



ClimateSouthWest

Opportunities for biodiversity enhancement in a changing climate: the Exe Catchment (Project Exe)

Project Summary and recommendations

June 2011



Photo: Brian Phipps

Recommended changes in land-use and management in the Exe catchment

1. Investigate options for the creation of new wetlands in the Exe valley.
2. Undertake actions to reduce soil compaction and improve soil structure, and promote an increase in clover-rich permanent pasture.
3. Increase native woodland and restore broadleaved tree cover to plantations on Ancient Woodland.
4. Increase the proportion of woodland in active management and establish new woodlands, using a wider range of species and provenances.
5. Restore natural water tables on Exmoor and put in place measures to prevent and tackle fire.
6. Remove invasive rhododendron and Himalayan balsam.
7. Increase habitat suitable for marsh fritillary.
8. Increase the number of trees on farmland throughout the catchment.
9. Plant and coppice broadleaved trees alongside rivers in the middle catchment and continue to remove obstructions to fish migration.
10. Undertake species surveys in the arable land around Crediton.

1. **Introduction and context**

Opportunities for biodiversity enhancement in a changing climate - the Exe Catchment (hereafter referred to as 'Project Exe') was initiated by the Climate SouthWest Biodiversity Sector Group and has been led by the Climate Change Officer for Natural England (South West) and Climate SouthWest. This document summarises the findings from the project. More detail about the methods and supporting evidence can be found in the accompanying Technical Appendix. This document will be of interest to those working in the biodiversity and agriculture sectors, as well as those working with land managers.

Project Exe has two aims:

- i) To illustrate how projected changes in climate are likely to affect habitats and species within the River Exe catchment¹, and;
- ii) To recommend sustainable changes in land use and management that would enhance biodiversity, thereby helping to safeguard the ecosystem benefits that are provided to society (such as clean, plentiful drinking water).

The project focuses on 4 key habitats and 4 mobile species within the River Exe catchment². These are:

- Floodplain grasslands
- Groundwater dependent fens

¹ The Exe estuary is excluded, as it is covered in detail in the Shoreline Management Plan.

² The project area is as defined in the Environment Agency's Exe Catchment Flood Management Plan 2009.

- Upland bogs and heath
- Woodland
- Bats
- Birds
- Butterflies
- Fish

The UKCP09³ high emissions scenario for 2050 was used, with a focus on the 50% probability level. The project also considered the need for more fuel and energy from renewable sources by 2050, and also the recycling of phosphate. A 20% increase in peak river flows was used to assess flooding.

So far, the project aims have been achieved through two workshops. Local experts in agricultural socio-economics, biodiversity, climate change, soils, and water contributed at the workshops. They were provided with the probabilistic projections for mean maximum and minimum air temperature, and precipitation, for all seasons. Comparison of the projections with the 1976 drought was made. A series of maps were also provided showing the distribution of bats, fritillary butterflies, soil types, flood zones, the England Habitat Network, and potential change in distribution of blanket bog.

Workshop one explored the scope of the project, what we knew about the natural environment of the catchment, the quality of data, and gaps in knowledge. The main output from workshop one was an initial assessment of how key habitats and species might respond to changes in temperature and rainfall. In workshop two, knowledge transfer was achieved through a series of short presentations followed by questions, and finally the group agreed upon changes in land use and management to promote resilience. These recommendations, and the rationale behind them, are reported here.

2. Projected changes in climate

Full tables showing the projected seasonal changes for key climatic variables⁴ can be found in the Technical Appendix. We present a summary below:

Exmoor	Baseline: 1961 – 1990	Projected changes: 2040 – 2069 (50% probability)
Average annual rainfall (mm)	1394	1172
Average rainfall in summer (mm)	255	202
Maximum summer temperature (°C)	17.3	21.2
Average summer change in relative humidity (%)	-	-3

Middle catchment	Baseline: 1961 – 1990	Projected changes: 2040 – 2069 (50% probability)
Average annual rainfall (mm)	1168	1168 (no change)
Average rainfall in summer (mm)	223	158
Average rainfall in winter (mm)	374	409
Maximum summer temperature (°C)	18.5	22.5
Average summer change in specific humidity (%)	-	+9

³ UK Climate Projections 2009.

⁴ Mean maximum temperature, mean minimum temperature, mean precipitation and cloud cover.

The 1975/76 drought

To help put the climate projections in context, and because of the importance of wetland in the catchment, statistics on the drought of 1975/76 were presented. Soil Moisture Deficit (SMD) during 1976 was the most severe on record⁵. In the period 1956-1975, average SMD varied from 150mm in Dorset to 50mm in Cornwall. By the end of August 1976, SMD was 375mm and 350mm respectively i.e. 250% and 700% greater. Water temperatures in the River Exe reached a maximum 25.5°C at Thorverton in June 1976 compared with 20.8°C for June 1974. In the River Barle, there was a pronounced diurnal variation of 4°C during August 1976. The drought ended abruptly when 313mm of rain fell in Sep/Oct over England and Wales, the highest for 250 years! Flushing of solutes following these autumn rainstorms occurred on the Exe, due to high soil temperature and dryness, followed by wetting, leading to rapid mineralisation and nitrification. Levels of nitrate rose from 4mg/l to 12mg/l.

2.1. Summary of potential changes

2.1.1. Soil

The most vulnerable soils in the catchment are the Redland soils of mid/east Devon where the land-use is mainly dairy farming. These soils are free draining and easily worked, but are low in humus and thus it is difficult to maintain good structure and biological activity within them. They are prone to capping, and rill/gully erosion if left bare in winter, especially on steep slopes. Drier summers may result in increased need for irrigation, demanding more scarce water.

2.1.2. Flooding

The risk of flooding in the catchment will increase with climate change. For instance, the chance of Exeter receiving 815m³ per second of water will increase from 1% in any year (currently) to about 2.5% in any year by 2050. Sea level rise of 26-29cm by 2050 will also increase the risk of flooding on the Exe Estuary.

2.1.3. Floodplain grasslands

By 2050, a 30% decline in rainfall and a 4°C increase in temperature during the summer will reduce the water table below the minimum threshold for species-rich water meadow communities. However, the 1975/76 drought had no significant long-term negative impacts on wet meadows. The major impact on these wetlands has been through an increase in the drainage, ploughing and reseeded of land previously too wet to work.

2.1.4. Groundwater dependent wetlands

Increased summer droughts and prolonged inundation in winter could lead to the tolerance limit for fen being exceeded, though some fen meadow communities survive in East Anglia, despite regularly drying out in summer. High summer temperatures may also exceed the upper temperature tolerance limit for rush pasture.

2.1.5. Upland bogs and heaths

The climate space associated with peatlands will shrink by 2050, even under a low emission scenario⁶. Blanket bog is highly unlikely to survive as annual rainfall levels drop below 1,200mm on Exmoor, and even wet heath may struggle. The restoration of natural water tables will be essential for the retention of core areas of wet heath and valley mire. Dry heath and acidic grassland will remain viable.

2.1.6. Woodland

Ash, Douglas fir and pedunculate oak will benefit from the changes in climate and new species may establish on south-facing slopes, giving them a more Mediterranean character e.g. Holm oak,

⁵ Institute of British Geographers (1980). *Atlas of drought in Britain 1975-76*. Edited by J.C.Doornkamp & K.J.Gregory

⁶ QUEST (2010). Climate change and upland peat loss.

walnut, sweet chestnut, small-leaved lime, field maple. However, mosses and lichens that characterise our Atlantic oak woods risk losing their climate space, unless north-facing refugia with ancient trees can be maintained. Bio-climatically linked diseases e.g. *Phytophthora ramorum* are an increasing threat and likely to become more common. There may also be increased losses of Sitka spruce & Corsican pine as populations of green spruce aphid & infections by red-band needle blight increase.

2.1.7. Bats

Warmer, drier summers will increase survival rates in bats but an increase in populations will hinge on the maintenance of healthy habitat, particularly roost space in buildings and trees. An increase in the removal of timber for fuel and building materials may have an effect, although the scale and extent of possible losses are not yet properly understood.

2.1.8. Birds

Warming on Exmoor will be beneficial to lowland heath species such as the Stonechat and Dartford Warbler, whose distribution has expanded uphill in the last 10 years with milder winters, even though the habitat has not changed significantly. However, northern species like Ring Ouzel are on the verge of local extinction. Abandonment and/or open woodland development on moorland fringes will benefit Whinchat. The classic Atlantic oak woodland trio of Pied Flycatcher, Redstart and Wood Warbler may do less well. Their migration from Africa is triggered by day length, which remains constant, whereas the peak emergence of their insect food is advancing as temperatures increase, and they may arrive too late to take advantage.

2.1.9. Butterflies

Warmer, drier summers will shorten the development period for larvae and pupae, and improve flying conditions for adults, resulting in better survival and dispersal rates and more opportunities for mating. However, droughts could lead to the wilting of larval food plants and warmer, wetter winters could increase fungal disease, and therefore reduce larval survival. High brown and heath fritillaries like it hot and are currently found on south-facing slopes. The Silver-spotted skipper is colonising north-facing slopes. Although there is scope for the high brown fritillary to do the same, its populations are small and isolated. However, 2010 was a good year for this species and management efforts should continue so that the butterfly can respond to more favourable conditions if they arrive.

2.1.10. Fish

The Exe is good for Atlantic salmon and the Little Exe and Barle are spawning strongholds. Higher temperatures and reduced summer flows could negatively affect survival and migration. Low flow and high temperature in estuaries is a particular concern, and mass mortality can occur in drought years. Increased rainfall and run-off may lead to greater siltation of gravels, reducing fish spawning and egg survival. Hydropower schemes along the river system are a concern, but this is manageable.

3. Recommended changes in land use and management

3.1. Flood attenuation

Changes in land use in a number of areas could alter the risk that defences in the Exe catchment will be over-topped during a flood event. Increasing attenuation locally could reduce flood risk downstream, although this is most effective for more frequent flood events (for example 1 in 10 to 1 in 30 chance in any year). Areas of search where this is most likely to bring benefits are shown on the Land Use & Management Priorities map (see [Appendix 1](#) on page 9). Delaying the flood peak could be beneficial for areas near the River Lowman in Tiverton and villages and towns further upstream on the River Exe,

giving the public more time to react to a flood warning. However, this is not as critical for Exeter, where the warning lead time is longer and the effectiveness of softer engineering will be reduced due to the size of the catchment.

We recommend investigating options for the creation of new wetlands in the Exe valley between Bickleigh and Exeter, consisting of reedbeds, wet woodland and marsh. The functional floodplain is not suitable for a water storage scheme because the flow is very fast in a flood. However, the shallower floodplain edges could be deepened and flows could be attenuated, possibly by woodland. When not in flood, this area could have a greater value for recreation and biodiversity. New/restored wet woodland upstream of Bampton and on the River Lowman upstream of Tiverton could provide local flood risk benefits.

Recommendation 1: Investigate options for the creation of new wetlands in the Exe valley.

3.2. Soil conservation

Much of flooding is often caused by surface water, rather than by rivers bursting their banks (for example, 80% of the flooding in nearby Ottery St Mary in 2007 was due to surface water). Therefore, ground infiltration is vital. Soil compaction reduces infiltration and can only be remedied in the short term through mechanical sub-soiling. Timeliness of field operations is very important to prevent soil compaction occurring. If operations are carried out when it's too wet, compaction can occur. For instance, intensive stocking in late summer/early autumn when soils are re-wetting should be avoided. It is important to dig holes to help identify fields that are compacted and at what depth. This can then help decide what action, if any, is required and can avoid unnecessary expensive operations.

Permanent pastures generally have better soil structure, particularly when the sward is more diverse and contains deep rooting species. Clovers, in addition to fixing nitrogen and providing nectar and pollen for bees and other invertebrates, can also improve soil structure through both physical and biological processes. An increase in clover-rich permanent pastures would therefore provide a range of ecosystem services.

Recommendation 2: Undertake actions to reduce soil compaction and improve soil structure, and promote an increase in clover-rich permanent pasture.

3.3. Focus efforts to restore and create habitat within ecological networks

The England Habitat Network and the SW Nature Map both identify locations to improve the condition of existing habitat and increase patch size. Conservation resources should be directed to these locations, but the top priorities are as follows:

3.3.1. Woodland

An increase in native woodland expansion is required to alleviate flooding and soil compaction, as well as for biodiversity. Between Bampton and Tiverton, the priority is to restore broadleaved tree cover to Plantations on Ancient Woodland. Some natural regeneration is already occurring on Exmoor due to livestock reductions, and total land abandonment is possible in pockets here and in the Blackdown Hills. Short-rotation ash has potential for wood fuel and restoration of farm woodland management will benefit bats, butterflies and spring flowers. Veteran broadleaved trees on north facing slopes in ancient woodland could become refuges for mosses and lichens. In these locations, small coupe management and halo thinning will help to maintain the humid micro-climate.

Recommendation 3: Increase native woodland and restore broadleaved tree cover to plantations on Ancient Woodland.

Throughout the project area there is scope to increase the proportion of woodland in active management. Well-managed woodland is better for wildlife and more resilient to the impacts of climatic change. The establishment of new woodlands, particularly in locations where they extend or link existing woodlands, provide opportunities to plant with a view to future climatic conditions,

using a wider range of native and non-native species with a range of provenances. In some locations e.g. upstream of Tiverton, new plantings can be designed and sited to assist with flood attenuation.

The Ward Forester project is one means by which management of undermanaged woodland can be achieved in the coming years. Other opportunities include the forthcoming Woodfuel Woodland Improvement Grant (WIG), part of the Forestry Commission's England Woodland Grant Scheme (EWGS), to be launched in June 2011, and the other grants and incentives for woodland management and creation under EWGS.

The biodiversity and resilience of woodlands in the Project Exe area could also benefit from the Woodland Wildlife initiative being developed by Natural England in partnership with RSPB, Plantlife, Butterfly Conservation, Forestry Commission and others.

Recommendation 4: Increase the proportion of woodland in active management and establish new woodlands, using a wider range of species and provenances.

3.3.2. Restore mire and heath on Exmoor

The survival of blanket mire on Exmoor is extremely threatened by the projected decline in annual rainfall and the increased risk of summer fires. However, wet heath and valley mire is viable provided that artificial drainage is reversed to restore natural water tables, and fire prevention and tackling measures are put in place. The Exmoor peatlands are a major source of drinking water and erosion would lead to significant losses of water quality and quantity for the public. Management to remove invasive rhododendron and Himalayan balsam remains a priority.

Recommendation 5: Restore natural water tables on Exmoor and put in place measures to prevent and tackle fire.

Recommendation 6: Remove invasive rhododendron and Himalayan balsam.

3.3.3. Upper Culm

There remains a good proportion of semi-natural wetland in the headwaters of the Culm; valley mire, marshy grassland, wet heath, alder woodland and the river itself. It also adjoins the Blackdown Hills, with its extensive woodland and dry heath. Efforts to increase habitat suitable for marsh fritillary are essential if a viable population is to remain. The area is likely to be important for carbon storage particularly in peaty soils, but also under semi-natural grassland and woodland soils. Alder has potential as wood fuel and purifies water. In the absence of agri-environment funding, land abandonment is likely in this area. Thus innovative funding mechanisms that pay for ecosystem services will be essential.

Recommendation 7: Increase habitat suitable for marsh fritillary.

3.4. Improve the ecological quality of landscapes for certain species

Linkages between the wooded hills south of Crediton and the Upper Culm have been identified, where an increase in trees could improve the viability of bat populations within the catchment. However, more trees on farms throughout the catchment would provide shade and shelter for livestock, woodfuel and, in some locations, reduce soil erosion.

Recommendation 8: Increase the number of trees on farmland throughout the catchment.

The Little Exe and River Barle are spawning grounds for Atlantic salmon but their populations are threatened by low flows, higher water temperatures, siltation and pollution. Siltation of spawning gravels is an issue on the River Lowman. In the middle catchment, the planting and coppicing of broadleaved trees alongside rivers will help to ameliorate higher water temperatures. The ecological status of the River Weaver & Clyst is poor⁷ because of high phosphate levels linked to dairy farming. Measures to reduce phosphate pollution would benefit drinking water quality and salmon populations.

⁷ Water Framework Directive 2009

The maintenance of autumn flows will be particularly crucial for estuarine salmon waiting to move upstream. Finally, obstructions to migration need to be removed on the Culm in particular.

Recommendation 9: Plant and coppice broadleaved trees alongside rivers in the middle catchment and continue to remove obstructions to fish migration.

Two areas are highlighted for farmland wildlife. Arable land around Crediton supports yellowhammers and woodlark and permanent pasture is important for bats. Species survey effort is needed here to confirm whether this is a priority for farmland wildlife conservation. The Exminster to Dawlish area is an existing focus for Cirl bunting. Agri-environmental funding will be needed to enable farmers to create stubbles in arable fields and provide winter seed and other food resources for birds on grassland farms.

Recommendation 10: Undertake species surveys in the arable land around Crediton.

4. Final considerations

Supporting landowners in transition

A number of land managers are making the changes in land use or management advocated and are, or could become, demonstration farms. We should help them to pass their knowledge on to other land managers. The identification of lowland livestock farms or LEAF farms, as well as those in agri-environment schemes, is recommended; these businesses are more likely to be viable in the long term. Support self-assessment of the income potential from ecosystem services, and particularly farm woodlands and trees, and use high profile species e.g. barn owl, to demonstrate quality land management.

Change conservation objectives

Communities of plants and animals that characterise our natural habitats will change. Conservation objectives therefore need to re-focus on natural processes. For example, we are likely to lose the mosses, lichens and migrant birds that make our western Atlantic oak woodland distinctive.

Available support

General support and advice for land owners and managers on the themes covered in this project summary and recommendations is available from:


- **Environment Agency** (Flooding and water resources; soil management) - <http://www.environment-agency.gov.uk/>
- **Forestry Commission** (Woodland management) - <http://www.forestry.gov.uk/>
- **Farming and Wildlife Advisory Group** (Farm conservation advice) - <http://www.fwag.org.uk/>
- **Natural England** (Wildlife conservation; agri-environment schemes) - <http://www.naturalengland.org.uk/>

Climate SouthWest has also contributed to a Farming Futures leaflet titled, '**Changing Climate, Changing Business – is your farm adapting?**' It includes more detailed signposting to further advice, as well as Top Tips on how farmers can effectively manage their water, soils and woodland to cope with the challenges of climate change. The leaflet is available from Climate SouthWest, or can be downloaded from the following link: http://www.oursouthwest.com/climate/registry/Farming_Futures_A3foldout_WEB2.pdf







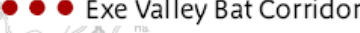
For further information or queries regarding Project Exe, please contact Climate SouthWest at: climatesw@environment-agency.gov.uk or 01392 352230.

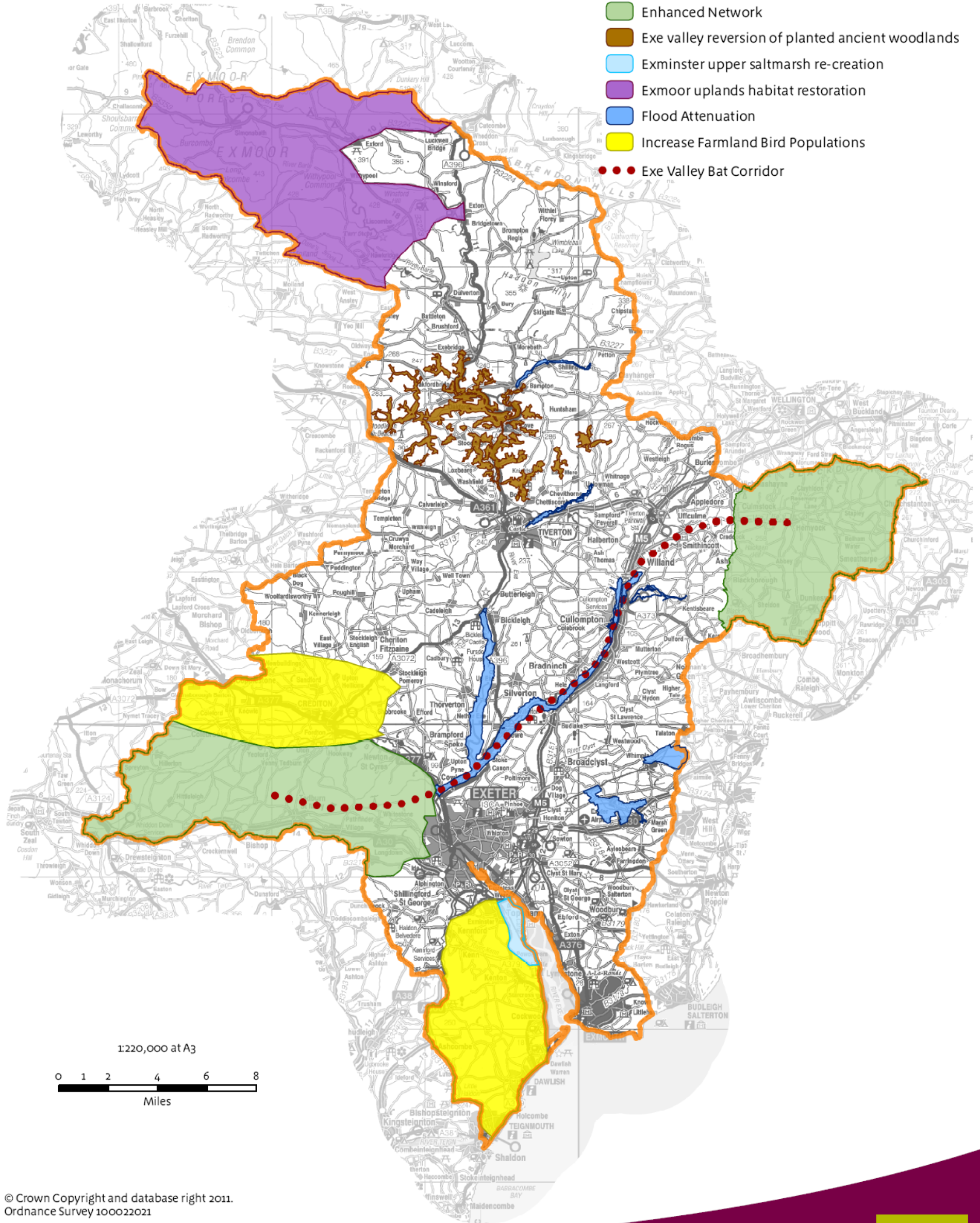
Exe Project Area

Land Use & Management Priorities

 Exe catchment boundary

Land Use & Management Priorities

-  Enhanced Network
-  Exe valley reversion of planted ancient woodlands
-  Exminster upper saltmarsh re-creation
-  Exmoor uplands habitat restoration
-  Flood Attenuation
-  Increase Farmland Bird Populations
-  Exe Valley Bat Corridor



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