundamental importance to their function and condition.

- Within the New Forest, freshwater habitats are primarily dependent on rainfall and surface run-off for their supply, making these habitats very sensitive to projected changes in climate (higher average and extreme temperatures coinciding with lower spring and summer rainfall).
- Across the New Forest, these habitats have exceptional biodiversity. Most aquatic species are ectothermic and highly sensitive to temperature. Those without aerial life stages have limited abilities to disperse in search of cooler conditions.
- Ongoing nutrient enrichment and chemical contamination issues increase the vulnerability of these habitats to climate change.
- Due to the limited ability of freshwater systems to respond to extensive drought, as well as physiological sensitivity of fish and aquatic invertebrates to changes in water temperature, the adaptive capacity of these habitats is very low.

Relevant sections of the Natural England & RSPB Climate Adaptation Manual are *rivers and streams* (sensitivity rated high) and *standing open water* (sensitivity rated high).

Context

Although the New Forest has a high number of good-quality waterbodies, their status and extent within England is highly degraded. An estimated 90% of wetlands, including 75% of ponds (90% of ponds in lowland England) have been lost over the last century. Most rivers and lakes are not close to their natural state in any part of the UK (Absalom and Bennett, 2024).

Within the New Forest, well over half the total length of main streams and tributaries have been modified in the past by drainage schemes to improve areas for forestry or grazing, dating back to 1870 (Smith, 2006, Part 2). Despite this, the freshwater and wetland habitats of the New Forest are of international importance and are recognised as a Ramsar site and a key feature of the New Forest SAC.

Freshwater and wetland habitats are described in Smith (2006, Part 2) and in the New Forest SAC Management Plan (NE, 2025). Whatley & Ewald (2012) also provide useful context with a focus on freshwater environments. Thomas et al. (2016) describe some of the historical issues of drainage and other physical modifications, and subsequent restoration efforts. The 2019 wetland restoration strategy (Hill et al., 2019) remains current.

There are two catchment partnership groups within the New Forest, the Hampshire Avon Catchment Partnership and the New Forest Catchment Partnership, which is co-hosted by the Freshwater Habitats Trust (FHT) and the NPA. Through the Higher-Level Stewardship Scheme (HLS), and other precursor initiatives, a major programme of wetland restoration in the New Forest has been ongoing since 2010.

Eco-hydrological processes

An understanding of the eco-hydrological processes that support New Forest freshwater and wetland habitats is fundamental to assessing their sensitivity to climate change, and to predicting how they may evolve in the future. A brief overview is provided here for context.

The geology and soils across much of the New Forest are relatively impermeable and consist of a combination of clay, silt, sand, and gravel deposits; these provide limited groundwater to support streams and wetlands, which are mostly dependent on rainfall and surface run-off for their supply. As a result, river flows tend to closely reflect the intensity and duration of rainfall, rising swiftly in response

to precipitation. Wetland bogs and mires act as sponges, absorbing and slowly releasing water that feeds the streams that flow into the New Forest and Avon Valley rivers and out into the Solent.

During prolonged dry summers, many of the ephemeral ponds and wetlands, smaller streams, and headwaters exhibit low flows or dry up completely. Natural seasonal drying helps to support important plant and invertebrate communities; however, sudden or unexpected drying of more permanent features has the potential to cause damage to species which have not evolved to tolerate these conditions (Whatley & Ewald, 2012).

Debris dams are important features along the New Forest streams, particularly in wooded catchments where large woody debris influences channel morphology, creating diverse microhabitats and refugia. Woody debris traps sediment and gravel and promotes overbank flow in localised areas, which support floodplain habitats, it also slows downstream flow, particularly during peak discharges, provides food for invertebrates, shelter for fish, and has an overall positive effect on river biodiversity and food webs (Smith, 2006; Thompson, 2017).

In terms of nutrients, the streams of the New Forest are typically base poor with low nutrient concentrations. Water chemistry varies according to the underlying geology, soils, and land use, with waters tending to be particularly acidic in the upper reaches of catchments. The naturally low nutrient levels increase the sensitivity of associated freshwater species to additional organic inputs such as sewage or diffuse pollution from other sources (Smith, 2006).

Periods of low flow can exacerbate water quality issues by reducing the volume of water available for dilution of pollutants, and habitat availability for freshwater species. This tends to occur in the summer when visitor numbers increase, which can exacerbate issues such as pollution and recreational disturbance (Whatley & Ewald, 2012).

Water quantity and quality

The proportion of New Forest waterbodies (rivers) meeting at least good ecological status declined from 20.8% in 2016 to 16% in 2019 (the last full assessment), with none meeting high ecological status (CNP, 2024*).* Current management issues for New Forest river catchments are:

- Poor water quality, particularly diffuse sources of phosphorus, nitrate, and sediment
- Water quantity, i.e. low summer flows and winter flood conditions
- Habitat degradation, including over-widening of the river channel, disconnection with the floodplain, and physical (man-made) in-channel obstructions
- Morphology, i.e. loss of natural processes, and floodplain and habitat connectivity

Sewage and other chemical pollutants are a major issue, with regular inputs from combined sewer overflows (CSO's) associated with moderate to high intensity rainfall. This is especially problematic at the head of the Beaulieu River, but also regularly impacts the Lymington River (James and Longley, 2023).

Concerns are increasing over other sources of chemical pollution, including the impact of flea treatment insecticides on freshwater biodiversity, introduced through the increasing number of pet dogs visiting the New Forest and 'dog dipping' into water bodies.[11] (Perkins et al., 2024).

[11] See also FHT and BBC reporting.

There are no surface water reservoirs within the New Forest and no abstraction for public water supply from the rivers or groundwater. There are, however, active abstraction licences to support activities including agriculture, horticulture, and the visitor economy (Smith, 2016, EA, 2019c, Southern Water, 2022).

Species

The freshwater biotic (living) environment includes an incredibly diverse range of fish, amphibians, reptiles, birds, mammals, micro and macro-invertebrates, bryophytes, plants, fungi, algae, and bacteria that all contribute to the ecosystem processes and dynamics of these habitats.

The varied nature and high quality of New Forest freshwater and wetland habitats is reflected in the number of species they support and their importance for nature conservation. These include 30% of England's threatened freshwater species, 30% of the UKs freshwater invertebrate species (approx. 400 species) and 65% of the UK's wetland plants (300 species) (Whatley & Ewald, 2012).

Freshwater habitats are also important for vertebrates, with Otter *Lutra lutra*, Daubenton's Bat *Myotis daubentonii*, and Kingfisher *Alcedo atthis* being relevant examples within the New Forest.

Impacts of Climate Change

Climate change impacts on freshwater habitats can be considered in terms of three types of impact (expanded below):

- Direct impacts in response to gradual changes in baseline conditions (temperature, precipitation)
- Direct impacts in response to episodic 'pulse' events (extreme precipitation, flooding, drought, heatwaves)
- Indirect effects (e.g. modified behaviour of people, livestock and wildlife in response to weather)

Direct impacts in response to gradual changes in baseline conditions

Flow and water temperature are the primary variables that influence river ecosystem structure and function. (EA, 2025). Temperature of freshwater bodies is largely controlled by solar radiation and therefore varies diurnally and seasonally in line with air temperature. Temperature is also dependent on water volume and catchment hydrology (i.e. where is the water coming from and how quickly) and other factors such as the geometry and condition of river channels and shading by riparian (bankside) vegetation.

Impacts of warming on fish species are described in Section 2.2.5 and on aquatic invertebrates in Section 2.2.6. A key concern is exceedance of thermal thresholds that may drive population or community change even at sub-lethal levels.

Warming water aggravates pervasive issues such as eutrophication, pollution, and the spread of disease, exacerbating the impacts of low flow rates which concentrate nutrients and pollutants by reducing the volume of water available for dilution.

Phosphorus (P) and nitrogen (N), when combined with higher temperatures, can drive excessive growth of algae and plants and lead to eutrophication[12]. This adversely affects water quality and is damaging to local ecology, especially species suited to low nutrient environments (EA, 2022).

Elevated temperature is also known to alter the toxicity of other pollutants such as ammonia, pesticides, and other chemicals. There is evidence that elevated water temperature can alter the bioavailability, toxicity, and bioaccumulation of toxic metals. The impact of how pollutants may affect the ability of an organism to cope with rising temperatures (i.e., toxicant-induced climate sensitivity) is less known. Local monitoring suggests that a combination of contamination and nutrient enrichment, alongside higher temperatures and low summer flows, have accelerated the decline of sensitive fish species, especially in the Beaulieu River (James & Longley, 2023).

Warmer average conditions may increase the suitability of freshwater habitats to non-native species, with the potential to become invasive. They may also alter the balance of competition enabling existing species to become invasive or otherwise dominant with the potential for cascading ecosystem effects.

Direct impacts in response to episodic 'pulse' events

Impacts associated with extreme changes in water flow and temperature have been found to substantially reduce species richness in streams and rivers. Of these, flow interruption (i.e. in response to drought) has been found to have the largest impact on river biota and ecosystem function (Sabater, 2022) with the potential to induce regime shifts in river ecosystems, particularly affecting organisms such as invertebrates.

Prolonged low flows and associated temporary reductions in habitat extent and quality lead to increased competition and predation, affect the passage of migratory fish, can increase siltation (due to reduced flushing), increase pollution concentrations, and lead to reduced dissolved oxygen levels in both sediments and overlying water. Vegetation can encroach into channels, further impeding flow and reducing habitat availability.

The species likely to suffer the most are those that are adapted to cool, fast-flowing waters and those that have poor powers of re-colonisation, such as those without aerial or drought-resistant life stages. Ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Trichoptera (Caddisflies) are identified as the most affected groups of invertebrates, as they tend to adapt poorly to warmer temperatures, lower dissolved oxygen levels, and shrinking waters (Sabater, 2022).

As well as droughts, flood risks are also projected to increase. Floods can help to shape and restore modified waterways, but they can also lead to human interventions and modifications to increase protection of people and property from flood risk, with the potential for habitat damage.

High intensity rainfall increases the volume and energy of catchment run-off, potentially generating enhanced loads of fine sediment and diffuse pollutants, particularly nutrients. Siltation and nutrient enrichment are key impacts on freshwater biota. Siltation can lead to smothering of coarse substrates and generate excessive growth of benthic and planktonic algae, leading to declines in species dependent on clean, coarse sediments (e.g. salmonids and many benthic invertebrate species) and species adapted to low nutrient and well oxygenated conditions (e.g. many stonefly species).

[12] Phosphorus is the main cause of eutrophication in freshwaters, whereas nitrogen is usually the key nutrient involved in eutrophication in saline waters (EA, 2025)

Increased scour may partly offset increased pollutant loads by transporting pollutants downstream more effectively.

High intensity rainfall can also cause downstream 'wash out' of species, although there is not yet any evidence of this causing issues in the New Forest.

Indirect effects

Consultees have provided anecdotal observations of changes in the behaviour of humans and livestock associated with hotter drier weather and heatwaves. During these periods, visitors and livestock are observed to be more highly concentrated around water bodies, with higher numbers of people and dogs entering the water. This can increase recreational disturbance, direct habitat damage, and pollutant load (e.g. from dogs).

Mitigation and Adaptation Opportunities

In general, measures to mitigate the impacts of climate change are largely the same as those needed to improve the ecological status of freshwater habitats, i.e. more effectively protecting our freshwater habitats from pollution, restoring natural flow wherever possible, retaining or increasing shade and natural features within channels, and creating new ponds and freshwater features across the landscape to increase resilience and connectivity.

For rivers and streams, important measures include ensuring availability of refugia such as deep pools and large woody debris and, depending on the location, either maintaining or increasing riparian shade. Warming is highest along stretches of open river exposed to direct solar radiation (insolation), the effects of which propagate downstream. As temperatures increase, reducing insolation becomes increasingly important.

Managing ponds for climate resilience needs to reflect the specific setting and characteristics, recognising that the wide variety of pond types found in the New Forest is a key feature that makes these habitats so valuable for biodiversity.

Ongoing work that is contributing to adaptation includes wetland restoration and habitat creation via the HLS and SSF projects.

Links to resources and further reading

- New Forest Freshwater and Wetland Habitats Restoration: Strategy 2019. (Hill et al., 2019)
- Storyboard created by the Freshwater and Wetland Restoration Forum
- Rivers Trust https://theriverstrust.org/key-issues
- Grantham et al., (2019) identify measures that address variability, heterogeneity, connectivity and work at catchment scale.
- The Environment Agency (2023b) report provides case studies and a review of measures to support wildlife during high and low flows.
- Keeping Rivers Cool Project: EWCO - Keeping Rivers Cool Riparian Buffers | Forestry Commission Open Data website

2.1.4 Peat Bogs and Valley Mires

The New Forest contains the largest concentration of valley mires in lowland Europe, as well as seepage mires and fens. They are diverse habitats with varying moisture, nutrient, and acidity levels, which drive the vegetation types that are found. The carbon-rich organic matter that accumulates under wet, anoxic conditions forms peat, or peaty soils that play a nationally important role in carbon sequestration as well as regulating the flow of water.

Sensitivity to Climate Change	Adaptive Capacity	Risk Rating	Confidence
High	Low	High	Medium

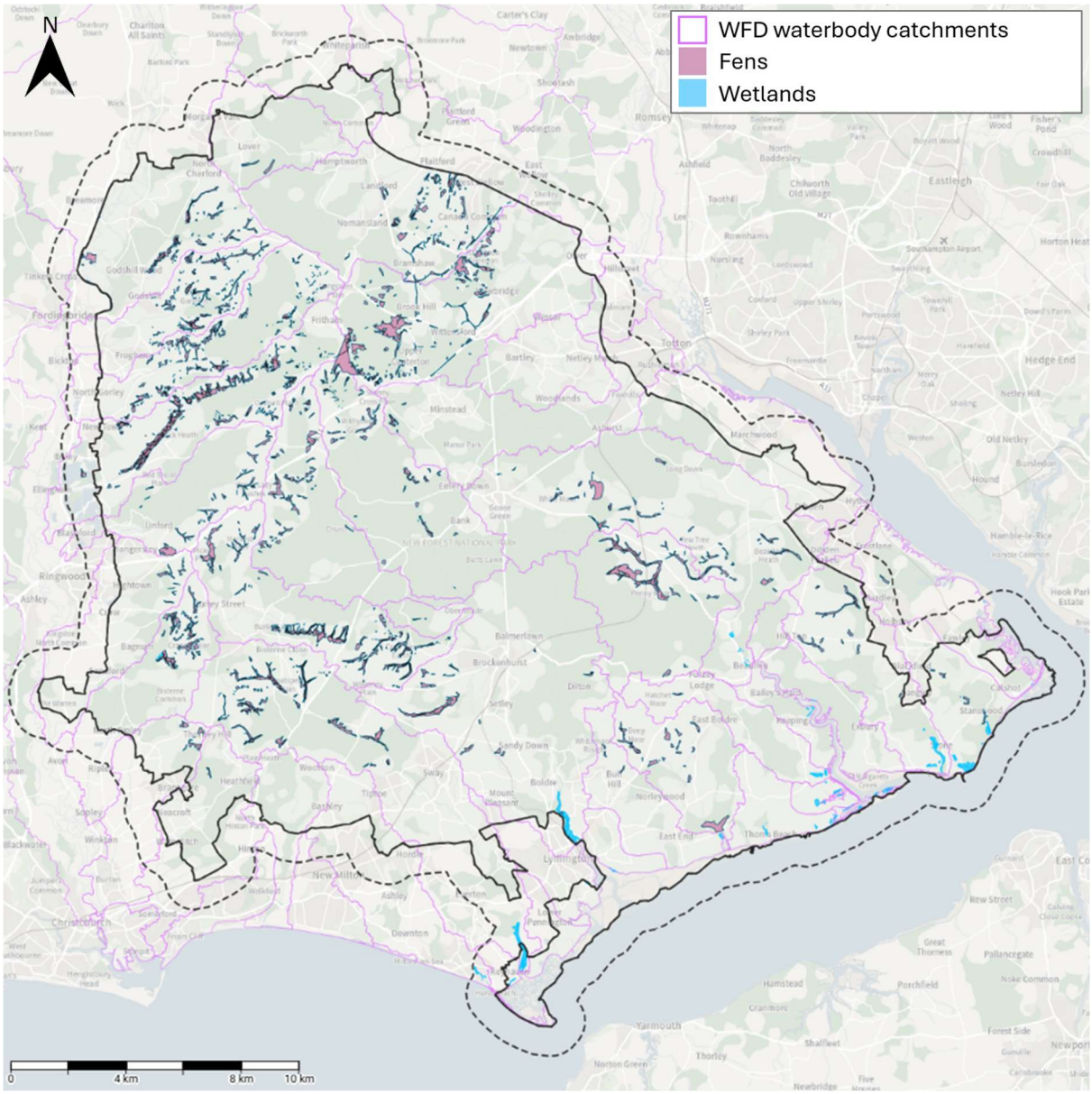


Figure 11: Map showing peat bogs, valley mires and fens within the New Forest boundary + 1km buffer (dotted line). Sources: Natural England Priority Habitats (Wetlands), Environment Agency catchments.

Summary

- These habitats support specialist species, many with narrow hydrological requirements that are sensitive to changes in the quality and quantity of water supply and its seasonal availability.
- Due to the limited availability of this habitat in central southern England, dispersal opportunities for species dependent on these habitats are limited.
- Reliance on precipitation, and potential for succession to a different type of habitat under a warmer and drier climatic regime, makes the overall risk for these habitats high.

Relevant sections of the Natural England & RSPB Adaptation Manual are *lowland fens* (sensitivity rated high), *lowland raised bog* (sensitivity rated medium) and *Purple Moor-grass and rush pastures* (sensitivity rated medium).

Context

Peat bogs are a type of wetland which is waterlogged only by direct rainfall; peat-forming bog systems are referred to as mires[13]. The seasonally (in some areas permanently), waterlogged bogs and valley mires of the New Forest rely on continuous grazing to prevent dominance of Purple Moor-grass *Molinia caerulea* and succession to willow and birch scrub and woodland. Associated specialised plant and bryophyte assemblages are dominated by a range of *Sphagnum* mosses, as well as vascular plants adapted to waterlogged conditions; these include carnivorous plants such as sundews and butterworts that have evolved to survive in low nutrient environments by feeding on insects (Chatters, 2024). Some of the specialist plant and invertebrate bog species are biogeographically isolated at a national and/or regional level, e.g. Marsh Gentian *Gentiana pneumonanthe*, Bog Orchid *Hammarbya paludosa*, Slender Cottongrass *Eriophorum gracile*, Great Sundew, *Drosera anglica*, and Black Bog Ant *Formica picea*.

Impacts of Climate Change

Temperature and precipitation have a controlling influence on peat-forming vegetation, in particular *Sphagnum* mosses (bryophytes) which are critical components of peatland ecosystems, due to their role as 'ecosystem engineers' favourably modifying their immediate environment and facilitating the accumulation of carbon in the soils.

There are numerous studies into the sensitivity of *Sphagnum* mosses to climate change showing that they are vulnerable to warming especially when combined with restricted availability of water. The condition of peatland habitats also influences their sensitivity to climate change. Degraded peatlands, that have been drained or otherwise compromised, have higher sensitivity to climate change than intact, functioning peatlands, due to their reduced ability to absorb and regulate water flow.

Paleo records reveal variations in the rate that peat formed in the past, showing that this was driven by climatic shifts, accumulating most in warmer periods. These records show minimal or non-existent growth during drier periods coupled with an ability of *Sphagnum* species to recover and continue to accumulate peat when hydrological conditions are favourable. This suggests that *Sphagnum* will grow more as the temperature rises provided there is enough moisture. This is cautioned by a note that the ability of bogs to recover from a dry period now is not certain as historic bog formation was not subject to the additional modern pressures of peat-cutting, drainage, and variable grazing intensity (Carey,

[13] Briefing#1 at https://www.iucn-uk-peatlandprogramme.org/resources/briefings

2015). Work by Bragazza (2008) in an alpine context identified an irreversible desiccation threshold for sphagnum moss of < 6.5 mm/°C (mean monthly precipitation to mean monthly temperature ratio).

Bioclimatic envelope modelling has been used to map the potential future distributions of UK peatlands under climate change, indicating as much as an 84% retreat under high emission scenarios (Ritson, 2025). This work aligns with the assessment made in the UK's 3rd climate risk assessment (Betts & Brown, 2021) which reported that at 4°C warming, large areas of UK peatlands could cease to be viable.

Although annual average precipitation volumes in the New Forest are not expected to change significantly, seasonal patterns are projected to be markedly different. This suggests that the future of these habitats in the New Forest will depend on how effectively precipitation can be retained within the landscape, and whether the volumes that are retained are sufficient to prevent irreversible damage during extended periods of hot, dry conditions.

When peat soils dry, *Sphagnum* and other mosses become less abundant and vascular plant cover increases, supporting the growth of more woody, shrubby vegetation which impacts species composition. Increasing pressure from generalist dominant species is anticipated. If allowed to grow, species such as Purple Moor-grass *Molinia caerulea*, Heather *Calluna vulgaris*, and Silver Birch *Betula pendula* will intercept rainfall, increase transpiration, and encourage the development of flow paths associated with root systems. This may in turn heighten the risk of wildfire damage and subsequent erosion. In an unmanaged fire, dry peat will burn along with surface vegetation and can be extremely difficult to extinguish.

Drying of peat soils increases the potential for oxidation, followed by a release of nutrients further driving composition changes. Hotter summers increase evapotranspiration, compounding the effects of drought, including increasing concentrations of pollutants such as nitrogen. There is some evidence that warmer temperatures and fluctuating water tables increase microbial activity to release stored carbon (Wentworth, 2022).

Under very wet conditions there are risks of increased nutrient inputs from in-washed sediment and run-off which will increase the stress on communities reliant on nutrient-poor conditions and may drive composition changes. Flooding and extreme wet weather increase the risks of peat slippage and erosion and directly hamper management activities.

Mitigation and Adaptation Opportunities

Increasing the resilience of these habitats to climate change requires restoration of natural hydrology (removing drainage, re-wetting) to slow the flow of water through these habitats, and the reduction of other pressures such as pollution from the atmosphere (nitrogen) and from road and other run-off sources.

Further Reading

- The IUCN UK Peatland Programme provides access to a large body of information on peatlands https://www.iucn-uk-peatlandprogramme.org/

2.1.5 Coastal and Estuarine Habitats

The New Forest coastline is dominated by sheltered mudflats and muddy gravels, with extensive areas of saltmarsh and grazing marsh. Interspersed within these habitats are stretches of shingle and sand, soft cliffs, and a small number of saline lagoons contained by spits or seawalls (HCC, 2025).

Although only covering a small area of the National Park (2-3%), coastal habitats, particularly mudflats, saltmarshes, and lagoons, are designated for their internationally important populations of overwintering waders and wildfowl, along with nationally important seabird colonies nesting on the shingle spits and offshore islands. The coastal area of the New Forest is designated under local (LNR, SINC, Wildlife Trust Reserve), national (NNR, SSSI), and international (SAC, SPA, RAMSAR) conservation designations.

Sensitivity to Climate Change	Adaptive Capacity	Risk Rating	Confidence
Very High	Low	Very High	High

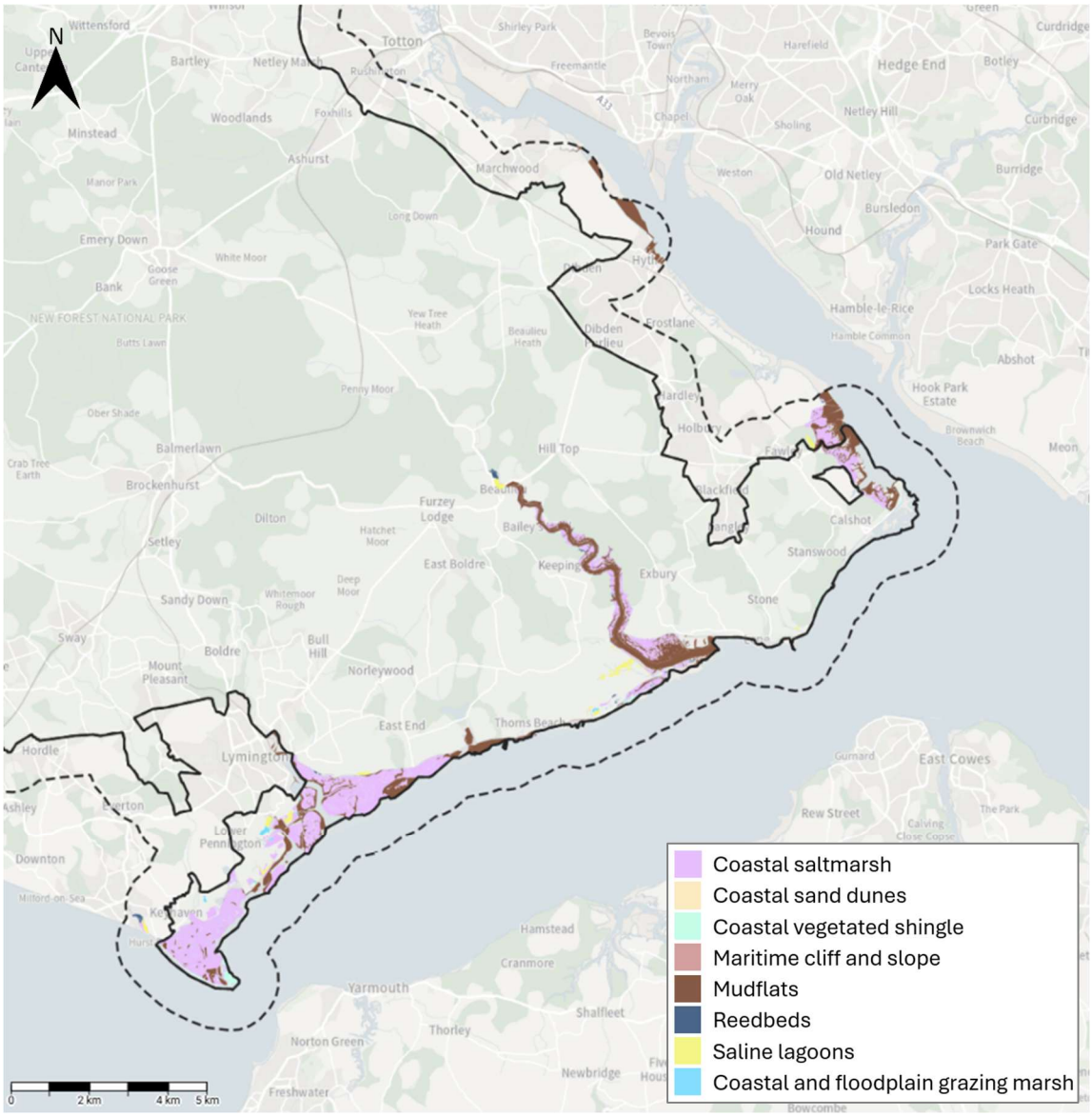


Figure 12: Coastal habitats

Summary

- Coastal and estuarine habitats are at risk due to sea-level rise, which is linked to increased rates of coastal erosion and coastal inundation. In locations where inland migration of coastal habitats is constrained by hard defences, the coastal strip can be 'squeezed' leading to loss of habitat. Habitat loss can also occur via natural coastal processes that may be exacerbated or modified by climate change. There is potential for marine and coastal habitats to expand.
- The Western Solent, bordering the length of the New Forest coastline, has experienced significant habitat degradation losing hundreds of hectares of saltmarsh, seagrass, and oyster beds over the recent and historic past. Although restoration projects are underway[14], saltmarsh extents are projected to continue to decline (e.g. Thurstan et al., 2024, Parry, 2022).
- Climate change threatens all the coastal habitats of the New Forest and wider Solent, not only through rising sea level but also from rising sea and air temperatures, changing patterns of precipitation (which influence water levels and flood risk), ocean acidification, saline intrusion, and indirect risks such as pollution release from the exposure of coastal landfill sites through higher water levels and erosion.
- For estuarine habitats, potential risks include habitat loss due to sea-level rise, modified river flows with impacts on freshwater-seawater mixing, changes in sediment transport, habitat composition, biodiversity, and the fluxes of nutrients, pollutants, pathogens, and viruses.
- Hotter, drier summers, and milder year-round conditions are expected to increase recreational pressures on these internationally important sites for wildlife.

Relevant sections of the Natural England & RSPB Adaptation Manual are *Coastal floodplain and grazing marsh* (sensitivity rated medium), *Coastal saltmarsh* (sensitivity rated high), *Saline lagoons* (sensitivity rated high), *Maritime cliffs and slopes* (sensitivity rated high), and *Coastal vegetated shingle* (sensitivity rated high).

[14] E.g. https://solentseascape.com/ and https://www.bluemarinefoundation.com/projects/solent/

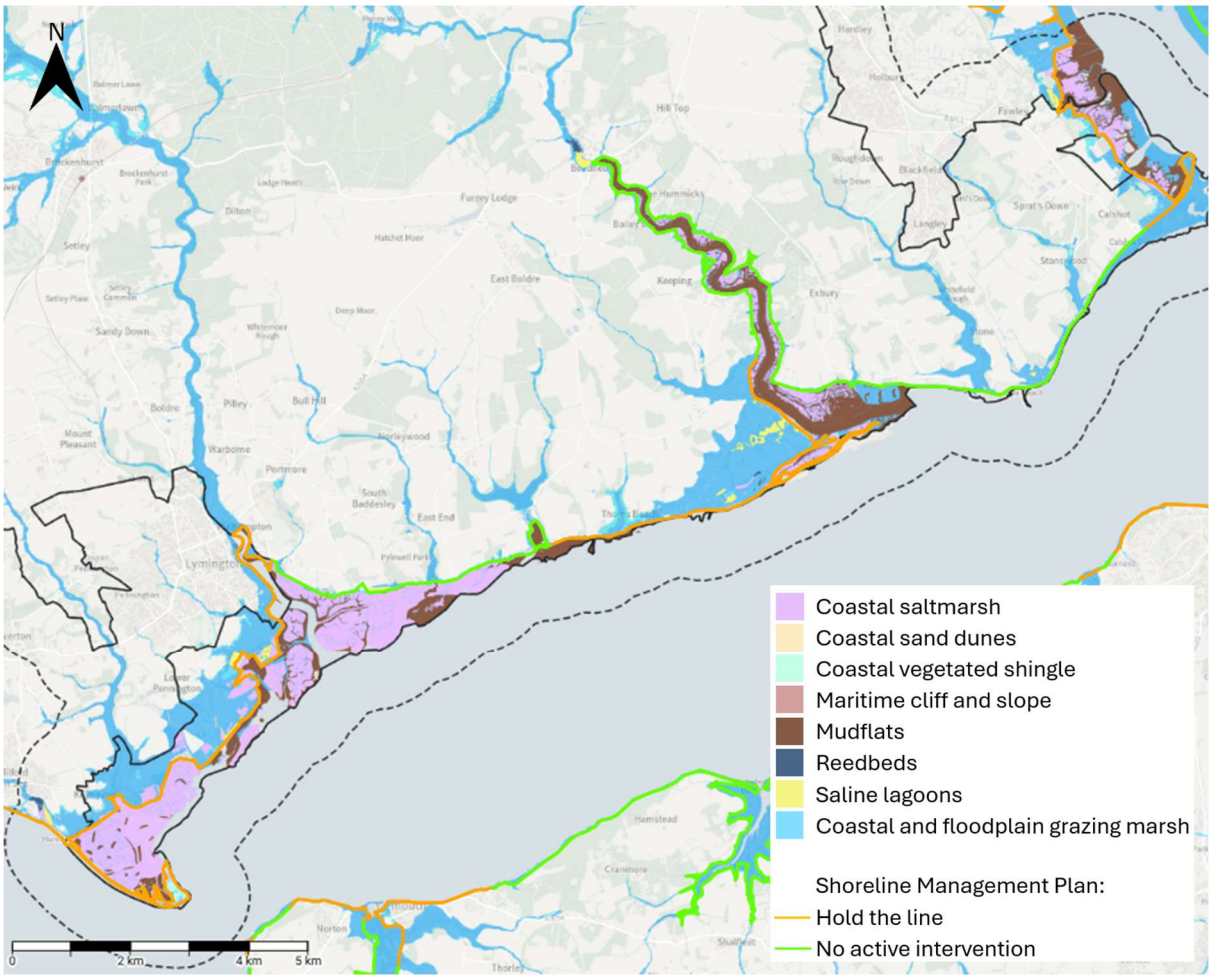


Figure 13: New Forest coastline showing Environment Agency Flood Risk Zones 2 and 3[15] in blue, the distribution of coastal habitats, and the current shoreline management plan policies.

Impacts of Climate Change

Sea-level rise along the coast of the New Forest is projected to increase from the current trajectory of ~0.5 m to as much as 1.0 m by the 2080's, relative to the 1981-2000 baseline[16]. Regardless of action to reduce emissions, sea levels will continue to rise for centuries (Stokes et al. 2025), the extent to which will be governed by ocean warming and ice melt. Exploratory sea-level rise projections are now available that extend to 2300[17].

Sea-level rise increases coastal erosion and inundation, (flood) risk, and (nationally) is contributing to a decline in the extent of saltmarshes, shingle beaches, and sand dunes that act as a natural buffer to flooding (Haigh et al. 2022).

Flooding affects coastal species and habitats through frequency of saline inundation, which may be temporary (e.g. due to a storm surge) or permanent (e.g. due to a planned or unplanned breach of coastal protection), and is heavily controlled by coastal topography. In the New Forest, vulnerable

[15] Flood Zone 2 is land with between 0.1% - 1% (1 in 1000 and 1 in 100) annual probability of flooding from rivers or between 0.1% - 0.5% (1 in 1000 and 1 in 200) annual probability of flooding from the sea. Flood Zone 3 are areas at a 1% (1 in 100) or greater annual probability of flooding from rivers or 0.5% (1 in 200) or greater annual probability of flooding from the sea
[16] relative to a baseline of 1981-2000, Met Office LCAS service for New Forest
[17] https://www.arcgis.com/home/item.html?id=4086d89fcd904e0c9b3005dc98ce5e59

habitats include the coastal grazing marshes, which are dominantly terrestrial/freshwater features and the coastal (saline) lagoons. Changes in precipitation patterns, coastal inundation frequency, and rising temperatures have the potential to modify the salinity and chemistry of the lagoons, which may alter suitability for a range of species, and facilitate the spread of invasive non-native species.[18]

As with terrestrial habitats, as conditions change the composition of coastal plant and associated species will evolve, although due to natural inertia and in the absence of disturbance, existing vegetation (notably dominant species) can have a strong intrinsic resistance to displacement which will manifest in a time-lag response (Burdon *et al.* 2020, Betts & Brown, 2021).

Saltmarsh habitats

Saltmarsh habitats are a particularly critical coastal habitat that have been declining across the Solent for decades (see Figure 14). They provide multiple ecosystem functions including coastal protection through accretion of sediments, pollution and carbon sequestration, and recreational benefits for a wide range of coastal users. They also support wildlife including breeding waders and wildfowl, provide habitat for specialist plants and invertebrates, and nursery sites for fish.

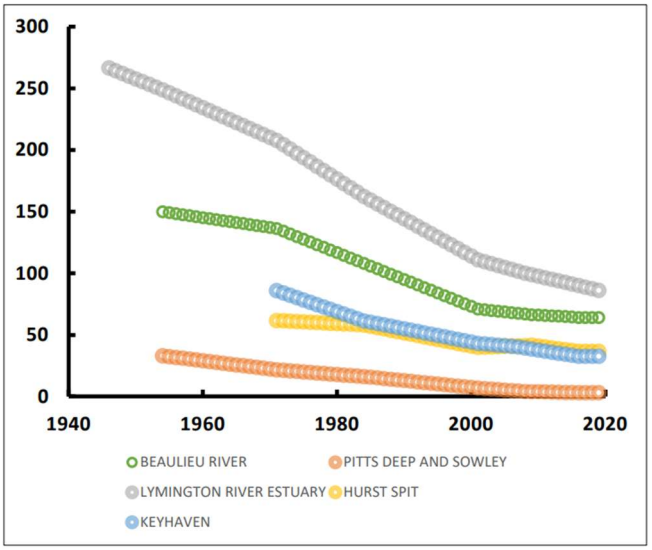


Figure 14: Historical change in saltmarsh extent for the western Solent (figure from Parry, 2022).

Saltmarsh losses within the New Forest are attributed to internal dissection (i.e. widening and lengthening of creeks) exacerbated by sea level rise, and large losses due to seaward edge erosion, representative of coastal squeeze. Chatters (2024) describes how the vegetation has evolved from seagrasses *Zostera* spp. and mud, to expansion and then contraction of cord-grasses (*Spartina* spp.)[19] None of the New Forest SSSI saltmarshes are in favourable condition (Parry, 2022).

If saltmarsh has space to migrate and sediment supply is sufficient, and if wind-wave regimes do not significantly change, then saltmarsh is capable of sustaining growth, potentially maintaining pace with sea level rise. If the rate of sea-level rise is greater than the rate of sedimentation, saltmarsh will continue to erode and eventually disappear. Due to coastal protection work to the west of the Solent,

[18] https://solentforum.org/publications/solent_biosecurity_plans/INNS_information/
[19] See https://sac.jncc.gov.uk/habitat/H1320/

natural sediment movement processes are impaired. Parry (2022) provides a timeline of when New Forest coastal saltmarsh is expected to disappear under current rates of loss.

If storm frequency increases, saltmarsh erosion will be further exacerbated as storms naturally erode and remove sediment. Fragmentation, as observed in the saltmarshes of Keyhaven, Lymington, and Beaulieu (as noted by Parry, 2022) also accelerates loss ("*fragmentation is particularly destructive to saltmarsh as the deepened gullies can remove large areas of saltmarsh sediment and leave the remaining marsh less stable, thus allowing elevated tidal flows to further break up the marsh*"). Loss of saltmarsh leads to loss of habitat and with that carbon storage, and ongoing carbon sequestration.

Extreme Events

Coastal change tends to be driven by extreme events that can cause dramatic modification in very short timeframes. A recent update to future storm and wave projections found that there could be an increase in the number of very severe winter storms crossing the UK as a result of climate change. The tendency of the UK to experience storm clustering, with typically less than two weeks between successive storms, has the potential to compound the impacts of these events (Bricheno et al. 2025).

Hurst and Calshot Spits are key features of the New Forest coast, with Hurst in particular providing storm protection. The Hurst to Lymington Strategy review has generated a large body of evidence on the impacts of sea-level rise associated with this stretch of the New Forest coast. The 'Do Nothing' scenario report (JBA, 2023) describes the impacts of coastal defence failures which are linked to age but significantly exacerbated by sea level rise. Figure 15 shows potential change in coastal habitats under a 'do nothing' scenario for coastal management of Hurst Spit, this is based on a breach of sea defences in 2036 and shows habitats landward of the defences experiencing a transition to more saline habitats following the breach (i.e. changes that would occur gradually from 2036 through to ~2122, which is the timeframe considered in the assessment) (JBA, 2023).

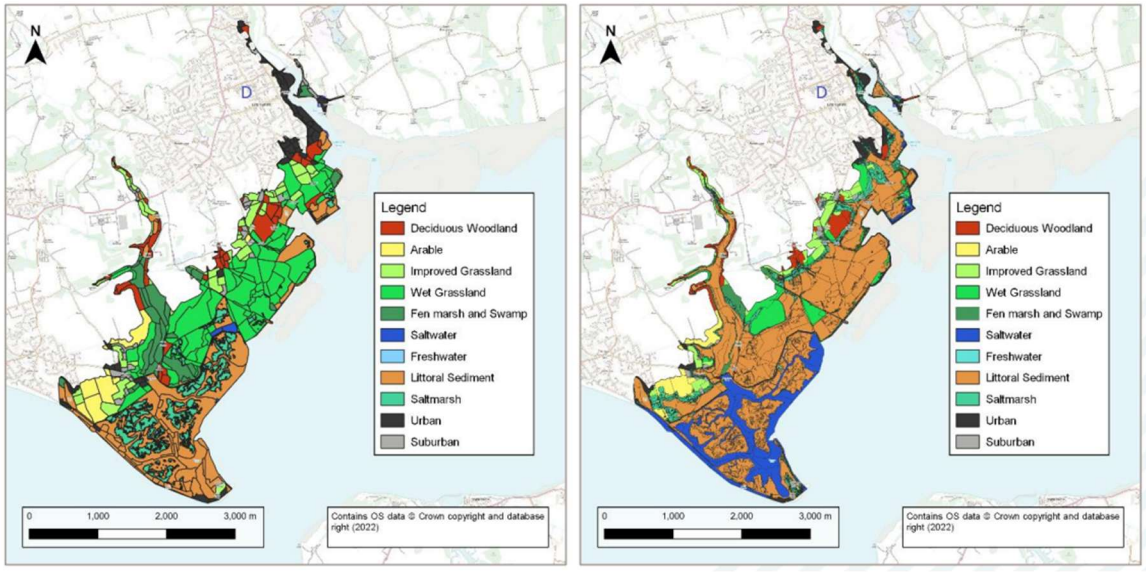


Figure 15: Current coastal habitats (left) alongside projected habitats under a future 'do nothing' scenario (right), (JBA, 2023).

Erosion rates of maritime cliffs (such as those found at Lepe) are expected to increase in response to increased periods and intensity of rainfall as well as rising sea level. Although the dynamic processes of erosion are critical to the specialist invertebrate and plant communities that these habitats support, their response to accelerated rates of change is uncertain.

Shingle habitat is relatively rare and therefore recolonisation rates by vegetation communities following extreme event disturbances such as storms are uncertain. Long-term change is also anticipated in these habitats in response to increased temperatures and changes in precipitation, especially due to the poor water retention of these environments leading to greater impact of summer droughts (Burdon *et al*, 2020).

Coastal change has potential increasing risks for coastal communities and visitors, although the frequency and consequences of flooding have reduced over time due to improvements in flood defences, as well as developments in flood forecasting, emergency response, and spatial planning (Haigh et al. 2022). Of the nine Category 5 or above coastal flooding events recorded in the UK over the past 150 years, three affected the Solent region[20] (Kovats & Brisley, 2021).

Impacts on Estuaries

Climate risks to estuaries vary according to their specific physical and biological conditions. In general, alongside habitat loss from sea-level rise, climate change is influencing and will continue to drive changes in freshwater-seawater mixing, sediment transport, habitat composition, biodiversity, and the fluxes of nutrients, pollutants, pathogens, and viruses (Robins et al. 2015). Altered river flows could increase the risk of eutrophication, hypoxia, and harmful algal blooms, although the risks for New Forest estuaries may be low.

Increased temperatures may increase microbial pathogen concentrations and increase public health risk, and changes to the salt balance may impact species reproduction. Rising sea levels combined with periods of low river flow increase the risk of saltwater intrusion into the upper zones of estuaries, with potential implications for ecosystem function and associated habitats and species. Little et al. (2022) define this as estuarine squeeze, reflecting the loss of upper estuarine tidal freshwater and low salinity zones against in-channel man-made barriers.

Mitigation and Adaptation Opportunities

Anticipating and planning for coastal change is vital. There is a large body of work addressing options associated with the shoreline management processes and ongoing coastal research. The Channel Coastal Observatory (CCO) provide local expertise and a rich time-series of data and analysis.

The Natural England and RSPB Climate Adaptation Manual notes the need to adjust boundaries and interest features of protected sites as coasts evolve, and the potential to enlarge functional units to increase resilience.

Efforts to restore or improve coastal habitat condition increase resilience to climate change. This includes eliminating or reducing any non-climate pressures such as pollution and disturbance and addressing as far as practicable physical modifications that have detrimental effects on coastal processes.

Further Reading

- Shoreline Management Plans for the Western Solent
- Lymington to Hurst Strategy https://www.hurstspit2lymington.co.uk/
- Solent State of Nature Report Solent State of Nature Report | Solent Seascape Project

[20] Category 5 events are those that involve either loss of life or reliable evidence that defences and/or flood warnings, and a substantial institutional response to the event, prevented multiple fatalities.

- The Solent Forum provide useful introductory information on coastal habitats and invasive non-native species
- Marine Climate Change Impacts Partnership evidence Reports (includes coastal)
- Channel Coastal Observatory (CCO) - channelcoast.org

2.1.6 Heathland

The New Forest contains the largest area of lowland heathland in the UK, covering around 24% of the area of the National Park (12,234 ha). It is particularly important for the diversity of its habitats and the range of rare and scarce species which it supports (Natural England, 2025). The majority of heathland (89%) lies within the Crown Lands managed by Forestry England.

Sensitivity to Climate Change	Adaptive Capacity	Risk Rating	Confidence
High	Low	High	Medium

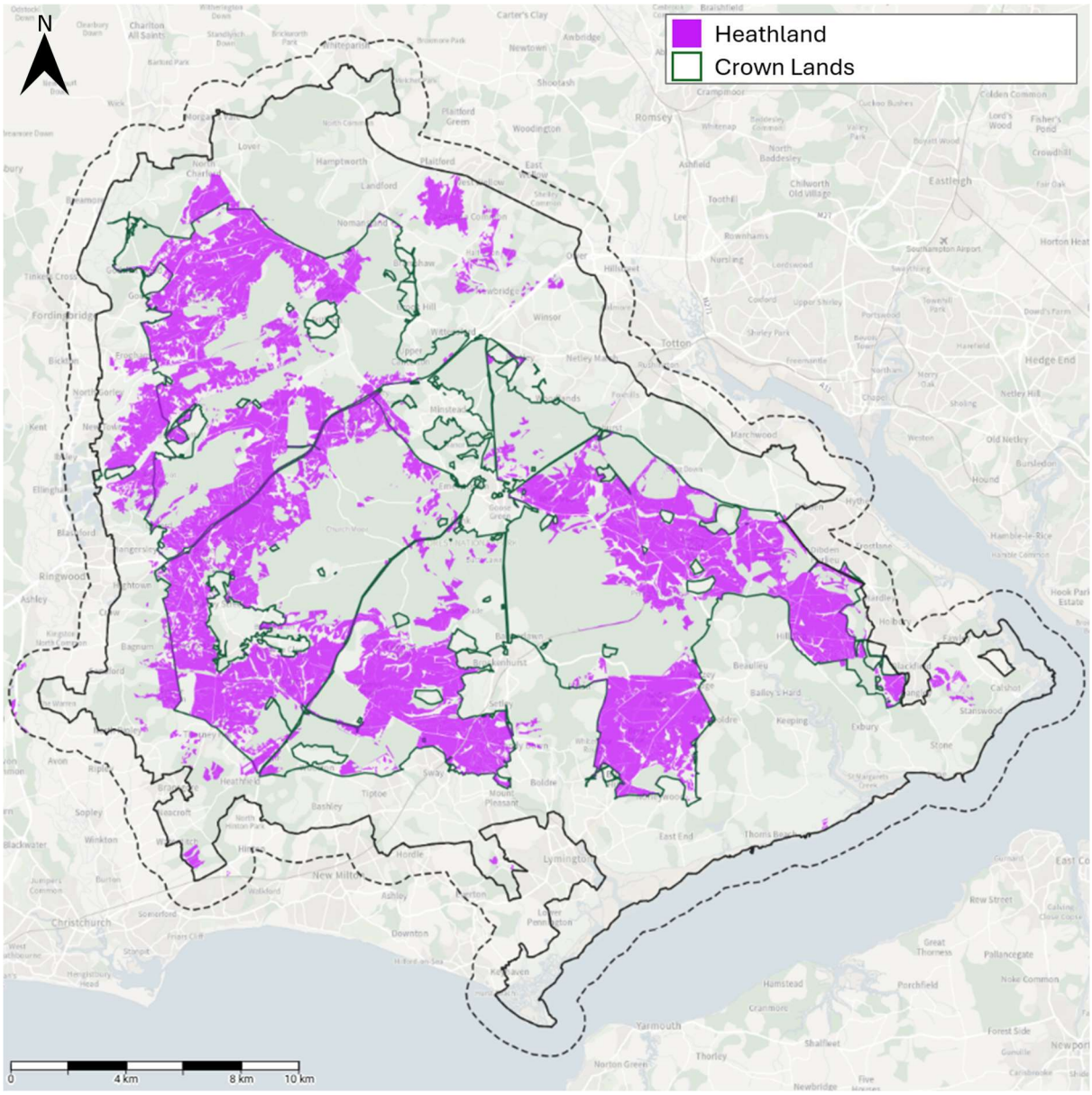


Figure 16: Heathland (Natural England Priority Habitats Inventory) showing the Crown Lands boundaries in green.

Summary

- Wet and dry heathland are sensitive to changes in temperature and precipitation.
- Climate change impacts will depend largely on how the changing precipitation patterns evolve. If overall annual precipitation rates remain similar (as suggested by current projections) the projected wetter winters may regulate or limit the potential consequences of hotter drier summers.
- Under hotter, drier conditions there is potential for wet and humid heaths to become drier, with associated changes in their species composition. Equally, if winter precipitation outpaces reductions in summer rainfall there is potential for wet heath to transition into mire. These types of adaptation have consequences for heathland specialist species (McCullagh et al., 2025).
- Heathland habitats are highly important for birds, reptiles, and several invertebrate groups, and support specialist communities such as rare bryophytes.
- Heaths are highly combustible. Wildfire risks are increasing, particularly in the south-east of England. This increases the risk of temporary heathland habitat loss.
- Although the heaths of the New Forest are managed through a combination of year-round grazing and a prescribed burning regime, neither of these management interventions are sufficient to prevent potential modification of community composition in response to the projected patterns of climate change.

The latest assessment led by Natural England (Staddon, 2023) concludes that both wet and dry lowland heath is highly sensitive to climate change regardless of condition. Relevant sections of the Natural England & RSPB Adaptation Manual (published 2021) are *Lowland heathland* (sensitivity rated medium).

Context

The extent of heathland in England has declined by ~70-80% over the past 300-400 years, mainly driven by changes in land use. Remaining areas of heathland, particularly in the lowlands, have become highly fragmented, divided by roads and separated by mixed land use. Heathland degradation is also linked to drainage, inappropriate vegetation management, and nutrient enrichment (McCullagh et al., 2025).

The heathlands of the New Forest occur across a gradient of moisture, from very dry conditions on nutrient poor, acidic mineral soils through to wet, shallow peats (<30 cm deep). Wet heaths feature bog-mosses (*Sphagnum* spp.), Cross-leaved Heath *Erica tetralix*, and Purple Moor-grass *Molinia caerulea*, and support specialist lichen communities that depend on periodic fires to survive (Chatters, 2024). Dry heaths are characterised by low nutrient, acidic soils supporting a mixture of dwarf shrubs such as Heather *Calluna vulgaris*, Bell Heather *Erica cinerea*, and gorses *Ulex* spp., with herbaceous vegetation, lichens, and bryophytes. These areas form a dynamic habitat which represents the succession from bare ground (e.g. after burning or tree clearing) through to grassland and/or mature, dense heath with scrubby patches.

Heathlands in the New Forest are particularly important habitats for plants, bryophytes, invertebrates, reptiles, SAC features and bird species noted within the Special Protection Area (SPA) designation including breeding Dartford Warbler *Curruca undata*, Nightjar *Caprimulgus europaeus*, and Woodlark *Lullua arborea*.[21] The New Forest has long been recognised as an ecologically important area in which

[21] https://sac.jncc.gov.uk/habitat/H4030/

the most complete spectrum of heathland fauna stands the best chance of survival, with the potential to function as a 'biodiversity bank' supporting re-colonisation of other viable sites. (Tubbs, 2001).

Impacts of Climate Change

The sensitivity of heathlands to changes in temperature and precipitation creates risks to their long-term survival, especially in southern England where heathland habitat is highly fragmented. Although the habitat is not expected to be lost in the foreseeable future, a marked shift in community composition is possible.

Hotter, drier weather will tend to modify the species assemblage, particularly on wet heath. Carey (2015) suggests that drier conditions will result in the disappearance of remnants of wet heath dominated by bog-mosses and Cross-leaved Heath, although the latter may be replaced by other *Erica* species.

On dry heath there is a (low) risk of transition to dry acid grassland. This pressure is exacerbated by increased nitrogen availability, which together with warmer temperatures and drier conditions encourages grass species, e.g. Purple Moor-grass, to become dominant over dwarf shrubs such as Heather and Bell Heather (NE and RSPB, 2021). In the New Forest given the relatively low levels of nitrogen deposition and projected increase in autumn and winter precipitation, this is not considered a likely scenario.

Changes in precipitation, frost, and fire will likely alter the amount of bare ground, which will impact plant assemblages through modified regeneration/recruitment of annual plants from the seed bank. This may favour stress-tolerant (e.g. deep rooted) and ruderal species due to the increased gaps/bare ground in swards. Summer drought may favour annual species over perennials, and oceanic/sub-oceanic species may decline e.g. Bird's-foot *Ornithopus perpusillus*, Heath-bedstraw *Galium saxatile*, and Sand-spurrey *Spergularia rubra*.

Both wildfire risk and the duration of the wildfire season will increase as temperature (and recreational pressure) increase, especially on dry heaths during periods of below average precipitation and drought. Dry acid grassland will potentially replace dry heath in the event of significant fires (Carey, 2015). Hot, dry conditions also lead to drying of soils and increased erosion risk, while higher temperatures also drive an increase in decomposition, which can lead to CO_2 release.

Hotter summers have the potential to drive increased visitor numbers. An increase in unmanaged access could lead to local damage to vegetation, increased risk of wildfires, and increased disturbance and predation of ground nesting birds. Local experience from recent dry spring-summer periods shows that, under drought conditions, areas of the New Forest that are normally waterlogged and inaccessible become accessible to both people and generalist predators.

Very wet winters impact heathland management. The exceptionally wet winter of 2023/24 had a major impact on the prescribed burning programme, with only ~5% of the planned area completed (noted in 2024 Open Forest Advisory Committee Minutes). Changing breeding bird phenology in early spring can lead to overlap with delayed management activities in spring.

Mitigation and Adaptation Opportunities

In the short to medium-term, addressing existing pressures on heathland (such as fragmentation, isolation, management, hydrology) will increase resilience to climate change (McCullagh et al., 2025).

Active management of heathlands is essential for above-ground vegetation dynamics, but also for maintaining below-ground soil nutrient and carbon pools (Gliesch et al., 2024). Ensuring optimal

management and adapting management to reflect changing growth characteristics (modifying grazing or burning regimes where practicable) increases resilience.

Effective management of wildfire risks is increasingly critical including ensuring wildfire management and mitigation plans are co-ordinated and joined up across the landscape as far as possible.

Further Reading:

McCullagh, F., Alonso, I., Hedley, S., Crowle, A., Diack, I., Glaves, D., Key, D., Mousley, S. 2025. Definition of favourable conservation status for heathland. RP2977. Natural England. https://publications.naturalengland.org.uk/publication/6212544182878208

2.1.7 Acid Grassland and Road Verges

Acid grassland occurs alongside heath on nutrient-poor soils, where the regime of year-round grazing and trampling creates a mosaic of short vegetation and bare ground. As with heathland, acid grasslands can be dry or wet.

Grass road verges are also included in this section, some of which are acid grassland, particularly within the SSSI. Outside the SSSI there is a diverse range of habitat types, mainly influenced by adjacent land use, including both non-designated verges and Road Verges of Ecological Importance (RVEI's[22]). RVEI's are a Hampshire County Council designation for verges that support a notable species or provide a species-rich semi-natural habitat. They are subject to a modified cutting programme that aims to maintain biodiversity. Verges support important plant species and provide forage, habitat, and habitat connectivity for wildlife.

Sensitivity to Climate Change	Adaptive Capacity	Risk Rating	Confidence
Low	Moderate	Low	Medium

(map shown overleaf/below)

Summary

- Acid grasslands are rated as having low sensitivity to climate change, in part because many of the constituent species are adapted to challenging conditions. The main risk is drought, although increased duration and intensity of winter inundation of wet grasslands may lead to changes in species assemblages.
- Road verges have not been rated separately (or mapped explicitly due to data availability). Sensitivity to climate change is likely to be highly context specific (location, species present), and will be influenced by prevailing management, and presence of other pressures.

Relevant sections of the Natural England & RSPB Adaptation Manual are *Lowland dry acid grassland* (sensitivity rated low)

[22] https://www.hants.gov.uk/landplanningandenvironment/environment/biodiversity/informationcentre/roadverges

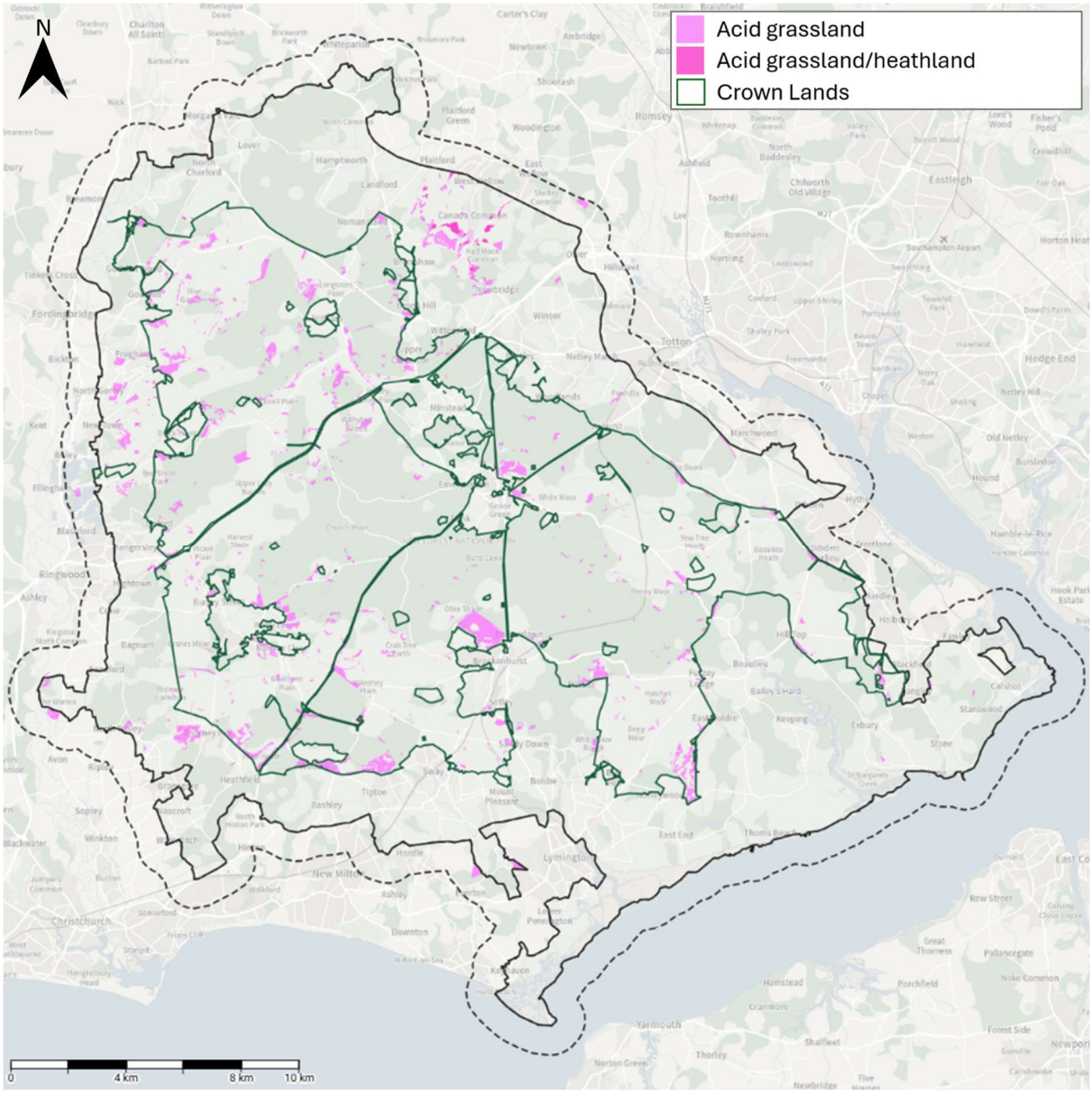


Figure 17: New Forest acid grassland extent, road verges are not shown as no land-cover class exists. Note that some mixed acid grasslands and heathlands are classified as heathland on the land-cover maps as shown on Fig. 18.

Context

Acid grasslands can have a high cover of bryophytes, and parched acid grassland can be rich in lichens. Parched acid grassland also contains a significant number of rare and scarce vascular plant species, many of which are annuals. As well as supporting several priority bird species, e.g. Woodlark, this habitat supports specialist invertebrates which do not occur in other types of grassland. For example, open, parched, acid grasslands on sandy soils support a considerable number of ground-dwelling and burrowing invertebrates such as solitary bees and wasps.

Nationally there are ~313,500 miles of rural grass road verges, equivalent in area to the total remaining lowland species-rich grassland in the UK. They support an estimated 700 species of wildflower and provide refugia and habitat connectivity for many different species (Bromley et al., 2019). Anecdotally, many road verges around the Forest fringe provide vital refugia for wildflowers

and their associated species (e.g. invertebrates) that are unable to survive in adjacent intensively managed grasslands. Opportunities to maintain and improve the condition of these habitats has the potential to boost biodiversity and increase climate resilience of grassland supported species.

Outside the SSSI, grass verge biodiversity value is reflected through local designation of selected verges as 'Road Verges of Ecological Importance' (RVEI's). These are an initiative of Hampshire County Council to recognise verges with important botanical communities and modify management (i.e. mowing regimes) to protect and enhance their botanical value. Hampshire has an estimated 13,000 ha of roadside verge habitat (see footnote 22).

The HLS programme has supported a programme of verge restoration within the Crown Lands over several years.[23]

Impacts of Climate Change

Grasslands are relatively resilient to climate change, however, as temperatures increase, and precipitation patterns change, there will be changes in the species assemblage. For example, phenology may change significantly, with flowering and seed setting occurring earlier in season, while there may be a shift to southern temperate and Mediterranean continental plant species. Bracken *Pteridium aquilinum* and Bramble *Rubus fruticosus agg*. may spread and dominate some areas.

Early growth in response to warmer temperatures is likely to be offset by parching during dry summers reducing summer forage for livestock. Wet winter conditions can lead to increased poaching and damage of grasslands and their associated soils.

Mitigation and Adaptation Opportunities

- Use of adaptive management to respond to growing and ground conditions e.g. additional capacity for back-up grazing to increase flexibility in the timing and intensity of grazing.
- Increasing the extent of dry acid grassland by restoring semi-improved grasslands and re-creating habitat on improved grassland and arable land will support resilience, enabling buffering of existing sites and improving connectivity.
- Managing, protecting, and creating refugia areas to mitigate the impacts of extreme heat and drought on species, considering shade, micro-topography, disturbance, pollution (e.g. nitrogen levels) and species diversity. Ensuring that these are under optimal management. Allowing growth of scattered scrub, especially on drought-prone sites can increase the range of microclimates and soil conditions.
- Aiming to increase topographic and hydrological heterogeneity when identifying potential restoration or habitat creation sites.
- Monitoring and controlling the spread of potential native and non-native invasive species.

Further Reading

- Definition of Favourable Conservation Status for Lowland Dry Acid Grassland (RP2945)
- Buglife page
- Plantlife pages on Road Verges

[23] https://www.hlsnewforest.org.uk/protecting-new-forest-verges/verge-restoration/

2.1.8 Woodland

Broadly, woodland types found within the New Forest can be grouped as: pasture woodland, riverine woodland, bog woodland, and silvicultural inclosures, with varying sensitivities to climate change depending on tree species and local setting including e.g. soil type, topography, and exposure. For all woodland types adaptive capacity is limited due to the slow rate of regeneration.

The New Forest is particularly notable for its ancient woodlands and veteran trees which are important for rare and specialist woodland-associated species. These habitats have been continuously wooded since 1600 and have extremely high ecosystem service value both culturally and ecologically. Due to their age and life histories these ancient woodland sites are irreplaceable. Their features include a range of native, naturally regenerated tree and shrub species, old trees and deadwood, woodland flora, and rich and undisturbed woodland soils (Read, 1999).

The woodland assessment has been split into three sub-groups to enable the variations in sensitivity and adaptive capacity of different woodland types to be discussed and reflected in the spatial assessment. The sub-groups considered, and rationale for their selection is as follows:

- Old growth pasture woodland (alternatively referred to as ancient and ornamental woodland). This type of woodland has extremely high cultural and ecological importance, is irreplaceable and is unique in the UK due to its extent and provenance
- Riverine and bog woodland, assessed separately due to the high quality of this habitat in the New Forest, it's rarity and ecological importance, and because climate change impacts include significant modification to seasonal precipitation.
- Other woodland types have been grouped together, this includes SSSI native woodland (ungrazed), managed native woodland outside the SSSI, managed conifer plantation, trees within the landscape (e.g. hedgerows, gardens/urban settings) and other woodland sites that encompass a variety of management regimes and species.

	Sensitivity to Climate Change	Adaptive Capacity	Risk Rating	Confidence
Old Growth Pasture	High	Very Low	Very High	Medium
Riverine and Bog	Moderate	Low	Moderate	Medium
Other Woodland	Moderate	Low	Moderate	Medium

Different woodland types are highlighted on the map below, this is followed by a bullet point summary, context, general impacts of climate change and then more specific impacts of climate change on Old Growth Pasture woodland and Riverine and Bog woodland.

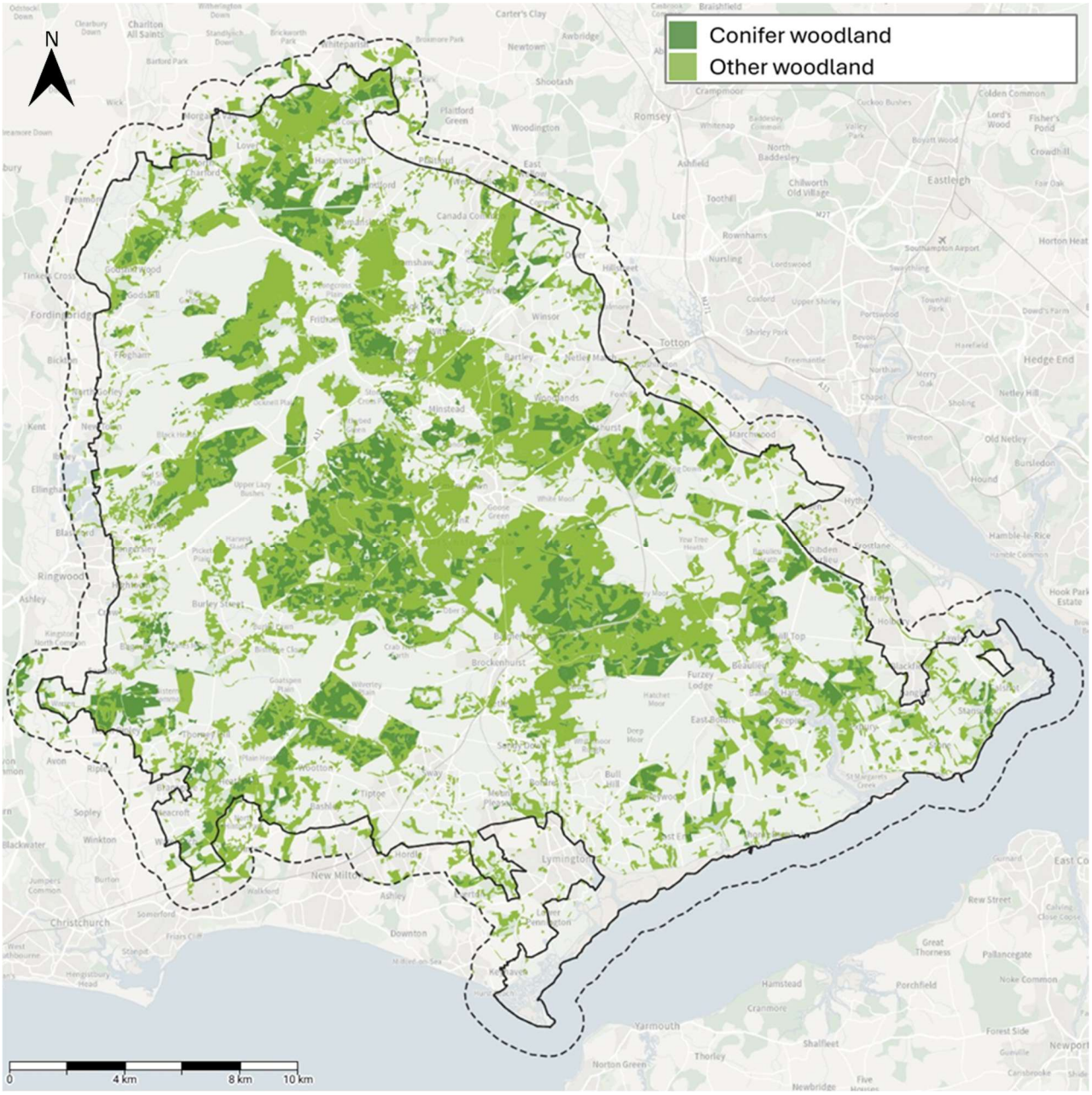


Figure 18: National Woodland Inventory dataset, with the ancient woodland areas shown in light green.

Summary

- Climate change influences woodland growth and survival rates.
- Increased temperatures extend the growing season but also create favourable conditions for new and existing pests and diseases to thrive. Trees affected by 'water stress' are more susceptible to pests and diseases which could drive increases in diseases, e.g. *Phytophthora* disease of alder (*Phytophthora alni)*[24]. Pest and disease risks are one of the least predictable risks, and potentially one of the greatest impacts of climate change on woodland habitats. Pest and disease risks are increasing.

[24] https://www.forestresearch.gov.uk/tools-and-resources/fthr/pest-and-disease-resources/phytophthora-disease-of-alder-phytophthora-alni/

- Non-native mammals such as Grey Squirrel *Sciurus carolinensis*, Fallow Deer *Dama dama*, Sika Deer *Cervus nippon*, and Muntjac Deer *Muntiacus reevesi* are expected to benefit from climate change, increasing the risk of stress and damage to existing trees and reducing the potential for natural regeneration to succeed.
- Alongside increased pest and disease risk, the other primary concern for New Forest woodland is drought, with the greatest impacts on woodland dependent on or defined by surface water availability such as lowland Beech and Yew, and wet woodland. In general woodland habitats with a 'dry' nature such as wood-pasture, parkland, and lowland mixed deciduous woodland are expected to have a relatively lower sensitivity to climate change (Staddon, 2023).
- Climate risk varies by species and is influenced by a wide range of very localised factors including the provenance of individual trees, soil conditions, location and surrounding environment, stand size, and exposure to aggravating pressures.
- Increasingly, as temperatures rise, and precipitation patterns are modified, suitability of species in this region will change. Prolonged and increased frequency of drought is likely to drive changes in the dominant tree species and ground flora with consequences for species assemblages. The rate at which these habitats evolve will depend on how precipitation patterns change and how these impact water levels in localised areas. Hotter drier summers may be countered by wetter winters but could still lead to species composition changes.
- Extreme and unseasonal weather increase stress and mortality rates. Extreme events could increase the loss of veteran trees leading to an increase in deadwood dependent species in the short to medium term before potentially decreasing if the host species is lost from the habitat altogether.
- Impacts of climate change are expected to be seen first in young and newly established trees, and as conditions change further, street trees and trees in hedgerows. This is likely to be followed by more widespread declining tree health (in climate sensitive species), increasingly difficult establishment, and increased mortality of mature trees due to both direct and indirect impacts. Even where the composition of the tree canopy remains unchanged, the composition, structure and character of the ground fora may change significantly.
- Woodland provides an important role in natural flood, erosion, and water quality management and therefore could play an important role in managing flood risks and drought, with opportunities for habitat expansion and creation.

Relevant sections of the Natural England & RSPB Adaptation Manual are *lowland mixed deciduous woodland* (sensitivity rated low), *beech and yew woodland* (sensitivity rated medium), *wet woodland* (sensitivity rated medium) and *wood pasture and parkland* (sensitivity rated low).

Context

Depending on the dataset used, somewhere between 36% to 40% of the New Forest is wooded, with about two-thirds of this being broadleaf woodland. About 75% of the ancient woodlands in the New Forest are in public ownership, with most managed by Forestry England but also including the Langley Wood National Nature Reserve managed by Natural England. The remaining 25% is split across a mix of eNGO's and private landowners, including the RSPB (e.g. Franchises Wood), Hampshire and Isle of Wight Wildlife Trust (e.g. Royden Woods) National Trust (Deazle Wood), larger private estates and smaller private land holdings.

There are also a significant number of trees outside woodlands e.g. in hedgerows, gardens, and urban settings[25].

Around 40 native tree species are commonly found within the New Forest (increasing to 136 if hybrids and apomictic species are included), predominantly Oak, Beech, Birch, Holly, Hawthorn, Willow, Alder, Ash, Hazel, Rowan, Whitebeam, Lime, and Hornbeam (Newton, 2010, Chatters, 2024). Non-native species, including those planted for commercial timber, include Sycamore, Sweet Chestnut, Red Oak and Scots Pine alongside other conifer species such as Corsican pine, Douglas Fir, Lawson Cypress, Sitka and Norway Spruce.

Some areas of the New Forest are managed for commercial forestry and timber production; where these areas are in public ownership the plans and long-term vision are published (i.e. the Forestry England 2019 – 2029 Plan [26]), for privately or trust owned woodlands management plans are not openly accessible. UK policy for ancient woodland sites includes a presumption towards conservation, and ambition for restoration where sites have been planted with non-native species, or where ancient wood pasture and parkland has been infilled.[27]

Trees, whether within or outside woodlands, play a crucial role in in the functional ecology of the New Forest ecosystem, providing habitat structure within or on which other flora and fauna exist whilst contributing to ecosystem processes that directly or indirectly support other flora and fauna.

Whilst native trees are generally considered to provide greater ecosystem value, non-native species also contribute to wildlife conservation. This is through the provision of breeding or roosting places for birds, bats, or invertebrates, providing a substrate on which important plant, lichen or fungi species may occur, or by contributing to geomorphological and hydrological processes.

Forests and woodlands are recognised for hosting the majority of the world's invertebrates, and highly diverse understudied groups such as soil bacteria, fungi, nematodes, protists and mites which alongside forest dependent pollinators and saproxylic beetles play crucial roles in ecosystem function (Rivers, 2023).

General impacts of climate change on woodland habitats are described below, followed by additional detail on old growth pasture and riverine and bog woodland.

Impacts of Climate Change

Climate change both directly and indirectly increases threats to woodlands, both those managed for commercial timber, woodlands managed for wildlife and conservation, and trees outside woodlands.

Assessing the risk for woodland habitats in the New Forest has been more challenging than other habitat classes due to conflicting literature - whilst some authoritative literature suggest risks are low, other references suggest that risk may be high (or very high) due to the relative exposure of this region to warming and drought stress, as well as proximity to Europe increasing the risks of new disease arrivals.

[25] Trees Outside Woodland Data accessible via Forest Research here
[26] https://www.forestryengland.uk/forest-planning/new-forest-inclosures-forest-plan-2019-2029
[27] https://www.gov.uk/government/publications/keepers-of-time-ancient-and-native-woodland-and-trees-policy-in-england/keepers-of-time-ancient-and-native-woodland-and-trees-policy-in-england

Forest Research state that climate change impacts on woodland are "…*likely to be most serious and apparent in southern England, particularly on the more freely draining soils."* (Nicoll, 2025) [28]

Rivers et al. (2023) suggest that the indirect risks associated with climate change from invasive species, pests, and diseases are expected to pose a greater threat to tree species than direct impacts from climate change.

The range of different impacts of climate change on woodland habitats are discussed below (primarily based on Atkinson, 2022):

Increased growth in response to higher levels of atmospheric CO_2. Where water is not a limiting factor, tree growth rates for most species are predicted to increase as a result of longer growing seasons, increased warmth, and the rising level of CO_2.

Altered suitability of tree species. Different woodland types and different species vary in their sensitivity to climate change. As average climatic conditions shift, the suitability of tree species also changes. For example, by 2050, under a high emissions scenario, species such as Silver Birch, Alder, Beech, and Sessile Oak become marginal or unsuitable for the projected climate of southeast England.[29] The implications are that these species will suffer higher mortality and lower growth rates, and in the absence of intervention overall woodland health and ultimately ecosystem function will suffer.

Changes in phenology. It has been widely recorded that there has been a general trend of earlier budburst across the UK in recent decades for several tree species. Analysis of the Marsham and Coombes phenological time series shows that bud burst of Pedunculate Oak in southeast England occurred about two weeks earlier during the period 1985-2000 compared to pre-1950 (Vitasse, 2022). Nature's Calendar[30] and the annual Met Office led 'State of the UK Climate' reports[31] provide further evidence of phenological shifts.

Earlier bud burst leads to an extended growing season, however, there is a trade-off between earlier budburst and the risk of damage from a late spring frost. If the growing seasons starts earlier and finishes later the risk of damage from frosts may not decrease and might increase. The risk will depend on whether minimum daily temperatures increase consistently, or whether they become more variable so that at critical periods in the year frosts will still occur, which is more likely in the near term.

There is also potential for cascading impacts on other woodland flora. Leafing phenology directly influences the amount of light penetrating the canopy, which can be a limiting factor on the rate of growth and reproduction in the ground flora. If phenological changes disrupt the characteristic chronology of spring emergence then this may lead to changes in species composition (Roberts, 2015).

Increased wildfire risk, especially in locations with high recreational use. Wildfires are expected to become an increasing factor affecting the condition and longevity of some woods and forest areas. (Forestry Commission, 2020). Woodland habitats considered high risk for wildfires are young coniferous stands of pine, spruce or fir, and plantations of eucalyptus or cypress. Broadleaved, mixed,

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[28] https://www.forestresearch.gov.uk/research/climate-change-adaptation/

[29] https://www.forestresearch.gov.uk/research/climate-change-impacts/climate-change-impacts-and-adaptation-in-englands-woodlands/regional-changes-in-england-in-tree-species-suitability-resulting-from-climate-change/#tree-species-suitability-in-a-future-climate-in-south-east-england

[30] https://naturescalendar.woodlandtrust.org.uk/analysis/seasonal-reports/

[31] https://www.metoffice.gov.uk/research/climate/maps-and-data/about/state-of-climate

and yew woodlands are usually considered low-risk habitats, although young or newly planted broadleaves will be at risk of substantial damage if there is combustible ground vegetation (Atkinson, 2022).

As the majority of UK wildfires are ignited by people (unintentionally), adjacent habitat types and recreational use are important contributing factors to overall risk.

Stress and damage from drought. Drought can drive physiological changes in trees leading to reduced tree growth, crown dieback, and mortality. Timing influences consequences: dry springs affect current year growth; late summer droughts may have a greater impact on subsequent season's growth. Repeated droughts can have cumulative effects, leading to growth reductions several years later. The impact of drought conditions is exacerbated by heatwaves that frequently occur at the same time, as warmer air increases the evaporative demand for water (Atkinson, 2022).

Soil characteristics, rooting depth, age, and woodland size all influence drought risk. Trees growing on shallow, light/free draining soils are more prone to water stress. Shallower rooting species are likely to be more affected than deeper rooted trees while trees growing on soils that are deep, but prone to waterlogging in winter, may have shallow rooting zones, and therefore at risk if upper soil layers dry out in summer, even if there is water below. Young or newly planted trees are particularly vulnerable to droughts and smaller, more fragmented woodlands are more likely to dry out than larger wooded areas.

Tree species differ substantially in their drought tolerance: Beech, Birch and Sycamore are more sensitive than Hornbeam or native Oak species, and species such as Douglas Fir and Western Hemlock are more tolerant of drought and show lower susceptibility to stem cracking than Sitka Spruce. Differences in drought tolerance can also exist between different local populations (depending on provenance).

Older, slower growing, and veteran trees are more likely to be affected by drought than younger ones. Because the effects of drought differ with species and tree age, this may result in changes to stand species composition and age structure.

Flooding and waterlogging causing stress and root damage to some species and impact forestry operations. Soil waterlogging restricts the supply of oxygen to tree roots and reduces their ability to absorb water and nutrients. Longer duration flooding typically has a greater impact on tree growth and survival, by prolonging these stresses. As with drought, timing matters - exposure to flood conditions during the dormant season is less damaging for most species than during the growing season in spring and summer.

For flood-intolerant tree species, flooding and prolonged waterlogging can damage trees and reduce growth via soil compaction, restrictions in rooting depth, damage to soil health and increased vulnerability to infection and disease. It can also increase vulnerability to secondary impacts such as windthrow due to reduced anchorage. For these reasons commercial forestry work is also hampered by waterlogged conditions, limiting the ability of forestry management activities to be completed within suitable operational windows.

Increased risks from pests, diseases, and pathogens. This is due to a combination of increased susceptibility (stressed trees), increased pest/pathogen survival rates in response to milder winters, and pathogen/vector range expansion.

Temperature, precipitation, soil moisture, and relative humidity have a direct influence on the growth, dispersal, and survival success of many pathogens. Most pathogens currently affecting UK forests are native or endemic and usually only cause low-impact damage or sporadic significant episodes.

Temperature and moisture are key to the development of epidemics, so the changing climate is likely to affect pathogen risk. Milder winters will increase the ability of some pathogens to survive winter in the UK such as some frost-intolerant, root-attacking *Phytophthora* species. Pathogens that infect foliage or that have an aerial phase of the life cycle will be especially responsive to climate change (Atkinson, 2022), storms with high rainfall and strong winds provide more opportunities for long-distance dispersal.

Climate stress on tree species has been found to increase vulnerability to decline from a range of pests and pathogens. Native Oaks (Pedunculate and Sessile) have been found to be particularly susceptible within their southern range of the UK (Broome, 2021). Within the New Forest, climate stress is believed to be a contributing factor to the poor health of Holly holms on free draining soils, particularly on higher ground (e.g. Bolderwood) under combined drought, grazing, and fungal pressure, and also in the recent increase in ancient Beech collapse.

Oak Processionary moth has been recorded annually in Hampshire since their arrival in 2020[32]. Large populations can strip oak trees, leaving them more vulnerable to other pests and diseases, and to other stresses, such as drought. They also pose a human health hazard.[33]

Declines of individual species such as Oak have cascading ecosystem impacts, e.g. Oak trees in Islands Thorns inclosure within the New Forest have been found to support 42 obligate species and 113 highly associated species (Mitchell, 2019).

Pest and disease impacts can enhance overall ecological richness, e.g. roost hollows resulting from Ash bacterial canker (NE, 2025). However, climate change is likely to increase the scale and extent of pathogenic impacts which in some cases could lead to breakdown of the woodland in question.

Mammal pest population densities are also expected to increase in response to climate change, due to improved food availability (increased seed production from warmer weather) and an increase in survival rates from milder winters. Grey Squirrels damage mature trees, while deer and mice can significantly impact woodland regeneration.

Damage and destruction from extreme events such as storms. The threat of wind damage is widely recognised to be a serious constraint to the management of British forests. The fundamental processes involved in windthrow include the interaction of trees and wind, the interaction of roots and soil, and the interaction of wind and topography.

As trees grow, they acclimate themselves to resist the wind loading that they have experienced, with open-grown and woodland edge trees strengthening themselves much more than internal, stand-grown trees. During extreme storms, wind loads can exceed the strength that has developed in tree stems and root systems, and trees will either uproot or their stems break.

[32] https://www.hantsmoths.org.uk/lep.php?code=71.001
[33] https://www.forestresearch.gov.uk/tools-and-resources/fthr/pest-and-disease-resources/oak-processionary-moth-thaumetopoea-processionea/

Windstorms disrupt forest management planning and the supply of timber, threaten public safety, and damage infrastructure including roads, rail links, and power supplies.[34]

Increased windthrow could impact rare and range-restricted invertebrate populations relying on decaying trees (e.g. Green Forest Hoverfly *Caliprobola speciosa*) with fewer habitat opportunities. Others using the root plate, such as mining bees and their nest parasites, can benefit.

Old Growth Pasture Woodland

This type of woodland, dominated by Beech *Fagus sylvatica*, Oak (Pendunculate and Sessile) *Quercus robur and Quercus petraea*, Birch (Downy and Silver) *Betula pubescens and Betula pendula* and Holly *Ilex aquifolium*, is found within the unenclosed areas within the New Forest perambulation. It is a fragmented habitat that is actively grazed by commoner's stock.

The longevity and historical management of Old Growth Pasture provide very high biodiversity value and include relatively undisturbed soils, veteran trees and dead wood supporting species of international importance. Some areas are considered primary sites, believed to be direct descendants of the original pre-human 'wildwood' having never been cleared since the arrival of humans in this region (Newton, 2010).

In the context of climate change, notwithstanding pest and disease risks, it is the presence and role of Beech in these woodlands that has driven the high sensitivity rating. The sensitivity of Beech to drought is well established (e.g. Peterken & Mountford, 1996) and confirmed by more recent studies (e.g. Martinez del Castillo et al., 2022). The 2022 work has shown that across Europe (including southern England) Beech growth rates have declined over the past 60 years in response to warming and changes in water availability, and that this trend is expected to accelerate under current climate trajectories. Growth and mortality in response to temperature rises can be compensated by increases in precipitation, but where temperature increases co-occur with drought (as expected in the New Forest) impacts are amplified (Martinez del Castillo et al., 2022).

The adaptive capacity of Old Growth Pasture woodland has been scored as very low. This is due to the combination of a lack of regeneration, coupled with the highly protected status of these habitats which limits the scale and types of interventions that might be considered.

Riverine and Bog Woodland

The New Forest is one of the best areas in the UK for riverine and bog woodland. Riverine woodland is estimated to extend to ~212 ha; these habitats remain functionally intact featuring seasonal flooding and exceptionally rare old-growth trees. Bog woodlands cover ~200-250 ha, these habitats are now extremely rare and a European priority habitat (habitat extents from Natural England, 2025).

[34] https://www.forestresearch.gov.uk/research/wind-and-trees/

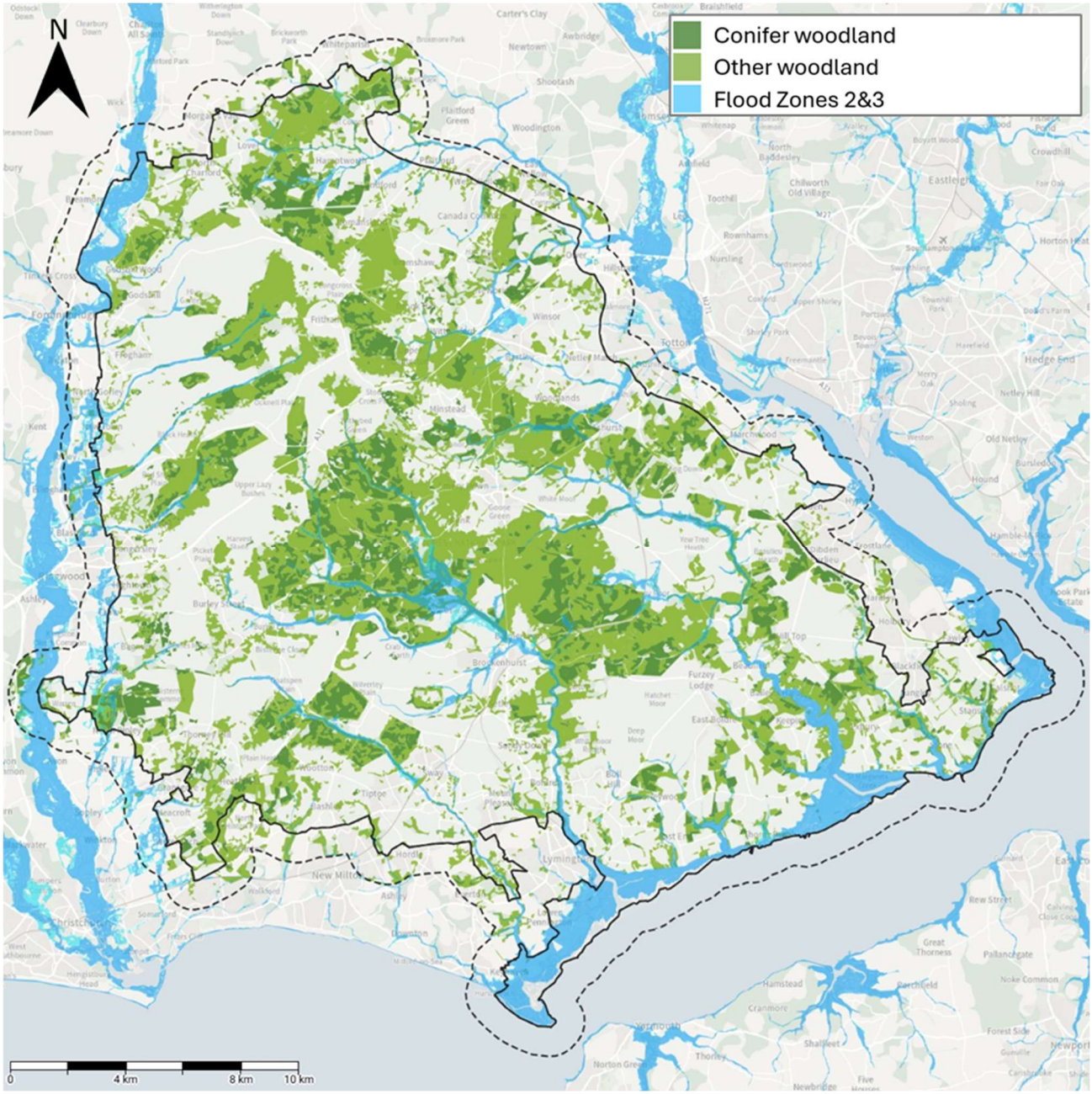

Figure 19: Map showing National Forest Inventory (green), Ordnance Survey MasterMap watercourses and Environment Agency Flood Risk Zones 2 and 3.

Riverine and bog woodland are not available as a specific land cover class in published datasets. Figure 19 shows the National Forest Inventory dataset with watercourses from Ordnance Survey data and the flood risk zones published by the Environment Agency (EA, 2025). Where woodland is located immediately adjacent to a watercourse it is assumed to be riverine. Comparison of the OS water courses and flood zones with Environment Agency's Vegetation Object Model (from LiDAR) allows a more detailed local picture of wet woodland canopy extent to be studied (Figure 20).

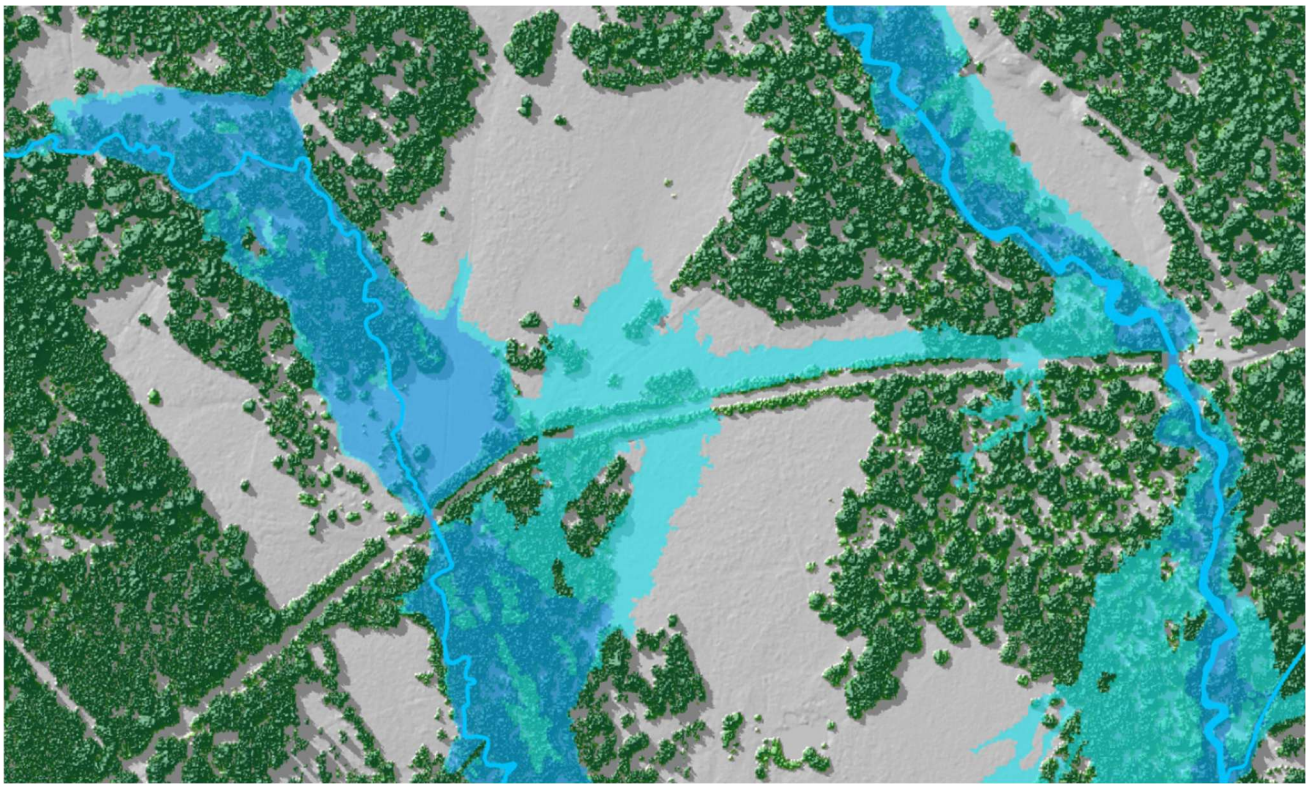

Figure 20: Example use of the GIS data to identify riverine woodland.

Riverine and bog (wet) woodland occurs on soils that are often or seasonally wet, with trees that are accustomed to experiencing waterlogged conditions for at least part of their annual lifecycle. Tree species found in the wet woodlands of the New Forest include Alder *Alnus glutinosa*, Birch (Downy and Silver) *Betula pubescens and Betula pendula*, Grey Willow *Salix cinerea* and sometimes Pedunculate Oak *Quercus robur*, Ash *Fraxinus excelsior*, and Beech *Fagus sylvatica* in drier areas.

Bog woodland is a rare habitat type, where scattered trees occur across the surface of a bog in a relatively stable ecological relationship that does not lead to loss of bog species. This differs from the progressive invasion of bogs by trees through succession (e.g. in response to drier conditions or changes in drainage) or planting, which eventually leads to the loss of the bog community.[35]

Riverine and bog woodlands provide important micro-habitats for species including bryophytes and specialist invertebrates. Natural England (2023) suggests that they are perhaps most important for invertebrates, some of which show a degree of habitat fidelity; studies outside the New Forest have identified fungus gnats, hoverflies, and craneflies amongst the most species-rich groups. These habitats also provide shade, cover, and features within and close to freshwater bodies that are vital for woodland vertebrates including bats and birds.

Trees found in wet woodland are expected to be relatively resilient to climate change. Changes in precipitation are more critical than temperature for these habitats.

Changes to a hotter, drier climate will encourage a transition from wet to dry woodland, which will influence species abundance and composition over time. Prolonged and increased frequency of drought is likely to drive changes in the dominant tree species and ground flora with consequences

[35] https://sac.jncc.gov.uk/habitat/H91D0/

for the ecosystems currently supported. Whether this occurs in the New Forest will depend on whether and by how much hydrology is modified.

Conversely, some riverine woodlands may be exposed to longer periods of inundation due to high winter precipitation levels and subsequent overbanking, exacerbated in some areas by stream restoration works; this may lead to a decrease in species such as Oak and Ash and an increase in species such as Alder and Grey Willow.

Mitigation and Adaptation Opportunities

The UK Forestry Standard provides guidance on managing woodlands to increase climate resilience.

Measures vary depending on site objectives, protections and species present. Opportunities include active management in line with UK Forestry Standard, species diversification where appropriate, connectivity and expansion through woodland creation where appropriate, connectivity and expansion of fragmented rare/unique habitat (e.g. Ancient & Ornamental) through restoration or management changes of adjacent woodland.

Regional and local surveillance of tree diseases and pathogens, and early action in response to any identified threats becomes increasingly important as climatic conditions change. Reducing pressures from non-native mammalian herbivores will also support increased resilience and regeneration success.

Examples of adaptation requirements and opportunities relevant to the New Forest include:

- SSSI native woodland (un-grazed), much of which is ancient woodland. These woodlands are recognised for the landscape character and ecological conditions that they provide supporting specialist flora and fauna species. Managing these woodlands so that they remain in favourable condition is key (managing quality), as well as increasing size and connectivity to increase resilience. These habitats have limited adaptive capacity due to the limited range of species that are appropriate for their associated (protected) flora & fauna/ecological features.
- Managed native woodland that is not ancient woodland and not SSSI. Although these habitats add important landscape character, adaptation options can include a slightly more diverse mix of species than the SSSI habitats. This enables strategies that can include diversification to manage risks of biodiversity and timber production losses.
- Managed conifer plantation woodland on sites that are not ancient woodland or SSSI. These sites tend to be managed for timber production and/or other ecosystem service provision and have a relatively higher adaptive capacity due to increased flexibility in planting and management decisions.
- Actions to support favourable condition of wet woodlands such as restoration or maintenance of natural hydrological processes, and pollution reduction (air and water), support climate mitigation. Groundwater abstraction (leading to drying of sites) and eutrophication from nutrient pollution are two of the main causes of unfavourable condition of terrestrial wetlands on designated sites (Natural England, 2023).
- Extending areas of existing riverine woodland or improving connectivity across the landscape increases opportunities for recruitment and genetic exchange, helping to maintain robustness of wet woodland at a landscape scale (provided natural regeneration is enabled). Connectivity

can include features such as wetlands, hedgerows, mesic woodland, watercourses, and meadows as many wet woodland species are also associated with these habitats (Natural England, 2023).

More generally the current England Woodland Creation Offer (EWCO) provides funding to create new woodland, including through natural colonisation, on areas as small as 1 hectare. This provides opportunities to increase resilience by expanding the spatial extent and connectivity of existing woodland across areas of the New Forest and could include the use of species with southern provenance which are expected be more resilient to future climate.

Further Reading

- Forest Research adaptation resources and UK Forestry Standard Practice Guide Adapting forest and woodland management to the changing climate
- Forestry and Tree Health Resources. https://www.forestresearch.gov.uk/tools-and-resources/fthr/
- UK Forestry Standard
- Woodland Trust page and Buglife page on wet woodland
- Forestry Commission Practice Guide, Wet Woodlands
- Natural England Definition of Favourable Conservation Status for Wet woodland (RP2969) [includes a UK distribution map]
- https://www.wetwoodlands.com/

2.1.9 Agriculture, Horticulture and Modified Grassland

An estimated 26%, or 13,343 ha of land within the New Forest National Park boundary falls within this diverse category which includes arable farming, agriculturally improved grassland (i.e. grasslands managed to produce hay, haylage, or sileage), hedgerows, horticulture (mainly fruit), some limited viticulture, and land used to support equestrian interests (intensively grazed and managed paddocks). Campsites and golf courses also fall into this category. Improved grasslands cover an estimated 7,870 ha or nearly 60% of this group of habitats.

Sensitivity to Climate Change	Adaptive Capacity	Risk Rating	Confidence
Moderate	High	Low	Medium

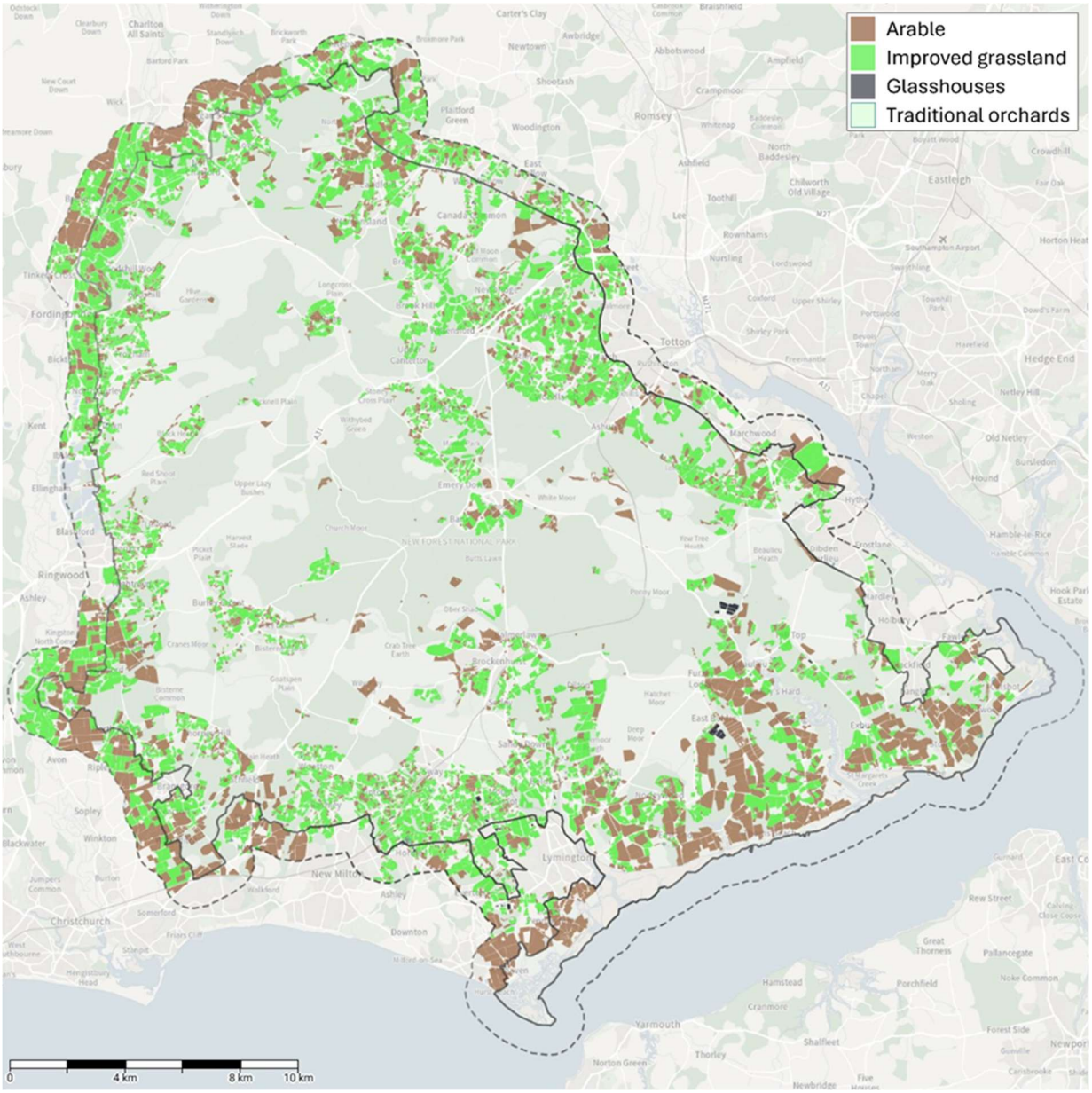

Figure 21: Assumed agricultural and modified grasslands and glasshouses based on the Ordnance Survey MasterMap dataset.

Summary

- The habitats in this category are dependent on water and sensitive to temperature but, as they are highly managed, adaptive capacity has been rated high and overall risk low.
- Availability of water is the main threat to arable and horticultural production in the UK (especially the southeast) and the most significant driver of year-to-year variability in crop yields (Squire et al. 2015). Extreme events, especially unseasonal or clustered events also increase the risks facing this sector (extended droughts or flooding).
- Potential benefits of climate change include increased yields, provided soil water and nutrients are sufficient.
- Hedgerows and field margins deliver important biodiversity value. Climate change is likely to drive increased growth, phenological changes and, over time, modification of the species assemblages in these habitats.
- Modified grasslands generally deliver very low biodiversity value across the New Forest. Risks include summer parching and winter saturation with increased potential for soil damage.

Relevant sections of the Natural England & RSPB Adaptation Manual are *hedgerows* (sensitivity rating low) and *arable field margins* (sensitivity rating low).

Hedgerows and arable field margins provide benefits for wildlife, while also reducing water and soil run-off into water courses (NE, 2019). Where they are managed for wildlife, they are classed as a priority habitat. The New Forest is within the best region of the UK for arable plants (arable plants are wildflowers that grow on cultivated land used for crops and are the most critically threatened group of wild plants in the UK)[36].

The Natural England *National Character Assessment* for the New Forest provides detailed assessments of agricultural land use[37]. With the exception of hedgerows and arable field margins set aside for wildlife, this group delivers the lowest biodiversity value of all the habitats found within the New Forest.

Climate Change Impacts

Across the UK, farmland biodiversity and ecosystem function have been strongly affected over the last 50 to 70 years by a range of influences, principally intensification. Relative to this, climate change is expected to have only incremental impact. Efforts that seek to improve farmland ecosystem health, particularly soils and above ground biodiversity are likely to also deliver increased resilience to climate change.

Climate change presents risks to agricultural production through changing precipitation patterns and extreme weather events such as drought, wildfire, and flooding. Changing climatic conditions also influence soil health, and increase the risk of new pest, pathogens and invasive non-native species.

Although both temperature and increased atmospheric CO_2 have direct positive effects on crop production (atmospheric CO_2 levels drive photosynthetic efficiency, with higher levels leading to accelerated biomass production), water is expected to be a limiting factor.

Many of the risks associated with agriculture are interrelated, e.g. between soil, climate, and forage. Climate change creates opportunities to diversify existing swards and to grow alternative crops.

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[36] See e.g. DEFRA blog and Plantlife Guide
[37] E.g. https://nationalcharacterareas.co.uk/new-forest/key-facts-data/

Earlier and more prolific grass growth will affect both grazing and silage production. The timing of silage cuts is likely to be affected, which may have knock on consequences for grass and farmland species. Hot, dry summers will increase demand for water and lead to parching of grasslands and paddocks, reducing productivity and forage available.

Squire et al. (2015) highlight the economic effects of new weed species, some of the most dominant of which are relatively (~100 year) new arrivals. Weed populations may be able to adapt more rapidly than crops since the main species consist of many genetically distinct variants that are highly phenotypically variable.

Warmer, wetter, winters have already been impacting field access for cultivation and harvesting, increasing the risk of soil compaction and damage. An increase in heavy rainfall events could result in direct damage to crops and pasture, increased risks to livestock, and damage to infrastructure. Livestock may have to be moved to other fields or housed indoors with an extra cost of providing feed.

Effects of climate change on soil are likely to be particularly pronounced in arable soils which have degraded biota and ecosystem function. Erosion of arable soil is sensitive to frequent soil disturbance (through tillage) and periods where soil is left without cover.

There are also risks to the New Forest biodiversity associated with agricultural management decisions that may be indirectly influenced by climate change (e.g. push for intensification leading to greater levels of pesticide use or loss of field margins) (Brown et al., 2016).

Sea level rise may impact the viability of agriculture in coastal areas through saline intrusion and coastal flooding.

Soil health and pests, diseases, and pathogens are assessed in more detail in sections 2.1.10 and 2.3.

Arable Field Margins

The impacts of climate change on arable field margins include changing composition, risk of dieback during droughts, phenotypic mismatch, and changes to farm management such crop selection, use of insecticides or herbicides and indirectly, intensification of field use leading to reversion of the buffer strips for crops.

Hedgerows

Hedgerows i.e. boundary lines of trees or shrubs (>20m long, <5m wide) play an important role in the landscape and provide important nest sites and refugia for wildlife.

The impacts of climate change on hedgerows include increased tree/plant growth in response to longer growing season, requiring greater management and increasing risk of abandonment, and an increased risk of shading of hedgerow-associated herbaceous flora.

As with woodlands, climate change is likely to drive changes in hedgerow tree/plant assemblages, and their associated animals. There may be impacts on hedgerow management windows due to changing phenology (e.g. earlier nesting) and ground conditions.

Reduced frost frequency will eventually mean that winter chill requirements of berry species will not be met, leading to reduced bud, flower, and fruit production (with cascading impacts on food webs).

Drought and storms are likely to have a greater impact on hedgerow trees than on trees in blocks of woodland due to edge effects. This may lead to increased losses of mature and veteran trees, and

trees with drought susceptibility (e.g. Beech on free draining soils). Stressed trees and hedgerow flora are more susceptible to pests, diseases, and pathogens.

Flooding, waterlogging, and erosion could damage soil structure or lead to die-back of some species, also increasing susceptibility to pests, diseases, and pathogens.

Hedgerows are vulnerable to indirect impacts from changes in adjacent land use/management, including risks of nutrient enrichment and pesticide drift.

Horticulture

Horticulture, a sub-sector of the agriculture industry, includes field-scale vegetables, protected crops, bulbs and outdoor flowers, hardy nursery stock, mushrooms, orchard fruit, and soft fruit. As per other crops the main risk to this sector is access to water, especially during periods of drought and high temperatures.

Many vegetable crops are resilient to climate change provided sufficient soil water and nutrients are available, e.g. potatoes, carrots, and onions.

Climate change will generally extend the growing season and increase crop yields due to higher concentrations of atmospheric CO_2. Increases in CO_2 levels have a direct impact on plant performance through its role as a substrate for photosynthesis. Plants grown at elevated CO_2 can have significant compositional differences (higher carbohydrates and lower nitrogen) with consequences for product quality and fertilisation requirements. (Collier & Thomas, 2016).

Salads and leafy vegetables will develop and mature more quickly / earlier in the year, offset by potentially decreasing yields later in the year during very hot periods. Root vegetables are also likely to increase yield for a given harvest date whereas higher temperatures may reduce yields of cereal crops by shortening the time to reach maturity. Impacts will depend on crop genotype (species/variety) and management.

A reduction in frost frequency will impact perennial fruit production, hampering floral bud development potentially leading to protracted and un-synchronised flowering and possible mismatches with pollinator life cycles; impacts may be offset by a longer growing season and CO_2 driven productivity increases. Selective breeding of new varieties is one way to manage this risk.[38]

Adaptation will be required to manage the changes in seasonal precipitation patterns, with disruption to, or consideration required around water management, land preparation, sowing/planting and harvesting activities.

Pests and disease risks are likely to change, with some pest infestations likely to become more frequent while others decline. See Collier & Thomas, 2016, and section 2.2.

Viticulture

Viticulture has been one of the UK climate-change ‘winners’ as conditions have become more suitable for the production of grape varieties (quality wine production requires average growing season temperatures of 13–21°C). However, the rate at which temperatures are changing, coupled with the need for long-term decision-making pose challenges.

[38] https://agricology.co.uk/resource/climate-change-and-uk-horticulture-what-come-and-how-build-resilience/

The natural variability of the UK climate system coupled with increasing extremes (drought, high intensity rainfall, storm clusters) mean that production is likely to be highly variable year to year for the foreseeable future. (Gannon et al., 2023).

Modified grasslands

Modified grasslands are used for equine recreational interests, and as back-up grazing for livestock. These are generally highly managed and deliver very little biodiversity value.

Although the longer growing season will potentially increase productivity, summer parching is a significant risk as well as winter waterlogging, with associated risks of soil compaction and poaching. There is some evidence that increased atmospheric CO_2 will not drive yield increases expected in other crops.[39]

Mitigation and Adaptation Opportunities

Actions that protect and preserve water supply and soil health will increase resilience to climate change.

For hedgerows, the most important response to climate change is likely to be effective buffering against the impact of adjacent land uses, through for example the use of grass, uncultivated or low intensity margins, and fencing off livestock. This will become increasingly important whether or not there is an intensification of adjacent land use, as trees stressed by factors such as drought or water-logging are more susceptible to other pressures.

Regeneration of hedgerow trees and shrubs can be promoted through the management of grazing mammals and vigorous weed species, to promote a greater range of age classes. Maintenance of a diverse range of hedgerow structures through appropriate management, ranging from hedgerows that grade from tall scrub, with plentiful side shoots and foliage in the summer, to well-developed shrubs and tall sward grassland with herbs. The wider and more varied the structure the better.

When establishing new hedges, the aim should be to provide links to the existing hedgerow network and patches of semi-natural habitat in order to promote the movement of species through the landscape. When planting or restocking, diversifying the range of species and selecting species and provenances adapted to a wider range of climatic conditions should be prioritised. Where hedgerows contain tree species susceptible to climate change, restocking with more resilient species to establish the next generation of hedgerow trees should be considered.

There are multiple opportunities for these habitats to more effectively support wider landscape and species resilience by e.g. maintaining or expanding arable field margins, and ensuring that they are protected from agricultural inputs, providing diversity of habitat (aspect, soil type, shading) to maximise support to multiple species and assist in the movement of species through the landscape and by tailoring the diversity of flowering species in planted margins to ensure the continued provision of pollen and nectar throughout the extended season, and including species and cultivars that are able to tolerate and flower under hotter, drier summers.

[39] https://www.rothamsted.ac.uk/news/grasslands-stopped-fighting-climate-change-over-century-ago

Further Reading

Agriculture and Horticulture Development Board (AHDB) Climate Change Adaptation Report (2025) includes adaptation opportunities and links to guidance and tools relevant to beef, lamb, cereal, oilseeds, dairy and pork farming.

Collier & Thomas, Climate change impacts on horticulture (2016) covers pests, pathogens and weed effects in detail.

2.1.10 Soils

Soil is the foundation on which all terrestrial ecosystems function, providing a habitat for soil organisms, acting as a medium for plant growth and providing storage and purification of water. There are very few areas of the UK which have not been strongly influenced by land management, making undisturbed soils such as those under the historic common lands of New Forest's ancient woodlands, heathlands, bogs and valley mires, a scarce and valuable national resource. These soils are the highest priority for protection (Natural England, 2015). The soils of the New Forest are described in Smith (2006, Part 2).

Sensitivity to Climate Change	Adaptive Capacity	Risk Rating	Confidence
High	Moderate	Moderate	Low

There are multiple soils datasets for the UK that can be explored via the UK Soil Observatory (https://www.ukso.org), Figure 22 shows the 1:250,000 scale simplified soils dataset (Soilscapes). Figure 23 shows a recently published peat soils map (peat soils are defined as soil with an organic content of 20 percent or more and a thickness of at least 10 cm). For the New Forest area this should be viewed as indicative only, owing to the methodology[40], nonetheless this forms a useful baseline for interpretation using local knowledge.

[40] Local discussion suggests that the results overestimate peat depth on the heaths, are showing peat in conifer woodlands which is not there and are likely underestimating the peat depth in valley mires.

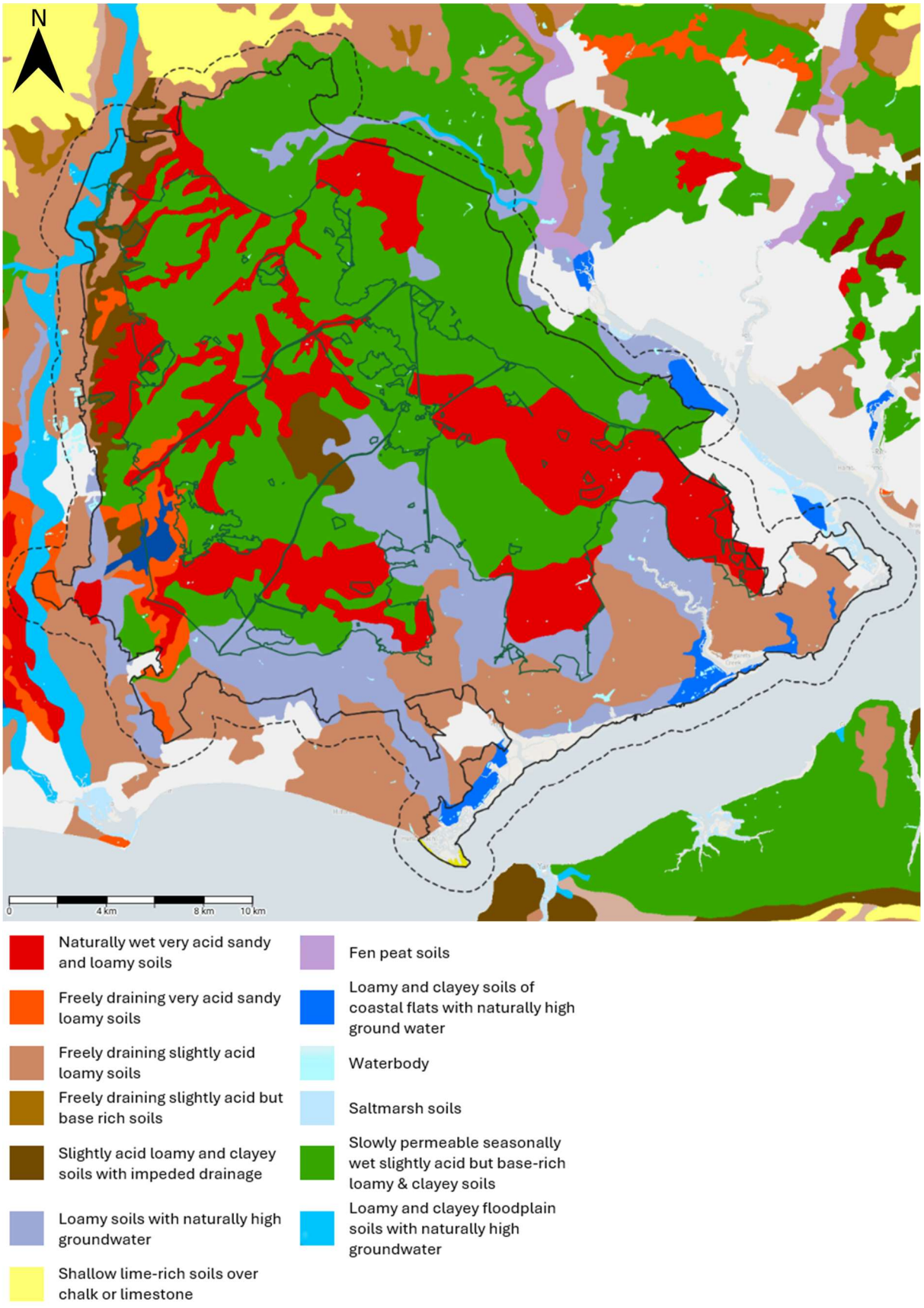

Figure 22: Distribution of different soil types across the New Forest (BGS dataset).

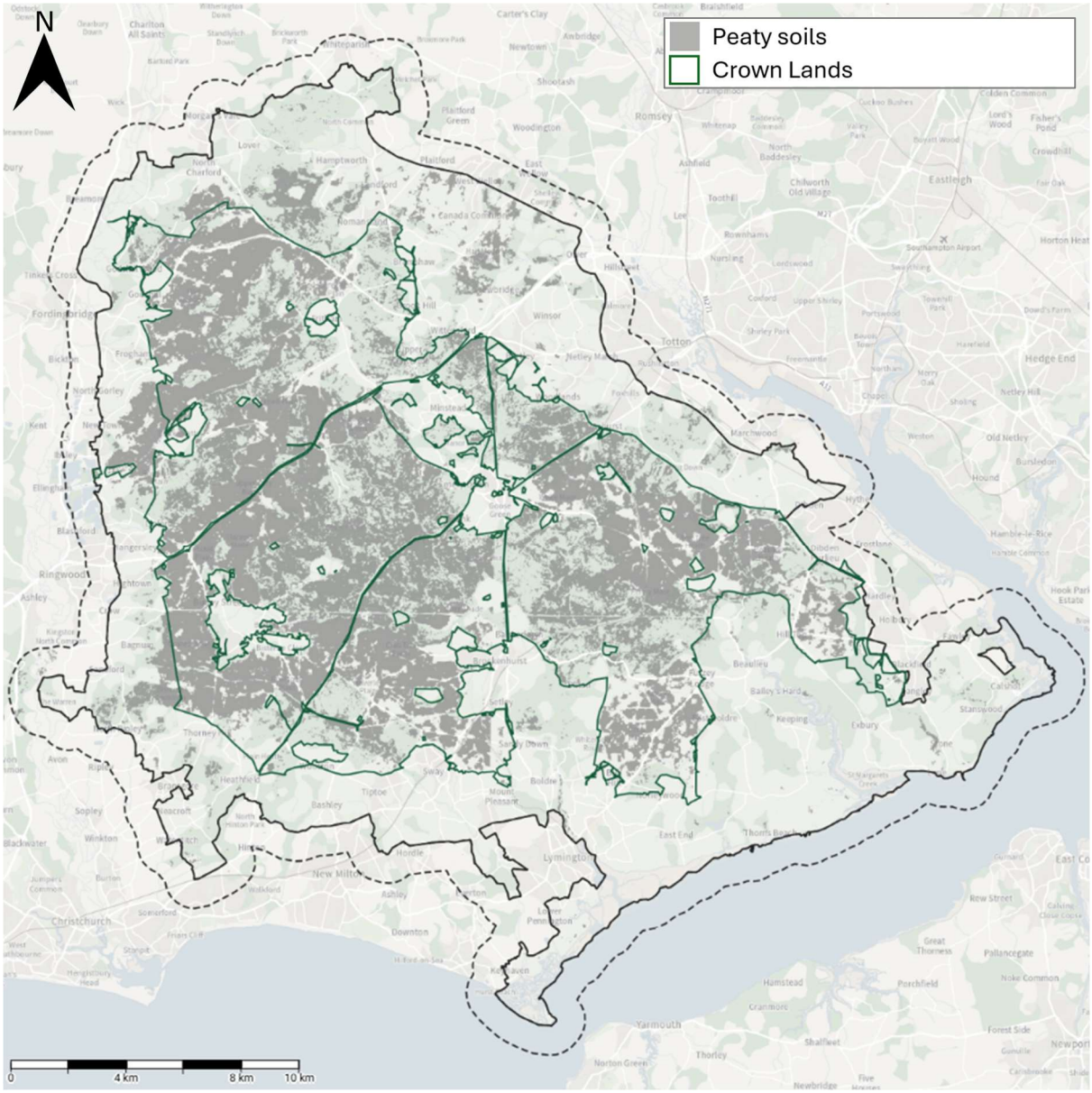

Figure 23: Natural England Peaty Soils map for the New Forest (2025)[41]

Summary

- The balance between soil temperature and moisture is a key driver of multiple soil processes influencing soil health.
- The living nature of soils and protection provided by above ground vegetation (where intact) enables soils to adapt to conditions. Disturbed or degraded soils impacted by compaction or loss of organic matter have reduced adaptive capacity, hence the overall moderate rating for risk.
- Physical impacts of climate change include increased risk of soil erosion from higher temperatures and repeated cycles of drought and flooding. Drier soils lose structural and water retention capacities. Higher intensity and increased winter precipitation increases the loss of

[41] https://publications.naturalengland.org.uk/publication/5075614867128320

soil nutrients and risk of run-off and erosion of soil into watercourses. Wetter winters increase the duration during which soils are saturated increasing susceptibility to compaction.

- Biological impacts include changes to the growth and activity of soil microorganisms in response to increased temperatures, both directly but also indirectly through plant-soil interactions. Higher temperatures boost microbial activity increasing the rate at which organic matter is broken down.
- There are large knowledge gaps in our understanding of soil function and biodiversity, in the relationships between climate change and soil pollution (e.g. nitrogen enrichment), and in pest and disease risks for soils. Research into the soils of the New Forest is limited hence the confidence rating is low.
- Measures which support soil health, i.e. reducing compaction, pollution, contamination and disturbance, and increasing organic matter in disturbed soils are likely to increase the resilience of soils to climate change.

Context

Soils are approximately 50% air and water, 45% minerals, and 5% organic matter. Soil organisms include earthworms, nematodes, arthropods, protozoa, fungi, and bacteria. These organisms form food webs which drive soil ecosystem processes.

Soil supports biomass production, biodiversity, the carbon, nitrogen and hydrological cycles, and the preservation of cultural artefacts (Stapleton et al., 2021). In general, UK soils are not in a sustainable condition owing to degradation through erosion, compaction, drainage, loss of organic matter, loss or modification of biodiversity, imbalance of nutrients, and soil sealing (i.e. through development).

Soils hold the UK's largest reservoir of organic carbon and hence have an important role in climate change mitigation. The potential conversion of organic carbon to CO_2 when soils are disturbed or degraded has significant implications for climate change. Most arable soils have lost 40–60% of their organic carbon.[42]

As well as carbon storage, soil delivers multiple ecosystem services. These include enabling agricultural and forestry production for which soil fertility is extremely important but also regulating water flows, water quality and recycling nutrients, alongside other benefits including landscape character, cultural and heritage value (Betts & Brown, 2021). There is also increasing human interest in soil biodiversity, historical records contained within soils (paleosols and paleoclimatic records), and gardening.

The ways in which soil biota react to changes in climate, and the ability of above-ground plants and animals to adjust to climate change will be limited or facilitated by soil conditions.

There are major knowledge gaps in relation to soil ecosystems - of the estimated 11 million species of organisms that live in soils, fewer than 2% have been named and classified (EA 2019b). Natural England maintain a Long-Term Monitoring Network for Soils, which includes five sites in the New Forest within the North Solent National Nature Reserve.[43]

The soil invertebrate community in the UK has been surveyed nationally twice (1998 and 2007), showing significantly fewer invertebrates in arable habitats than other habitats (EA 2019b).

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[42] https://post.parliament.uk/soil-as-an-essential-national-asset/

[43] https://publications.naturalengland.org.uk/publication/5143675349237760 & https://publications.naturalengland.org.uk/publication/5821581510049792?category=5316639066161152

Soil health

Soil health is defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans. (EA, 2019b). It depends on a range of physical, biological and chemical factors including nutrients and acidity, organic carbon content, structure and water capacity, biological activities and chemical pollution.

Impacts of Climate Change

The sensitivity of soils to climate change is directly linked to the amount of organic matter, level of compaction, and overall 'health' of the soil. Soil processes are controlled by a complex range of factors but most importantly by the balance between soil temperature and soil moisture (Abdalla and Smith, 2016). Effects of these primary controls varies depending on soil type and land use.

Physical

Physical impacts include increased risk of soil erosion from higher temperatures and repeated cycles of drought and flooding. Hotter drier summers increase the risk of wind erosion and soil drought. Soil organic matter content is positively correlated with rainfall, so drier soils could lose structural and water retention capacities.

The structural health of soils is compromised by compaction. When compacted, they are more likely to become waterlogged and experience surface ponding that leads to increased run-off and flooding. This increases nutrient losses to watercourses causing pollution and reducing nutrient levels in soil. Severe soil compaction and poor soil condition is an issue for around 10% to 15% of grassland fields (UK wide) due to over-grazing.

Compaction risk is influenced by precipitation with wetter winters potentially increasing the duration during which soils are saturated. Compaction risk constrains access for agricultural and forestry management, and if livestock are present increases risks of soil degradation from poaching.

Compaction has a serious detrimental effect on soil structure affecting plant rooting and productivity, decreasing infiltration rates (therefore affecting flood risk and water quality through increased runoff), and increasing N_2O emissions. Compaction risk is highest on clay soils.

Chemical

Chemical impacts include a risk of changes in soil organic carbon, with higher temperatures enhancing carbon fluxes to and from the soil. Decomposition rates are also controlled by moisture, slowing in response to drier conditions and speeding up when water is available.

Many steps in the nitrogen cycle occur in soil and are strongly influenced by soil moisture and temperature. Consequently, there is high potential for changes in climate to alter the impacts of nitrogen deposition on biodiversity and ecosystem functioning including nutrient and carbon cycling (Britton et al., 2022).

Nitrogen deposition from air pollution is a key driver of the eutrophication (nutrient enrichment) of soils and, by extension, the habitats and vegetation that they support. "*Nitrogen-containing compounds act as plant nutrients and, in otherwise Nitrogen-limited systems can cause the rapid growth of plants. This can result in elevated crop yields in agricultural systems, but in semi-natural systems results in the vigorous growth of aggressive nitrophilous species that then out-compete other, more delicate native species, leading to a precipitous loss of biodiversity*." (Stapleton et al., 2021).

Although the New Forest has relatively low rates of nitrogen deposition (estimated as 10 to 15 kg N ha^{-1} yr^{-1} between 2011 and 2013), these rates are close to critical load thresholds for heathland, valley mire and bog habitats (critical loads are 5 to 15, and 5 to 10 kg N ha^{-1} yr^{-1} respectively) (Plantlife, 2023).

There are mixed perspectives locally on how significant this issue is for the New Forest. Stapleton (2021) provides more details and guidance on critical loads, highlighting tools available to support assessments.[44] Beyond the New Forest boundary, both nitrogen deposition and ammonia concentrations increase, with potential consequences for range expansion by sensitive species (see maps in Plantlife, 2023).

Biological

Soil organic matter is an important indicator of soil health and is crucial for long-term yields, food quality, and extreme weather resilience, and as a vital store of soil carbon. Organic matter acts like a sponge and can hold up to 20 times its weight in water. It makes soil more resistant to drought and erosion.

Biological impacts include changes to the growth and activity of soil microorganisms in response to increased temperatures, both directly but also indirectly through plant-soil interactions. Higher temperatures boost microbial activity increasing the rate at which organic matter is broken down. This accelerates the release of gas (respiration) and stimulates increased plant growth.

There is limited understanding of the impacts of climate change on soil biological function, pests and diseases, pollutant processing and interactive effects between changes in CO_2, temperature, rainfall and atmospheric deposition, as well as management responses to increase the resilience of soils to climate change.

An additional risk factor is the introduction of invasive species with their establishment and spread encouraged by climate change. For example, it has been suggested that UK introduction of the New Zealandflatworm *Arthurdendyus triangulatus* (so far only recorded in northern areas of the UK) may have reduced earthworm biomass in some regions by 20% (Murchie et al., 2013), with resulting implications for soil structure and functioning because of earthworms' key role as ecosystem engineers. Earthworm presence in agricultural soil has been associated with a 25% increase in crop yield and a 23% increase in above-ground biodiversity (Betts & Brown, 2021).

Mitigation and Adaptation

Protecting and restoring soil health supports resilience to climate change.

Intact soils such as those found under ancient woodland, heathland, and in valley mires, bogs and fen habitats can be protected by maintaining above-ground vegetation.

Restoring soils that have been degraded or compromised by drainage, compaction, or loss of organic material will increase resilience and boost ecosystem service value. The ELMS Test & Trial study (Eftec and Environment Systems, 2024) produced several soil maps, including the soil carbon opportunities map shown in Figure 24.

[44] https://www.apis.ac.uk/

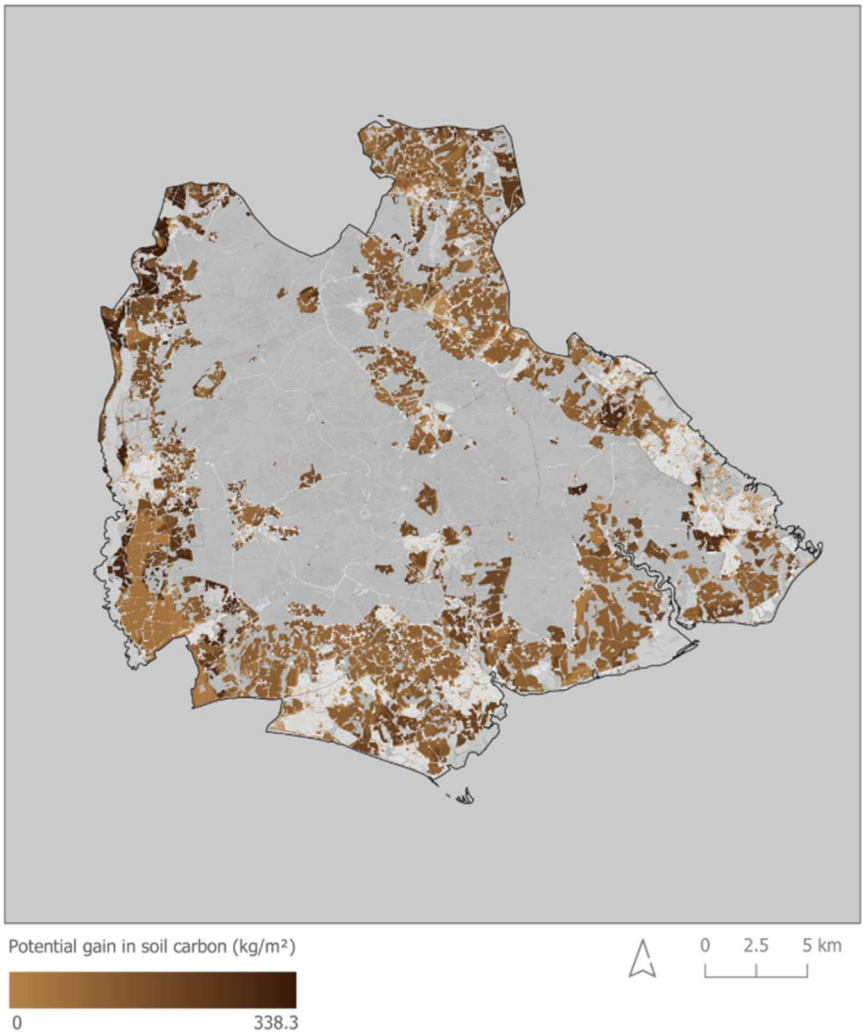


Figure 24: New Forest Prioritised Soil Carbon Opportunities: Potential Gain in Soil Carbon (Eftec and Environment Systems, 2024).

Further Reading

- Environment Agency State of the Environment Report for Soil in England and Wales (2019)
- Soil structure and its benefits. An evidence synthesis (2020) Royal Society Report
- Soil Association, Saving Our Soils Report (2021)
- British Society of Soil Science https://soils.org.uk/education/guidance-and-science-notes/
- Isle of Purbeck Case Study (Loss of Soil Biodiversity) https://www.envista.it/archive/recare-hub.eu/case-studies/isle-of-purbeck-uk.html
- Ron Allen's Soil and Water webpages

2.2 Species

The New Forest is increasingly recognised for its exceptional species diversity, which includes an estimated total of over 20,000 species of animal, plant, and fungus (Chatters, 2024), including at least 15,000 insects (Brock, 2011) and 2,600 fungi (Dickson and Leonard, 1996). The aim of this section is to summarise responses to climate change that might occur across different species groups and provide examples of observed and predicted changes in the New Forest that are primarily attributed to climate change.

At a UK scale, based on evidence from the last 50 years, climate change has been identified as the second most important driver of change in terrestrial and freshwater wildlife abundance and distribution, behind (primarily agricultural) land-use change (Burns et al., 2023).

Climate determines where species can live, consequently (ultimately) species that cannot tolerate changing conditions in their current range or successfully move out of areas that become unfavourable into suitable habitat elsewhere will face extinction (Gardner et al., 2023).

Species responses to climate change can generally be considered as changes in 1) distribution, 2) phenological and behavioural change, 3) physiological and/or genetic evolution, and 4) changes in (ecological) network interactions. This section focuses mainly on distribution and phenology, which are the more easily observed and more widely researched impacts.

Changes in distribution

Although it remains challenging to disaggregate climate change drivers from other drivers of change, there is now a considerable evidence base for climate change impacts across many different species groups and individual species, the most widely documented of which are northward range expansions observed in multiple species groups (Figure 25).

Pearce-Higgins et al. (2017) carried out a risk assessment for 3000 UK species, looking at risks of range loss and opportunities for range expansion in the future. The results show that, at a national level, the distributions of most species are liable to change, with change expected to become the norm, not the exception, as climate change continues to progress (Figure 26).

For the UK, in the short term, more species are being positively impacted by climate change than negatively, thought to largely reflect the prevalence of species with their northern range margin in the UK. It may also reflect a bias of climate change impact studies towards taxonomic groups where dispersal ability is generally high (Burns et al., 2016), alongside the fact that detecting colonisation is much easier than reliably detecting species absence.

It is important to note that expansion and retraction in terrestrial environments do not occur as ‘parallel’ processes. Gardner et al. (2023) highlight that although clear latitudinal expansions have been observed at the leading edge of species ranges, at the trailing edge declines are more localised and much more limited (rarely more than a few 100 metres/yr).

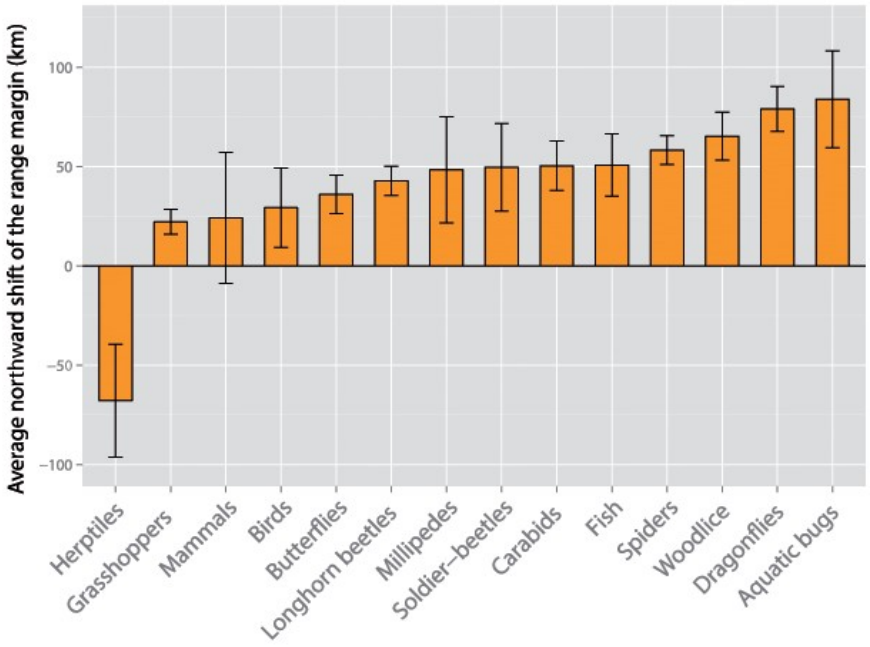


Figure 25: General patterns of northwards range shift across many different taxonomic groups based on distribution data from 1960-2002. Bars show results for hectads where 10% of the species in a group were recorded in both time periods (Credit S. Mason, CEH). [45]

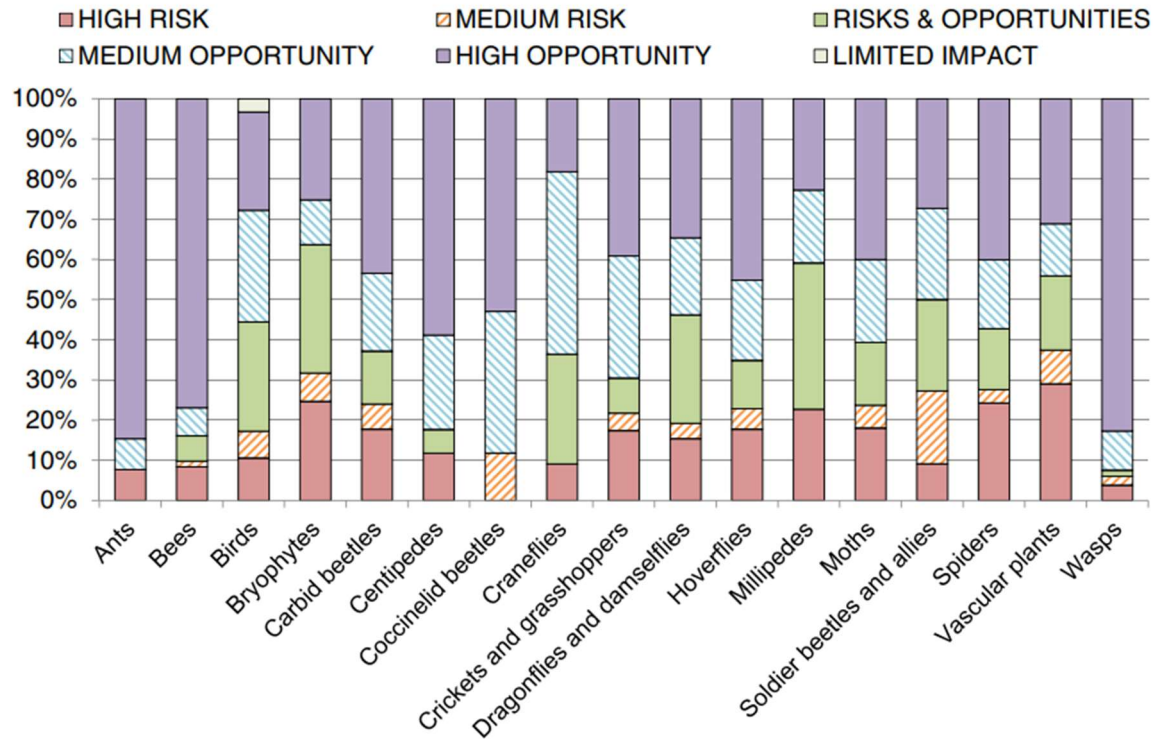


Figure 26: Proportion of species categorised as likely to be at risk or to have an opportunity for expansion from climate change, based upon a low emission B1 projection for 2070–2099 (Pearce-Higgins et al.,2017).

[45] https://www.brc.ac.uk/theme/climate-change-ecology

The variation in range expansion versus retraction is also partly explained by the scales at which we model, measure, and understand climate change (generally 10's of metres to multiple km's) versus the scale at which species experience climate within habitats (generally cm, mm, or smaller). The coarse scale at which climate change is assessed masks the huge variation in microclimate provided by differences in topography, vegetation (e.g. shading), and soils. Variations in microclimate can significantly exceed the projected magnitude of climate change, even in the long term (75+ years), highlighting the potential for habitat refugia to provide a buffer to climate change at very local levels and the potential for species to persist beyond macroclimatic thresholds.

For the New Forest, changes in species distribution have several implications:

- Dispersal / expansion opportunities for multiple species groups, with the potential to improve biodiversity in other regions (i.e. increasing potential for the New Forest to act as a biodiversity bank). Dispersal success depends on many factors including existing population size, dispersal capabilities, availability of habitat and food, and the pathways and barriers (e.g. verges, roads) associated with movement.
- There is likely to be an increase in the number of new species arriving (climate 'colonists' or 'refugees'), mainly from the south. The arrival of new species may boost diversity but also increases the risk of new pests and diseases and potential for new invasive species.
- There is potential for loss of species that cannot tolerate the new climate envelope of the New Forest, although as outlined above this will in part be linked to the continued availability of suitable climate refugia, i.e. habitat areas with sufficient heterogeneity to buffer unfavourable macroclimatic conditions.
- The impact of range shifts on ecological networks is essentially unknown but has the potential to impact ecosystem function.

Phenological and behavioural change

Phenology is the study of the timing of recurring natural events in relation to climate. This usually has a focus on spring and autumn events (often focusing on first and last occurrences) such as bird migration, egg laying or spawning, flowering or leafing of plants, emergence of invertebrates, fruiting of fungi, fish migration, and breeding of mammals.

In the UK, temperature is an important trigger for spring events. There is a large body of evidence showing that spring events are occurring earlier and some evidence of delayed occurrence of autumn events. A comprehensive study of UK phenological trends over a standardised period (1976- 2005), reported by Sparks and Crick (2015), revealed that 84% of events had advanced and that there were considerable differences between trophic levels, with lower trophic levels advancing more than secondary consumers.

The UK tracks a 'spring index' calculated from the annual mean observation date of four biological events: first flowering of Hawthorn *Crataegus monogyna*, first flowering of Horse-chestnut *Aesculus hippocastanum*, first recorded flight of an Orange-tip butterfly *Anthocharis cardamines*, and first sighting of a Swallow *Hirundo rustica*. The index (Figure 27) shows that earlier occurrence of spring events is strongly linked to warmer temperatures in March and April. The difference between the averages of the two periods shown is 8.6 days. There is a marked increase in the spring advance when the mean March to April temperature is above 7°C.[46]

[46] See additional details provided here https://jncc.gov.uk/our-work/ukbi-spring-index/

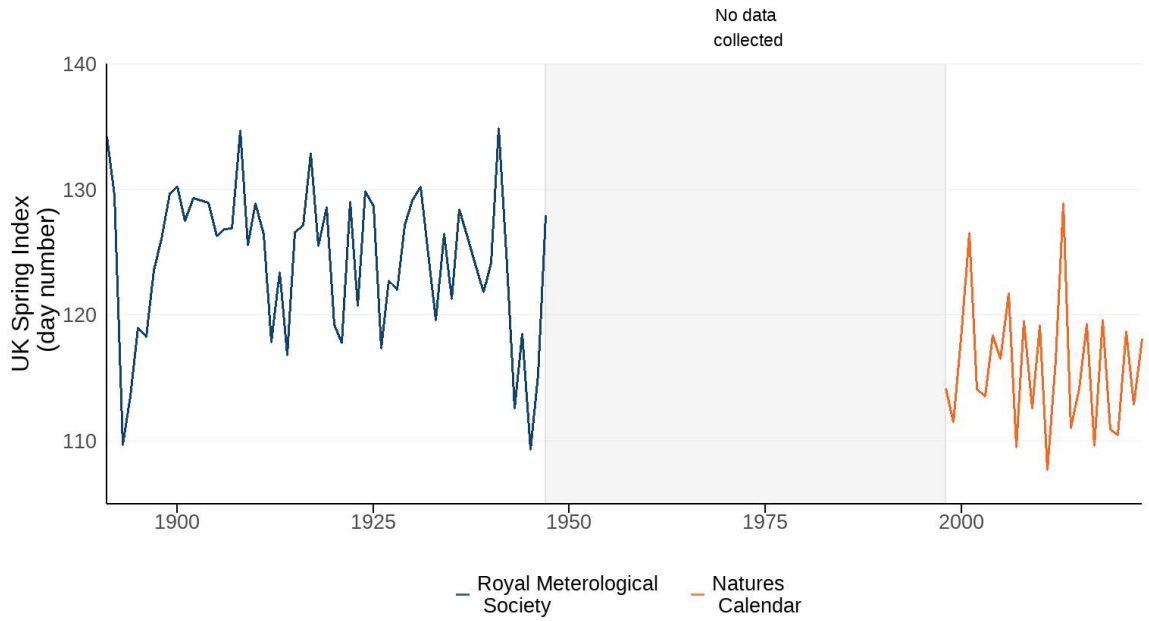


Figure 27: Index of the timing of biological spring events (number of days after 31 December) in the UK, 1891 to 1947, and 1998 to 2023. JNCC published, based on UK Phenology Network (Nature's Calendar, currently funded by the People's Postcode Lottery, Postcode Green Trust) and Royal Meteorological Society datasets.

Sparks and Crick (2015) report that there is very strong evidence that changes in phenology are species-specific, and possibly genotype-specific, citing the example of the migration arrival of Sand Martin *Riparia riparia*, which has advanced much more than that of Pied Flycatcher *Ficedula hypoleuca*. They also report that garden experiments reveal phenological differences in leafing between different provenances of trees.

Although changes in phenology may offer competitive advantage to some species, there are also concerns that mistiming will cause problems by altering food supply or symbiotic relationships and hence the fitness of certain species.

Phenological adjustment is mainly via individual plasticity although in species with rapid generation time, microevolutionary responses have been demonstrated. Species that do not adjust their phenology in response to climate change are more likely to show population declines.

Species which use environmental cues that are 1) not directly related to climate (such as day length), 2) have a narrow ecological niche, 3) rely on few species at a lower trophic level, or 4) have low mobility and low reproduction rates, are those likely to be most at risk. It is challenging to identify which species these will be, since phenological data are available for relatively few species (Sparks and Crick, 2015).

Physiological and genetic evolution

Climate change increases local extinction risk for sensitive species, and can also drive non-lethal impacts on physiology, phenology, body-size, and trophic interactions that may lead to significant population-level effects.

Genetic diversity is a recognised component of overall biological diversity that underpins the fitness of individuals, persistence of populations, the ecosystem services and functions these provide, and, ultimately, long term species viability (Neaves et al., 2015). It provides the basis on which natural selection acts to adapt populations to their environment (evolutionary responses) and is hence critical for population persistence through environmental change such as climate change.

Although there are some studies showing evolutionary adaptation in wild populations, e.g. Avaria-Llautureo et al., (2021) showing size reductions in pilchard and herring *Clupeiforms,* and Visser's (2019) work on Pied Flycatcher*,* a key concern is the rate of change. It is unlikely that the combination of phenotypic plasticity and genetic change seen in the wild can be sufficient to keep up with the rate at which climate change is currently modifying conditions.

Active management to prevent the loss of genetic diversity is likely to be the most effective means to facilitate adaptive evolutionary responses to climate change. Proactive management involves maximising population sizes and health and connecting populations to facilitate the movement of genes/individuals in the landscape. This management approach will also buffer sub-populations against extinction and facilitate other responses, such as range shifts (Neaves et al., 2015).

Network interactions and dependencies

No organism can survive and reproduce without interacting with other organisms around it. Most of these interactions reflect the need to access energy to maintain metabolism, such as predation, herbivory, or parasitism, with varying benefits for the species involved. These ecological networks (or food webs) involve countless vertical and horizontal, antagonistic and mutualistic interactions spanning multiple spatial and temporal scales.

These networks are intrinsically dynamic, rearranging as new species enter or leave the network due to natural (e.g. seasonal changes) or anthropogenic (e.g. species extinctions or introductions) disturbances.

Impacts of climate change include:

- increasing the potential for phenological mismatch. As different species respond differently there is an increased possibility of temporal mismatch reducing the time windows during which interactions are possible.
- Increasing the potential for spatial mismatch e.g. if species distribution changes this can directly affect species encounter probabilities, leading to the spatial decoupling of biotic interactions. Differential range shifts between predator and prey (or other dependencies) can generate a spatial window where their interaction is no longer possible.
- Increasing potential for disruption due to new species arrivals which might displace or otherwise modify existing interactions.

There is also an increasing understanding of the potential for modification to chemical interactions which provide the basis for the vast majority of ecological processes in terrestrial and aquatic ecosystems. Roggatz et al. (2022) use the example of insects which can be affected by thermal stress; citing the ladybeetle *coccinellidae* larvae which produce twice as much pheromone ('infochemical') under 25°C conditions than 15°C, which once emitted, is vulnerable to sudden shifts in environmental temperature which can accelerate pheromone decay and reduce pheromone detectability. These types of disruptions in chemical communication can cause a reduction in individuals' ability to locate each other at a distance and identify potential mates.

2.2.1 Climate Change Impacts on Species Groups

The sections below provide brief summaries of published evidence on the impacts of climate change on selected species groups found within the New Forest, together with examples of recent observed changes (primarily based on local expert knowledge).

2.2.2 Mammals

The New Forest habitats support a range of mammals, including 18 species of conservation concern, namely Water Vole *Arvicola terrestris*, Otter *Lutra lutra*, Polecat *Mustela putorius*, Pine Marten *Martes*, Dormouse *Muscardinus avellanarius* and 13 species of bat. Five species of deer are established, including Muntjac despite efforts to prevent colonisation.

A recent review of the population and conservation status of British mammals (Matthews, 2018) suggested that most of the observed trends have been driven by habitat changes or human intervention. Climate was identified as a driver of change for only a few species - those that might benefit from warmer winters, and those that feed on seeds and berries, where changes in fruiting times could affect food availability. Warmer winters increase survival rates of mammals, while cold and damp spring conditions can cause excessive mortality and retard population growth rates.

Newman et al. (2015) identify four interactive consequences of climate change as the main areas of concern for mammals: changes to food availability, thermoregulatory compromise, altered disease exposure / susceptibility, and habitat change. They concluded (from 'generally weak evidence') that climate change presents a moderate risk, overall, for mammals in the UK.

Changes in food availability, or phenological change influencing the availability of food at critical times, are influenced by gradual temperature shifts (extended or early reproduction) and by extreme weather events (in particular, droughts and flooding), with the potential for cascading impacts through the food chain.

Thermoregulatory stresses, i.e. the impacts of changes in air or water temperature on body temperature, are most critical for small mammals. Hibernating species are compromised by warmer winters during which metabolic rates are not sufficiently suppressed; this increases energy use, drawing down fat reserves[47]. Evidence to date suggests climate change may have detrimental consequences for some hibernating species and populations, influenced by whether hibernation is optional or obligatory, and availability and criticality of specific food sources immediately prior to or when emerging from hibernation (Scopes, 2024).

Exposure to, and response to pathogens can be exacerbated by climate change. The spread of disease by mobile insect vectors (e.g., midges and mosquitoes), as well as altered susceptibility to parasite infestation due to heat, drought, or other extreme event stress are well reported (e.g. Newman, 2015).

New Forest examples

- The New Forest hosts 13 of the 18 UK bat species including nationally important populations of Bechstein's Bat *Myotis bechsteinii* and Barbastelle *Barbastella barbastellus* that primarily roost in old / dead broadleaf trees. A nascent population of Pine Martens *Martes martes* is also highly reliant upon deadwood in ancient woodland habitats in the New Forest (Saleiko and

[47] https://www.britishecologicalsociety.org/flexible-hibernation-could-help-hedgehogs-adapt-to-environmental-changes/

Ward, 2025). Consequently, any climate-driven changes to the composition, age structure, and deadwood abundance in New Forest woodlands is likely to impact these species.

- Bats and other insectivores may also be impacted by changing prey availability, including climate-driven changes in prey distribution, abundance, and phenology. For example, the invasive and rapidly increasing non-native micro-moth *Musotima nitidalis* has a protracted flight season into late autumn and is likely benefitting from milder conditions in these periods - in the last five years it has become abundant in Bracken-dominated woodlands in the New Forest (see here and here) and may therefore provide an additional new food resource for bats and other insectivores at a time when relatively few native species are on the wing.
- Increased overwinter survival of generalist predators and perceived 'pest' species (e.g. Grey Squirrel *Sciurus carolinensis*, Red Fox *Vulpes vulpes*, various deer and rodents) can negatively impact native animal and plant species, e.g. predation of vulnerable ground-nesting birds such as Curlew *Numenius arquata* and Lapwing *Vanellus vanellus*, and excessive grazing of tree saplings and wildflowers.
- Species that hibernate (e.g. bats and Hedgehogs *Erinaceus europaeus*) or enter a torpid state in winter (e.g. Badgers *Meles meles*) may be disrupted by milder winter weather, especially as energetic losses during winter activity are much higher and prey availability is usually much lower than at other seasons.
- The New Forest hosts a small but increasing colony of seals, primarily Grey Seal *Halichoerus grypus* but with smaller numbers of Common/Harbour Seal *Phoca vitulina*, and these are likely to be impacted by climate-driven changes to coastal habitat (e.g. loss of haul-out and pupping sites due to coastal squeeze), prey availability (e.g. changing distribution of fish species), and waterborne diseases and harmful algal blooms associated with warming sea temperatures.

2.2.3 Birds

The New Forest supports an exceptionally rich bird fauna including internationally important breeding populations and wintering populations, and heathland and woodland specialists. Qualifying Features of the New Forest SPA are European Honey-buzzard *Pernis apivorus* (breeding), Hen Harrier *Circus cyaneus* (non-breeding), Eurasian Hobby *Falco subbuteo* (breeding), European Nightjar *Caprimulgus europaeus* (breeding), Woodlark *Lullula arborea* (breeding), Dartford Warbler *Sylvia undata* (breeding), and Wood Warbler *Phylloscopus sibilatrix* (breeding) (Natural England, 2025).

Climate change is most likely to drive population trends in the UK breeding bird assemblage through altered over-winter survival, changes in spring conditions affecting breeding success (e.g. intensity of spring rainfall), and summer drought reducing food supplies for some species. For example, milder winters drove increases in the abundance of many common and widespread resident species during the 1990s and 2000s, with effects typically stronger in small-bodied species.

Populations of many winter migrants are declining due to shifts in wintering locations, and for some species these declines are also likely to reflect changes in global population size due to reduced quality of Arctic breeding environments. Burton et al. (2023) note that "*in particular, waders and diving ducks have shown long-term north-eastwards shifts in distributional abundance through this period, reflecting the Arctic or sub-Arctic breeding origins of the majority of species, warming temperatures, and an increase ice-free deep water at the edges of species' wintering ranges*". Conversely, some summer migrants will be sensitive to changes in the frequency of Sahel drought, which climate models typically, but not universally, predict will increase in severity.

Newson et al. (2016) used extensive large-scale data collected in the UK over a 40-year period to present standardised measures of migration phenology for common migratory birds and examined how the phenology of bird migration has changed in the UK since the 1960s. They found that arrival dates for 11 of 14 common migrants became significantly earlier, with six species advancing their arrival by more than 10 days. Species that have advanced their timing of arrival showed the most positive trends in abundance, in accordance with previous studies.

There is increasing evidence for northwards range shifts in UK birds, similar to those observed in other mobile species. For example, Massimino et al. (2015) found that, for 80 breeding birds in the period 1994-2009, the leading edge had moved northwards at 3.3 km year^{-1}, while the trailing edge had remained largely static. Gillings et al. (2015) analysed the range shifts of the distributions of 122 species of British breeding birds during 1988–1991 and 2008–2011 using a full range of directional axes. They estimated a northwards range shift of 13.5 km between the two periods but also a retraction of southern margins. They concluded that the range shifts were multidirectional, individualistic, and probably determined by species-specific interactions of multiple climate factors, with a consequence for change in community composition (Betts, 2021).

The *State of the UK's Birds 2017* report shows that colonising bird species such as Cetti's Warbler *Cettia cetti* had spread to cover much of southern Britain but were still limited by cold winters.

More recently, Pearce-Higgins (2021) observed that "*climate change appears to be contributing to population increases and expansion in breeding waterbirds, including species colonising from continental Europe. Southerly-distributed waterbirds, coastal species, and heathland species are those most likely to benefit from climate change*."

New Forest examples

- A recent monitoring study of New Forest woodland bird species here showed that most resident and short-distance migrants are stable or increasing (with increased over-winter survival thought to be a key factor), whereas almost all the long-term summer migrants such as Willow Warbler *Phylloscopus trochilus* are decreasing. The most rapid decline was shown by Wood Warbler *Phylloscopus sibilatrix*, which is a feature of the New Forest SPA, but is now on the verge of local extinction. Long-distance summer migrants are being impacted by desertification and extreme weather events in their sub-Saharan wintering grounds and during their annual migrations, additional to 'intrinsic' factors on their breeding grounds. Conversely, the study showed increases in two short-distance summer migrant species (Blackcap *Sylvia atricapilla* and Chiffchaff *Phylloscopus collybita*), which have also become established as wintering species in our region.
- A cohort of southern species have colonised the New Forest in recent decades, including Little Egret *Egretta garzetta* and Firecrest *Regulus ignicapillus* that are now well-established and familiar residents. In addition, species at their northern range limit such as Cetti's Warbler *Cettia cetti*, Dartford Warbler *Curruca undata*, and Woodlark *Lullula arborea* are benefiting from an overall reduction in hard winters, while at wetland sites Spoonbill *Platalea leucorodia* and Great White Egret *Ardea alba* are increasingly common winter visitors (and likely future breeding species).
- In addition to climate change 'colonists' that are benefiting from overall warming conditions, some species are climate change 'refugees' that are predicted to be increasingly displaced by long-term desertification and/or acute drought events in southern Europe, with examples including Black-winged Stilt *Himantopus himantopus* and Glossy Ibis *Plegadis falcinellus*.

- Several migratory species that have traditionally moved south and west to winter in the New Forest are now 'short-stopping', with warmer winters allowing them to winter further north and east closer to their breeding grounds. This is driving declines in several species of wintering waders and wildfowl, including common species such as Dunlin *Calidris alpina*, Shelduck *Tadorna tadorna*, and Red-breasted Merganser *Mergus serrator*, and less common species such as Bewick's Swan *Cygnus columbianus bewickii*, European White-fronted Goose *Anser albifrons albifrons*, and Smew *Mergus abellus* (which are now very rare winter visitors). The Great Grey Shrike *Lanius excubitor* has also recently disappeared as a wintering species, with short stopping thought to be a potential factor.
- Coastal breeding birds are being impacted by sea-level rise and extreme storm events, particularly gulls, terns, and waders that nest on offshore saltmarshes and shingle banks.
- Breeding waders of the New Forest interior such as Curlew *Numenius arquata*, Lapwing *Vanellus vanellus*, Snipe *Gallinago gallinago*, and Redshank *Tringa totanus* may be impacted by spring/summer drought that leads to drying-out of wetland habitats - this can increase access for mammalian predators, people and dogs, and may lead to reduced vegetation growth leaving chicks more exposed to avian predators.

2.2.4 Reptiles and Amphibians

The New Forest is of national importance for reptile and amphibian populations, supporting all six native species of reptile (Grass Snake *Natrix helvetica*, Smooth Snake *Coronella austriaca*, Adder *Vipera berus*, Sand Lizard *Lacerta agilis*, Common Lizard *Zootoca vivipara*, Slow-worm *Anguis fragilis*) and five of the seven native species of amphibian (Common Frog *Rana temporaria*, Common Toad *Bufo bufo*, Smooth Newt *Lissotriton vulgaris*, Palmate Newt *Lissotriton helveticus*, and Great Crested Newt *Triturus cristatus*). It is of international importance for its population of Great Crested Newt, supporting an estimated population of between 500-1000 individuals across 13 locations (Natural England, 2025).

There is potential for reptiles and amphibians to be significantly impacted by climate change. For example, they are especially sensitive to habitat change and loss as they are generally philopatric (tending to return to or remain near the same area), with populations often centred around relatively small habitat pockets. Lowland heaths are of particular importance for reptiles, but these habitats are predicted to be impacted by changes in vegetation composition, increased wildfire risk, and direct risks to nest sites and juvenile survival from high intensity rainfall (see section 2.1.6 for more details). It is notable that lowland heath habitats in southern Europe support a greater diversity of reptiles than the UK, suggesting there may be potential climate benefits for reptiles in this habitat if the above risks can be effectively mitigated.

Ponds and lakes are of particular importance for amphibians, but climate change impacts such as warming-induced toxic algal blooms can lead to die-offs of amphibians and/or impact prey species such as invertebrates.

For reptiles, warming should increase reptile growth and maturation rates, due to longer periods of activity. Milder winters will likely reduce hibernation duration, potentially bring reproduction forward in the year and enable a greater number of number of broods per year, as observed in Slow-worms and Common Lizards (see Mather-Gratton, 2021 for references). These lifecycle changes may however have additional (possibly negative) impacts on population demographics and survival.

For amphibians, phenological changes such as early spawning, in the near term, increase the risks of losses due to freezing. Milder winters may lead to increased winter activity when invertebrates are

scarce, which may affect condition and survival, or lead to increased mortality during periods of colder weather.[48]

Disease risks are increasing due to warming, such as *Ranavirus* which is temperature sensitive with incidence peaking when average monthly temperatures reach 16°C. Introduced non-native species, which are potential vectors for novel diseases and parasites, may experience increased survival under warming scenarios.

Previous modelling predicted significant changes to UK reptile and amphibian distribution (Dunford and Berry, 2012), with northwards range expansion and/or range shifts indicated for most species, but with significant differences between species. Key species currently at the northern end of their range in England such as the Smooth Snake and Sand Lizard may extend their range as the climate becomes milder (McCullagh et al., 2025), although this depends on whether there are habitats and connectivity pathways for them to do so. However, they cope poorly with fragmented landscapes and are therefore less able to shift their distributions as the climate changes (Foster, 2022). Habitat management is critical for supporting any potential expansion e.g. ensuring suitability and connectivity between patches (Edgar et al., 2010, Mather-Gratton, 2021).

New Forest examples

- Ongoing heathland and wetland restoration work in the New Forest is increasing the quantum, quality, and connectivity of heathland and wetland habitats for reptiles and amphibians, e.g. recent surveys have demonstrated that species such as Common Lizard and Slow-worm can re-occupy heathland habitats within 12-24 months of conifer clearance, and that Sand Lizards can spread into new sites where bare sand patches are created.
- Increasing resilience to wildfire and drought will be vital to protect important reptile and amphibian populations, e.g. through controlled burning/cutting of heathland and deepening of important breeding ponds. Other measures such as reduction of nitrate and phosphate input to minimise risk of HABs, and provision of shade and movement corridors through targeted tree and hedgerow planting will benefit reptiles and amphibians.
- There is potential conflict between earlier emergence of reptiles and heathland management via controlled burning, particularly if the latter is delayed due to unusually wet winters; maintaining accurate and up-to-date records of key reptile hibernacula and making these available to land managers will be vital.
- Reptiles and amphibians suffer significant roadkill mortality in the New Forest, and major roads such as the A31 are potential barriers to movement. Provision of road tunnels and green bridges may therefore reduce this mortality.
- Trained volunteers play an important role in reptile and amphibian conservation in the New Forest. For example, Ringwood and Poulner Toad Patrol operate at a key road crossing point for amphibians moving between the non-breeding sites on the open forest and spawning grounds in the Blashford Lakes complex. Phenological change in amphibian populations may require changes to the timing and duration of these interventions.
- Populations of non-native species such as Green Lizard and Wall Lizard are likely to be benefitting from increasing temperatures - both species currently occur at coastal sites a few kilometres from New Forest heathland, so careful monitoring of these populations combined with early intervention will be necessary to minimise impacts on native Sand Lizards.

[48] https://www.arc-trust.org/news/winter-conditions-for-amphibians-and-reptiles

2.2.5 Fish

Of the 42 native and 13 introduced freshwater species in the UK fish fauna, 20 have been recorded in New Forest streams and rivers including Bullhead *Cottus gobio* and Brook Lamprey *Lampetra planeri* (both species listed on Annex II of the Habitats Directive), European Eel *Anguilla anguilla* and Brown Trout *Salmo trutta*. The Bullhead is a small bottom-living fish found in the upper reaches of lowland rivers. The Brook Lamprey is a primitive, jawless fish resembling an eel and is the smallest of the lampreys found in the UK. It lives entirely in freshwater. European Eel populations have declined by 95% since 1980, they are a species of principal importance under NERC Act and protected by the Eel Regulations 2009. Brown/Sea Trout are also Species of Principal Importance under the NERC Act, and protected under the Salmon and Freshwater Fisheries Act 1975 (Natural England, 2025).

Fish and aquatic invertebrates are ectotherms (i.e. dependent on external sources of body heat) so changes in temperature have a direct impact on their physiology. Each species has its own thermal thresholds, i.e. minimum and maximum temperatures, beyond which activities essential for survival are compromised or cannot be sustained. With warming, the risk of crossing upper threshold values increases, which will drive changes in phenology, loss of species, and modification of species communities. Understanding of species thresholds is increasing[49], however, in general, thermal thresholds are not well understood for most freshwater species.

Brown Trout *Salmo trutta* is an iconic New Forest freshwater species which has been well studied. Projections show that this cool-water species is likely to become unviable across much of England as river temperatures exceed their upper growth/feeding temperature range of 19.5°C (EA, 2025). Local surveys suggest that climate change is already affecting both juvenile survival and adult migration success of Brown Trout, whilst favouring more thermally tolerant species such as Minnow *Phoxinus phoxinus*, Stone Loach *Barbatula barbatula* and Three-spined Stickleback *Gasterosteus aculeatus* (Environment Agency, 2019).

Species can respond to higher temperatures through either physiological and/or genetic acclimatisation, behavioural or phenological change, or by moving to more suitable locations (range shifts). Differences in the mobility of different species will lead to changes in community composition and interactions between species.

Warming can also drive harder to detect sub-lethal impacts on animal physiology and phenology, body size, and trophic interactions, with the potential for significant population-level effects. Warming autumn and winter temperatures, well below thermal maxima, have been shown to influence the survival and performance of aquatic animals, including diapause, phenology, and reproduction (Johnson, 2024). Research suggests that food webs become less complex in warmer, nutrient-rich waters, and that simplified food webs can result in degradation of ecosystem function (Bonnaffé, 2024).

New Forest examples

Fish surveys are carried out by the Environment Agency (EA) and Freshwater Habitats Trust and have been commissioned under the HLS scheme. EA monitoring is primarily focused on the abundance and spatial distribution of juvenile wild Brown Trout but also provide information on eels, coarse fish (e.g. Roach, Chub and Pike) and the "minor" fish species (Brook Lamprey, Bullhead, Minnow, Stone

[49] E.g. GlobTherm database (Bennett, 2018) which includes 92 records of freshwater fish with thermal maxima spanning 20–43°C, and approach in Macadam et al., 2022.

Loach and Three-spined Stickleback). These reports have been concluding for several years that climate warming and fluctuations in flow regime are having negative impacts on juvenile trout abundance, and likely also other life stages of this thermally sensitive fish. The latest reports provide stark evidence of collapsing populations in both the Lymington and Beaulieu rivers, calling for urgent action to implement improvements to the wastewater/sewage treatment works that discharge into these rivers, address other sources of pollution, and to preserve and enhance habitat complexity to provide climate refugia (EA, 2019).

Research based on the Ober Water and Dockens water, highlighted in Dom Longley's talk at the 2025 New Forest Biodiversity Forum provides guidance on requirements for riparian shade:

"A relatively low level of shade (20-40%) was found to be effective in keeping summer temperatures below the incipient lethal limit for Brown Trout, but ~80% shade prevented water temperatures from exceeding the range reported for optimum growth of Brown Trout. Higher levels of shade are likely to be necessary for protecting temperature sensitive species from climate warming" (Broadwater et al., 2010).

2.2.6 Invertebrates

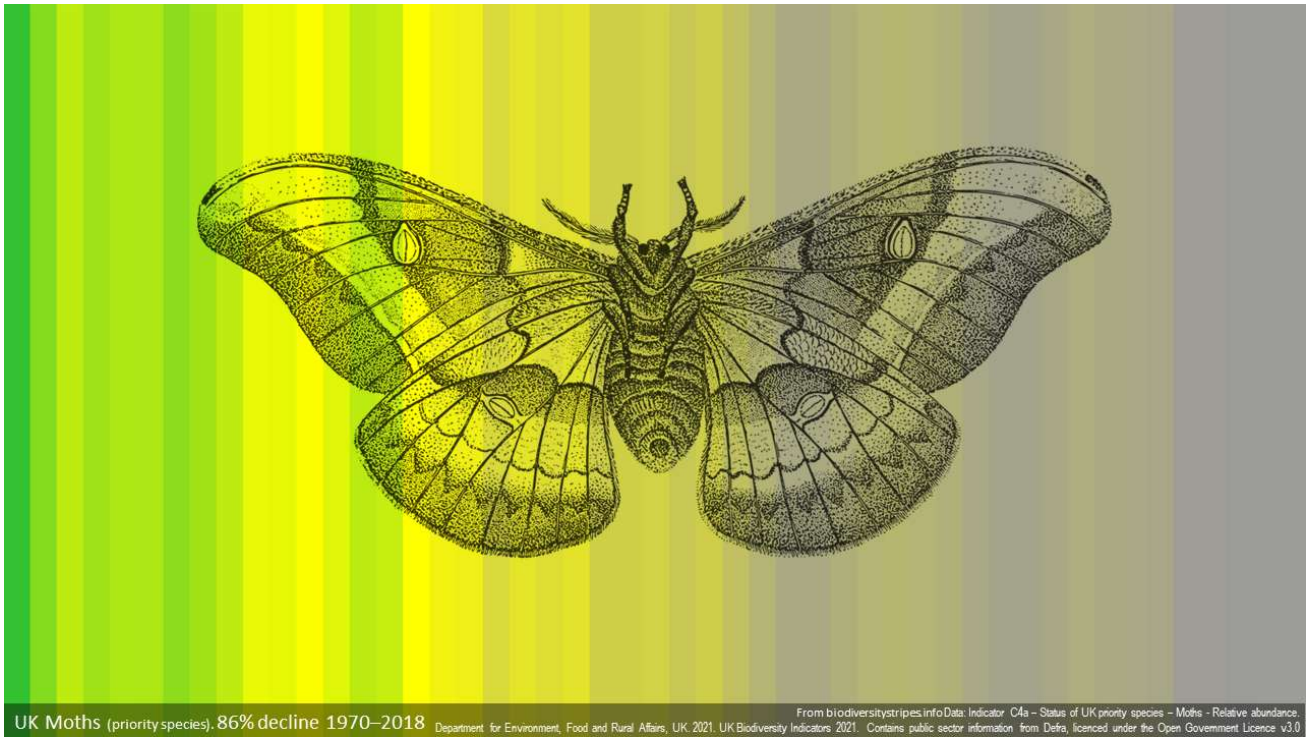
The New Forest supports an enormous diversity of invertebrate species, estimated at 15,000 species out of a UK total of ~24,000. Qualifying features of the New Forest SAC are the Stag Beetle *Lucanus cervus*, the UK's largest terrestrial beetle, and southern damselfly *Coenagrion mercurial*. (Brock, 2011 and Natural England, 2025). The significant population richness is related to the extent of semi-natural woodland and heathland habitats and associated structural diversity featuring extensive areas of transitional edge habitats.

A total of 164 Red Data Book species and more than 400 nationally notable invertebrate species have been recorded within the New Forest SAC. The deadwood invertebrate fauna is regarded as being of international importance and it is likely that in future specialist invertebrate communities of heathland and wetland habitats will prove to be important at a European level. New records continue to be found. (Natural England, 2025).

The New Forest and adjacent areas are the richest area of the UK for large moths (500+ species), mainly due to the warmer climate but also owing to the proximity of continental Europe for immigration and colonisation (Fox et al., 2021).

At a national level, aggregate species abundance and distribution indicators are available for freshwater invertebrates, bumblebees, moths, and butterflies. From a very low baseline (UK biodiversity is estimated to be only 50.3% intact [50]) data show freshwater invertebrate abundance and richness have increased slightly, while bumblebee, moth, and butterfly abundance and distribution in the main continue to deteriorate.[51]

[50] https://www.nhm.ac.uk/our-science/services/data/biodiversity-intactness-index.html
[51] https://www.gov.uk/government/statistics/indicators-of-species-abundance-in-england/indicators-of-species-abundance-in-england & https://www.gov.uk/government/statistics/butterflies-in-the-wider-countryside-uk/butterflies-in-the-united-kingdom-habitat-specialists-and-species-of-the-wider-countryside-1976-to-2021



https://biodiversitystripes.info/ukmoths/moth

Changes in distribution

There are many studies providing evidence of changes in **invertebrate distribution** attributed to climate change, which are strongest for relatively well-recorded species such as *Lepidoptera* (butterflies and moths) and *Odonata* (dragonflies and damselflies). For example:

- Fox et al, (2021) in their study of range shifts of 487 large moth species, found that 71% of these had statistically significant rates of northward expansion, with a mean range shift of 5.1km per year over the period 1995–2016.
- The most recent *Odonata* 'state of' (2021) report shows that generalist species, such as the Emperor Dragonfly and Migrant Hawker are increasing in range and abundance and that new species (6 since 1996) are colonising Britain at a rate greater than ever before (Taylor, 2021). Figure 28 shows a clear northward expansion in species richness.
- As assessment by Pearce-Higgins et al. (2017) of the risks and opportunities for ~3000 UK species found several invertebrate groups (ants, bees, centipedes, coccinellid beetles and wasps) for which most species (>70%) have the potential to benefit from climate change through range expansion.

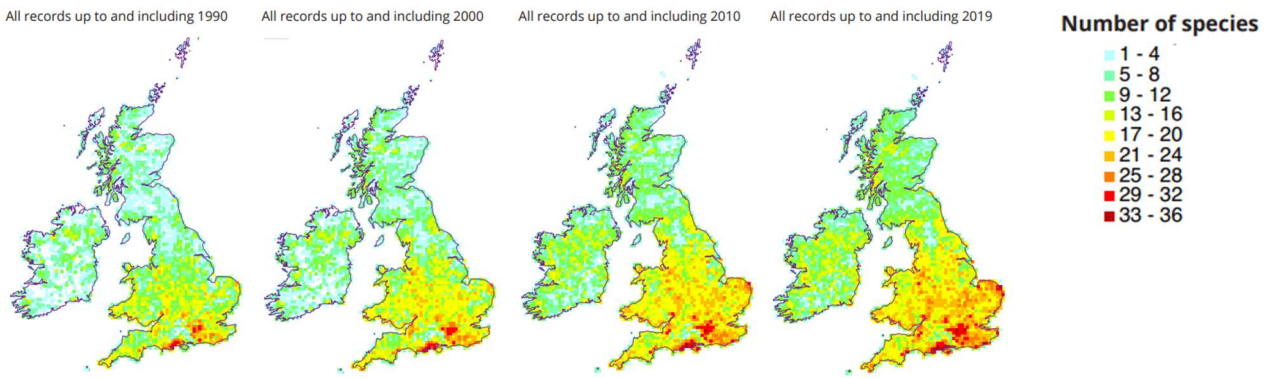


Figure 28: Hectad maps of dragonfly diversity showing the recent increases in species richness, from Taylor et al., 2021.

Changes in phenology

Evidence shows numerous examples of phenological change in response to climate. For example:

- Hickinbotham et al., (2024) found that flight periods of moth species that breed once per year (univoltine) are starting earlier in the year and overall duration is increasing. They also found variations in phenological shifts that varied depending on the overwintering stage of the species, with those that overwinter as pupa showing the highest rate of change suggesting higher adaptability and hence lower conservation concern than species that overwinter as either larvae or eggs.
- For *Odonata*, raised water temperatures (up to a threshold) increase development rates and modify phenology, such as two-year lifecycles reducing to one year, and single (annual) generation cycles doubling to two. On the flip side, drought conditions have also been shown to lead to local extinctions and/or trigger adult dispersal. Flood event impacts are poorly understood, potentially leading to dispersal and range expansion but also microhabitat damage and increased pollution incidents (Taylor, 2021).
- Fox et al., (2021) provide the example of Winter Moth *Operophtera brumata* whose eggs hatch earlier in warmer springs to remain synchronised with the earlier appearance of oak leave, noting that insectivorous birds have not adjusted their egg-laying dates sufficiently to keep up with shifts in the peak of caterpillar biomass.

For **aquatic invertebrates**, warming consequences include a decrease in organism size, changes in the composition of the benthic invertebrate community, and changes in the distribution of individual species. Increases in temperature and precipitation have also been shown to influence multiple biological traits including phenology, reproduction, and feeding (references in Macadam et al., 2022).

Using species trait information and data from the National Riverfly Recording Schemes, Macadam et al. (2022) assessed the vulnerability of mayflies E*phemeroptera,* stoneflies *Plecoptera,* and caddisflies *Trichoptera* to climate change. This identified 16 out of 289 species present in British waters as vulnerable to climate change. Species associated with headwaters and springs, particularly in upland areas, were the most vulnerable group. A cursory cross-check of this list against results

from HLS surveys suggests that some of these vulnerable species are present in the New Forest.[52] Recommended actions include planting riparian woodland to provide shade (noting this needs to be balanced against the impacts on other open-water favouring species), increasing heterogeneity, e.g. by restoring sections that have previously been straightened (canalised), and reducing other pressures (catchment scale pollution, abstraction etc.).

The existence of a rare long-term dataset of observations (weekly over 42 years) made at protected headwaters in Germany provides evidence of climate-driven invertebrate change in freshwater habitats. The results show multiple, complex changes in insect abundance, diversity, community structure, and phenology in response to increased water temperature (+1.88°C) and flow. Over 42 years, the observations show an 81.6% decline in total insect abundance (average loss of 1.94% per year), an increase in species richness (10%), and changes in phenology (earlier emergence). Notably, the study also revealed high fluctuations within the time series (e.g. over five-year periods) that may have been misinterpreted based on short time-series analysis, illustrating the value of long-term continuous studies for generating evidence of climate change impacts (Baranov, 2020).

Climate change is predicted to have negative impacts on species with low dispersal capabilities, intolerance to warm or highly variable temperatures, and specialists with dependencies on a narrow range of climate sensitive plants or habitat niches, with potential changes in abundance and increased risk of local extinctions.

New Forest examples

- A cohort of mobile southern species, including many formerly rare migrants, have naturally become established in the last two decades as 'climate colonists', including the Little Arboreal Ladybird *Calvia decemguttata* that arrived in numbers in summer 2025 as well as numerous moths such as Jersey Tiger *Euplagia quadripunctaria*, L-Album Wainscot *Mythimna l-album*, Tree-lichen Beauty *Cryphia algae*, and Dewick's Plusia *Macdunnoughia confuse* - most of these naturally colonising moth species are habitat generalists with widely accessible larval foodplants including herbaceous plants, grasses, and lichens; consequently their spread northwards typically follows the eastern and western fringes of the National Park although this may in part reflect recorder effort.
- Other southern moth species are additionally benefitting from an increase in southern tree and plant species, e.g. Blair's Mocha *Cyclophora puppillaria* and Oak Rustic *Dryobota labecula* that both have Holm Oak as the preferred larval foodplant.
- Some southern invertebrate species that were formerly restricted to the New Forest coast have spread inland in recent years and are now widespread in suitable habitat, including Wasp Spider, Roesel's Bush-cricket, and Long-winged Conehead (the former predates the latter two). In addition, the recent spread of Scarce Chaser dragonfly and Willow Emerald Damselfly across the New Forest may also be linked to warming temperatures.
- Many non-native species that previously arrived in southern England with human assistance are benefitting from increased temperatures and are now spreading northwards, particularly in winter, with examples including the Variable Cockroach *Planuncus tingitanus s.l.*, Box-tree Moth *Cydalima perspectalis*, False Widow Spider *Steatoda nobilis* and the Green-fanged Tube

[52] https://www.hlsnewforest.org.uk/hls-new-forest-projects/surveys-and-monitoring/monitoring-wetland-restorations/fish-and-freshwater-invertebrate-surveys/

Web Spider *Segestria florentina* - all these species are now established in urban and suburban habitats in the New Forest.

2.2.7 Vascular Plants

Of the 1,500 native vascular plants recorded in Britain, ~540 have been recorded within the New Forest Crown Lands and commons. Private lands within the SAC are thought to support 10-20 additional species. Due to the destruction of heathland habitat elsewhere in the UK, most native species of conservation concern found in the New Forest are associated with heathland habitat, however grasslands (particularly parched acid) and woodlands also support nationally scarce species. Ancient woodland habitats support 78 out of 100 species, listed on the Ancient Woodland Vascular Plant indicator lists for southern England (Natural England, 2025).

The SAC management plan highlights ephemeral ponds as the 'jewel in the crown' of New Forest flora, representing the best-preserved heathland ephemeral pond assemblage in Britain and one of international significance. These habitats, which are highly dependent on grazing to maintain their open nature, harbour the main concentration of Red Data Book species, including the vulnerable *Mentha pulegium* and *Pulicaria vulgaris* and two near-threatened species *Galium constrictum* and *Ludwigia palustris* (Natural England, 2025).

In the UK, there are now more introduced plant species growing in the wild (1,753) than native species (1,692). One in every five species of vascular plant is listed as threatened, mainly because of the degradation of their habitats by human activities (Walker et al., 2023).

Headline indictors of plant health are provided by JNCC ('plants of the wider countryside')[53] which reports abundance of plant species in four UK broad habitat types (arable field margins; broadleaved woodlands and hedges; bog and wet heath; and lowland grassland) and the BSBI Plant Atlas (summarised in Walker et al., 2023). The JNCC data show plant abundance fluctuating but remaining at similar levels to the 2015 baseline.

The more comprehensive and longer-term assessment provided by the BSBI Plant Atlas shows that the majority of native and archaeophyte species (ancient introductions) have decreased in range (~65% of species) whilst the majority of modern introductions (neophytes, introduced since 1500) have increased in range (61%) (Figure 29). The Plant Atlas concludes that some species are already shifting their distributions in response to climate change, and states that a warmer climate is likely to hasten the arrival of more Mediterranean species such as tongue-orchids.

[53] https://jncc.gov.uk/our-work/ukbi-plants-of-the-wider-countryside/

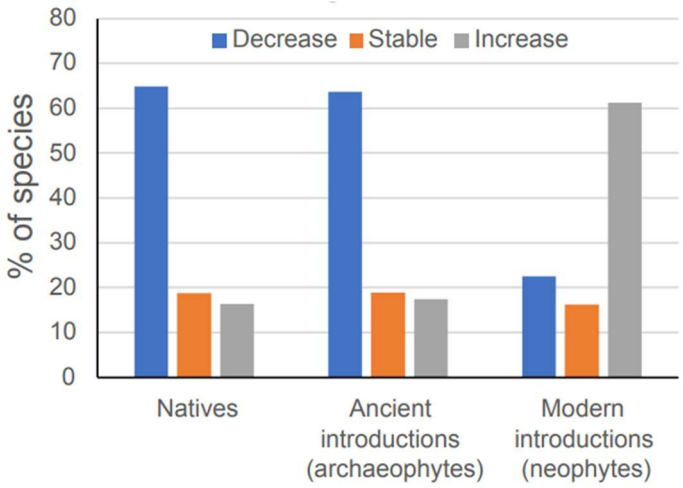


Figure 29: The proportion of plants with decreasing, increasing, or stable estimated mean distribution trends at the 10 km square scale in England since the 1950s. Mean trends are shown in relation to whether species are native or were introduced by humans in ancient or modern times (archaeophytes, neophytes). Walker et al., 2023 (BSBI Plant Atlas 2020).

Prevailing climatic conditions are the main driver of the vegetation composition of ecosystems. As outlined in the introduction, the New Forest is within the area of the UK predicted to experience the greatest change in climate, including, under a 'worst case' (RCP 8.5) scenario, shifting into new climate types in the future that have historically been absent from the UK. This highlights the potential for significant ecological change.

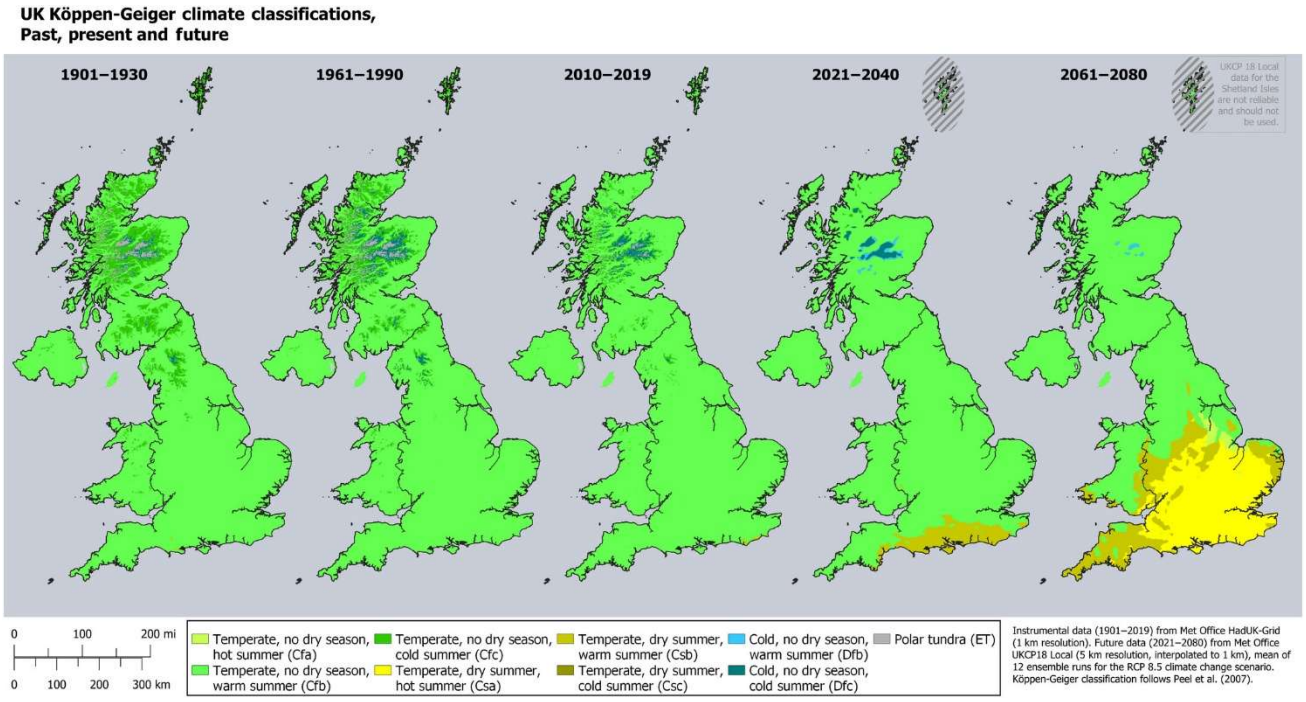


Figure 30: Maps showing Köppen-Geiger climate classifications for the UK from the early 20th century to the late 21st century (Wilson and Pescott, 2023).

In the near term, and under different emissions scenarios, there are high levels of uncertainty and considerable variation in the responses of vascular plant communities, as discussed throughout the habitat sections. For example, Carey (2015) suggests that many habitats and the plant communities within them are resistant to changes in environmental conditions, especially those communities

dominated by long-lived individuals, a natural inertia that in the absence of major disturbance confers a level of habitat resilience. Carey (2015) notes that there are plant species in the UK that have continued to exist centuries after the conditions to which they are adapted have ceased to exist both nationally and locally.

Although natural inertia may function at a community level, the relative abundance of plants within a community are expected to change, whilst some species may disappear and be replaced by others. This may occur less in highly stressed habitats - one European study, cited by Carey (2015) assessed patterns of invasion by alien species, finding none or few alien species in environmentally extreme and nutrient-poor habitats (e.g. mires, heathlands) and many in frequently disturbed habitats with fluctuating nutrient availability. They suggest that the number of archaeophytes in habitats will be a good predictor of alien invasion risk.

"For many communities there will be a small number of species that cover a large proportion of the ground. These could be called 'matrix' species, and these are typically essential for community functioning. The rest of the characteristic species of a community fill in gaps between the matrix species and, if missing, do not (as far as we know) fundamentally affect the function of the plant community. It follows that to understand how plant communities and habitats might change in the coming decades an understanding of what determines the abundance of the matrix species is vital." (Carey, 2015).

The 2017 Pearce-Higgins et al. study into climate change risks and opportunities for UK species found that along with bryophytes, vascular plants had the greatest proportion of species at risk (>30%).

New Forest examples

A discussion with a local plant expert highlighted several examples of vascular plant climate 'winners' in the New Forest including:

- Coral Necklace *Illecebrum verticillatum* is an example of a species that seems to be thriving locally in response to climate change[54]
- Sea Storksbill *erodium maritimum* (http://www.wildflowerweb.co.uk/plant/2881/sea-storksbill)
- Bramble *Rubus* seems to be thriving, which may help support natural regeneration of woodland trees[55]

This discussion also highlighted possibly secondary impacts via changing recreational use of the New Forest. Jo-jo-weed *Cotula sessilis*, an invasive non-native species that is increasing in abundance, notably around rural campsites and car parks. The species is of concern due to its upward pointing spines which pose a risk to the welfare of people, livestock, and wildlife as they are capable of penetrating human footwear and animals' feet. The distribution of Jo-jo weed provides an example of recreational activities acting as a vector for invasive non-native species. [56]

[54] https://naturebftb.co.uk/wp-content/uploads/2020/07/Coral-Necklace.pdf
[55] See e.g. https://knepp.co.uk/wp-content/uploads/2022/01/Bramble-as-a-Facilitator-of-English-Oak-Regeneration-Catherine-King.pdf
[56] https://hantsplants.uk/assets/documents/flora_news/Flora%20News%20Spring%202023.pdf

2.2.8 Lichens

The New Forest pasture woodlands and heathlands are of international importance for their lichen flora. 718 lichen species have been recorded since 1967, representing 30% of the British and Irish flora (~1900 species in total). Of these, 71 species are of conservation concern. Old-growth pasture woodlands (i.e. stand continuity greater than 200 years) provide the most significant lichen habitat in the New Forest (NE, 2025, Part 2, Sanderson, 1998).

Lichens are symbioses of fungi and photosynthetic algae or bacteria and are ubiquitous on Earth. They grow on rocks, bark or leaves, soil, and other substrates, weathering the rock, stabilizing soil and providing animals with food, shelter and camouflage. They are important carbon and nitrogen sinks, fixing carbon dioxide from the air to build biomass. They grow slowly and may become very old (Seminara et al., 2018).

Lichens are poikilohydric, meaning that they rely on the atmosphere for access to moisture and do not have water transporting systems like those found in vascular plants. Different species are variously adapted to a spectrum of moisture conditions from constant wetness or humidity to dry environments; some species are tolerant to extreme periods of desiccation. They are known to be highly sensitive to microclimatic environmental conditions i.e. differences in moisture and temperature at mm or cm scale. Differences in regional distribution indicate that they also show macro-climatic sensitivity (Ellis, 2015).

Changes in lichen distribution for England are reported in the 2024 state of nature report for 1,437 species. However, this notes that there is no evidence linking these changes directly to climate. The stronger driver of lichen distribution historically, and likely currently, is due to their high sensitivity to atmospheric pollution (in particular SO_2 and Nitrogen).

Discussion of lichens and climate change in literature suggest that sensitivity is highly species- and habitat-specific, with concerns highlighting their slow growth and hence limited capacity for in situ adaptation. This may be mediated by the availability of suitable microclimatic refugia buffering large scale changes in climate.

There are also risks for lichens associated with indirect impacts from climate change, for example those associated with woodland ecosystems may be affected by climate driven change in woodland composition, adaptive changes in woodland management, or tree pests and diseases.

2.2.9 Bryophytes

There are about 1,030 species of bryophytes in Britain, of which at least 326 have been recorded from the New Forest SAC (96 liverworts and 230 mosses), representing ~31% of the British flora. Of these, 33 are of conservation concern. Four liverworts of conservation concern are known only from 19th century records. Of the recently recorded species, one-third (11) are woodland species and the rest are heathland species. A major feature of the New Forest is the presence of many species that are otherwise rare or absent in lowland England (NE, 2025)

Bryophytes are a group of small, non-vascular plants that include mosses, liverworts, and hornworts. They are found in almost every terrestrial environment and play important roles in regulating the global carbon cycle and maintaining ecosystem stability (Číhal, 2023).

Bryophytes have ‘exceptional importance’ in the control of global carbon fluxes and climate due to the vast stores of carbon found in peat. More carbon is stored in *Sphagnum* than in any other genus of

plant, (Zanatta, 2020). As highlighted in the habitats section, *Sphagnum* species play a critical role regulating water flow in the mires and bogs of the New Forest as well as sequestering and storing carbon. Their lack of roots makes them dependent on precipitation. A key concern is how these species and the growth and productivity of other bryophytes respond to climate change and how this affects their ability to deliver this critical ecosystem service.

As mentioned previously, the 2017 Pearce-Higgins et al. study into climate change risks and opportunities for UK species found that bryophytes, along with vascular plants, had the greatest proportion of species at risk (>30%). A key concern is the thresholds of resistance of bryophytes to temperature and precipitation which remain mostly unknown, creating uncertainty about how long the climate buffering capacity they currently provide will remain functional.

Heatwaves and drought are thought to pose significant climate risks for bryophytes. Different species have different tolerances to desiccation, with some research showing that they become more sensitive to drought as a result of prolonged stress from drying. Work on blanket bogs (Ritson, 2025), found that frequency of *Sphagnum* desiccation events will increase by between 44% and 82% across a number of UK case study areas (by 2061–2080), and that probability of peat in UK in 2061–2080 being inside its baseline bioclimatic envelope is virtually zero under the RCP8.5 pathway. The drying out of the New Forest valley mires, and consequential impact on the peat soils of the National Park, are a significant and poorly understood risk.

Recently published work found that climatic stressors and vulnerabilities may significantly differ between seasons, finding that high temperatures are damaging to hydrated bryophytes during the wet season but may have minimal impact on dormant bryophytes in the dry season; these types of divergent responses to the same environmental stress require further investigation (Slate et al., 2024).

Slate et al. (2024) also note that bryophytes are incredibly resilient plants. They are among the first colonizers, regrowing after being dry or entombed in glaciers for years. The variability of changing climate may provide unanticipated opportunities for natural recovery and adaptation. They also have strong positive impacts on the resilience of the ecosystems in which they occur and may increase the thermotolerance of their hosts by inducing a physiological stress response to increasing temperatures. Their ability to colonize after severe wildfire, increase soil bacterial diversity, and promote succession of microbial communities on fire-affected soils, highlight their potentially increasing value and the importance of conserving these species within regions such as the New Forest.

Epiphytic and ground-flora bryophytes and lichens associated with woodland ecosystems are potentially more likely to suffer from indirect effects of climate change such as adaptive changes in woodland management, or tree pests and diseases.

2.2.10 Fungi

The New Forest SAC woodlands are of international significance for fungi. At least 89 fungi of conservation concern have been recorded within the SAC. Of the species of nature conservation concern most are woodland species, with only nine heathland and grassland species recorded. These include species of acid grassland and species that are mycorrhizal on *Salix repens*. The best-known heathland species is Nail Fungus *Poronia punctata*, a specialist found on horse dung from grazing acidic rough pastures. The 71 woodland species include a group of 11 species confined to old trees, or fallen large trees, within the pasture woodlands. These include the toothed fungi (*Hericium cirrhatus, Hericium coralloides, Hericium erinaceum*) and the bracket fungus *Phellinus robustus*. These are old growth dependent species with very low population densities. Many epiphytic lichens

exhibit a similar restriction to tiny numbers of trees, which suggests that very large areas of pasture woodland are required to support such old growth dependent species. (NE, 2025, Part 2).

Challenges in field-based fungi identification and the ephemeral nature of their visible fruiting bodies means that abundance and distribution trends are poorly defined or lacking for almost all species.

Shifts in temperature and moisture levels are known to directly affect fungi and therefore some changes are likely, although evidence is severely lacking. Climate change impacts are also likely to occur due to the symbiotic relationships that fungi have with plants, whether as beneficial partners, decomposers or parasites. Climate-related impacts that modify plant diversity are likely to also affect their co-existing fungi.

New Forest examples

- Saprotrophic fungi associated with ancient Beech woodland are likely to be benefitting in the short term from the abundance of dead and decaying wood, in part linked to the decline of a particular age cohort of Beech trees (Tubbs, 1968) but with a potential contribution of climate change. However, in the longer term, if projections of climate-linked decline of Beech in southern England are correct, then this will also lead to a decline of Beech-dependent saprotrophic fungi in the New Forest (unless they are able to switch host trees).
- Some fungi species may be able to follow northwards distribution shifts of their host tree and plant species via natural spore dispersal, which will be aided by improved connectivity, e.g. woodland and hedgerow creation.
- Interventions including 'veteranisation' of trees may increasingly require donor fungi from important reservoir sites such as the New Forest.
- Periods of drought in summer and autumn may impact the generation of mycorrhizal fungi fruiting bodies, particularly those associated with heat-stressed trees such as Beech, e.g. during the record-breaking hot summer of 2022 there were noticeably fewer mycorrhizal fungi fruiting bodies to be found in their usual locations within their usual timeframe. In contrast, saprotrophic fungi can secure moisture from their host tree and are able to thermo-regulate; they can therefore develop fruiting bodies even during periods of exceptionally hot and dry weather.
- Sooty Bark Disease is thought to be more prevalent following drought years[57] and was found on Sycamore trees at two New Forest sites in autumn 2023 following the severe drought of summer 2022.
- Recent colonisation and/or rapid spread of fungi species from southern Europe (including the Mediterranean region) may be a result of increased spore dispersal, survival, and recruitment linked to a warming climate. Examples include the now common and widespread Yellowing Curtain Crust *Stereum subtomentosum*, which has rapidly spread north through England and is now widespread in the New Forest.
- Some southern fungi may also benefit from changing woodland composition in response to climate change, e.g. an increase in tree species prevalent in southern Europe, such as Holm Oak, may support the spread of recent colonists such as Bearded Amanita *Amanita ovoidea*, which to date has been recorded from the Isle of Wight and Wiltshire and is ectomycorrhizal with Holm Oak (Mattock, 2006).

[57] See https://cdn.forestresearch.gov.uk/2022/04/21_0026_Leaflet_CC_factsheet_Tree_diseases_Canker_wip07_Acc.pdf

2.3 Pests, diseases and pathogens

This section reviews and discusses some of the current and potential future impacts of climate change on pests, diseases and pathogens relevant to the New Forest considering people, animals (wildlife and livestock), and plants. Invasive Non-Native Species (INNS) are also discussed briefly.

Pests, diseases and pathogens is a broad term used to describe organisms that impair normal function, cause damage or are otherwise harmful to other organisms. Pathogens include disease-causing viruses, bacteria, fungi or protists (single celled microscopic organisms) which attack plants and animals.

Non-native species are animals, plants or other organisms that are introduced by humans, either intentionally or accidentally, into places outside of their natural range. When their presence in a region has a harmful effect on native biodiversity, ecosystem services, the economy or human well-being they are referred to as invasive.[58] INNS can also be vectors for pathogens and disease.

Summary of climate impacts		Consequences	Risk
People	Increase in infections of Lyme disease and tick-borne encephalitis due to extended transmission season and increase in person-tick contact. Transmission of mosquito driven dengue, chikungunya, and West Nile virus increasingly likely Warming freshwater and marine environments increase the risk of bacterial (e.g. vibrio) occurrence, and harmful cyanobacterial blooms which can occur in eutrophic waters.	Increased risks to visitors and those volunteering or working in the natural environment such as frontline conservation and forestry workers. Potential for disruption or changes in visitor behaviour Potential conflict between needs of people and nature (habitat management, restoration)	Moderate, increasing
Animals	For livestock diseases such as bluetongue and liver fluke are expected to increase	Implications for commoning viability and costs, with associated consequences for habitat management	Moderate, increasing
Plants	Primary concerns are pathogens, especially fungal, and mobile insect pests.	Species specific risks, difficult to predict or plan for. Risks of landscape scale change if an abundant or keystone species is affected.	High, increasing
Invasive Non-Native Species (INNS)	Potential influence on the survival, distribution and abundance of INNS, for example through flood driven dispersal of seeds.	Significant long-term threat, difficult to predict or plan for. Incurs multi-year and ongoing costs to manage and eradicate.	Moderate, increasing

Impacts of Climate Change

Climate change increases uncertainty in the risks associated with pests, diseases and pathogens, with higher temperatures and modified climatic conditions enabling new species to become

[58] https://iucn.org/our-work/topic/invasive-alien-species#:~:text=Invasive%20alien%20species%20are%20animals,human%20economy%20and%20well%2Dbeing.

established and potentially changing the impact of existing species due to altered relationships, abundance and susceptibility.

Many infectious diseases are highly climate sensitive, and with warmer temperatures risks of new and emerging infectious diseases increase, including those transmitted through mosquito and tick bites. Southern England is particularly at risk in the UK due to higher relative temperatures and proximity to mainland Europe.

Projecting impacts associated with pests, diseases and pathogens is highly complex. The disease process relies on many interacting factors between the host, the pathogen and/or vector, and their environment. All of these will be impacted by climate change in different ways.

Temperature is widely recognised to directly affect the development, survival, range and abundance of species. Higher average temperatures influence the likelihood of species overwintering successfully (existing species and new arrivals) and extend seasonally driven activity by increasing the available thermal budget for growth and reproduction (Hulme, 2015).

Host susceptibility may be modified due to climate stress, i.e. due to drought, heat stress or impacts of wetter winters and extreme events (Goberville *et al.* 2016).

Wetter winters and high intensity precipitation increases the frequency of water flowing over land and into habitats such as rivers, lakes, wetlands and estuaries. These flows of water can carry nutrients, seeds and other material with them, promoting the spread of INNS, pests and diseases.

Socio-economic factors are likely to play a primary role in future risk influencing the likelihood of new species arrivals (e.g. via biosecurity practices and changing trade routes). Other uncertainties relate to risks posed by cryptic diseases (those with unknown or obscure causes) that are difficult to detect such as phytophthoras.[59]

Although climate change predominantly increases pest and disease risks (Mora et al., 2022), there are cases where climate change can reduce the risks associated with some diseases. In a review of climate driven health impacts on wildlife, Greening *et al.* (2025) found that climate change can lead to declines or shifts in disease just as often as increases. In the case of Ash, and ash-die back (caused by the fungi *Hymenoscyphus fraxineus)*, research by Goberville *et al.* (2016), suggests that climate change could lead to increased ash productivity in the future based on the combination of higher temperatures encouraging ash growth and drier summer conditions constraining the growth of the disease-causing fungi. There is also recent evidence indicating the development of evolutionary resistance to the disease in naturally regenerated Ash.[60]

Risks to Human Health

For people, Lyme disease and tick-borne encephalitis are of increasing concern, alongside mosquito driven dengue, chikungunya, and West Nile virus.

Rising average temperatures and hotter summers modify the transmission dynamics of Vector Borne Diseases (VBD's) such as those spread through insect carriers (e.g. mosquitos, ticks, fleas, flies or lice). Warmer temperatures facilitate the spread of VBD's by increasing the abundance and

[59] https://www.forestresearch.gov.uk/research/threats-from-phytophthora/
[60] https://www.theguardian.com/environment/2025/jun/26/ash-trees-evolve-resistance-dieback-study?CMP=share_btn_url

distribution of the vector species, prolonging the transmission season and increasing the rate at which pathogens can reproduce.

Infections of Lyme disease and tick-borne encephalitis (TBE) transmitted by *Ixodes Ricinus* (Castor Bean or Deer tick) are expected to increase due to an extended transmission season and increase in person-tick contact. Although the risk of TBE is currently very low, there have been a small number of TBE detections in the UK since 2019. Increases in these infections are the most likely emergent tick-borne risks in the UK as the climate warms (Kovats et al., 2021).

Transmission of mosquito driven dengue, chikungunya, and West Nile virus become increasingly likely with climate change. West Nile was detected in the UK for the first time in 2023.[61]

The UK Health Security Agency highlight establishment of the tiger mosquito as one of the most significant risks for public health posed by climate change (UKHSA, 2023). The tiger mosquito (Aedes albopictus) native to Southeast Asia, is now present in most of mainland Europe, with a preference for urban environments.[62] The first UK record occurred in 2016. This day biting mosquito has been involved in transmission of dengue, chikungunya and occasionally Zika viruses and has adapted to survive Northern Europe winters.[63]

In the marine environment the prevalence of new human pathogenic Vibrio species (bacteria) has been identified in the UK in response to rising sea-surface temperatures. In 2022 two new species were identified at sites on the South Coast (Chichester Harbour and Lyme Bay), (Harrison, 2022). The human risks associated with vibrio are predominantly associated with un-cooked shellfish, but they can affect sea users who swallow infected seawater or from the bacteria entering exposed wounds or cuts.[64]

Climate change is expected to increase the frequency, intensity and duration of cyanobacterial blooms in eutrophic waters. Hotter drier summers can lead to increased thermal stratification and drought conditions that increase water residence times (leading to stagnation) and can provide ideal conditions for cyanobacterial bloom development (Cavicchioli, 2019). Eutrophication issues in the New Forest are currently restricted to a small number of ponds with water quality issues. The CEH app records public sightings, showing only one confirmed occurrence within the New Forest (in 2022), and a small number of unconfirmed but plausible sightings.[65] Although eutrophication is an issue in some areas of the Solent the New Forest coast is not currently affected (Environment Agency, 2023).[66]

The consequences of the changing disease risk profile for humans for the New Forest include:

- Increased risks to conservation practitioners working in the forest (rangers, foresters, ecologists, volunteers)
- Potential modification of visitor and recreational behaviours
- Potential for conflict between the needs of people and the natural environment, impacting habitat management or restoration

[61] https://www.gov.uk/government/news/first-detection-of-west-nile-virus-in-uk-mosquitoes
[62] See Aedes albopictus (tiger mosquito) details here
[63] https://ukhsa.blog.gov.uk/2024/12/03/how-we-monitor-invasive-mosquitoes-and-stop-them-spreading-in-the-uk/
[64] https://www.port.ac.uk/news-events-and-blogs/news/new-bacteria-in-uk-waters-as-temperatures-rise
[65] Online CEH portal here - https://www.ceh.ac.uk/our-science/projects/bloomin-algae
[66] See also https://environmentagency.blog.gov.uk/2024/09/10/wet-winters-leading-to-more-macroalgae-in-solent-but-nutrient-reduction-offers-hope-for-the-future/

Risks to Animal Health

Livestock pest and disease risks are already changing and will continue to do so, with increased risks from parasites such as liver fluke in response to milder winters (liver fluke populations are limited by frost) (Betts & Brown, 2021).

Bluetongue is an example of a viral disease that is believed to have emerged in Europe in response to climate change. Transmitted by biting midges (*Culicoides*), it affects ruminants such as cattle, sheep, goats and deer. Population size, mortality rate and biting rate are temperature-dependent, as is the virus replication rate, which governs the time taken for an infected vector to become infectious. Bluetongue occurred for the first time in northern Europe in 2006 and in the UK in 2007. The disease is believed to have been carried by wind-borne infected midges from mainland Europe. As climate change continues the disease is expected to continue to spread north, the transmission season is expected to lengthen and the size of outbreaks is projected to increase (Cavicchioli, 2019 and Jones, 2019). The latest UK outbreak occurred in 2023 with cases occurring in the New Forest in 2024/25.[67]

Impacts of bluetongue vary depending on the species inflected and the strain of the virus, some show no symptoms, for others it can cause reduced milk yield, in some cases it can be fatal. As well as direct harm to livestock the bluetongue adds financial (and psychological) cost to farmers or others affected. Control strategies currently include movement restrictions, which have affected the New Forest Commoning community and may impact on other, non-Commoning livestock farms within and around the National Park.

There is limited published work on the impacts of climate change on disease relevant to UK wildlife. Price et al. (2019), show that climate change has already increased the spread and severity of *Ranavirus,* that can cause mortality in common frogs, suggesting that higher temperatures drive increasing severity of epidemics. There is a large body of work focused on zoonotic diseases (those which can jump between different species), although this is largely focused on the increasing risks of transmission between animals and humans.[68] Little is known about the impacts of alien pathogens (including viruses, bacteria, fungi, and protists) and associated emerging infectious diseases on biodiversity and ecosystems. Thurman et al. (2024) highlight the opportunity for 'disease-smart' adaptation in wildlife conservation, offering case studies for integrating climate adaptation with disease management to avoid potential unintended consequences of conservation actions.

Risks to Plant Health

Nationally, threats from plant pests and diseases are assessed by pest risk analysis and managed through the UK Plant Health Risk Register.[69] The register is growing, with around a hundred new pests and pathogens being identified and added each year (particularly since c. 2000). Currently (2025) there are 1426 entries.

Taxa that are very likely to be the most responsive to the changes in temperature and precipitation are plant pathogens, especially fungal species, and mobile insect herbivores.

Crop pests and pathogens have shown an average poleward shift of 2.7+/-0.8 km per year since 1960, consistent with climate driven warming. These trends are expected to continue with further climate change, leading to more frequent incursions of new species into the UK, particularly in south-

[67] Overview of Bluetongue Cases & Zones since August 2024 (DEFRA, Animal and Plant Health Agency)
[68] See e.g. https://www.carbonbrief.org/climate-change-already-raising-risk-of-virus-spread-between-mammals/
[69] https://planthealthportal.defra.gov.uk/pests-and-diseases/uk-plant-health-risk-register/

eastern England where average temperatures are warmer and the proximity to Europe results in some species being introduced by suitable wind patterns (Betts and Brown, 2021)

The Diamond-back Moth (*Plutella xylostella*) is a well cited example. This pest of *Brassica* crops is particularly well known in tropical regions, where it can produce up to 14 generations in a year. Sporadic outbreaks occur in the UK and Northern Europe, but cold temperatures have so far limited establishment. Recent evidence suggests that these moths may increasingly survive as winters become milder (Wainwright et al., 2020).

Climate driven risks from pests and diseases are recognised as posing a particularly high risk to trees and woodland habitats. “At least 10% of the world’s tree species are now vulnerable to disease, decline or extinction, with all evidence suggesting an increase in the amount of disease and extinction events driven by fungi.” (Goberville et al. 2016)

Weather is often a factor in the severity of many tree disease epidemics, with temperature, rainfall, and soil moisture acting as the main drivers and influencing sporulation, dispersal, and survival. Drought or heat stress contribute to susceptibility of the host tree to the impacts of disease (Wainhouse et al., 2016). Forest Research has identified increased climate-driven risks from several pathogen groups:

- Phytophthoras (fungus-like pathogens). This diverse group includes species that benefit from increased rainfall, flooding, and milder winters leading to increased infection rates.[70]
- Canker diseases, such as Sooty Bark on Sycamore, which only causes disease if host trees suffer drought or high temperature stress. Symptoms typically develop in the year following a summer in which the mean temperature in one or more months equalled or exceeded 23°C.[71]
- Foliar pathogens infect the leaves or needles of trees. ‘*The most dangerous plant pathogen worldwide’* (European Commission) is currently the bacteria *Xylella fastidiosa*. It can infect over 500 plant species resulting in leaf scorch, wilt and increased mortality. It is transmitted between plants by sap-feeding insects. This pathogen is not yet present in the UK but is now established in Italy, Spain and France.[72]
- Root pathogens infect and damage the root systems of trees, impacting water and mineral uptake; this can reduce tree growth and may lead to tree death. Climate change is expected to increase growth or spore release of these common pathogens leading to increased infection, and may also extend the active period of pathogens, allowing them to cause successive years of damage to a host species.

Initiatives such as Observatree disseminate information on priority tree pests to the public and encourage and support citizen science observations.[73]

Insect pests are also a concern for trees, shrubs and other plants, with different groups of insects influenced in different ways that are challenging to predict. Warmer temperatures may enable pest species to have more generations each year, extend the period over which they are active, or expand their distribution. Conversely there may be increased pest mortality due to high intensity rainfall, or phenological mismatches between defoliators such as butterfly or moth larvae.

[70] https://cdn.forestresearch.gov.uk/2022/07/21_0027_Leaflet-CC-factsheet-Tree-diseases-Phytophthora_wip06_Acc.pdf
[71] https://cdn.forestresearch.gov.uk/2022/04/21_0026_Leaflet_CC_factsheet_Tree_diseases_Canker_wip07_Acc.pdf
[72] https://cdn.forestresearch.gov.uk/2021/06/21_0003_leaflet_cc_factsheet_diseases_of_tree_foliage_wip06_acc.pdf
[73] https://www.observatree.org.uk/pests-and-diseases/priority-pests-and-diseases/

Mammals such as deer, grazing livestock, and small mammals (e.g. Grey Squirrels) damage trees and reduce natural regeneration of trees and scrub. This is a recognised issue within the New Forest. Numbers of Grey Squirrel are expected to increase due to milder winters and improved food availability (higher temperatures enhancing seed production). Grey Squirrels can cause major damage to trees by stripping the bark, which reduces timber quality, value, and yield. If ringbarked, the tree or branch will die. The damage caused by Grey Squirrels can also cause wounds through which pests and diseases may gain entry. Forest Research note that Oak damage from Grey Squirrels in lowland Britain is expected to increase, and that dominant Oak trees >7.5 cm in diameter have been found to be damaged most.[74]

Deer have been identified as being a substantial problem for the establishment of trees and new woodlands and for the management and biodiversity interests of existing woodlands, particularly by reducing or preventing natural regeneration of trees. All six deer species established in the UK have been increasing in number and range over the last forty years. Deer are more abundant and widespread now than at any time in the past 1,000 years. Climate change is expected to reduce fawn mortality and benefit deer populations. In particular, the Fallow Deer population is thought to be rising due to lower mortality during milder winters (Natural England, 2025).

Climate driven changes in pest and disease risks to plants are a significant and increasing concern for the New Forest due to the primary importance of the living natural environment, and potential for pest or disease outbreaks to drive wider biodiversity loss. When a plant or plant species is damaged or killed there are cascading implications for the many known and unknown associated species. Depending on the functional role of the affected species within the ecosystem, and level of functional redundancy present, the consequences may be far reaching.[75]

Invasive non-native species (INNS)

The Global Assessment report on Biodiversity and Ecosystem Services identifies INNS as one of the top five threats to biodiversity worldwide (IPBES, 2019). There are currently more than 2000 established NNS in the UK, c. 195 of which are considered to be invasive (47 freshwater species, 40 marine species and 108 terrestrial species).[76] Some endemic species that are currently not invasive may become invasive as a result of future climate change. Islands and coastal mainland areas are hotspots of invasions. (Pyšek, 2020).

INNS risks are primarily influenced by socioeconomic drivers, including international trade, within-country movements, biosecurity measures and land use change. Climate change is generally considered a second order influence.

CCRA3 assessed the climate risk associated with INNS as medium (today) increasing in the future (becoming high) for England, based on the combination of proximity to continental Europe and warmer annual average temperatures. Together these lead to a higher likelihood of arrivals and establishment. In the longer term continued warming and changing patterns of extreme events are expected to further expand the range of climate suitability and increase the chance of establishment of INNS, thereby increasing future risk to species and habitats. (Betts, 2021)

INNS have complex and often immense long-term direct and indirect impacts, many of which manifest decades or more after arrival. INNS can break down biogeographic realms, affect native species

[74] https://www.forestresearch.gov.uk/climate-change/risks/pests-and-diseases/
[75] https://www.forestresearch.gov.uk/news/115144-loss-of-tree-species-has-cumulative-impact-on-biodiversity/
[76] https://jncc.gov.uk/our-work/ukbi-invasive-species/

richness and abundance, increase the risk of native species extinction, affect the genetic composition of native populations, change native animal behaviour, alter phylogenetic diversity across communities, and modify trophic networks. Many invasions alter ecosystem functioning and the delivery of ecosystem services (Pyšek, 2020).

Management of INNS can also incur significant economic costs (Eschen et al., 2023).

The New Forest has an ongoing Non-Native Plants Project[77] led by Hampshire and Isle of Wight Wildlife Trust which aims to stop the spread of invasive non-native plants particularly along water courses and in wetland habitats. Species currently being tackled include Giant Hogweed, Rhododendron, Himalayan Balsam, Japanese knotweed, American Skunk Cabbage, Yellow Azalea, Parrots Feather, New Zealand pigmyweed, Gaultheria, Montbretia, Pickerel Weed, Bog Arum, Cotoneaster and Pitcherplants. These species were all introduced by horticulturists for use in domestic gardens and ponds but have 'jumped the fence' or been deliberately planted in the countryside and can be a significant contributor to (localised) native biodiversity loss.

Evidence shows that flooding contributes to the distribution of INNS (Wildlife and Countryside Link, 2024), as has been the (anecdotal) experience in the New Forest.

Mitigation and Adaptation Opportunities

Ensuring the risks to people are understood, managed and communicated is essential, especially for conservation practitioners, farmers, foresters and volunteers.

Stressed trees, plants and animals are more vulnerable to pests and disease than when healthy, therefore managing other pressures alongside pests and diseases is vital.

Key responses to this risk include increasing awareness of pest and disease risks amongst the relevant visitor, resident and landowner, land manager, habitat management communities, and ensuring clear signposting to advice on how to respond (e.g. reporting or otherwise managing the risk).

Further reading

- New Forest Non-Native Plants Project and GB Non Native Species Secretariat advice
- Summary and links to the latest (2025) watch list
- Health Effects of Climate Change (HECC) report
- Wildlife and Countryside Link, Stemming the Flood of Invasive Non-Native Species (2024) (Report), includes case study on Water Primrose eradication at Round Pond Breamore Marsh (HIWWT)
- Forest Research Tools and Resources
- The Met office UK Climate-Pest Risk Web Tool

[77] https://www.hiwwt.org.uk/new-forest-non-native-plants

2.4 Natural Capital & Ecosystem Services

This section assesses whether and how the natural capital value, and related ecosystem service functions of the New Forest, may change in response to climate change.

"Nature is not fragile … what is fragile are the ecosystems services on which humans depend". (Levin 1999)

The natural environment of the New Forest delivers a multitude of benefits to people - these include both direct and indirect 'services' that ecosystems deliver that underpin human wellbeing and quality of life.

"*Nature's goods and services are the foundations of our economies. They include the provisioning services that supply the goods we harvest and extract (food, water, fibres, timber, medicines) and cultural services, such as the gardens, parks and coastlines we visit for pleasure, even emotional sustenance and recuperation… Nature's processes also maintain a genetic library, preserve and regenerate soil, control floods, filter pollutants, assimilate waste, pollinate crops, maintain the hydrological cycle, regulate climate, and fulfil many other functions besides. Without those regulating and maint*

enance services, life as we know it would not be possible." (Dasgupta, 2021)

Natural capital provides a framework that can be used to place an economic value on ecosystem services, enabling natural assets and their value to people to be integrated into economic assessments and decision making. Although not without criticism, these economic approaches aim to redress historic undervaluation and overexploitation of nature as a 'free' resource. Natural capital assessments enable financial recognition that degradation of the natural environment has a current and future cost to the economy and requires investment and protection to be managed sustainably.

Figure 31, (IEMA, 2024) illustrates how the natural environment provides services that deliver benefits to people.

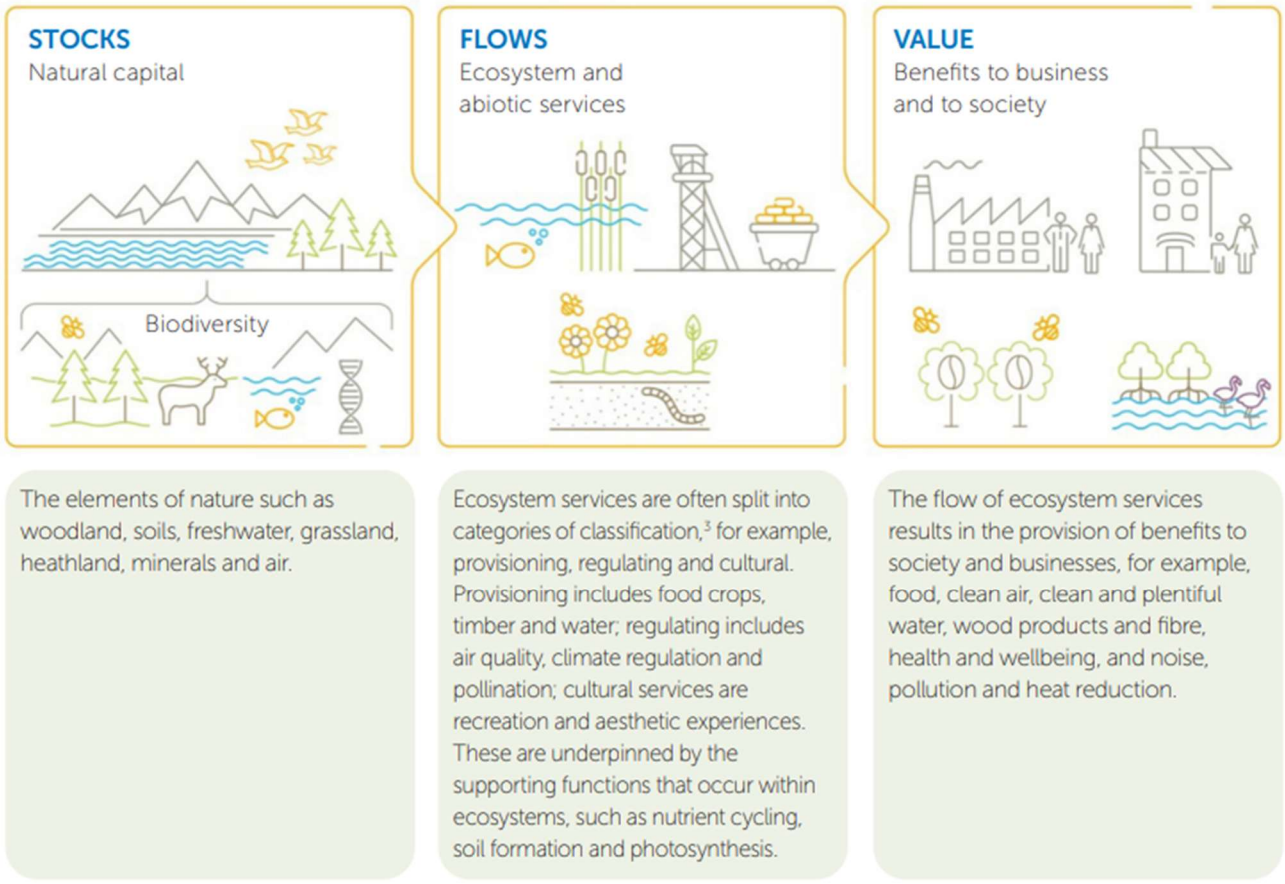


Figure 31: Natural capital relationship between biodiversity, natural capital stocks and the arising flows and values (IEMA, 2024, based on original work by the Capitals Coalition and Cambridge Conservation Initiative).

Terminology

Ecosystem processes (or functions) are the biological, geochemical, and physical processes that take place within an ecosystem. When an ecosystem process provides a benefit to humans it provides an *ecosystem service.* When a process solves a societal challenge, it may alternatively be referred to as a *'nature-based solution*' (NBS).

In natural capital language, biodiversity underpins the ecological condition and quality of ecosystems that support the services provided. It directly benefits people through the existence of valued species, through nature-based solutions and by enriching other benefits (like nature-based recreation). Biodiversity also underpins the resilience of ecosystems to shocks and can provide insurance value.[78]

Ecosystem functions depend on environmental conditions and the traits of species that together make up the ecological communities within a specific habitat or biome. An ecosystem can deliver functions only as long as it possesses sufficient species richness and diversity of functional traits. Biodiversity is a critically important characteristic. It enables ecosystems to flourish and supply the services on which we depend. Reduce biodiversity, and the health of ecosystems generally suffers. Reversing declines in biodiversity is therefore key to preserving ecosystem functions. (Dasgupta, 2021).

78 https://www.gov.uk/government/publications/enabling-a-natural-capital-approach-enca-guidance/enabling-a-natural-capital-approach-guidance

The absorption of carbon dioxide by forests, the control of rodent populations by birds of prey, and the filtering and storing of water by wetlands are all examples of ecosystem processes that are also nature-based solutions. Ultimately ecosystem processes operate across all habitat types supporting human life and contributing to ecosystems' health, stability, and resilience. (Moffett et al., 2024)

Context

Several reports have assessed or include information on the natural capital of the New Forest (see bullet list below). Consistent, up to date landcover information is a vital underpinning dataset that can make comparison between different assessments challenging – no attempt has been made to assess these studies for evidence or any increase or decline. The most recent baseline, completed as part of the DEFRA Environment Land Management Scheme assesses the current state of Natural Capital within the New Forest National Character Area (which covers an area of 67,197 ha i.e. larger than the National Park boundary), assessing risks and identifying opportunities for improvement, with a primary focus on farming (Eftec and Environment Systems, 2024).

This study quantifies an annual monetary benefit of £129 million per year from the New Forest National Character Area assets, (see Figure 32) highlighting recreation (43%), tourism (which generates an additional ~£72 million), carbon sequestration (25%) and physical health (16%) as the main economic benefits generated. Importantly, the work was only able to place a monetary value a sub-set of benefits, with no assessment made of the service value of water quality regulation, flood risk mitigation and biodiversity. Interestingly the study found that New Forest woodland generates annual benefits of £27m for carbon sequestration and £2m for air pollution removal, sums which significantly exceed timber production values.

Nature's benefits in New Forest

These are only a sub-set of benefits that have been possible to quantify and express in monetary terms. Significant benefits not evaluated in monetary terms: water quality regulation, flood risk mitigation, and diversity of nature

Benefit type	£m /year	%
Arable food production	3	2%
Livestock food production	4	3%
Timber production	1	1%
Renewable energy (solar)	<1	<1%
Water supply	9	7%
Carbon sequestration	32	25%
Air quality regulation	2	2%
Recreation	56	43%
Physical Health	21	16%
Gross Benefits	**129**	100%

Numbers may not add due to rounding.

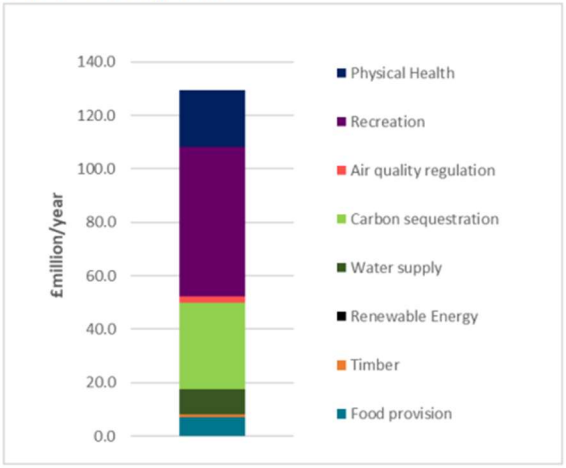


Figure 32: Natural Capital Valuation of the New Forest National Character Area generated for the DEFRA ELM's scheme by eftec and partners – note limitations described in the text. (Eftec and Environment Systems, 2024).

The report highlights four main areas in which natural capital benefits could be increased (noting the study limitations and focus on farming); soil carbon sequestration (by improving soil health), greenhouse gas emissions reduction (by implementing improvements in farming practices), water quality improvement (by managing nutrient inputs) and biodiversity (through habitat creation and restoration).

Depletion of soils, particularly on arable and improved grasslands, is highlighted as a key risk (erosion, compaction, loss of organic matter and microbial health), alongside water pollution from wastewater treatment and farming, climate change (water stress) and biodiversity loss (particularly recognising losses over the past 5 decades).

The work cautions that land use decisions and spatial priorities should be based on a complete view of the potential benefits that can be delivered, and not solely on what funding is available at the time and that the use of funding mechanisms should support the overall priorities for land use, rather than optimise a funding stream at the potential expense of other more valuable benefits. It also notes that nature markets are unlikely to ever fully pay for the true economic value of nature.

List of reports or studies that include assessments of the New Forest (oldest to newest):

- Envsys Report for the NPA (2014)
- AECOM Report on behalf of DEFRA (2015)
- Forest Farming Group Report (2019)
- State of Hampshire's Natural Environment Report (2020)
- Natural Capital Associates Research Report (2021)
- Hampshire and the Isle of Wight's Natural Wealth Report (2022)
- Report 'Evaluating the natural capital value of the New Forest National Park and surrounds for health and wellbeing' (~2023)
- eftec Natural Capital Baseline developed for the Defra ELMs Test & Trial in Hampshire (2024)
- The Natural England National Character Area assessment for the New Forest includes details of ecosystem services

Climate Risks

This section uses the ecosystem services identified in the Natural England New Forest character assessment as a basis and structure for a high-level assessment of climate sensitivity, i.e. grouping services into either provisioning, regulating or cultural services. In line with the habitats sections the assessment considers sensitivity to climate and adaptive capacity of each of these service groups. Rather than an overall rating of risk, summary comments are included noting how the services may change in the future in response to climate change, as some aspects are positive, some negative and all will depend on the actions taken now and, in the future, to manage these changes. The results are summarised in Table 11 followed by a short discussion on each ecosystem service.

Provisioning, regulating and cultural services are typically classified as 'final' ecosystem services as they directly contribute to society's welfare. Supporting services such as soil formation and pollination, do not produce outputs for final consumption or production, but are essential for the functioning of provisioning, regulating and cultural services. In line with the UK government's Enabling a Natural Capital Approach (ENCA) guidance[79] these are not included as their effect is captured within other categories, however it is worth noting the prominence of soil health depletion as a major risk identified in the 2024 DEFRA ELM's work discussed above.

[79] https://www.gov.uk/government/publications/enabling-a-natural-capital-approach-enca-guidance/enabling-a-natural-capital-approach-guidance

A key challenge when valuing ecosystem services relates to their spatial characteristics; some locally generated services are mainly 'consumed' locally (e.g. cultural services) whilst other services provide benefits that are dislocated in time and/or space from their beneficiaries. Examples include locally produced timber or agricultural products which feed into global markets (provisioning) and regulating services such as carbon sequestration which have national and global beneficiaries. It is frequently the case that natural habitats act as hotspots of ecosystem service supply, with consumption or demand more strongly concentrated in highly populated urban environments or intensively managed areas.

At a global level, the 20th century has seen provisioning ecosystem services increase multiple times, and regulating services decrease, driven mainly by land use change and biodiversity loss. These trends reveal the ecological 'debt' incurred by modern systems of production and consumption and the need for rebalancing of these systems. Globally, regulating services are expected to further decline under most climate change scenarios (Henrique et al., 2024).

The IUCN estimate that more than 80% of ecological processes are impacted by climate change.[80]

[80] https://iucn.org/our-work/topic/climate-change-impacts-on-nature

Table 11: Summary table

Category	Description	Examples	Sensitivity to Climate Change	Adaptive Capacity	Overall change
Provisioning services	Tangible outputs that can be obtained from ecosystems that meet human needs	Food, timber, water supply, crops, genetic resources and biological/ biochemical material (e.g. medicines)	The growth or productivity of natural living resources are dependent on precipitation, temperature, humidity and CO_2 and sensitive to extreme events with variable consequences. Pests, disease and pathogen risks are increased by climate change	Within practical limits management can be adapted to prevailing conditions	Provided sufficient water and nutrient availability, and effective management of wider risks, productivity of several provisioning services has the potential to increase in response to climate change. This however may be offset by hotter, drier weather and damage from extreme events. Water supply is expected to come under increasing pressure in the UK, especially in the south-east and poses a major risk
Regulating services	Ecological processes that regulate and reduce pollution and other adverse effects	Air filtration, water regulation, carbon sequestration & natural hazard reduction (e.g. flooding)	Climate change is likely to modify New Forest carbon sequestration and storage rates e.g. modification of seasonal patterns of storage (potentially higher in winter, lower in summer), increasing risks of temporary losses due to wildfire, or pest/disease driven mortality, and increased potential of crossing sequestration thresholds (e.g. if peaty habitats suffer irreversible desiccation). The overall impact and extent to which this may occur is highly uncertain. There is high potential for change to regulating services, especially at the coast and across wetland habitats in response to sea level rise and drought/flood risks.	Within practical limits management actions can influence these risks by supporting the health and resilience of ecosystems (i.e. monitoring, adaptive management, reducing other pressures, restoring, expanding and connecting habitat)	Unknown impacts to carbon sequestration and pollution cycling by semi-natural habitats, risks of decline but also opportunities for increases due to longer growing season and milder conditions. Changing biodiversity may impact regulating services. Significant upside opportunity to restore and increase regulating services across wider landscape (habitat restoration and implementation of conservation approaches beyond the SAC areas).

Category	Description	Examples	Sensitivity to Climate Change	Adaptive Capacity	Overall change
Cultural services	Environ-mental settings that enable cultural interaction and activity	Settings for recreation, education and tourism	Potential for unintended consequences on cultural services due to strategic or management decisions made in response to other threats (e.g. provisioning or regulating needs) - an example might be coastal change which impacts certain user groups. Cultural benefits may also be impacted temporarily or on a longer term by extreme events (wildfires, major flood or storm event) or via indirect effects from climate change such as changing visitor numbers or behaviour, or a major disease outbreak leading to loss or damage to cultural heritage assets or viability of cultural practices (e.g. commoning)	Local communities have a critical role in driving adaptation efforts for cultural heritage sites and assets. The use of participatory processes, integration of traditional and practitioner knowledge and supporting locally led initiatives are all recognised approaches that support climate adaptation.	Multiple routes are available to protect and enhance cultural services, habitat management, restoration and protection, ensuring that landowners /managers have the knowledge and capacity to implement adaptation. Planning for human responses to climate change

Provisioning services

The main provisioning services relevant to the New Forest are timber from forestry, produce from agriculture and horticulture (including commoning livestock and wild venison), and water. Most of these feed into national or international supply chains, although there is some local consumption of produce via e.g. farm shops.

Agricultural provisioning is diverse and at a relatively small scale (<30,000 ha across 481 different holdings) and includes grazing livestock, general cropping, horticulture, cereals, dairy, poultry and pigs.[81]

According to the Natural England National Character Area assessment there are 50 water abstraction licences in the New Forest area, which produce 2.3 million cubic metres per year, mostly for agricultural use.

Impacts of climate change

In theory there is potential for provisioning services to increase in response to climate change, although this is contingent on availability of water and effective management of wider climate risks and other factors.

Eftec and Environment Systems (2024), in their assessment of Hampshire's Natural Capital highlight that agriculture has a pivotal role in reversing biodiversity loss, mitigating climate change, improving food security and sustaining local community resilience and well-being, the value of which, when combined are likely to far exceed the value of food produced. Finding pathways to reduce the costs to nature associated with farming (water pollution, biodiversity loss etc.) and maximise these multi-benefits is a critical contemporary challenge.

For forestry there is potential for increased productivity which could increase profitability and enable shorter rotations when considered within conventional timber markets, however as noted above, if financially viable pathways emerge, trees and woodland within the New Forest could potentially be managed with a focus on carbon sequestration, air quality regulation and non-use values. These opportunities however are also subject to increased uncertainty and risk as species selection needs to consider conditions over multiple decades, in some cases exceeding the horizon available for climate projections (+75 yrs). Potential limiting factors include storms, wildfire, drought and waterlogging, soil health and pest and disease risks. Management of these risks will be key to outcomes.

Provisioning services from the agricultural sector will equally depend on how effectively adaptation measures are identified and implemented. Provided water management can be resolved (i.e. maintaining sufficient supply under hotter drier and more variable conditions), and wider risks managed (e.g. livestock disease risk) it is possible that this sector could realise benefits from climate change. There are however likely to be significant increased costs in the short term to facilitate adaptation and, as with forestry, a need to accommodate increased uncertainty and increase flexibility.

Water scarcity is a significant and increasing concern in the south-east of the UK.[82] A national dataset is available projecting river flows and ground water levels[83] which confirms the

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[81] https://nationalcharacterareas.co.uk/new-forest/key-facts-data/
[82] https://www.southernwater.co.uk/our-region/water-scarcity/
[83] eFLaG project - https://www.ceh.ac.uk/our-science/projects/eflag-enhanced-future-flows-and-groundwater

expectation of diminishing low river flows and increasing severity of hydrological droughts (Parry, 2024). This has the potential to impact abstraction in the future and will increase the need for new infrastructure or other solutions locally. Wider residential and business use of water may be impacted.

Regulating services

Key services provided by the New Forest are:

- carbon sequestration and storage, especially in trees, shrubs and peaty soils but also more widely in soils and permanent vegetation
- coastal erosion and flood protection
- water quality and water flow within each catchment, supporting freshwater and marine biodiversity and reducing flood risk
- soil health (provided by vegetation, water and soil biota)

Impacts of climate change

The highly protected core of the New Forest includes habitats that deliver very high regulating service value, especially ancient woodland and other areas with intact soils, wetland habitats and wet and humid heaths with peaty soil layers. Protecting existing habitats is essential as the associated biodiversity and carbon store may have taken many centuries to become established and can be quickly lost if disturbed. Figure 34 shows estimates of carbon storage by habitat (Natural England, 2021b), using colour-coding to reflect uncertainty. This highlights the importance of woodland and peaty soil habitats for sequestering CO_2.

The threats to these habitats are discussed in section 2.1. From an ecosystem services perspective better baseline understanding of existing habitats and locally evidenced data on their carbon stocks and flows are needed, alongside change monitoring to assess how these are being impacted.

It is likely, although there is limited evidence available locally, that due to the trend of nature loss the unprotected fringe areas of the forest have declined over past decades in their stock and flows of regulating services. This is based on the extent of highly modified grasslands that support low biodiversity and, in some cases, have eroded soil health. Addressing ongoing biodiversity loss and loss of natural capital around the Forest fringe will help to protect New Forest biodiversity and ecosystem service provision.

Degraded habitats offer significant opportunities to increase the natural capital stock and flow of regulating services through more sympathetic conservation focused management or reversion to semi-natural habitat. These could potentially be framed and funded as NBS, especially in the case of freshwater, wetland and heathland restoration and, in the right areas, woodland creation. Multiple opportunity maps exist, such as the one shown in Figure 33, which excludes coastal habitats.

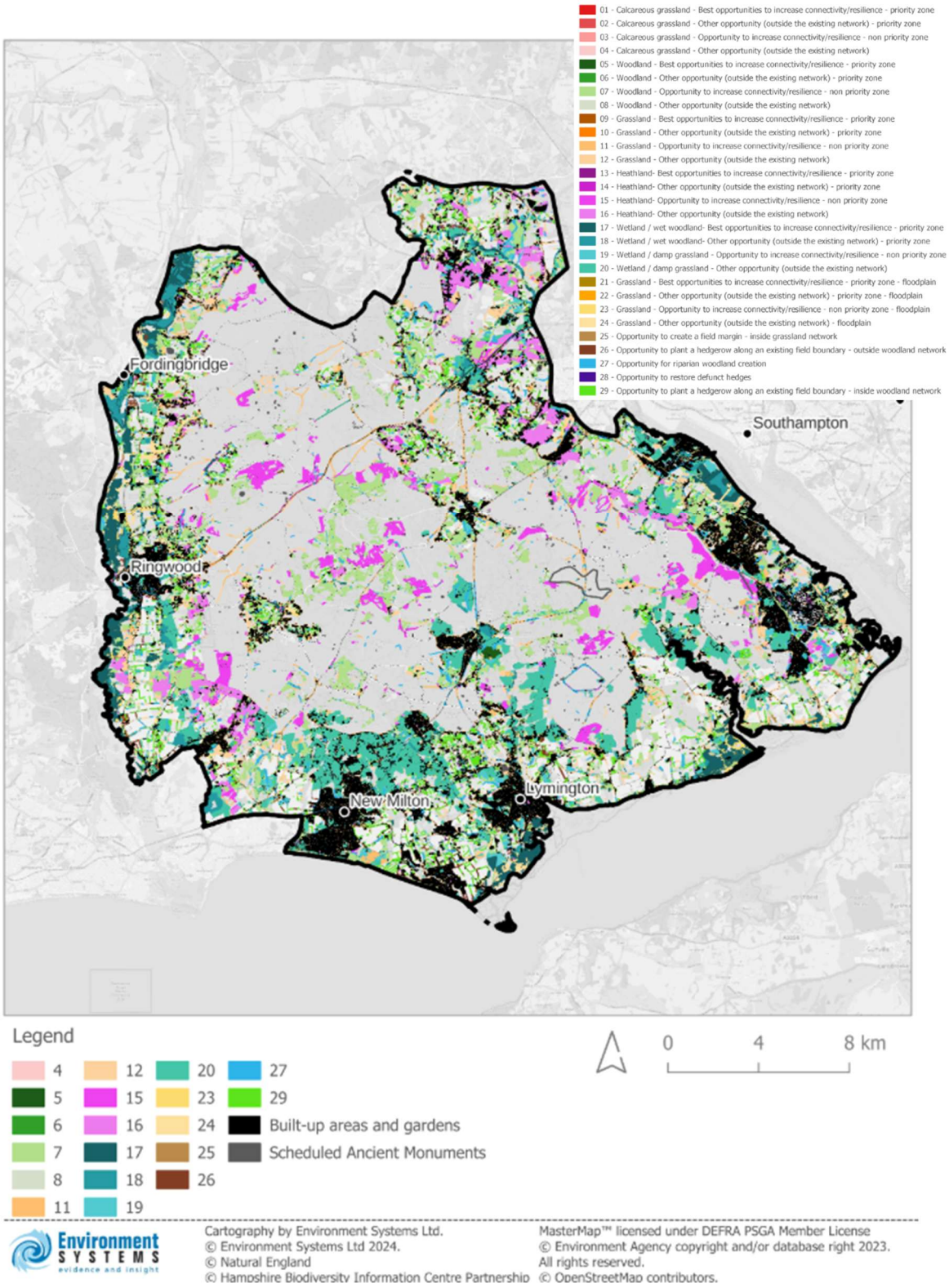

Figure 33: New Forest Opportunities to Enhance Biodiversity (eftec and Environmental Systems, 2024) map and legend can be viewed online.

The New Forest coast provides a diverse range of services across all categories, including cultural (e.g. leisure and recreation), provisioning (e.g. supporting fisheries) and, critically the regulation of natural hazards such as coastal flooding and erosion, alongside carbon

sequestration by habitats such as saltmarsh and seagrass. Climate change is and will continue to directly modify these habitats through changing temperatures and rising mean sea level. The extent to which ecosystem services will be modified will ultimately depend on the shoreline management strategies that are taken forward, with high risk of losses but potential for gains.

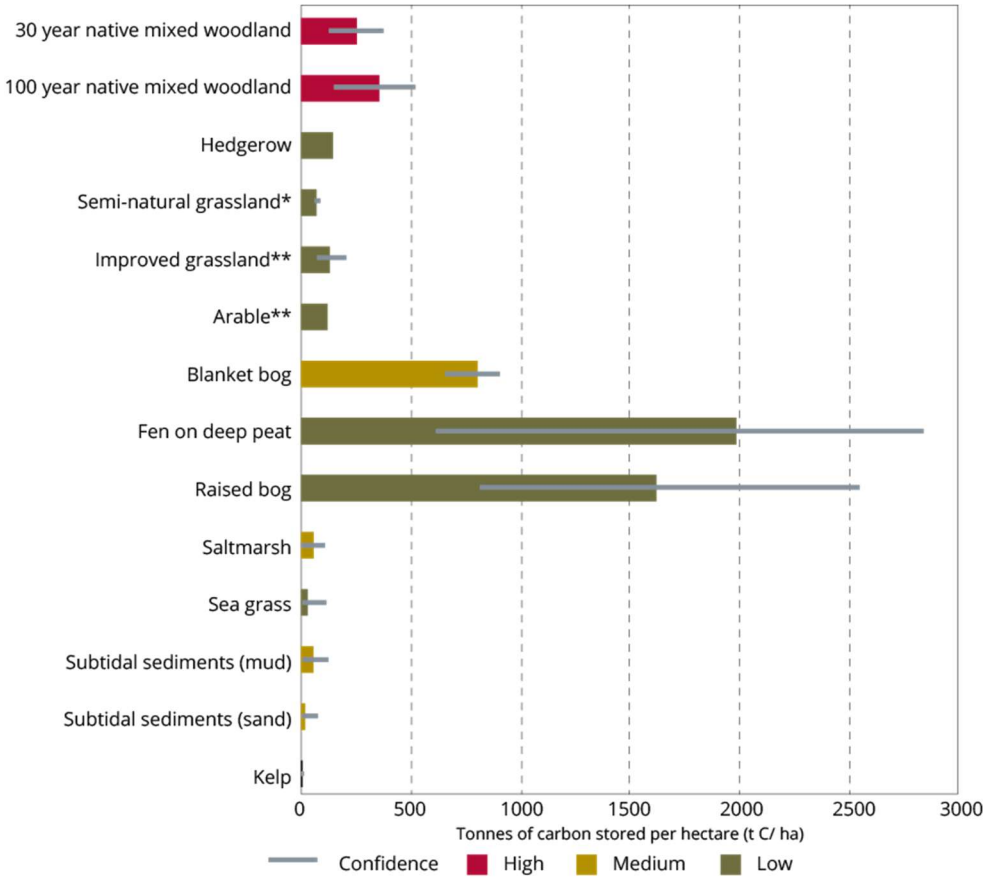

Figure 34: Estimates of carbon storage by habitat (Natural England, 2021b)

Cultural services

Section 2.7 describes the cultural qualities of the New Forest and potential impacts of climate change (see *Table 13: Special qualities of the New Forest and potential impacts of climate change*).

Impacts of climate change

Climate change is expected to drive increased day-visits and numbers of people holidaying in the UK. Alongside population expansion in the region this change will potentially increase recreation, education and tourism value of the New Forest. However, as noted in many studies (e.g. eftec and environmental systems, 2024, Footprint Ecology New Forest reports) this projected increase creates multiple risks to natural capital assets, with mitigation needed especially for nature sensitive areas.

Further reading

- see list of studies above that include estimates of the natural capital of the New Forest
- Natural England (2021) Carbon storage and sequestration by habitat: a review of the evidence
- Environment Agency (2021) review of the evidence behind potential carbon offsetting approaches
- House of Lords Science and Technology Committee, (2022) Nature-based solutions: rhetoric or reality?
- British Ecological Society (2022) Nature-based Solutions for Climate Change in the UK
- Wildlife Trusts (2022) Quantifying the potential impact of nature-based solutions on greenhouse gas emissions from UK habitats
- Exploring the carbon sequestration potential of rewilding in the UK (2024) policy brief and report

2.5 Heritage

Heritage is concerned with the legacies of past people, culture, and environments. Within the New Forest, this includes archaeological sites, monuments, historical buildings and their contents, parks, gardens, ancient and veteran trees, and cultural practices such as commoning. These assets, alongside their intangible aspects are the inherited legacy that gives the New Forest a sense of place and identity that can be especially important for local populations, and those interested in understanding history. These form a critical element of the cultural natural capital services (see previous section) provided by the New Forest.

Of primary importance to the cultural heritage of the New Forest is the ancient, ongoing practice of commoning, which plays a fundamental role in conserving and maintaining the open landscape through year-round grazing by livestock.

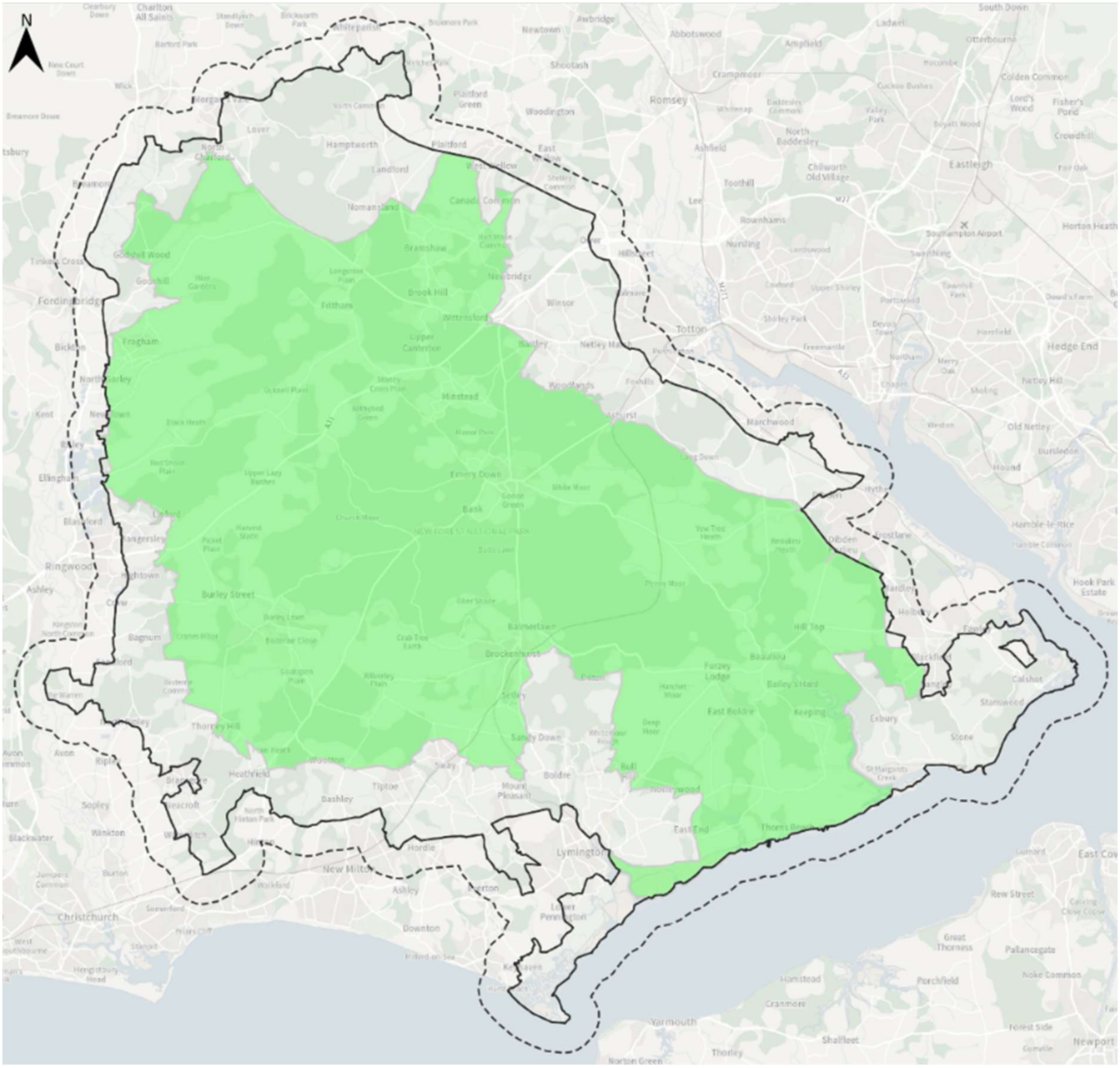

Figure 35: Map showing the area (highlighted green) known as the perambulation - the area in which common rights apply, and commoner's livestock can roam freely.

The intact survival of the semi-natural landscape in the New Forest makes it an important location for understanding the past. Legal protections of the natural environment have enabled

the preservation of thousands of sites of archaeological or historic interest, many of which have yet to be fully recorded or evaluated for their significance.

Surviving elements of the historic environment take many forms. Alongside visible buildings, monuments, and legacies of past industry, are ancient woodland and veteran trees, earthworks, ruined structures and archaeological sites, soils and paleoenvironmental sequences.

The waterlogged, acidic, and anaerobic conditions of peat are ideal environments for long-term preservation of organic and inorganic remains. The slow accumulation of peat leads to sequences with chronological integrity, preserving information on past climate and ecology, revealed through pollen, plant, insect, and other records. These can provide clues about the environment around archaeological sites and contribute to an understanding of human and environmental change and wider landscape development processes (Page, 2020).

Within the New Forest are sites of historic and archaeological importance dating from prehistoric, roman, medieval and post-medieval periods through to the first and second world wars. Nationally important sites include the abbey and palace at Beaulieu, artillery forts at Hurst and Calshot Spits, the tidal mills at Eling and Beaulieu, and Buckler's Hard.

Heritage assets can be classified into three tiers according to their levels of protection and assessment. Nationally designated sites, listed by Historic England, are offered the highest levels of protection. At the next level are non-designated sites that are recognised as historically significant and considered within local planning processes. The final tier captures locally identified, yet to be investigated assets or sites. These have the potential to be locally or nationally significant but require investment to fund assessment.

Figure 36 shows the distribution of mapped assets across the New Forest, further details of which are provided below.

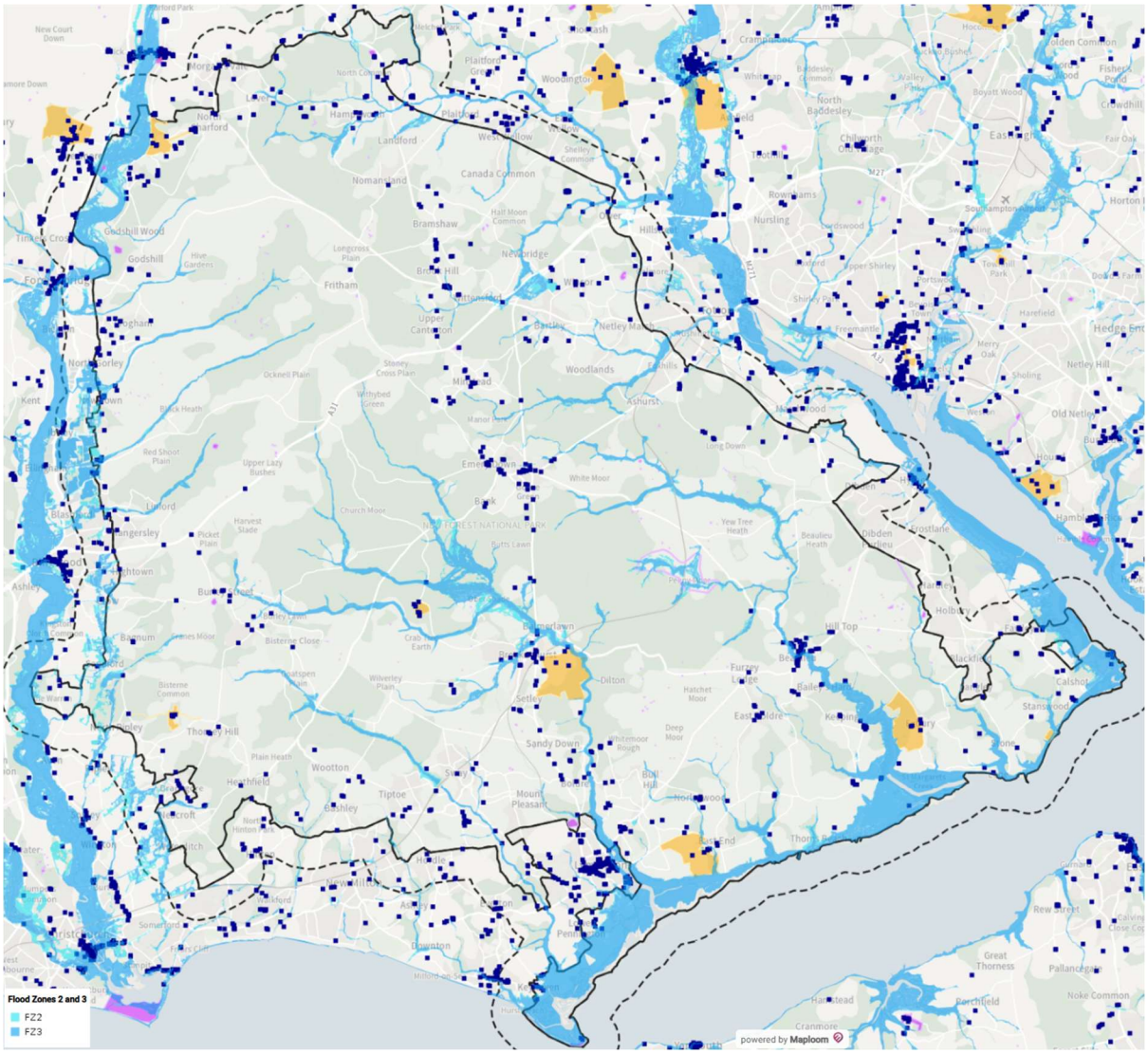

Figure 36: New Forest showing listed buildings, scheduled monuments and registered parks and gardens, and flood risk zones 2 and 3. add legend + local list layer/TPO's? [placeholder]

Designated assets within the New Forest include ~621 listed buildings (palaces, country houses, typical cottages and hovels built of brick, timber frame or cob), ~241 scheduled monuments and seven registered parks and gardens (including Exbury, Pylewell, Brockenhurst Park, and Cadland). These are on the National Heritage List for England and subject to enhanced protection measures in the planning system.

Non-designated assets are locally identified buildings, monuments, sites, places, areas or landscapes with heritage significance that are given consideration in planning decisions.[84] Within the New Forest these include ~2375 non-designated heritage assets and 20 conservation areas.[85]

[84] https://historicengland.org.uk/images-books/publications/local-heritage-listing-advice-note-7/heag301-local-heritage-listing/

[85] https://www.newforestnpa.gov.uk/planning/heritage-conservation/buildings-local-interest/

Sites or assets that have been identified as of potential historic significance but have not been assessed or evaluated for their significance are mapped and listed in records maintained by the NPA; there are currently c. 9000 sites on this list.

Historic England maintain a 'Heritage at Risk' [86] register which highlights assets that are at risk of being lost due to neglect, decay, or inappropriate development. There are five assets within the New Forest currently on this list; four scheduled monuments (bowl barrow nr Avon Tyrrell, Hurst Castle and Lighthouse, bell and bowl barrows at Stagbury Hill and Furzley Common) and one listed building (Church of St Katherine, Exbury, subject to slow decay and visitor erosion). Hurst Castle is noted to be in "immediate risk of further rapid deterioration or loss of fabric", in part due to the impacts of sea level rise.

Impacts of Climate Change

Heritage risks for physical assets tend to be individual, reflecting the location-specific environmental setting (soils, topography, proximity to trees or other features) and condition (well maintained, inhabited, buried, neglected etc.) rather than reflecting the asset type. Examples of the types of climate impacts on physical heritage assets are summarised in *Table 12* followed by further discussion of some of the key points.

The most significant climate risk in the New Forest is loss and damage to coastal and estuarine assets in response to sea level rise. Hurst Castle is a high-profile example of nationally significant heritage at risk, with work ongoing to assess future shoreline management options for this stretch of the New Forest coastline. A further example is the D-Day remains at Lepe, which are being recorded ('preservation by record') as they decay and succumb to rising sea level.[87]

Indirectly, climate change may modify visitor pressure at sites, with potential for increased numbers in response to milder temperatures and a longer potential 'summer' season, leading to increased risks of erosion and damage. Climate may also impact on land use across the New Forest and modify flora and fauna with potential consequences for heritage assets.

Wildfire risk will increase, particularly in southeast England, the risk of which is amplified by higher visitor numbers (most wildfires are unintentionally ignited by people).

Climate change creates new opportunities to uncover archaeological sites. This includes artifacts exposed at the coast through processes of erosion, but also elsewhere in response to habitat changes and changes in soil condition which expose new sites or previously unrecorded features.

Climate change will increasingly force a reconsideration of how some heritage assets are managed and maintained; in some situations, full or partial loss or extensive adaptation will be necessary. The planning system has a role in assessing the significance of heritage assets and considering their maintenance and renewal in favour of bringing assets most at risk through neglect or decay back into use. The Local Plan sets out the framework for these decisions.[88]

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[86] https://historicengland.org.uk/listing/heritage-at-risk/
[87] https://www.newforestnpa.gov.uk/discover/history-culture/historical-sites/lepe-country-park/ & https://www.wessexarch.co.uk/our-work/lepe-d-day
[88] https://www.newforestnpa.gov.uk/planning/local-plan/

Climate Hazard (direct and indirect)	Potential Impact
Sea-level rise, leading to increase risks of storm surge, coastal erosion, and coastal inundation	Direct loss or physical damage Water damage
Wetter winters and higher intensity downpours especially in summer and autumn	Building structures are being damaged by high intensity and persistent periods of rainfall on saturated or impermeable ground which can damage buildings, flood historic areas and exceed drainage capacity leading to water damage, erosion and accelerated rates of decay. This is increasingly driving up maintenance costs and increases the risk of asset loss. Soils may be 'washed out' damaging any records they contain. Wind-driven rain can erode materials, damage surfaces of buildings, and increase the risk of water penetration into porous materials.
Hotter, drier summer weather including extreme heat and drought	Increased fire risk Desiccation of soils and potential increased erosion risk Subsidence, especially on clay soils Easier access to areas normally inaccessible due to (waterlogged) ground conditions, risks of trampling and damage Shrink-swell
Compound events and extremes e.g. windstorms during very wet conditions	Tree throw damaging or exposing buried artefacts, or directly damaging structures or buildings Roof damage
Longer growing season	Increased growth of vegetation with potential increased risks of root damage. Increased management requirements to maintain condition
Changes to average temperatures and humidity, including rapid fluctuations in humidity	Increased temperature and humidity can increase plant and fungal growth, and enable new or existing pest and disease damage, accelerating decay and driving up maintenance costs. Indoor heritage (paintings, books etc) may be affected by moisture and humidity damage.

Table 12: Climate Risks to Heritage Assets.

Beyond risks to physical heritage assets, climate change has potential positive and negative impacts on cultural heritage.

Climate change amplifies the existing pressures on commoning. Increased visitor numbers and lengthening of the 'visitor season' in response to warmer weather increases the potential for accidents and incidents associated with road traffic and people and increases the potential for conflict at popular sites, especially during very hot weather around water.

Changes in weather patterns also potentially increases costs of management through requirements for supplementary feeding during droughts or very wet winters, increased disease risk, and indirectly through wider socio-economic pathways (e.g. land prices).

Warmer days may also encourage increased engagement in cultural activities, including recreation and festivities, and other cultural practices that facilitate community cohesiveness and placemaking, and lead to greater interaction with cultural landscapes. Climate change is

seen by many as the major challenge of this era and is expected to have an increasingly profound impact on human culture and our relationship with the natural environment. There is therefore a major opportunity for the New Forest to expand the role of the heritage sector in tackling climate change and engaging residents, visitors, and businesses in this topic.

Further reading

Historic England resources (Heritage, Climate Change and Environment) including guidance on historic building adaptations in response to climate change impacts.

Historic England Climate Adaptation Report 2024, includes a case study on Hurst Castle.

Workflows and Hazard Data for Climate Change Risk Assessment of Heritage Assets, Research Report by JBA Consulting on behalf of Historic England (May 2025).

Marine Climate Change Impacts paper on Cultural Heritage (Coastal) Report.

2.6 Landscape

Landscape includes both tangible and intangible elements, including natural features and cultural aspects that reflect the dynamic interaction of natural processes with the legacy and perceptions of people.

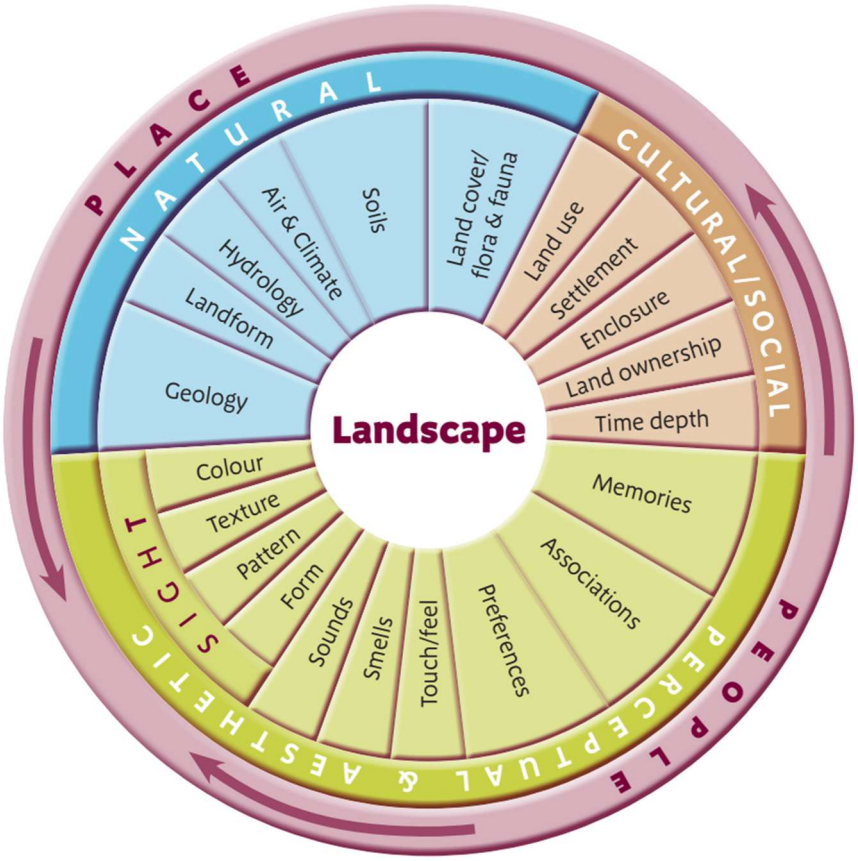

Figure 37: Illustration of the different elements that together form a landscape (figure from Tudor, C., 2014. An Approach to Landscape Character Assessment. Natural England).

Landscape can be defined as '*an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors*' (European Landscape Convention, 2000). Reference to human factors highlights that ideas about landscape vary from person to person. "*Any landscape is composed not only of what lies before our eyes but what lies within our heads.*" (Donald W. Meinig, as quoted by the landscape research group[89]).

Natural England use the term landscape *character* to refer to the 'distinct and recognisable pattern of elements that occur consistently in a particular type of landscape, making one landscape different from another, and contributing to a sense of place'. (NE, 2013).

The landscape character of the New Forest is defined within Natural Character Area 131 (New Forest), which includes eight landscape opportunities focused primarily on conservation and protection, encompassing education, reactional management, habitat creation and resilience /adaptation to climate change.

[89] https://landscaperesearch.org/about-us/what-is-landscape/

The New Forest is a *protected* landscape, i.e. a defined area, recognised legally, and managed practically in a way that delivers long-term conservation of nature alongside associated ecosystem services and cultural values. Government expectations are that these landscapes support the delivery of the 25-year Environment Plan goals which include thriving plants and wildlife, mitigating and adapting to climate change and enhancing beauty, heritage and engagement with the natural environment. [90] Ambitions for these landscapes also extend to supporting thriving local communities and economies, improving public health and wellbeing, driving forward nature recovery, and building resilience to climate change (DEFRA, 2022).

DEFRA acknowledge that climate change may mean that our protected landscapes look different in the future, and that this may require changes in the way that they are managed (DEFRA, 2022).

Natural England also recognise climate risks to protected landscapes: "*The scale and pace of climate change impacts may present risks for the ability of the marine and terrestrial protected site network to be able to adapt to climate change. For example, through tipping points, which may lead to sudden changes in site condition. This includes designated landscapes, which could be subject to significant changes in landscape character and loss of certain landscape features such as from coastal erosion and sea level rise*." (NE, 2021)

The NPA landscape policy documents[91] include a Landscape Character Assessment which divides the New Forest into 19 distinct character areas and an action plan (developed in 2013, looking ahead to 2033) that identifies issues, pressures, objectives, management guidelines and actions for the next 20 years. These documents recognise that the landscape of the New Forest has changed and will continue to change in response to climate change and regional population growth, "…*potentially at a significantly faster rate in the future than in the past and on a 'landscape' scale.*". This work also recognises the potential for indirect climate related changes to the landscape from solutions such as renewable energy infrastructure or socio-economic responses (e.g. change in viability of commoning due to increased operating costs impacting habitat management).

Impacts of Climate Change

As noted in previous work (see above) it is certain that climate change is, and will continue to modify the landscape of the New Forest, most visibly through physical changes to hydro-ecological and coastal processes but also as, for example as people respond. A gradual modification of the living landscape is already underway, as species assemblages adapt to the changing environment (see e.g. section 2.2).

Some changes will occur rapidly, with both temporary short-term impacts and longer-term implications (e.g. changes to vegetation in the event of a wildfire or severe drought, changes at the coast in response to storm events). Other changes will be more gradual and may be imperceivable to all but the specialist.

Some of the most significant landscape changes will occur as a result of deliberate decisions, driven by the need for climate adaptation, for example the UK Forestry Standard (UKFS) requires consideration of future climate in planting and management decisions. Beech, which

[90] https://www.gov.uk/government/publications/protected-landscapes-targets-and-outcomes-framework/protected-landscapes-targets-and-outcomes-framework
[91] https://www.newforestnpa.gov.uk/planning/landscape-policy-documents/

is currently widespread in the New Forest shows reduced growth during hot drought periods (Martinez del Castillo et al., 2022) and along with Sycamore, Silver Birch and Sessile Oak are expected to become unsuitable or marginal for the South-East under high emissions scenarios as early as 2050.[92] Responses to this include the potential use of seed sources from Southern Europe for currently established species when planting or restocking woodland, in an effort to maintain the landscape whilst increasing genetic diversity and resilience to warmer conditions. There are however likely to be species composition changes to the New Forest treescape and a move towards a greater diversity of species.

The coastline and estuaries are another area of inevitable change, where our response to sea level rise will require modification of the status quo. Whether defended or undefended the mosaic of habitats, their extent and their composition will evolve due to increased inundation by saltwater and changes to sedimentation and erosion processes.

Perhaps the most significant changes will arise in response to pressures on freshwater environments, which are expected to increase in response to summer droughts and extreme heatwaves[93] The availability and seasonality of water, and the condition and hence capacity of the New Forest habitats to hold onto this water has major implications for the species composition and function of the extensive freshwater, heathland, bog and mire habitats. In the long term (25+ years) there is a potential for significant irreversible changes to these habitats in the absence of effective protection, management and restoration.

Landscape character will also be modified by indirect effects of a changing climate, including the possibility of changes in land use across the areas of the New Forest not subject to restrictions by various designations. This particularly includes agricultural land and modified grasslands and also privately managed habitats of various types, from estates to gardens. Management decisions taken across these landscapes have consequences for the New Forest as a whole, but with significant potential to enhance biodiversity and ecosystem services across the New Forest.

One of the implications of higher levels of CO_2, and the longer growing season is the potential for faster growth of vegetation with consequences for management of relevance e.g. to hedgerows, verges and crops.

Changing phenology is already requiring modification of management practices, squeezing the window available to carry out prescribed burning, scrub clearing and forestry management in sensitive areas. In combination with wetter winters which constrains access due to risks of soil compaction, or makes burning unviable due to the wet vegetation, completion of essential management tasks may become more challenging and require new approaches.

As outlined in the Pests, Diseases and Pathogens section, climate change increases the risks of new or existing disease outbreaks. A major outbreak has the potential to dramatically, and potentially permanently modify the landscape especially if affecting trees or commonly occurring vegetation such as heather.

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[92] https://www.forestresearch.gov.uk/research/climate-change-impacts/climate-change-impacts-and-adaptation-in-englands-woodlands/regional-changes-in-england-in-tree-species-suitability-resulting-from-climate-change/
[93] https://www.southernwater.co.uk/media/rd4ddsbn/5670_climatechangeadaptation_2021_v13.pdf

Major extensive drought will likewise have both temporary and potentially permanent legacy impacts at the landscape scale.

Further reading

Example of an adaptation guide aimed at those living and working within a protected landscape, Clwydian Range and Dee Valley AONB ‘Working with Climate Change Guidance’

2.7 Special qualities and purposes of the New Forest

The statutory purposes of the National Parks, and socio-economic responsibilities of the Park Authorities are specified in the 1995 Environment Act. These are:

> (a) to conserve and enhance the natural beauty, wildlife and cultural heritage of the area; and
>
> (b) promote opportunities for the understanding and enjoyment of the special qualities of the National Park by the public.

Additionally, the National Park Authority is required to seek to foster the economic and social well-being of local communities within the National Park.

The Sandford Principle is a concept in the management of protected landscapes named after Lord Sandford. This states that where conflict between socio-economic interests and conservation arises, conservation must be prioritised.[94]

Each National Park has a unique set of *special qualities*, characteristics that define the area, make it unique and distinguish it from other parts of the UK. The 9 special qualities of the New Forest are shown in *Table 13*, alongside a brief summary of the potential impacts of climate change.

	Special quality[95]	Potential Impacts of Climate Change
1	The New Forest's outstanding natural beauty: the sights, sounds and smells of ancient woodland with veteran trees, heathland, bog, autumn colour and an unspoilt coastline with views of the Solent and Isle of Wight	Over short timescales extreme events such as wildfire, flooding, a major coastal storm event, tree or plant disease could have a major impact on this quality. Over longer timescales change will gradually occur, the extent and nature of which will depend on deliberate adaptation efforts (e.g. decisions around tree planting and habitat protection, management and restoration) and also on the relative resilience of existing habitats to the prevailing conditions. Freshwater and wetlands, including wet and humid heaths are expected to be the most sensitive to climate change.

[94] https://democracy.peakdistrict.gov.uk/documents/s30764/1.3%20Planning%20Law.pdf
[95] https://www.newforestnpa.gov.uk/app/uploads/2022/07/2325-NEW FORESTA-PP22-FULL-WEB-AW.pdf

	Special quality[95]	Potential Impacts of Climate Change
2	An extraordinary diversity of plants and animals of international importance	There is insufficient evidence to make projections of how overall species diversity in the New Forest will evolve however some change is inevitable and already being observed. In general climate change creates opportunities for lowland southern species to expand their ranges. The southerly location of the New Forest creates opportunities for new colonist species expanding northwards from mainland Europe or dispersing from the SE/SW of UK. There is considerable uncertainty about the likely pace of any distributional shift, Pearce-Higgens et al., (2022) note that bird and butterfly communities appear to be lagging behind the rate of warming observed across Europe and less-mobile groups, such as many of the vascular plants, may lag even more. Dispersal ability, availability of suitable habitat and underlying population dynamics are all important constraints on distribution changes.
3	A unique historic, cultural and archaeological heritage from royal hunting ground to ship-building, salt making and 500 years of military coastal defence	See section on heritage. Coastal heritage faces the highest risks from climate change with the greatest potential for damage or loss. Opportunities exist to utilise climate change to strengthen engagement with the unique heritage and natural environment of the New Forest.
4	An historic commoning system that maintains so much of what people know and love as 'the New Forest' forming the heart of a working landscape based on farming and forestry	Climate change amplifies the pressures currently facing the commoning community potentially adding costs and pressures on land access (e.g. back up grazing). Climate change increases pressures on forestry to implement adaptative management and modify planting and management regimes as detailed within UKFS guidance.
5	The iconic New Forest Pony together with donkeys, pigs and cattle roaming free	As above, livestock are dependent on the long-term survival of the practice of commoning, and effective management of increased risks from disease.
6	Tranquillity in the midst of the busy, built up south of England	Several studies suggest that visitor numbers will continue to increase, partly in response to changes in the climate but also linked to development and housing targets within and around the New Forest. Warmer weather leads to increased pressures on coastal and freshwater environments. If unmanaged or ineffectively managed increased visitor numbers have the potential to negatively impact tranquillity.

	Special quality[95]	Potential Impacts of Climate Change
7	Wonderful opportunities for quiet recreation, learning and discovery in one of the last extensive, gentle landscapes in the south including unmatched open access on foot and horseback	Extreme events may drive temporary access restrictions such as wildfire or disease outbreaks. There are risks that unmanaged or unseen impacts from climate change gradually degrade the quality of the landscape flora and fauna. A 'shifting baselines' problem. Rapid unmanaged climate change may drive increased conflict between people and nature (e.g. need to protect specific habitats under certain conditions) limiting opportunities.
8	A healthy environment: fresh air, clean water, local produce and a sense of 'wildness', low levels of urbanisation	Climate change acts as an amplifier of many existing environmental pressures including water contamination and nutrient enrichment, and atmospheric pollution (e.g. nitrogen deposition). Effective management of these existing pressures becomes more urgent under climate change and is a key adaptation strategy. Extreme temperatures are likely to drive increased use of the New Forest as people seek to escape the hotter urban centres, with implications for the sense of 'wildness' and levels of different types of pollution (e.g. traffic, noise)
9	Strong and distinctive local communities with real pride in and sense of identity with their local area	This provides an opportunity to increase participation in the wide range of actions needed to address the risks associated with climate change. It is important to show how climate change and biodiversity are deeply interwoven, how actions to support wildlife are valuable at any scale, and how actions to support net zero are vital.

Table 13: Special qualities of the New Forest and potential impacts of climate change

Impacts of Climate Change on the purposes of the New Forest

The impacts of climate change on conserving and enhancing the natural beauty, wildlife and cultural heritage of the New Forest and described throughout this report are considered in terms of impacts on different habitats, species, heritage and landscape. There is no doubt that change is underway and will be shaped by the decisions and actions of the people who live, visit and manage this unique and special place, and in the development of policy and approaches to the management of Protected Landscapes overseen by DEFRA and Natural England.

3 Climate Change Opportunities

This section identifies thirteen climate change opportunities for the New Forest across six themes; Lead, Learn, Enable, Protect, Manage, Restore & Create.

The intention is that these are used to prompt dialogue and inform the ongoing development of adaptation plans. For many of these opportunities there are already activities in progress led by different partners across the New Forest, but in all cases, more can be done.

Table 14 shows a summary of the opportunities, these are described in the sections below.

Topic	ID	Opportunity
Lead	O1	Link climate mitigation and adaptation with nature, and mainstream into decision-making, policy, and the planning process via the Local Plan
	O2	Build a strategic narrative linking climate change with nature, people and the New Forest, and align messaging across public sector bodies and NGO's
	O3	Monitor climate risk and impacts, track and report actions and progress
Learn	O4	Expand and appropriately target research and monitoring efforts to provide the evidence needed to inform adaptation
	O5	Strengthen efforts to share data and knowledge across the community and between disciplines
Enable	O6	Motivate action by increasing public awareness and understanding of climate change as the most important driver of current and future environmental change in the New Forest National Park
	O7	Support landowners and land managers to increase climate and biodiversity positive land management and use
	O8	Facilitate mobilisation of private finance and business investment in nature that supports New Forest species and landscape
Protect	O9	Reduce non-climate pressures and directly protect the most sensitive or vulnerable habitats
	O10	Increase focus on habitat heterogeneity and maintaining climate refugia for species most at risk from climate change, provide guidance for landowners and managers
Manage	O11	Explore the opportunities for adaptive management or other decision-making frameworks that integrate climate change at a landscape scale
Restore & Create	O12	Restore and create habitats to increase resilience and connectivity within the New Forest National Park, and support forest-friendly changes in land use that deliver climate and biodiversity benefits
	O13	Improve habitat quality and connectivity beyond the boundaries of the New Forest National Park

Table 14: Summary of Opportunities

3.1 Lead

O1: Link climate mitigation and adaptation with nature, and mainstream into decision-making, policy, and the planning process via the Local Plan

Climate change and nature recovery are linked within the current Partnership Plan[96] under the Net Zero with Nature theme which has driven the development of a portfolio of projects and activities.[97]

However, as summarised in this report, the rate at which climate change is accelerating, and the extent to which it is already impacting e.g. New Forest land management, recreational use, and species distributions, provides impetus to **centralise climate change adaptation as a core operational activity in the next iteration of the partnership plan.** Opportunities exist to continue to refine and develop climate adaptation and mitigation ambition, and mainstream delivery through all aspects of decision-making, policy, and planning. For example, the NPA's role as a planning authority provides direct opportunities to enhance or strengthen measures that support climate adaptation, setting strategic requirements and ambitions out in the Local Plan potentially providing more specific or prescriptive guidance aligned to a strengthened adaptation ambition.

A more detailed overarching vision that sets out what adaptation means for the New Forest is essential, with consideration of how the different operational elements of the NPA and its partners can spearhead delivery of the outcomes that need to be achieved to realise the vision. This might include setting quantitative thresholds, such as to prepare for 2°C and plan for 4°C of global warming within the next 75 years (an approach set out by the UK Climate Change Committee).

Theory-of-change and similar methodologies could be used for mapping and communicating delivery plans. For example, Figure 33 shows a monitoring map for nature resilience under a changing climate, used by the UK Climate Change Committee to track UK government progress. A summary document such as this shows clearly how multiple activities can be aligned to contribute towards a clear objective; development of something similar for the New Forest would help reveal gaps and show where changes may be needed to align efforts.

There also needs to be recognition of the potential climate change risks to delivery of national and local nature recovery strategies, including EIP23[98] and (due imminently) EIP25, and Local Nature Recovery Strategies (LNRS). This includes development of **mechanisms to recognise and address the potentially conflicting requirements of different environmental objectives** such as climate change mitigation, carbon sequestration and storage, and increasing biomass and biodiversity; topical examples in the New Forest include construction of solar farms on farmland that is currently used for back-up grazing, and removal of trees and controlled burning to restore and maintain internationally important heathland habitats.

Beyond this, there is an opportunity to **review and refresh the organisational structures, interest groups, and co-operation and collaboration mechanisms** that are in place or are

[96] https://www.newforestnpa.gov.uk/conservation/partnership-plan/about-the-partnership-plan/
[97] See e.g. details here https://www.newforestnpa.gov.uk/app/uploads/2023/08/AM-676-24-Draft-Authority-paper-NZWN-Mar-24.pdf
[98] https://www.gov.uk/government/publications/environmental-improvement-plan

convened by the NPA that have relevance to the delivery of climate adaptation. These may require re-design or a refresh of the terms of reference to ensure that they are fit for purpose and reflect adaptation needs and opportunities; topical examples include sharing of best practise between landowners in the New Forest around wildfire mitigation and response, and woodland creation and management.

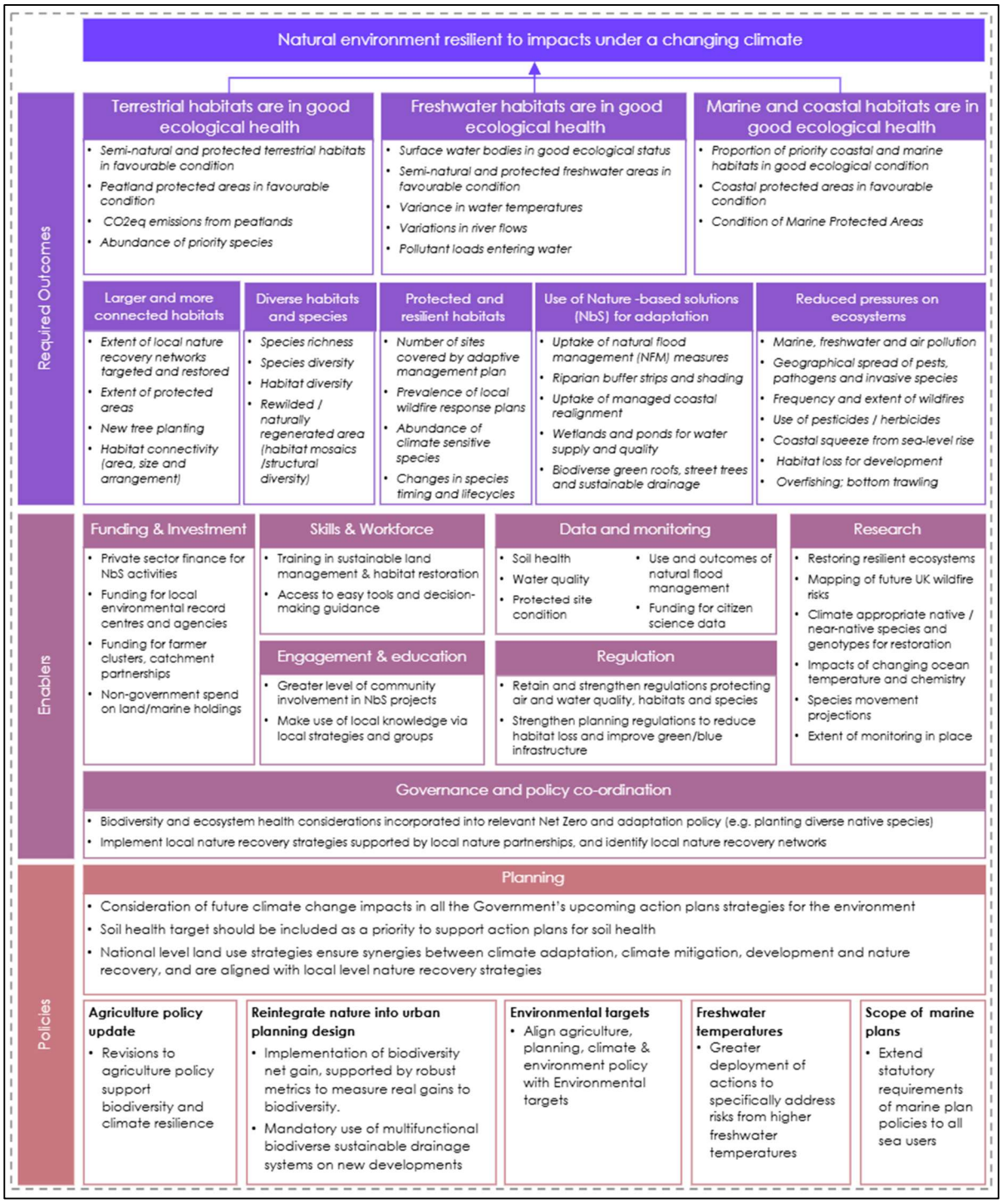

Figure 38: Example of a monitoring map for nature produced by the UK Climate Change Committee showing how policies, enablers and outcomes align to deliver a natural environment resilient to impacts under a changing climate.

O2: Build a strategic narrative linking climate change with nature, people and the New Forest, and align messaging across public sector bodies and NGO's

Clear messaging about climate change is essential and a prerequisite for mobilising action. In the words of Miles Richardson, "*Three of the most important issues of our time have one thing at their heart: the relationship between people and nature*." (referencing climate change, wildlife loss and the mental health crisis, see footnote 99). Research shows that pro-environmental behaviours are positively influenced by measures of nature connectedness, and that nature connectedness can be measured and increased. This is illustrated in Figure 39, which shows that as nature connectedness scores increase, people are more likely to demonstrate first pro-environmental and subsequently pro-nature behaviours.

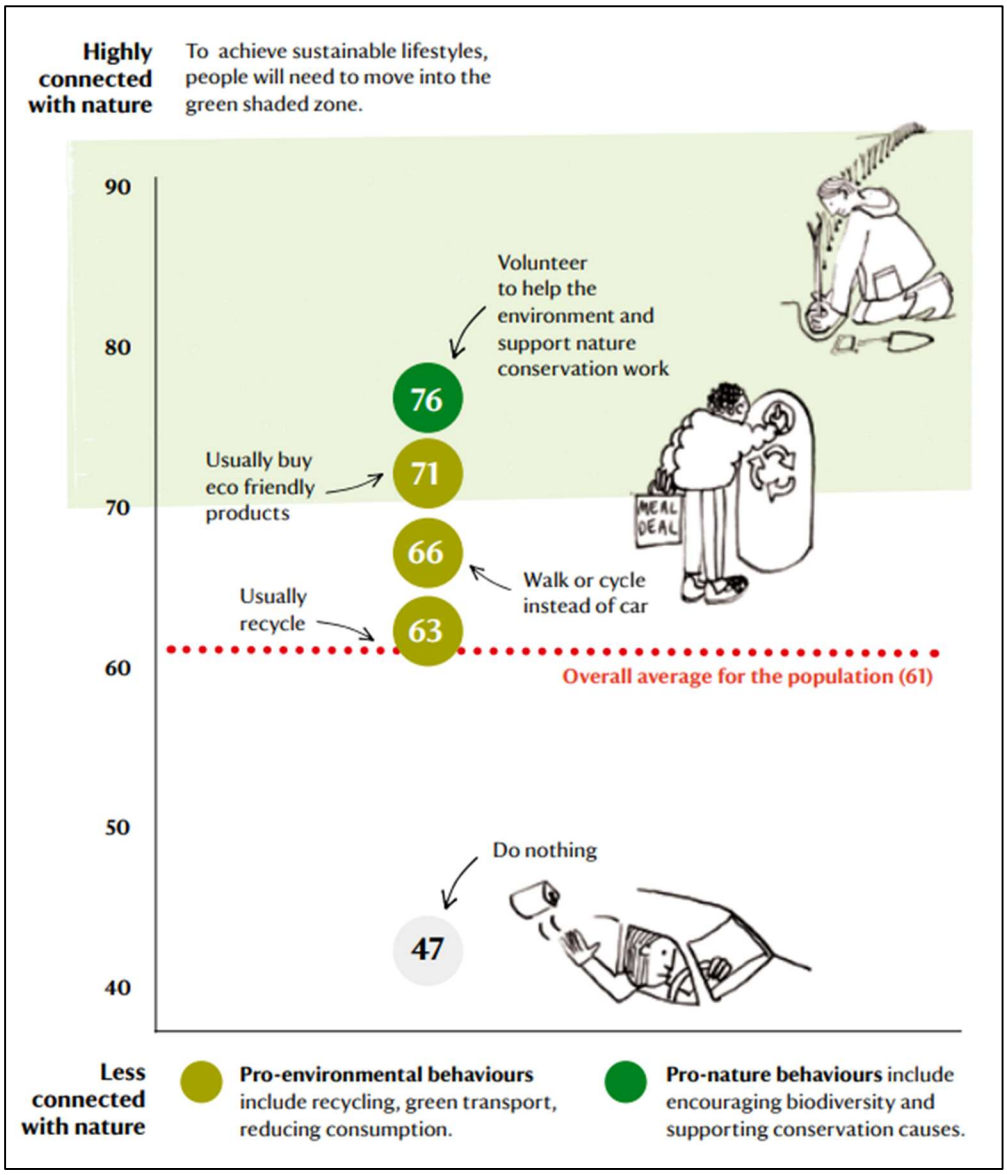

Figure 39: A link between connection and action: people with a closer relationship with nature are prepared to do more for the environment or nature.[99]

[99] https://ncxrg.wp.derby.ac.uk/wp-content/uploads/sites/28/2021/04/NatureMe-Booklet-2021.pdf

The New Forest has a unique opportunity to demonstrate national and international leadership in community-led climate change mitigation and adaptation. This is aided by the fact that the New Forest is 1) the most biodiverse landscape in the UK with the highest proportion of land designated for nature conservation of any UK National Park, 2) located on the south coast where climate change impacts on the environment are particularly acute, 3) a major recreational destination with >15 million visitor days per year and proximity to multiple major conurbations, and 4) home to a resident population that includes a culturally important commoning and farming community.

Climate change mitigation and adaptation require an increase in pro-environmental behaviours, but **a major opportunity for the New Forest is to also increase pro-nature behaviours**, which will contribute to a reduction of direct pressures on the New Forest and increase in activities to support conservation.

This needs to be driven by a strategic narrative that clearly links climate change with biodiversity, wellbeing, and the local environment. This will be strengthened and improved if 1) it is developed in partnership with the expertise and resources of the environmental NGO's and public sector bodies operating within the New Forest, 2) the messaging is aligned, and 3) the narrative is focused on the unique context and needs of the New Forest.

This narrative should be both aimed at people living in and visiting the New Forest, **underpinned by positive stories of what is happening, why it is happening and inspiring examples and guidance showing how human actions make a difference**.

O3: Monitor climate risk and impacts, track and report progress

There is an opportunity to **establish a New Forest climate adaptation monitoring programme**, with clear objectives, accountability, and open reporting. This should build on best practice and evolve in response to learning and improvement opportunities. It should also be accessible and supported by the widest possible community of New Forest interests.

Monitoring, evaluating, and reporting on climate risks and adaptation supports learning, informs decision making, and demonstrates accountability and credibility. Done effectively, it can be used to underpin funding bids, influence partnerships, and enable more efficient use of limited resources.

Consideration should be given to:

- Identifying a clear set of goals or objectives that align to an overall vision of adaptation
- The development of adaptation metrics underpinned by effective data recording
- Opportunities for alignment of actions by the diverse communities present within or otherwise connected to the New Forest
- Regular and ongoing open reporting processes that are engaging, accessible, and enable learning and adjustment.

An important aspect of climate risk management is the early recognition of potential conflicting requirements. Adaptation measures will almost certainly include trade-offs and have significant potential to ignite activism and resistance, especially where short term losses or costs are necessary to tackle longer term needs. **These need to be identified and strategies formulated with partners to address potential conflict, including development of a**

robust evidence base to inform debate and decision-making. Examples of potential climate driven issues include:

- Wetland restoration and their perceived potential to support increased abundance of mosquito species (especially in the event of a new mosquito borne disease outbreak)[100]
- The need for measures to reduce warming of freshwater streams and rivers, such as increasing riparian shade along open stretches of river[101]
- Management of coastal change[102]
- Habitat management conflicts and trade-offs including new challenges associated with phenological change e.g. shortened heathland management windows due to wet winters and earlier spring emergence and reproduction of protected species
- Species (re) introductions or translocations, e.g. Beaver is a likely imminent arrival that has the potential to dramatically alter protected New Forest habitats (see link).
- Protection of species or habitats from non-climate pressures that will help to increase climate resilience, e.g. exclusion fencing, car park closures, or other measures that increase the resilience of sensitive habitats

Strategic evidence-based approaches that inform and facilitate participation in decision-making processes (and give voice to the diverse communities of the New Forest) are therefore essential, and their importance likely to be magnified under higher emission scenarios.

3.2 Learn

O4: Expand and appropriately target research and monitoring efforts to provide the evidence needed to inform adaptation

Although the New Forest has a strong history and practice of biological recording, it is evident that many knowledge gaps exist that limit understanding of climate change impacts. **Local observations and evidence are vital for informing decision making and driving action, informed by priorities and risks.** Research and monitoring efforts need to extend beyond biological recording to include, for example, cultural and heritage assets, and increase understanding of the wider socio-economic impacts of climate change relevant to the future of the New Forest.

There are opportunities to ensure that local work is informed by, and builds on evidence generated beyond the Forest, internationally, nationally and in other regions (e.g. Purbeck, other Protected areas and landscapes), and to make the learning accessible to those who can benefit. It is equally essential to share lessons and experience from the New Forest to support efforts to manage climate change risks and opportunities with others who can benefit.

Climate change is driving changes in species distribution; there are opportunities to work with people and organisations on the receiving end of new arrivals that have expanded from the

[100] See e.g. https://www.campop.geog.cam.ac.uk/research/projects/malaria/
[101] https://www.theguardian.com/environment/2025/jul/03/they-are-a-species-on-the-brink-can-trees-save-the-salmon-in-scotlands-river-dee
[102] The 'Save Lymington and Keyhaven' (SLAK) group is an example of a local group, formed to fight proposals for changes to shoreline management along the NEW FOREST coastline.

New Forest to improve habitat connectivity and management and develop evidence for adaptation and understanding of success factors and impacts.

There is a requirement to **continue to strengthen the communities of people working with the aligned interest of sustaining and enhancing the resilience of the New Forest and its exceptional biodiversity for the long term**. Many efforts to do this are already underway and are generating new evidence, including local landowner clusters and water catchment partnerships, the New Forest Biodiversity Forum[103], and partnership projects such as the Species Survival Fund[104], but there are opportunities to improve and more effectively align these efforts across a wider range of landowners and community groups to tackle climate change.

There are already well-established networks of local ecological recording groups, specialist expertise, and a growing community of wildlife recording and conservation volunteers, but **there are also opportunities to make scientific recording and information accessible and understandable to a more diverse range of people**. Scientific nomenclature (including scientific species names) and obscure or specialist pathways to access and work with biological data, can all be perceived as barriers to 'amateur' naturalists seeking to support the critical work of observing and understanding how the New Forest is changing.

A simple example is the opportunity to create a single, accessible, mapping service, and a baseline habitat map that can be used as a common source of 'truth'. Having an ability to query and generate bespoke layers from a single source of baseline data could help engage people, provide a resource to aid communication, and support recording and record-sharing activities. The NPA Rangers have highlighted this as something that could be used for public engagement, with layers showing e.g. habitat restoration, wildfire risk, and sensitive areas, viewed and explored via an interactive tablet, rather than their current use of static maps.

There are also multiple opportunities to leverage enhanced monitoring for research, for engagement through stories, case studies, or to support public outreach. Using and contributing to initiatives such as conservation evidence, and working with partners and projects to ensure that monitoring is designed into projects, recorded, reported and most importantly made available for others to use is an important knowledge investment opportunity that the New Forest can champion and support. Attention is also required on implementing and supporting data management, to ensure that data generated is high quality, accurate and re-usable, according to e.g. FAIR principles and best practices for biodiversity recording.

A selection of evidence needs identified during this review are noted below, intended as a high-level prompt (with a bias towards biological recording and evidence). There is an opportunity to more formally establish (and regularly refresh) priority research needs relevant to the New Forest across public sector bodies and NGO's and make this accessible to the wider research community.

- Considerable knowledge gaps exist regarding the species that are present (especially invertebrates and fungi), their abundance and distribution, and in many cases their habitat requirements throughout their life histories, including seasonally and during

[103] https://www.newforestbiohub.org/
[104] https://www.newforestnpa.gov.uk/conservation/protecting-nature/species-survival-project/

extreme weather events. Climate adaptation and new species arrivals add urgency to the need for a more comprehensive baseline, and an ongoing need for monitoring.

- Better understanding of keystone species in different habitats and their climate related thresholds would enable a much more robust understanding of climate risk.
- Better understanding of the relationships between biodiversity and ecosystem function for different habitats.
- Better understanding of the trade-offs and overlaps between actions to deliver climate adaptation and actions to support priority species and habitats (considering the long term).
- Having some common agreement and dynamic (accessible) understanding of monitoring priorities (annual, seasonal, monthly, potentially weekly) could help direct effort and improve understanding.
- Considering climate change exposure within recording schemes would also help inform understanding of climate risk. Explicit consideration within the design and implementation of recording can be used to understand how widely applicable or scalable results might be when considering climate impacts (see e.g. Wilson and Prescott, 2023).
- Use of (new) technology to support local recording, e.g. satellite earth observation products, drone mounted sensors, tags and microclimate recording systems - many of these technologies are accessible but rarely used except by specialists. A deliberate effort to review, test, and validate new methods and support local use has the potential to improve recording. For example, the spectral reflectance of *Sphagnum* measured by satellites can give useful information in assessing whether desiccation damage has occurred during a severe drought (Lees et al., 2019).
- Link recording effort with management activity and high-resolution (micro + macro) climate data to support implementation of adaptive management**.**
- Improve spatial and temporal understanding of eco-hydrological dynamics, correlation to precipitation and temperature to build a better (or more accessible) understanding of spatial risk and sensitivities to drought for New Forest wetlands.
- Climate refugia use, requirements, efficacy, costs, locations, and extent.
- Species network interactions, dependencies, and how/whether they vary in response to climate (extremes).
- Promote national phenological recording schemes and potentially develop a New Forest specific index.
- Climate sentinels, can local climate indicator species be identified and monitoring established (or modified) to enhance understanding of local climate change impacts and rates of change?
- Responsive event monitoring, i.e. impacts on species or habitats of concern during extreme weather events such as drought, flood, compound events, speed of recovery, evidence of impacts etc.
- Growth rates - how are key New Forest tree (or other) species responding to the changing conditions?
- Investigation of the interplay between climate change and non-climate pressures.

O5: Strengthen efforts to share data and knowledge across the community and between disciplines

Climate change is disrupting land management practices that have been established over decades of experience and learning. Changes in vegetation growth rates, in animal emergence and hibernation behaviours, and in the prevailing conditions that influence when and where management activities can be carried out, are all being modified by climate change.

In addition, the rate at which climate change is taking place constrains the time available for experiential learning and potentially leads to an ongoing process of continually shifting goalposts. **Opportunities that support knowledge exchange and accelerate community learning become far more important under these evolving conditions and require the integration of knowledge across multiple different practitioner and specialist groups**. This can help to increase confidence and outcomes from decision making under uncertainty, while also increasing flexibility and the use of adaptive approaches to manage habitats and species, e.g. a shift from preserving current ecosystems to managing and supporting the dynamic responses of species and ecosystems to climate change (ref here).

The UK has one of the most comprehensive biodiversity recording schemes in the world, and a world-leading climate science capability that supports open-access data policies. Much of this material is already available for public use. **However, there are examples of national resources that could be more effectively disseminated amongst relevant New Forest stakeholders**, e.g. the outputs of the Forest Research Climate Change Hub (link here) that informs management of the Crown Lands by Forestry England.

At a local level, the New Forest has a strong volunteer biological recording community, several local universities with well-established environmental science departments, a high number of engaged landowners including major environmental NGOs, and accessible local facilities such as the Fort Climate Centre in Beaulieu. **The ingredients are therefore in place to develop and deliver local research and demonstration projects that contribute underpinning evidence on climate adaptation options and solutions**. However, careful thought will be required to ensure the generated data are effectively shared amongst the community via e.g. peer-to-peer learning and practitioner/expert insights, case studies highlighting key learnings, demonstrations of new technologies and techniques, and easy access to research syntheses. In some cases, this will require modification of existing fora, but these should be reviewed and new fora established where required.

Finally, **development of a single online New Forest 'environmental change' hub would facilitate access to new climate data and mitigation/adaptation knowledge**; key resources could include:

- Real-time and recent observations, e.g. hydro-meteorological data, satellite remote sensing imagery, LIDAR data.
- Inventory of active and archived research projects - who, where, why, outputs.
- Inventory of key organisations and contacts - NGO's, NPA, NFDC, HBIC etc.

The channel coastal observatory provides an example of a successful model; highly valued by users and well connected to both coastal management practitioners and the research community.

3.3 Enable

O6: Motivate action by increasing public awareness and understanding of climate change as the most important driver of current and future environmental change in the New Forest

The most consistent indicator of concern for the environment, and the uptake of pro-environmental behaviours, is an individual's connection to nature. Although most people in the UK (>83%) are concerned about climate change, almost one-third of the population remain unaware of the threat to biodiversity in the UK (Starling Research, 2023). **The Starling report also found that most individuals perceive the threat of climate change to be a future problem likely to have a greater impact on others, and a general lack of knowledge of how to combat climate change effectively**. Suggesting that "*The first and most important objective for public engagement is to close the gap between knowledge and perception around climate change and biodiversity loss. Raising awareness of the science behind these phenomena, especially the role of humans and the speed at which impact is occurring, is essential to creating a public with the knowledge base needed to drive widespread climate change action.*" (Starling Research, 2023)

Research on nature connectedness has shown that visiting nature once per week or more is associated with better household pro-environmental behaviours and general health, but not directly to pro-nature-conservation behaviours. It has shown that pro-environmental behaviours and pro-nature-conservation behaviours are distinct, and that they form two types of human behaviours that need to be thought of differently. Pro-conservation behaviours are driven by the type of interactions with nature, i.e. they are driven by the things that people do more than the time spent. Richardson et al. (2019) show that nature connectedness can be measured, and show how activities, places, and initiatives can be designed to help people develop closer relationships with nature (see e.g. Richardson & Butler, 2022).

The New Forest provides a living, dynamic showcase of environmental change and species responses to climate change across all the main species groups and lowland habitats found in the UK. Many of these changes, such as those seen in plant, amphibian, and bird phenology, and in new species arrivals and changes in abundance, can be easily observed with minimal guidance in the forest or back garden.

Encouraging and supporting activities that involve observing, recording, sharing, and otherwise engaging with these changes in ways that suit diverse audiences, provides a pathway to increase nature connectedness and encourage pro-social, pro-environment, and pro-nature behaviours (see O2). Activities can be designed to highlight climate change as a local issue, interwoven with biodiversity and directly linked to the human benefits gained from a thriving New Forest.

Connecting these experiences and activities to information and advice on climate action with focused campaigns that provide feedback on impacts, can be used to **show how individual action can make a difference to the outcomes and impacts of climate change, and build empowerment and social motivation to participate**.

Eight key principles for public engagement on climate change and biodiversity loss are illustrated in Figure 40, highlighting the need to create participatory, locally led, positive experiences to underpin action.

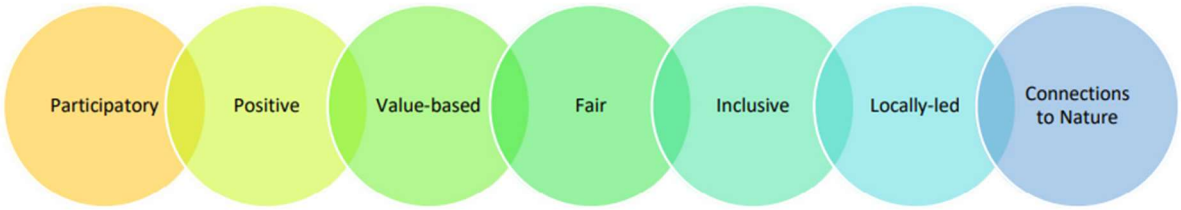

Figure 40: Eight Principles for Engaging the Public on Climate Change and Biodiversity Loss (Starling Research, 2023).

The New Forest provides an opportunity to tackle this, using experience in nature supplemented by targeted resources to make the connections between climate and biodiversity clear, and linked to suggested actions. Engaging resources could be generated providing information on effective actions to address climate risk and support biodiversity, made available to residents through Local Authority or other routes[105]. There are many good examples that could be used as a basis, and a wealth of resources to build on.[106] Guidance might include:

- Information on gardening or managing land for wildlife (advice tailored depending on spatial extent/type) including wildlife ponds and water management, which climate-resilient plant species to encourage, and mowing regimes to increase grassland biodiversity and resilience, e.g. reducing lawn mowing frequencies from two weeks to 12 weeks leads to greater floral species richness and wildflower cover and increases pollinator abundance by >170% (Morrison et al. 2025).
- Tree management/planting and climate change.
- Information on environmentally-friendly pet ownership in the New Forest, utilising resources and expertise including NFDOG, the veterinary advisor to the Verderers, and recent evidence[107].
- Information on wildfire risk and what to do in extreme weather.
- Advice on water management to reduce pressure on the sewage system and protect the New Forest streams, rivers, and coastal waters.
- Advice on how to contribute to net zero - https://www.wildlifetrusts.org/blog/kathryn-brown/how-can-i-get-net-zero.
- Bioblitzes and nature days, designed using e.g. pathways to connectedness resources.
- Curated walks and access to information (e.g. Blackwater Arboretum).

[105] Current information on NFDC website https://www.newforest.gov.uk/article/3968/How-to-prepare-for-climate-change
[106] See e.g. Bristol City Pack, National Trust Adaptation Guidance, RHS information and report, Wildlife Trust things you can do, and Freshwater Habitats Trust Advice and Resources
[107] See also https://www.exeter.ac.uk/research/institutes/esi/research/cats/

O7: Support landowners and land managers to increase climate and biodiversity positive land management and use

Land management is the primary key to climate adaptation. Slightly more than half of the New Forest National Park is privately owned with minimal limitations or constraints on how this land is managed.

Influencing management practices on privately (or publicly managed) land to increase climate friendly and biodiversity positive approaches provides an opportunity to tackle multiple issues. These range from the human-nature connectedness and climate-nature awareness (see O2 and O6), to improvements in water catchment management (see O9), and habitat and biodiversity to protection through to habitat restoration and creation with ecosystem service and natural capital benefits. These could be developed and tailored according to different ownership categories such as interests (e.g. equine), habitat type or size (ha) supported with appropriate guidance, advice or other resources.

The New Forest Land Advice Service (NFLAS) has in the past covered some of these aspects but is not currently focused on long term climate resilience.

Table 15 provides some potential (initial) ideas.

Group / category	Details	Opportunities
Residential Properties	There are an estimated 35,000 residents within the New Forest Park boundary, across ~11,000 properties, the majority of which have private outside space. Data is not available to calculate the extent of these areas, nor the level to which these are currently supporting climate resilience and biodiversity, however it is likely that opportunities exist to help these spaces support the needs of the New Forest landscape and biodiversity.	Guidance on wildlife friendly gardening and why it matters to the future of the New Forest - which native plants are most important, where to source, how to grow and manage (potentially access to seeds, saplings, local business?) - wildlife friendly mowing regimes - support to establish wildlife ponds - guidance on creation of climate refugia (habitat management) - non-native plants and INNS risks and information tailored to the New Forest - managing water, reducing impacts of drought and floods through use of water butts (inc. slow-release systems) - garden wildlife recording support and local encouragement / feedback
Small holdings	Mostly livestock and recreational horse-keeping; potentially includes a significant proportion of back-up land.	Increased grassland resilience through development of wood pasture, installation of ponds, supporting infrastructure (e.g. tracks, shelters). Hedgerow and buffer strips or 'wild spaces' management guidance - inclusion in future small grants scheme?
Farms / tenant farmers	Mostly livestock and associated grasslands, but some arable, particularly in the southern New Forest.	Agri-environment schemes, water management, increased grassland resilience (see above), land-use change to increase resilience e.g. different crops or delivery of different public benefits (e.g. from provisioning to regulating or cultural services via appropriate funding schemes)
Large Estates	Usually mixed businesses with forestry, farming, recreational, and sporting interests.	Access to climate risk information and ongoing guidance as new information becomes available. Habitat management advice and funding pathways to support nature and climate friendly land management. Opportunities to modify land-use to increase resilience and provide alternative/enhanced public benefit (assuming suitable funding mechanisms available). Integration into landscape scale climate initiatives.

Table 15: Examples of adaptation opportunities for different landowner / land manager groups

O8: Facilitate mobilisation of private finance and business investment in nature that supports New Forest species and landscape

Habitat restoration in the New Forest has, to date, primarily relied on public funding through discrete projects such as EU LIFE (>£8M between 1997 and 2006) and the current Higher Level Stewardship scheme (HLS, active from 2010 to 2027). Commoning activity, essential to habitat maintenance on the open forest, is supported through a combination of the HLS-funded

Verderers Grazing Scheme and the Basic Payment Scheme. Future funding options from 2028 onwards are currently under assessment.

At a national level, there is recognition that UK Government funding is not sufficient to deliver nature recovery. Nature-based solutions to meet the UK's nature-related commitments face a £56 billion financing gap (Ward and McNab, 2025), with implications for the likely availability of future funding to support the wide range of habitat management and restoration, and biodiversity monitoring, required to effectively deliver climate resilience.

Government ambition and expectation is that funding models increasingly draw on a blend of public and private finance to support delivery, e.g. the Defra Landscape Recovery scheme requires bids to develop plans for blended finance. In June 2025, the UK Government announced a new call for evidence to better understand how to support and incentivise business to invest in nature recovery.

Established pathways for mobilising private funding primarily draw on concepts of natural capital and ecosystem services. Potential private funding routes, based on Ward and McNab (2025), include:

- *Voluntary payments for ecosystem services,* where land managers undertake actions that provide specific, quantified ecosystem services available for buyers to purchase (e.g. carbon offsetting, or natural flood management credits[108]).
- *Compliance payments for ecosystem services*, where landowners are paid to provide a specific ecosystem service which the buyer is required to purchase to achieve policy compliance, e.g. Biodiversity Net Gain (BNG), or Suitable Alternative Natural Greenspace (SANG).
- *Payments to supply chains,* where products or services derived from land use form part of a supply chain, there may be potential funding routes to improve the delivery of ecosystem services on site, i.e. businesses pay land managers in their supply chains to incentivise them to change management practices.
- *Private investment*, e.g. payments for delivery of specific ecosystem services / habitat creation / restoration.
- *Philanthropic funding*, i.e. financial contributions with no expected financial returns.

Further examples of potential nature investment pathways are provided below in Figure 41.

[108] wyreriverstrust.org

Figure 41: Illustration of potential nature investment pathways (3Keel, 2025).

Successful examples of attracting private and business finance into the New Forest include the BNG offer led by HIWWT (nitrogen offsetting)[109] and the New Forest Biodiversity Forum, which is supported by locally based philanthropists (Kairos Philanthropy Fund). Match funding models have also been used, e.g. landowner contributions to the current Species Survival Fund project, which can include a combination of cash and in-kind resources.

Current mobilisation of the private finance opportunity must be stepped up to a scale properly reflecting the **national importance and long-term stability of the New Forest as a low risk, high (biodiversity) return, nature investment prospect.**

[109] See https://www.hiwwt.org.uk/reducing-nitrates-solent/environmental-credits & background

3.4 Protect

O9: Reduce non-climate pressures and directly protect the most sensitive or vulnerable habitats

97% of the land cover mapped within the New Forest for this report has been rated as moderately to very highly sensitive to climate change, with habitats that are compromised by altered hydrology or coastal squeeze at the highest end of this spectrum. With some exceptions (see Staddon, 2023), naturally functioning ecosystems are more capable of adapting to climate change than human-modified systems, including habitats in poor condition and/or under pressure from other stressors. Mechanisms include stress pressures on individuals or species within the habitats, or loss of certain species impacting ecosystem function.

Restoration of natural function, management of habitats to improve condition (including improving SSSIs so that they are in favourable condition), and reducing or eliminating other pressures, all help habitats to adapt to climate change by increasing their natural capacity to respond.[110]

For the New Forest, primary non-climate pressures include land-use change, pollution (chemical, noise, light), non-native invasive species, and recreational activity. For example:

- Agricultural intensification and urbanisation of the forest fringe and surrounds reduce connectivity and impacts the ability of mobile species to move through the landscape in response to climate change.
- Aquatic pollution can lead to eutrophication and de-oxygenation of rivers and streams, exacerbated by warming temperatures and reduced flow, with direct impacts on multiple aquatic species.
- Non-native invasive species, especially those adapted to warmer climates, can outcompete native species, e.g. the Harlequin Ladybird Harmonia axyridis, which is a highly adaptable species that is outcompeting native ladybird species.
- Recreational use of the New Forest has recognised costs to ecosystem health and biodiversity including direct habitat damage from erosion and trampling, nutrient enrichment and chemical contamination, increased sedimentation and turbidity in freshwater habitats, increased fire risk, atmospheric and diffuse pollution from traffic, littering, livestock disturbance and livestock mortality from road traffic incidents.

Although individually these pressures can have detrimental effects, they also act together in ways that are poorly understood (see e.g. Birk et al., 2020)[111]. **Climate change increases the urgency with which these issues need to be addressed, and potentially, depending on how habitats and species are responding in the short term, may drive new requirements for management interventions**.

[110] Natural England refer to *Favourable conservation status* which is the minimum threshold at which the habitat, and its associated species, are thriving in England and are expected to continue to thrive sustainably in the future.
[111] https://www.ceh.ac.uk/news-and-media/blogs/unpicking-impacts-multiple-stressors-freshwater-ecosystems

O10: Increase focus on habitat heterogeneity and maintaining climate refugia for species most at risk from climate change, provide guidance for landowners and managers

As outlined in Section 2.2, variations in microclimate within heterogeneous habitats provide refugia for species that are sensitive to macroclimatic conditions. Microclimates are primarily mediated by topography, vegetation, and soil, and reflect a combination of local temperature, water (precipitation, air humidity, water availability), solar radiation, cloud, wind, and evaporation conditions. They directly influence the physiology of individuals, and in turn, indirectly affect the dynamics of populations, communities, and ecosystems (Kemppinen et al., 2024). **The fine-resolution variations in microclimate that habitat heterogeneity provide can greatly exceed the magnitude of climate change expected over the next 100 years (Gardner et al., 2023).**

Suggitt et al. (2018) reported that the buffering effect of topographic microclimates was strongest for those species adversely affected by warming and in areas that experienced the highest levels of warming; in such conditions, extirpation risk in topographic microclimates was reduced by 22% for plants and by 9% for insects. Their results indicate the critical role of topographic variation in creating microrefugia and provide empirical evidence that microclimatic heterogeneity can substantially reduce extinction risk from climate change. In addition, Greenwood et al. (2016) cite research on the Glanville Fritillary Melitaea cinxia, which has shown that availability of suitable microclimates (as determined by the successional stage of vegetation) is almost twice as strong a predictor of butterfly abundance as regional air temperature. A keynote presentation at the 2025 New Forest Biodiversity Conference, by Dr Andy Barker of Butterfly Conservation, emphasised similar points in a New Forest context.

Explicit consideration of climate refugia / habitat heterogeneity in habitat management can therefore 1) increase the ability of species to withstand climate change within their existing locations and 2) help to reduce some of the risks of disruption to existing food webs or other network interactions and dependencies from range shifts.

There are 3 key elements to this opportunity:

1) Understanding and maintaining a list of local species of concern (with respect to climate change)
2) Assessing the availability of habitat management advice for these species and assessing whether and how it may differ as a result of climate change, and where evidence gaps exist opportunities to address this
3) Implementation and monitoring, including resourcing where required

There are multiple sources of management guidance available (e.g. Butterfly conservation for butterflies and moths[112], Edgar et al., 2010 for reptiles, Buglife for invertebrates, Natural England 'managing for species', many others[113]). There is an opportunity to review, assess for relevance and collate this information to reflect the New Forest context, and New Forest species of concern/priorities. A subset of information could then be used to develop practical

[112] Or guidance for other habitat types here: https://butterfly-conservation.org/our-work/reports-and-factsheets
[113] See e.g. CIEEM list here https://cieem.net/wp-content/uploads/2021/05/Good-Practice-Guide-2023-edit.pdf

accessible guidance for New Forest landowners and managers (small to large) seeking to support biodiversity in the National Park.

3.5 Manage

O11: Explore the opportunities for adaptive management or other decision-making frameworks that integrate climate change at a landscape scale

There are multiple management frameworks available to guide and aide habitat management decision making under climate change. Two examples of these are adaptive management, and the Resist Accept Direct (RAD) framework.

Adaptive management is a structured and systematic approach to supporting decision making, planning, action and evaluation of those actions (Macleod et al., 2016). It is almost certainly implemented within the New Forest by some land managers, however there is an opportunity to explore whether and how it might be feasibly implemented at the landscape scale, enabling the integration of multiple landowner groups that might be willing to, to some extent, to align to an overarching effort to support the New Forest requirement to increase climate resilience and support biodiversity. Adaptive management is about connecting the 'doing' of natural resource management with 'learning' about the context of the management situation, and the responses and effects of the management actions, it could be tied into a climate adaptation monitoring programme (see O3).

Another approach increasingly valued as a framework for guiding decisions under the context of climate change is the Resist Accept Direct (RAD) framework (used for example for the Amberley Wild Brooks SSSI vulnerability and adaptation assessment[114]). This is designed to provide a simple and flexible way to explore options that aim to either 'Resist' change and strive to maintain existing ecosystems, 'Accept' transformation when it is not feasible to resist, or 'Direct' changes to a future ecosystem configuration for desirable outcomes. (Schuurman, 2022, see also[115]). Again, there is an opportunity to explore whether and how this might help guide decision making at the landscape scale.

3.6 Restore and Create

O12: Restore and create habitats that increase the area of land within the New Forest that is working for climate and biodiversity, support forest-friendly changes in land use

As outlined in Mosedale et al. (2022), the most commonly advocated approach for helping species adapt to climate change is by enhancing connectivity, an approach which a growing body of evidence suggests is not always necessarily the most effective strategy. They argue that increasing the quality and size of protected areas has a more positive impact on species dispersal, persistence and adaptation.

This suggests that in the context of the New Forest measures that seek to ensure the survival of species within their existing geographic range may prove more effective than focusing on the development of corridors for movement. Mosedale et al. refer to this as making '*SSSIs bigger and National Parks better*'.

[114] https://publications.naturalengland.org.uk/publication/5011263307120640?category=10003
[115] https://www.nps.gov/subjects/climatechange/resistacceptdirect.htm

Based on 2019 land cover data, about 34% of the New Forest is urban and agricultural land, compared to about 54% that is priority habitat. This '34%' has potentially the greatest scope for change, both positive and negative, in part because of the lack of designations. This creates both risks and opportunities, and positive climate and biodiversity outcomes will depend on effective engagement with landowners and land managers.

Table 16 provides 'rule of thumb' hierarchy for designing nature networks that could be used together with the recently published Local Nature Recovery Strategies (LNRS) for Hampshire, and Wiltshire & Swindon (draft)[116] to guide landscape scale discussions to prioritise efforts. The LNRS's identify and map opportunities to expand priority habitats, including areas within and adjacent to the New Forest National Park, and are intended as spatial masterplans for nature recovery in the region. The Hampshire report highlights local opportunities for:

- Heathland and acid grassland mosaic restoration.
- Lowland meadow restoration.
- Tree planting and hedgerow creation in the New Forest and forest fringes.
- Creation of wildlife corridors to link areas of high nature value, e.g. Forest to Coast and Avon Valley. Creation of new ponds, wetlands and reedbed habitat.
- Restoration of the Avon Valley Floodplain.
- Restoration and enhancement of the area's rivers and streams for habitat and water quality, including buffer strips and shading.
- Development of more farm clusters.
- Better management of visitors to reduce disturbance to sensitive habitats and species.

The Wiltshire LNRS identifies, for the area within the New Forest National Park, opportunities to improve woodland, heathland, acid bog and acid grassland and open mixed habitats (with a focus on maintaining, enhancing, restoring and creating these habitats).

O13: Improve habitat quality and connectivity beyond the boundaries of the New Forest

As Pearce-Higgins et al. (2017) show, changes in species distributions across the UK are likely to become the norm, not the exception, in the coming years in response to climate change. Although they concluded that many species could potentially benefit from an expanding area of potentially suitable climate, this will be constrained by factors including availability and quality of habitat, habitat connectivity, and species population size and health.

This opportunity therefore focuses on the development of habitat creation/restoration and connectivity beyond the boundaries of the New Forest that will improve the chances of survival and expansion for those species that can or need to move.

Crick et al. (2020) provide a 'rules of thumb' hierarchy for the design of nature networks (Table 16) building on the principles originally outlined in the Lawton review (Lawton et al., 2010). The approach involves working effectively with the planning system, and with landowners, through encouraging the use of agri-environment schemes and green infrastructure development within urban areas.

[116] https://www.hants.gov.uk/landplanningandenvironment/nature-recovery-hampshire/hampshire-strategy & https://www.wiltshire.gov.uk/article/8288/Wiltshire-and-Swindon-Local-Nature-Recovery-Strategy

Better site quality >	Bigger sites >	More sites >	Stepping stones & permeable matrix >	Corridors
• Encourage natural processes • Encourage habitat mosaics • Create more niches for more species – use 'ecosystem engineers' and welcome ecological disturbance. • Increase messiness (variation of physical structure within sites). • Restore missing biodiversity by increasing niches or by reintroduction • Maintain rare species • Encourage climate colonists • Reduce edge effects by buffering sites and encouraging graded ecotones to 'soften the edge' • Buffer sites with at least a 50-100 m buffer strip, possibly up to 500 m wide • Maintain ecological continuity of management to protect soils	• Big enough to encourage natural processes – include sufficient area to ensure functioning ecosystems • Provide space for ecosystem dynamism, supporting mosaics and to encourage succession • Reduce edge effects by decreasing the edge:area ratio • Join habitat fragments; choose the ones that will create the biggest site • Restore degraded habitat surrounding the site. • Enlarge sites to >40 ha (or >100 ha for wide-ranging species)	• Add larger sites in preference to many smaller sites • Target areas of unprotected irreplaceable habitat or with a long ecological continuity of un-intensive land management • Target areas with complex or additional topography & geomorphology and with a potential to be climate change refugia • Target areas of important habitat potential in the surrounding area. • Target degraded areas with potential for high ecosystem service delivery. • Ensure connectivity is good for new sites.	• For poorly dispersing species, sites should be < 1 km from each other and < 200 m apart for highly specialised species within a habitat • Expand sites towards existing habitat to reduce space between patches. • Increase the cover of semi-natural habitat in landscape to at least 20% • Reduce the intensity and increase the diversity of landuse in the surrounding countryside • Stepping stones should provide appropriate resources to avoid becoming ecological traps	• Natural corridors are better than human designed corridors • Use linear landscape features • Ensure corridor habitat matches that in core sites • Minimum width of corridors = 100 m, preferably wider

Table 16: 'Rules of thumb' hierarchy for the design of nature networks. Natural England (Crick at al., 2020).

The opportunities and needs differ considerably depending on species and habitats. For example, in the New Forest there is specific interest in heathland restoration and connectivity with adjacent areas of heathland in Dorset. A recent Natural England publication (McCullagh et al., 2025), highlights the need to increase the area of existing heathland habitat at national level, and reduce the effects of fragmentation through targeted re-creation and restoration around existing patches, to increase the core area and reduce edge effects. The snapshot below (Fig. 37), showing the local distribution of wet heath and dry heath in central southern England, illustrates how isolated this pocket of habitat is, but also the potential to work more effectively to better connect the two largest extents in Purbeck and the New Forest.

For heathland resilience and connectivity McCullagh et al., (2025) provide some key numbers:

- 30 ha was found to be the minimum area of lowland heathland to be functionally viable to support characteristic invertebrate species. Below that size, species, particularly

those with lower powers of dispersal, tend to go extinct. At the same time, generalist species from edge habitats will invade the small fragments.

- An optimum size of heathland landscape (covering multiple habitats) is indicated by a size of greater than 200 ha, although areas in excess of 250-300 ha are needed if the bird assemblage is to be as naturally diverse as possible.
- The ‘stepping-stone’ distance - the distance between unconnected areas of semi-natural habitat that allows more mobile species to move through the landscape - is estimated to be around 1 km for lowland heathland.

An increase in connectivity will support habitat patches less than 30 ha in size and is also likely to help the habitat to adapt to climate change. Note that patches less than 30 ha need protection in the landscape as they can still act as important refugia and sources from which to restore a wider landscape, particularly where the surrounding matrix is favourable

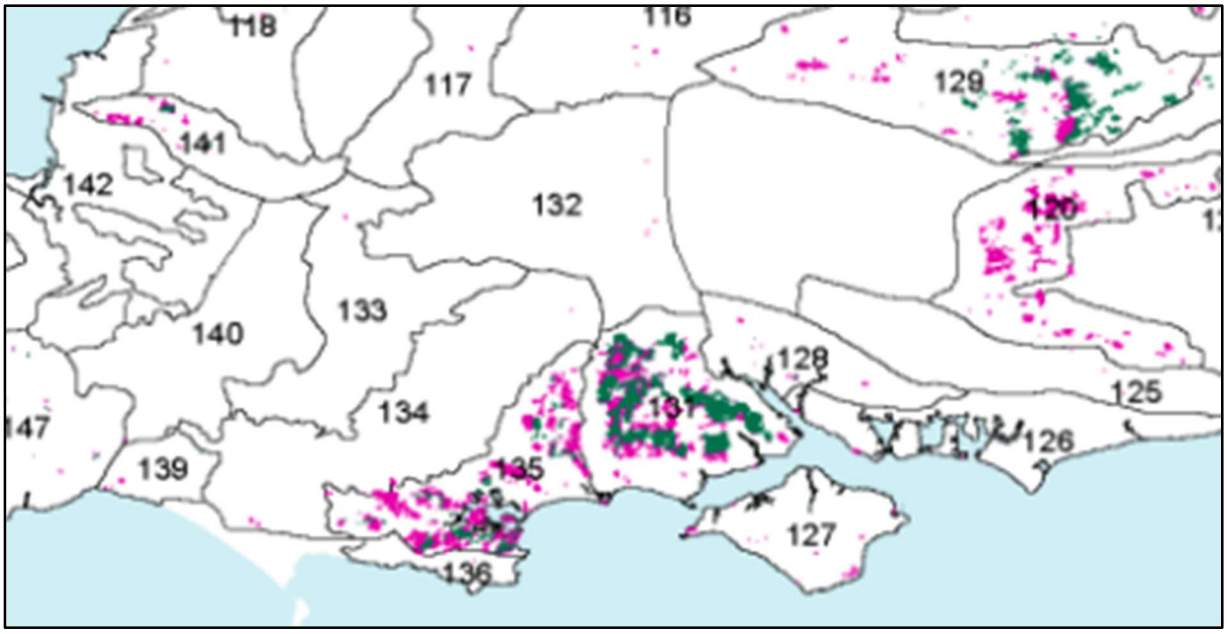

Figure 42: Distribution of wet and dry heath in central southern England, reproduced from McCullagh et al. (2025).

Similar opportunities exist around 1) wetland connectivity between the New Forest and Purbeck (already deemed to be a national Important Freshwater Area by Freshwater Habitats Trust), 2) river connectivity between the New Forest and the Rivers Avon, Test, and Itchen, 3) woodland connectivity between the New Forest and e.g. Bentley Wood and Spearywell Wood to the north and 4) open habitat / grassland connectivity through Wiltshire to Salisbury Plain.

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