Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP)

ERAMMP Report-110: Revised Assessment of Natural Capital Social Benefits for 2025

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Abbreviations Used in this Report

CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
CO_2-e	Carbon dioxide equivalent
DCE	Discrete choice experiment
ENCA	Enabling a Natural Capital Approach
ERAMMP	Environment and Rural Affairs Monitoring & Modelling Programme
IMP	Integrated Modelling Platform
JULES	Joint UK Land Environment Simulator
LPIS	Land Parcel Identification System
MENE	Monitor of Engagement in Natural Environment
ONS	Office for National Statistics
ORVal	Outdoor Recreation Valuation Tool
PV	Present value
UA	Universal Actions
RPW	Rural Payments Wales
SFS	Sustainable Farming Scheme
SLM	Sustainable Land Management
SRUC	Scotland's Rural College
UKCEH	UK Centre for Ecology & Hydrology
WORS	The Welsh Outdoor Recreation Survey
WTP	Willingness-to-pay

CONTENTS

EXECUTIVE SUMMARY

This report, prepared by eftec and the UK Centre for Ecology & Hydrology (UKCEH), as part of the UKCEH-led ERAMMP programme, reassesses the integration of social values from natural capital into the revised Sustainable Farming Scheme (SFS) proposal. It builds on ERAMMP Report-102: Natural Capital in Payment Rates (2021), which examined how adjusted payment mechanisms could reflect natural capital benefits.

SFS is an agricultural support scheme which seeks to achieve statutory Sustainable Land Management (SLM) objectives alongside the sustainable production of food. The Welsh Government developed the SFS to replace the previous European Union (EU) Common Agricultural (CAP) system of support, which ended in January 2020, when the United Kingdom withdrew from the EU.

Prior to withdrawal from the EU, Welsh farmers received both direct payments (the Basic Payment Scheme, decoupled from agricultural production) and rural development payments, which included payments for environmental benefits under the agri-environment scheme Glastir[1]. After withdrawal from the EU, support under the Basic Payment Scheme (BPS) has continued domestically but is planned to be phased out between 2026-2029 following the introduction of the new proposed SFS.

The SFS will reward farmers for delivering sustainable food production, mitigating and adapting to climate change and enhancing the reliance of ecosystems and their benefits, all of which have social value. Following consultation, the SFS has been streamlined to include 12 Universal Actions. This report assesses the value of three of these: actions to support habitat maintenance (UA7); action to create additional temporary habitats on improved land if less than 10% of land is classed as existing habitat (UA8); and an action to maintain existing woodlands (UA12).

Updates to the Natural Capital Assessment

This report builds on a previous analysis of the size and distribution of potential benefits of the SFS (ERAMMP Report-102). Several important revisions have been made to the natural capital assessment of the SFS, including to the data sources used, benefits assessed, the underlying evidence base and the type of assessment. The main revisions are as follows:

- **Farmland and habitat spatial data:** an update and assessment of the type and extent of farmland and habitat in scope, based on the revised scheme, best available data sources and an intention to align with National Trends reporting from the Environment and Rural Affairs Monitoring and Modelling Programme (ERAMMP). This led to using data for temporary habitat and woodland creation, previously modelled by Moxey et al (2023)) for Welsh Government, and the Rural Payment Wales data source for the existing habitat area, as this was available by local authority, which is needed for the air quality valuation and is closer aligned to land cover classes used with ERAMMP reports. This took

[1] See the following research briefing for more information: https://research.senedd.wales/media/msjkrnu2/22-43-agricultural-support.pdf

advantage of the previous work done to define boundaries of agricultural land eligible for payments.

- **Natural capital benefits:** an assessment of natural capital benefits from farmland, covering:
    - Carbon sequestration and air quality benefits delivered by existing on-farm woodland, and recreation benefits delivered by existing on-farm woodland and other habitats, and
    - Species recovery delivered new temporary habitat creation. The assessment of species recovery is based on recently published valuation evidence in Browning et al. (2024). It applies to potential change in species abundance from new habitat creation.
- **Update of valuation evidence:** an assessment of the latest valuation evidence including consideration of how the natural capital assessment aligns with ecosystem accounting data. Updates in the evidence base were reviewed across natural capital benefits. The data accuracy was sense checked where possible, for example the recreation benefits of farmland were compared to values for tourism in the ONS' ecosystem accounts.
- **Spatial variance**: was not assessed for this updated revision, so national-level aggregates are reported. Insights from ERAMMP Report-102 on the spatial variance of values and benefits are unchanged.

Summary of Findings

Natural capital values were assessed for existing farmland and habitats and for the new semi-natural habitat area expected under the new SFS proposal. The total annualised value for each benefit and the total annualised value per hectare are reported across 5, 10, 25, and 75 year time horizons. Annualised values are reported to give consistent comparison and enable use in policy design.

Existing farm woodland and habitat area is estimated as 82,481 hectares and 366,352 hectares, respectively, across Wales. The assessment finds the annualised benefit to be between £226m and £502m and £1,230-£2,200 per hectare depending on the time horizon of the assessment.[2] Carbon sequestration provides the largest per hectare value of £1,096 per hectare, with air quality and recreation providing smaller per hectare values of £70 and £63 over a 75-year time horizon (see Table E0.1). Recreation, however, provides the highest overall benefit, as it is assessed across all agricultural land, rather than only farm woodland and new semi-natural habitat.

[2] Values per hectare are not equal to total annualised value divided by farm woodland and habitat area, as recreation benefits are values across the total agricultural area in Wales, and not just woodland and habitat on farms.

Table E0.1: Average annualised present value (PV) per ha of benefits for existing farmland, including farm woodlands and semi-natural habitats in Wales

	Average annualised PV by Time Horizon per ha (£ per ha, 2024 prices)[1,2]				
Benefit	5PV	10PV	25PV	50PV	75PV
Carbon sequestration in farm woodlands	1,887	1,850	1,639	1,330	1,096
Air quality regulation by farm woodlands	151	125	101	82	70
Farmland recreation value, including farm woodlands and semi-natural habitats	161	148	118	84	63

1. *Average annual figures are annualised present values, which is calculated by dividing the PV by the time horizon.*
2. *Discount rates are from HM Treasury (2022) and IMP modelling. For carbon reduction, and recreation the rate is 3.5%, reducing to 3% from year 31. For air pollutant removal the rate is 1.5% reducing to 1.29% from year 31.*

New semi-natural habitat to meet the 10% scheme rule is estimated[3] to cover 25,700 hectares on 8,774 full time farms. As the selected methodology only values changes in species abundance in habitats, it cannot be applied to existing habitat or woodland. New temporary semi-natural habitat could be created on grassland or arable land, but only measures on arable land are expected to produce a benefit for species abundance[4]. Only 3% of this habitat creation (771 ha) was assumed to be grass strip measures on arable land[5], so the benefit is only calculated for this habitat area. The calculation assumes that this habitat creation occurs every year but is temporary in that its location within a farm can change each year.

For the arable land that provides this land use change the annualised PV benefit per ha is £137 over 75 years. However, to assess value for money, the benefit should be divided by the whole action area (25,700 ha), giving this measure a benefit of £4/ha, over a 75-year time horizon (see Table E0.2).

[3] Andrew Moxey, Steven Thomson, and Liz Lewis-Reddy (2023) Potential economic effects of the Sustainable Farming Scheme Phase 4 Universal Actions Modelling Results A deliverable under Welsh Government project C280/2019/2020.
[4] Source: ERAMMP modelling team, May 2025.
[5] Source: ERAMMP modelled uptake for UA8.

Table E0.2: Average annualised present value (PV) per ha of benefits for new semi-natural habitat

	Average annualised PV by time horizon (£ per ha, 2024 prices) [1,2]				
Benefit	5PV	10PV	25PV	50PV	75PV
Species Recovery over 10 years (arable area only)	225	369	367	201	137
Species Recovery over 10 years (arable and grassland area) RECOMMENDED DATA	7	11	11	6	4

1. *Average annual figures are annualised present values, which is calculated by dividing the PV by the time horizon*
2. *Discount rates are from HM Treasury (2022) and IMP modelling. For carbon reduction and species recovery the rate is 3.5%, reducing to 3% from year 31. For air pollutant removal the rate is 1.5% reducing to 1.29% from year 31.*

Species recovery, per hectare values decrease with a longer time horizon, highlighting the critical role of existing habitats in delivering immediate and medium-term environmental benefits. For Universal Action 8, per hectare values are expected to increase with longer time-horizons up to the 25-year horizon reflecting how species recovery benefits can take time to be fully realised (see Figure E0-1). Not all this creation will be permanent, but even if temporary it will provide a small contribution to species abundance.

The findings are considered robust and with limited risks from double-counting and data inaccuracy. Double counting is assessed as low across the benefits in scope, whilst data accuracy is assessed as high for air quality, medium for carbon sequestration and recreation, and low for species recovery. Key assumptions to enable the analysis are:

- That recreational benefits of farmland are the same as the average recreational value per ha of land in the relevant local authority, and
- For species recovery: assuming temporary habitat on arable land supports moderate species abundance. This assumption is necessary due to a lack of data on the expected habitat mix for new temporary semi-natural habitat to meet the 10% rule.

Of note:

ERAMMP Report-110 [this document] and the ERAMMP Integrated Modelling Platform (IMP) universal SFS modelling run (SFS7) both provide projections for Ecosystem Services delivery and valuation associated with land on Welsh farms. However, there are key differences in what is captured by these separate sets of work, and as a result the estimated values will differ.

In addition, new ERAMMP programme evidence on agri-environment scheme outcomes (ERAMMP Report-105) was published after some of the analysis for this report (e.g. for existing farmland habitats in Section 4.1) were completed.

These differences are explained in more detail in Annex-1.

1 INTRODUCTION

eftec and the UK Centre for Ecology & Hydrology (UKCEH) have been tasked to assess the social value from natural capital in the revised outline Sustainable Farming Scheme (SFS) published in November 2024. The assessment updates the data contained in ERAMMP Report-102 'Natural Capital in Payment Rates'. It builds on the methodology and findings in ERAMMP Report-102, whilst both focussing on the core elements of the revised SFS policy and exploiting the best available data which aligns as far as possible with ERAMMP data reported in the National Field Survey.

The main contributions of this revision are intended to be an assessment of:

1. **The natural capital value of existing farm woodland and habitats**: including an assessment of air quality benefits of woodland habitats for filtering $PM_{2.5}$, carbon sequestration benefits for woodland, hedgerows and other habitats and the recreation value of agricultural land. This component provides social values of use for the Universal Action 7 on Habitat Maintenance.

2. **The value of species recovery supported by the new habitat created to meet the 10% scheme rule for semi-natural habitats:** species recovery (which has not been valued under this scheme before, based on areas of habitat created). This component provides social values of use for the Universal Action 8 on Creating Temporary Habitat on Improved Land.

As with the ERAMMP Report-102, the term 'social value' is defined and scoped as referring to the value to Welsh society from the public goods provided by the natural environment in Wales. This definition means that market goods and transboundary impacts are excluded, so the emphasis is on non-market impacts.[6]

It should be noted that this report analyses SFS outcomes expected by the Welsh Government. This differs from the modelling of outcomes from expected SFS actions by the ERAMMP programme. This is described in detail in Annex-2.

1.1 Project background

This project builds on previous natural capital assessments of earlier SFS schemes, and the Natural Capital Accounts for Farmland, Woodland Freshwaters (ERAMMP Report-24). The main project background relevant to understanding this report includes the development of SFS in Wales and the related natural capital assessment of the schemes.

Sustainable Farming Schemes

SFS is an agricultural support scheme which seeks to achieve statutory Sustainable Land Management (SLM) objectives alongside the sustainable production of food. The Welsh Government developed the SFS to replace the previous European Union (EU) Common

[6] See the revised outline SFS, which was published in November 2024 Sustainable Farming Scheme: https://www.gov.wales/sustainable-farming-scheme-proposed-scheme-outline-2024

Agricultural (CAP) system of support, which ended in January 2020, when the United Kingdom withdrew from the EU. Prior to withdrawal from the EU, Welsh farmers received both direct payments (the Basic Payment Scheme, decoupled from agricultural production) and rural development payments, which included payments for environmental benefits under the agri-environment scheme Glastir.[7] After withdrawal from the EU, support under the Basic Payment Scheme (BPS) has continued domestically but is planned to be phased out between 2026-2029 following the introduction of the new proposed SFS.

Under the SFS proposals, farmers are to be rewarded for actions beyond minimum requirements to deliver wider social benefits, including: producing food and goods sustainably; mitigating and adapting to climate change; maintaining and enhancing the resilience of ecosystems and the benefits they provide; and conserving and enhancing the countryside and cultural resources to promote public access to and engagement with them. Under the scheme, farmers participating in the SFS would be required to carry out a suite of 'Universal Actions' for which they would receive payment.

Updated revised proposed outline SFS 2024

After a series of consultations and revisions, the proposed SFS has been through several iterations. The previous proposal of a Scheme Rule for at least 10% of each farm as tree cover or individual trees no longer applies.

As the SFS has been developed, the ERAMMP programme has been tasked to assess the social value created under these actions to assist with designing the forthcoming policy. These natural capital assessments have built on both well-established natural capital approaches and wider applications to the Welsh agri-environment context.

NC assessment background

The foundational natural capital assessment the analysis in this report builds on is the Natural Capital Accounts for Farmland, Woodland and Freshwaters (Engledew *et al.*, 2019). The NCA account from 2019 presented 7 service accounts containing estimates of the quantity and value of services being supplied by Welsh natural capital in woodland, farmland, and freshwater broad habitats. These services include food, water, air filtration and recreation. The accounts were a collaboration between the ERAMMP programme and the Office for National Statistics (ONS) Natural Capital accounts division.

The approach in this analysis develops methods used to assess the inclusion of social values from natural capital in SFS payments in ERAMMP Report-102 'Natural Capital in Payment Rates'. Report-102 covered 8 ecosystem service benefits and assessed the spatial (across all Welsh local authorities) and temporal variation in services, established a natural capital assessment methodology for designing the Agri-environment payments and discussed policy risks. It informed both universal and optional layers of the SFS policy.

[7] See the following research briefing for more information: https://research.senedd.wales/media/msjkrnu2/22-43-agricultural-support.pdf.

Differences with IMP Modelling Runs

ERAMMP Report-110 [this document] and the ERAMMP Integrated Modelling Platform (IMP) universal SFS modelling run (SFS7) both provide projections for Ecosystem Services delivery and valuation associated with land on Welsh farms. However, there are key differences in what is captured by these separate sets of work, and as a result the estimated values will differ. These differences are explained in more detail in Annex-1.

1.2 Project objectives

This project aims to revise the data contained in the previous 'Natural Capital in Payment Rates' report for the new proposed SFS.

The NC assessment will include:

- Assessment of air quality benefits, carbon sequestration benefits and recreation benefits for existing farm woodland and existing farm habitats.
- Assessment of species recovery value for the new temporary habitat created.

In addition, the project aims for data alignment and consistency with the ONS Wales ecosystem accounts, and the latest data included in the ERAMMP National Trends and Glastir Evaluation Report. Where applicable, an update of the valuation evidence is provided; for instance, where new methods and valuation evidence has become available for the services assessed. Otherwise, the method follows the approach developed in prior reports (e.g. ERAMMP Report-102) and provides insights and guidance on natural capital for the latest iteration of the SFS.

The report summarises results in terms of the magnitude of specific natural capital benefits over time, and as an annualised PV which enables comparison to payment rates. It does not include an assessment of spatial distribution of benefits. The findings of the last report, that spatially targeting is socially efficient remain relevant to the updated SFS policy proposal.

This revised report relates to the social value of benefits arising from existing farm woodland, and new temporary habitat management (UA8) and now excludes the benefits of new tree planting previously required to meet the 10% tree cover scheme rule, which no longer applies. It can be used to incorporate, and scale, natural capital values into the policy for these actions. The revised report provides breakdowns of the relevant data, and/or descriptions of how to use the evidence sources available to derive such data.

Ultimately, the findings from this revised report, alongside previous reports, will help the Welsh Government consider different policy design in light of natural capital benefits and social values and assess issues pertinent to environmental outcomes and scheme delivery at scale.

1.3 Report structure

The remainder of this report is structured as follows:

- **Section 2** introduces the methodology, scope and evidence base, including a description of the benefits covered in this assessment.
- **Section 3** outlines findings on the value of natural capital for both existing woodland and farm habitat and new semi-natural habitats, compares results across both of these scheme components and discusses double-counting and data accuracy considerations.

- **Section 4** presents conclusions in the context of the revised assessment and discusses next steps.
- **Annex-1** explains differences between analysis here and in IMP modelling runs.
- **Annex-2** summarises the area data and methodological approach used for the four benefits: atmospheric carbon reduction, air quality, recreation and species recovery.

2 Method

This section describes the methods used to value air quality regulation and carbon sequestration ecosystem services, and to calculate the value of species recovery. These methods build on the approach taken in ERAMMP Report-102.

2.1 Background

This update is based on the methodological approach taken in ERAMMP Report-102, utilising the same sources (but the most recent data) and expanding to include an analysis of species recovery. A short summary of the approach taken in ERAMMP Report-102 to identify evidence is therefore useful context. The following steps were taken for collecting and collating available literature to establish an evidence base: (i) develop a research approach (ii) search for evidence and produce a database; and (iii) extract relevant evidence.

The evidence review was based on sources already used to inform analysis of natural capital values in the ERAMMP work programme (e.g., ENCA (Defra, 2021)) and the priorities under the earlier version of the SFS policy. The review focused on key literature that discusses the value of management of natural capital by farmers. The benefits that were within scope were those that are routinely assessed using existing data and evidence sources within the UK.[8]

Table 2.1 shows the list of benefits that were assessed in ERAMMP Report-102, along with the type of ecosystem service as categorised in ENCA (Defra, 2021), a description of the benefit, and those included (or updated) in this analysis.

[8] Key sources of evidence for Report-102 were: Wales-Relevant Policy Evidence, based on Defra's ENCA guidance, which serves as a key source of evidence on natural capital, recognised in HM Treasury's 'The Green Book' guidance on policy appraisal by Government; IMP model runs; and ADAS research.

Table 2.1: List of benefits covered in ERAMMP Report-102

Benefit name[9]	Type of ecosystem service	ENCA Description (Defra, 2021)	Included in this Assessment[1]	Habitat included
Carbon sequestration	Regulating	Sequestration and storage of carbon dioxide by growing vegetation, soils and sediments	Included	Mixed native woodland only
Air quality	Regulating	Removal of harmful air pollutants from the atmosphere through a) direct deposition onto leaves and bark and b) internal absorption of pollutants through stomatal uptake	Included	Mixed native woodland only
Recreation	Cultural	Environmental settings for recreational use	Included	All farmland
Biodiversity (Species Recovery)	Aggregate/bundled	Defined by the Convention on Biological Diversity (CBD) as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part, this includes diversity within species, between species and ecosystems." As such, biodiversity underpins all ecosystems and the services that they provide.	New valuation methodology (species recovery)	Grass strips on arable land only
Water quality	Aggregate/bundled	Provision of clean water by nature	Excluded	None
Physical health	Cultural	Environmental settings for physical activity	Excluded	None
Natural Flood risk management	Regulating	Regulating water flow by vegetation retaining water and releasing it slowly, or absorbing wave energy	Excluded	None
Water supply	Provisioning	Surface and groundwater for various uses.	Excluded	None

[1] Services excluded from this assessment were assessed in ERAMMP Report-102 for SFS 3.

[9] Three benefits reviewed have different names in ENCA (2021): atmospheric carbon reduction is "carbon reduction", air quality is "air pollutant removal" and flood risk management is "flood regulation".

2.2 Analysis framing

Throughout this report, benefits are assessed using a baseline scenario where 'baseline' refers to the counterfactual or existing land management before SFS will be implemented in 2025. Benefits may be calculated as either a) the social value provided by existing habitat (i.e. benefits delivered by continuation of the existing baseline), or b) additional social values arising from specific SFS actions.

Benefits are calculated using the following assumptions:

- 75-year period of assessment to mirror the IMP time horizon (calculated in ERAMMP Report-102). We have also used 5-year, 10-year, 25-year and 50-year figures for comparison in the relevant sections.
- Figures are presented as an annualised PV. This represents the average annual value of present values (annualised PV), which is calculated by dividing the PV by the time horizon (e.g., the total PV5 is divided by 5 to give the annualised value).
- Use of discount rates is in alignment with The Green Book (HM Treasury, 2022) and IMP modelling. For carbon reduction, recreation and biodiversity, a 3.5% discount rate, reducing to 3% from year 31. For health-related benefits from air pollutant removal from vegetation, a 1.5% discount rate is used, reducing to 1.29% from year 31.
- Prices have been inflated, where original evidence is in an earlier year, to 2024 price levels using GDP inflators and indices.

The ecosystem services excluded (water quality and supply, and flood risk management) will be impacted by the change to habitats in rural areas given the change in habitat requirements for the revised proposed SFS, but quantifying this impact is not in scope for this revision.

2.3 Updated approach and scope

This analysis builds on ERAMMP Report-102 with four key revisions:

1. Type and extent of habitat in scope has changed due to an update in available data and use of some different information sources.
2. Benefits assessed for adjusted Universal Actions under revised proposed SFS scheme outline[10]
3. The approach to assessing the value of biodiversity has been updated to reflect new species recovery valuation evidence.
4. Spatial variation in benefit provision is no longer in scope for the analysis

The scope area is defined as existing woodland (broadleaf and conifer) and semi-natural habitat, and creation of new and temporary semi-natural habitat, on agricultural land across Wales (specifically, agricultural land eligible for payments - as it is believed that all (or nearly all) farmers will participate in SFS). The definitions and spatial area of these habitats was taken from modelling by an ADAS-led consortium for Welsh Government[11], which used Land Parcel

[10] Sustainable Farming Scheme: proposed scheme outline (2024) | GOV.WALES

[11] Andrew Moxey, Steven Thomson, and Liz Lewis-Reddy (2023) Potential economic effects of the Sustainable Farming Scheme Phase 4 Universal Actions Modelling Results A deliverable under Welsh Government project C280/2019/2020

Identification System (LPIS) (2020) field boundaries to map woodland and semi-natural habitats[12] to field and grazing boundaries (SRUC et al., 2022).

Temporary habitat (i.e., the habitats that will be created to comply with Universal Action 8 – see Box 2.1) and woodland creation was calculated by Moxey et al., (2023), assuming that all Welsh farms (more than 8,000) will adjust their land management. ADAS also submitted existing woodland and semi-natural areas broken down by local authority, which are based on area data published by Rural Payments Wales (RPW, 2024). This data was chosen for the carbon and air quality estimates as it closer aligned with coverage of agricultural habitat classes within the LandCoverMap 2021 which underpins reporting data used in ERAMMP.

Box 2.1: Habitat creation types under Universal Action 8 to Create Temporary Habitat on Improved Land

The scheme rule for farmers to create at least 10% of farm area designated to be tree cover or individual trees has been revised. The revision now proposes farmers develop a plan which identifies the opportunities for planting additional trees and creating new hedgerows on the farm.

Under UA8, Farmers will need to create sufficient temporary habitat from the list below to meet the scheme requirement if less than 10% of the land is classed as existing habitat:

- Fallow crop margins
- Unfertilised, unsprayed and unharvested cereal and linseed headlands
- Fixed rough grass margins on arable land
- Rotational rough grass margins on arable land
- Unsprayed spring sown cereal and protein crop mix with stubbles retained
- Establishment of mixed leys on improved land (also referred to as multi-species or herbal leys)
- Establish a wildlife cover crop on improved land

This scheme detail provides the habitat type context which informs analytical decisions in this assessment around how to value the new temporary habitat created to meet the revised 10% rule.

Source: Welsh Government (2024)

[12] Semi-natural habitat includes heathlands, wetlands and the range of species rich grasslands of all types managed as pasture and hay fields, and temporary habitat are those designed to attract a greater variety of wildlife, such as grass and fallow crop margins (Welsh Government, 2024).

Table 2.2 presents a summary of the habitat areas provided by ADAS and ERAMMP (UKCEH), with which this report is designed to align. LCM2021 Land Cover maps (LCM) (UKCEH, 2021) covers a slightly larger area than the RPW data. It also has significantly larger woodland area. This is due to differences in woodland classification between sources. The ADAS & SRUC analysis were based on NFI2019 data; both NFI and LCM summarise broadleaf woodland and conifer on farmland, but NFI has additional classes of woodland which were probably not included in the estimates. An analysis of differences between LCM2018 and NFI2018 coverage of woodland conducted for Defra by UKCEH showed that total woodland cover was broadly similar between the two sources if the NFI broad category of ‘Assumed Woodland’ was included. This includes the following categories of land “Felled, Ground prepared for planting; Young trees; Cloud shadow; Low density; Assumed woodland.” It is possible that this category was excluded from the estimates used by ADAS/SRUC. The RPW data also has a lower figure for existing semi-natural area. It is not known which specific habitats were included in the RPW data.

The RPW data source was used for the existing habitat area as this was available by local authority, which is needed for the air quality calculations, as the unit values are local authority specific. The ADAS spatial data (SRUC et al., 2022) was chosen for new habitat areas as it specifically estimated new habitat areas and it has been used in other analysis of the effects of potential SFS design for Welsh Government, which the results of this analysis are designed to compliment. Further breakdown of habitat areas by local authority are provided in Annex-2.

The data does not distinguish between types of woodland within the farmland area that could receive the proposed SFS payments. This woodland area will include some areas of commercial forestry (although the main areas of commercial forestry are not within farm boundaries), farm woodland with some timber harvesting, shelter belts and unharvested woodland. The data needed to differentiate between woodland types in order to analyse benefits is not available. Estimation of benefits (e.g. for recreation, carbon sequestration), therefore, is based on averages for all woodland.

This approach is considered acceptable because the mix of woodland types within the farmland area in Wales is likely to be similar to the mix of woodland across the UK as a whole. Furthermore, given the different estimates of woodland areas (shown in Table 2.2), specific breakdowns of different woodland types would have significant uncertainty.

The ADAS spatial data

SRUC et al. (2022) was chosen for new habitat areas as it is the only source to have estimated these areas and was used in other inputs on potential SFS payment rates for Welsh Government, which the results of this analysis are designed to complement. Further breakdown of habitat areas by local authority is provided in Annex-2.

Table 2.2 Summary of area data by area category and source in hectares (ha)

	Sources		
Area type	SRUC et al (2022)	RPW (2024)	UKCEH (2021)
Total existing woodland[1]	61,800	82,481	128,771
Total new woodland planted to meet the previous 10% tree cover scheme rule	28,200	NA	NA
Total existing semi-natural habitat[2]	405,700	366,352	440,239
Total new semi-habitat to meet 10% scheme rule	25,700	NA	NA
Total farm area	Approx 1.2m ha on 8,774 farms, plus 0.1m ha of common land	1,329,106	1,367,845

Table notes:

[1] Woodland includes deciduous and conifer trees.

[2] Semi-natural habitat includes only habitats listed in the revised SFS (published November 2024).

[3] SRUC data was calculated using LPIS (2020), RPW has an online database accessible via their web portal, and ERAMMP uses 2021 Land Cover maps.

The benefits included are those with a measurable change that result from the change in habitats in scope, and that can be valued in monetary terms. As results are to be used to inform social value, benefits were also chosen where there is high confidence in the related evidence.[13] Table 2.3 sets out the benefits that are in scope and updates to the sources or approach taken in ERAMMP Report-102. Individual approaches taken for each ecosystem service valuation are described in detail in Annex-2.

Table 2.3 List of benefits covered in this report

Benefit name	Type of ecosystem service	Approach taken in update	Source
Carbon sequestration	Regulating	Area of woodland (existing) is updated. Semi-natural habitat is newly added.	Estimated semi-natural and woodland area calculated by ERAMMP.
Air quality	Regulating	Area of woodland created is updated and divided by local authority area. The air quality valuation tool was updated in 2024.	Air quality valuation tool by eftec and UKCEH (2024).
Recreation	Cultural	Modelling the value of existing visits across Wales, using local authority level data produced by the ORVal tool.	Values are estimated using the ORVal tool (Day and Smith, 2018).
Species recovery (Biodiversity)	Aggregate/bundled	New approach as described in Annex-2. This approach replaces the qualitative biodiversity assessment done in the previous work.	Estimated using the transferable values from Browning et al (2024), in an adapted eftec et al (2024) tool.

[13] Water quality, biodiversity (pre-species abundance work), flood regulation and water supply are out of scope, but were included in Report-102.

2.3.1 Species Abundance Valuation Method

The biodiversity assessment undertaken in ERAMMP Report-102 has been updated with a new valuation methodology applied to species recovery. Species recovery reflects the value of biodiversity improvements on habitats for given changes in habitat types and levels of intactness. As the methodology can only be applied to *changes*, rather than existing habitat, the analysis is only applied to semi-natural habitat creation, and the biodiversity benefits of existing habitat and woodland are not valued. The new methodology uses willingness-to-pay (WTP) findings from Browning et al. (2024). As the original study was conducted for English habitat it also follows eftec et al.'s (2010) value transfer guidelines to apply the valuation evidence to Wales.

The values represent the aggregate "cultural" (including non-use) values of habitat recovery to households, which are attributed to each habitat type (Browning *et al.* 2024). The area of habitat recovery (both quality and quantity) predicted for SFS is a key input for this analysis. The expected area of semi-natural habitat that will be created is 25,700 hectares. This falls short of the 50,000-hectare minimum area designed for use in the eftec et al (2024) tool.

The type of semi-natural habitats that landowners will create under SFS is unknown but can be estimated from previous IMP model runs of SFS actions. These suggest that only the semi-natural habitat creation on arable land will increase species abundance, and that these actions make up 3% of the expected temporary habitat creation. Therefore, only 3% of the 25,700 hectares of temporary semi-natural habitat (771 ha) is expected to have species recovery benefits.[14], so the benefit is only calculated for this habitat area. The calculation assumes that this habitat creation occurs every year but is temporary in that its location within a farm can change each year.

Therefore, to value this change, the analysis uses a per 1,000-hectare generic 'transferable' value, derived from the Browning et al., (2024) technical report's guidance for smaller scale outcomes. This is an average, or non-specific habitat value, of £0.70 per household per 1,000 hectares, that the paper recommends is applied to any positive, one-step change in the level of species intactness (minimal, low, moderate, etc.) in generic habitat. As Browning et al., (2024) found an increasing WTP for improvements from moderate to high than from changes lower down the scale (see Section 3.4.2 for further discussion), the accuracy of estimates could be increased if data was to become available on the type of habitat landowners will create under the SFS.

In their species recovery valuation tool, eftec et al. (2024), used a 20-year lag factor for a one-step change in species abundance, with a linear progression towards a full change in species intactness in year 20. This timespan was a pragmatic assumption used to account for the ancient woodland habitat that was part of the tool. As this analysis is not valuing any woodland creation, it is assumed that a lag-factor of 10 years can be used to reflect the time an average habitat will take to achieve a change in species intactness, following habitat creation. The benefit value rises linearly from 10% of the full value in the first year following habitat creation (year 1), to 100% in year ten and beyond.

[14] Source: ERAMMP modelled uptake for UA8.

Browning et al., undertook their study in England, so values are adjusted to reflect the differing populations s and average income per household, in England and Wales. The robustness of value transfer depends on how well the valuation evidence (the study) matches the context (the policy) in which it is being used.

Further description of species recovery methodology is provided in Annex-2. This method enables the valuation of improving biodiversity, going beyond what was possible in the previous assessment.

2.4 Update of valuation evidence

As part of updating the natural capital value of Universal Actions under the revised proposed SFS, consideration is also given to any developments in the valuation evidence and natural capital data context.

In terms of wider natural capital data and methods, the analysis is conducted by considering and leveraging the ONS Wales ecosystem accounting data. The physical ecosystems in scope slightly differ as the ecosystem accounts included a broader set of ecosystems, whereas this assessment focuses on farm woodland and semi-natural habitats. In terms of concepts, some of the values in the ecosystem account differ from the values used in this assessment because ecosystem accounting standards do not always translate across to a policy appraisal and evaluation. In this case, this exception applies to air quality regulation, recreation, and species recovery (the aggregate results for the recreation value of agricultural land are compared to the ONS account figures for tourism on agricultural land in Section 3.4.2). Carbon sequestration uses the physical flow rate used in the ONS ecosystem account.

3 FINDINGS

This section presents the findings of the revised natural capital assessment to inform social values under the proposal for the SFS. Values are quantified as annualised PVs over 5, 10, 25, 50 and 75 years. To mirror the approach in ERAMMP Report-102, the central estimate reported on is the PV75, however, the other time horizons are included as a sensitivity.

A time horizon of 75 years is in line with other ERAMMP programme analyses, and the Green Book's recommendation of assessing natural capital benefits over at least 60 years and up to 100 years. This reflects the longer time horizon (e.g., spanning two or more generations), over which benefits arising from the protection, enhancement or creation of natural capital and other related environmental management activities tend to occur. It aligns to the requirements of the Wellbeing of Future Generations Act (2015) Wales.

This section on findings is structured as follows:

- Values of natural capital benefits from existing woodland and farm habitats (Section 3.1).
- Values of natural capital benefits from new habitat created to meet the 10% scheme rule (Section 3.2).
- Discussion of assessments across both Universal Actions (Section 3.3).
- Evaluation of double-counting and data accuracy risks (Section 3.4).

3.1 Values of natural capital benefits from existing woodland and farm habitats

This section discusses the findings for the total annual value of existing woodland and farm habitats which are based on the area data described in Section 2.3. Values are broken-down into carbon sequestration, air quality and recreation benefits, with more details on how unit values are calculated in Annex-2: Benefit review.

Table 3.1 presents the total annual values by benefit for existing woodland and habitat, which provides results on the total annual values across different time horizons and the relative importance of each service. Table 3.2 provides the same values as an average per hectare.

Table 3.1: Average annualised value (PV) of benefits over 5, 10, 25, 50, and 75 years for existing farm woodlands and habitats in Wales

	Average annualised PV by time horizon (£ million, 2024 prices)[1,2]				
Benefit	5PV	10PV	25PV	50PV	75PV
Carbon sequestration on farm woodlands only	156	153	135	110	90
Air quality on farm woodlands only	12.4	10.3	8.3	6.8	5.8
Farmland recreation value, including farm woodlands and semi-natural habitats	334	307	244	173	130

Table notes:

1. *Average annual figures are annualised present values, which is calculated by dividing the PV by the time horizon.*
2. *Discount rates are from HM Treasury (2022) and IMP modelling. For carbon reduction, and recreation the rate is 3.5%, reducing to 3% from year 31. For air pollutant removal the rate is 1.5% reducing to 1.29% from year 31.*

Table 3.2: Average annualised present value (PV) per ha of benefits over 5, 10, 25, 50, and 75 years for existing farm woodlands and habitats in Wales, £, 2024

	Average annualised PV by Time Horizon per ha (£ per ha, 2024 prices)[1,2]					
Benefit	5PV	10PV	25PV	50PV	75PV	75PV
Carbon sequestration on farm woodlands	1,887	1,850	1,639	1,330	1,096	1,096
Air quality on farm woodlands	151	125	101	82	70	70
Recreation value of farmland including farm woodlands and semi-natural habitats	161	148	118	84	63	63

Table notes:

1. *Average annual figures are annualised present values, which is calculated by dividing the PV by the time horizon.*
2. *Discount rates are from HM Treasury (2022) and IMP modelling. For carbon reduction, and recreation the rate is 3.5%, reducing to 3% from year 31. For air pollutant removal the rate is 1.5% reducing to 1.29% from year 31.*
3. *The rate for carbon sequestration is for woodland at 5.15 tCO_2e/ha/yr (ONS, 2022).*
4. *The rate for recreation is based on the total agricultural area in scope (1.3 million ha).*

3.1.1 Results

The total annual and average annual per hectare valuation for each service for existing farm woodland and habitat are presented below. As shown in Table 2.2, these values are quantified for an area of 82,481 ha of woodland (carbon sequestration and air quality) and 1.3 million ha of all farmland habitat (recreation). The results for each benefit are as follows:

Carbon sequestration or reduction in emissions relate to woodland management. The present values from woodland over 75 years are valued at £1,096 per ha. This equates to an annualised value of £90 million over 75 years. This makes it the largest of the natural capital benefits assessed here representing 84% of the total annual natural capital value. The shorter the time-horizon of the PV the larger the annualised benefit: over 50 years the value is £110 million, but over 5 years it is £156 million. This represents an 80% increase when a 5-year figure is used relative to a 75-year figure. The same trend is found for the average annual per hectare value with the range being from £1,096 per ha to £1, 887 per ha (see Table 3.2).The increase due to a shorter time frame reflects the impact of discounting (at a rate of 3.5%, and 3%), which are offset by increases in the monetary carbon value series (which increase at around 1.52%) (DESNZ, 2023).

Key assumptions

- Physical flow of carbon sequestration is calculated using the ONS (2022) figure for woodland (5.15 tCO2e/ha) as published in the UK natural capital account and is assumed constant over period.
- Flow rates are valued using the non-traded price of carbon (Department for Energy Security and Net Zero, 2023), which increases at a rate of 1.52% until 2050.

Air pollutant removal by existing woodland relates to the health benefits of reducing air pollution people are exposed to. The average present value in Wales from woodland on farmland over 75 years is £130/ha. This equates to an annualised value of £5.8 million over 75 years. As with carbon, the shorter the time-horizon of the PV the larger the annualised benefit: the 50 years value is £82 million, but over 5 years it is 25PV is £151 million. This represents an 114% increase when a 5-year timescale is used relative to a 75-year timescale. There is the same rate of increase for the per hectare values. The increase due to a shorter time frame reflects the effects of discounting benefits over time whilst the air filtration rate of vegetation and economic benefits to improved health remain constant.

Key assumptions:

- PM2.5 removal is quantified for existing woodland habitats using rates for each Welsh local authority and weighted based on area.
- PM2.5 removal fluctuates until 2030 then remains constant in line with eftec and UKCEH (2024) modelling.

Benefits from recreation from accessible green space provide a value of £63 per ha (annualised PV over 75 years) across all local authorities in Wales. This equates to an annualised value of £130 million for agricultural land (about 1.3 million ha (Table 2.2). The average annual PV is calculated using ORVal, which provides an average recreational value per hectare in each local authority. The per hectare average was calculated by dividing the total value of recreation in each local authority, by the total land area in each local authority (including accessible and inaccessible land). This average value was then applied to the agricultural area in each local authority (some of which is accessible, some is inaccessible).

The shorter the time-horizon of the PV the larger the annualised benefit. For example, an annualised 5PV is £334 million, which is 156% higher than the 75PV. The increase due to a shorter time frame reflects the impact of discount rates. As the average value/ha in each local authority has been applied to farmland this introduces some uncertainty. Values per ha may be higher in urban than rural areas, due to population concentrations, so there may be some overestimation of recreational value on agricultural land. However, the population in Wales has increased since 2018 when data was collected for ORVal, and in ORVal, agricultural land is one of the highest value habitats for visits, after recreational grassland and wood pasture, so using an average value is considered to be realistic. As the analysis in ERAMMP Report-102 showed, the distribution of recreational value across farmland may be highly variable.

Key assumptions:

- Value of visits remains constant over the assessment period. Visits were calculated based on total recreational value per Welsh local authority and weighted by area. See Annex-2 for information on how the ORVal tool, calculates the total welfare value of recreation across a local authority.
- The total value of visits per ha of farmland are the same as the average value of visits per ha to the whole Welsh Countryside.

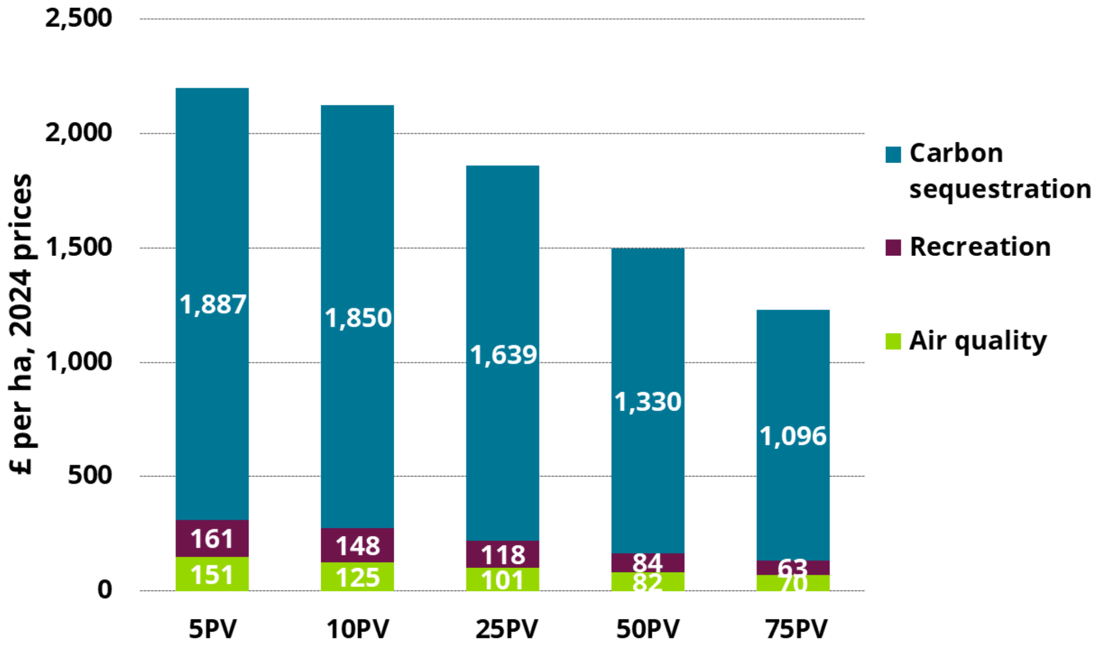

Figure 3.1: Average annualised present value (PV) per ha of benefits over 5, 10, 25, 50, and 75 years for existing farm woodlands and habitats

3.2 Values of natural capital benefits from new habitat created to meet the 10% scheme rule

This section discusses the findings for the value of new habitat created to meet the 10% scheme rule, which are based on the extent data from ADAS. The extent data was mapped to field and grazing boundaries, using assumptions from SRUC et al., (2022). Values are for species recovery benefits only, with more details on how unit values are calculated in Annex-2: Benefit review. Table 3.3 the total annual values by benefit for new semi-natural habitat, which provides results on the total annual values across different time horizons and the relative importance of each service. Table 3.4 provides the same values as an average per hectare.

Table 3.3: Average annualised present value (PV) of benefits over 5, 10, 25, 50, and 75 years for new semi-natural habitat

	Average annualised PV by time horizon (£ million, 2024 prices) [1,2]				
Benefit	5PV	10PV	25PV	50PV	75PV
Species Recovery	0.17	0.28	0.28	0.16	0.11

Table notes:

1. *Average annual figures are annualised present values, which is calculated by dividing the PV by the time horizon.*
2. *Discount rates are from HM Treasury (2022) and IMP modelling. The rate is 3.5%, reducing to 3% from year 31.*

Table 3.4: Average annualised present value (PV) per ha of benefits over 5, 10, 25, 50, and 75 years for new semi-natural habitat

	Average annualised PV by time horizon (£ per ha, 2024 prices) [1,2]				
Benefit	5PV	10PV	25PV	50PV	75PV
Species Recovery over 10 years (arable area)	225	369	367	201	137
Species Recovery over 10 years (arable and grassland area)	7	11	11	6	4

Table notes:

3. *Average annual figures are annualised present values, which is calculated by dividing the PV by the time horizon*
4. *Discount rates are from HM Treasury (2022) and IMP modelling. The rate is 3.5%, reducing to 3% from year 31.*

3.2.1 Results

The total annual and average annual per hectare valuation for the benefit of newly created semi-natural habitat are presented below. As shown in Table 2.2, these values are quantified for an area of 25,700 ha (of which 771 ha represents an estimable improvement for biodiversity) of land based on (SRUC et al., 2022).

Species recovery valuation relates to the benefits to households in Wales of the expected increase in species abundance resulting from the predicted area of creation of semi-natural habitat, to meet the criteria in SFS. The annualised PV over 75 years is £0.11 million or £4 per hectare for the scale of the action (25,700 ha). The incremental increase in benefit value over the first 10 years, which reflects the assumed time it takes for species intactness to change, is manifested in the increasing annualised values for 5 and 10 years (refer to Section 2.3.1 for details on the time-lag approach). Following this time period, the annual household benefit of habitat creation remains static but the effect of discounting results in decreasing annualised values for PV50 and PV75.

The 10-year lag for species recovery benefits to realise are judged as the most reasonable assumption on the basis of current evidence, however, 5-year and 20-year timescales were used to test the sensitivity and accuracy of results to the lag factor. The sensitivity to habitat type created results are presented in Table A1.8. The 5-year lag-factor represents fast-growing habitats, such as some grasslands (note a 20-year lag factor represents slower-growing habitats like ancient woodland).

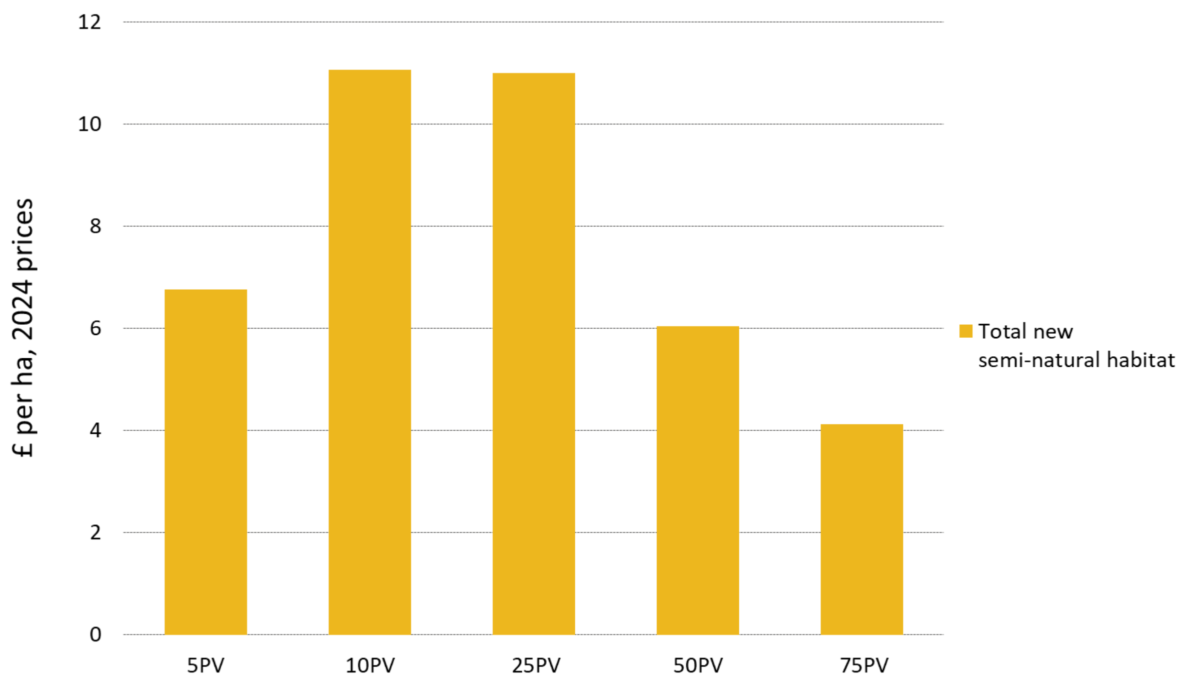

Figure 3.-2: Average annualised present value (PV) per ha of benefits over 5, 10, 25, 50, and 75 years for new semi-natural habitats

3.3 Discussion

Key findings

- All services have lower annualised PVs per ha the longer the PV, with the exception being species recovery, due to the assumed lag in realising the benefit.
- The largest benefit (measured as an annualised PV per hectare) for existing habitat is carbon sequestration. This is because the combination of sequestration rate and carbon values are higher than the service value per hectare of other services.
- For temporary semi-natural habitat, the benefit is species recovery (The majority of social value is due to carbon sequestration benefits, and annual benefits will be lower if a longer time horizon is taken.
- Woodland provides significantly higher levels of some ecosystem services compared to other semi-natural habitat, resulting in models to measure and value those services, such as carbon sequestration and air quality regulation. A recreational benefit can also be applied to woodland, but this cannot be directly attributed in this analysis.
- Recreational benefit was calculated using an average per hectare value for all land in each local authority (i.e. is not directly reflective of habitats on agricultural land) and scaled to total farm area in scope (about 1.3 million hectares). This is due to data limitations (see Section 3.4.2 for discussion). The annualised PV per hectare represents an average recreational value of existing habitats, agnostic of habitat.
- The average annual total and per hectare present values for species recovery are quite small initially. It is assumed that creating the additional habitat areas will take time (10 years in our central estimate) to achieve the full species abundance change to a higher condition level (in this case from low to moderate). The implication of this assumption is that temporary habitat creation on different parcels of land within the farm, but

which total to the required 10%, support a higher level of species abundance (moderate rather than low) after 10 years, and sustain this benefit thereafter.

- This sustained benefit is assumed to be maintained even when the location of the temporary habitat changes. This assumption is likely to be more accurate for some more mobile species (e.g. farmland birds), within the farmland landscape than for others. It introduces uncertainty into the calculation of the species recovery benefit but is considered an acceptable assumption as the temporary habitat creation is only assumed to increase a to moderate level of species abundance. The assumption that species abundance would improve only one level (from low to moderate) was used to allow for the fact that temporary habitat creation is unlikely ever to lead to full species abundance.
- Results are all national averages for Wales and, therefore, do not reflect spatial variation which was discussed in ERAMMP Report-102, and showed that services can have large ranges across Welsh regions.

Note that this finding is limited to the benefits that could be measured and valued for the two actions and omits significant natural capital values (e.g. biodiversity values for existing habitat, recreation values for habitat creation).

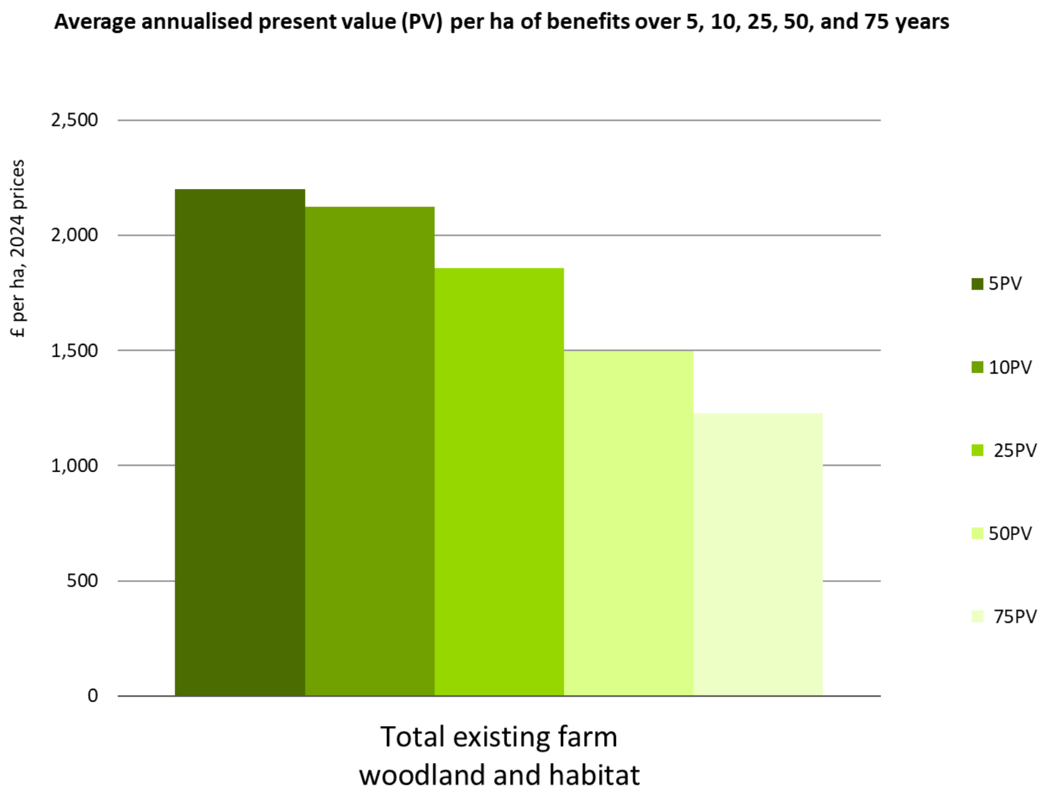

Figure 3.3: Average annualised present value (PV) per ha of benefits over 5, 10, 25, 50, and 75 years

3.4 Evaluation of double-counting and data accuracy risks

This section discusses the risks with incorporating natural capital values into policy design across several dimensions, including the degree to which values are additive without double-counting and data accuracy risks. These are summarised in Table 3.5.

3.4.1 Double counting risks

Double counting in natural capital benefit values arise where different valuation methods or evidence capture multiple types of benefits of a public good (referred to as "bundles") and these are not mutually exclusive to one benefit type. If there is a significant risk of double-counting values should not be considered additive. This is of high importance when interpreting the above natural capital assessment in relation to possible social values under the proposed SFS.

Risks of double-counting are assessed as follows:

- **There is a low risk of double-counting for carbon sequestration and air quality**. Carbon sequestration is valued using DESNZ (2023) for the non-traded price of carbon and reflects the environmental and social benefits of removing carbon from the air. Air quality is valued as the benefit of removing PM2.5 from the air via its attributable health benefits (e.g., avoided respiratory hospital admissions) (eftec and UKCEH, 2024). Actions which deliver these benefits could therefore be assessed on the sum of these benefit values.

- **There are risks associated with valuing recreation and species recovery benefits**, as species recovery benefits capture a combination of use and non-use values which might include recreation. However, there is no double-counting in this assessment, as the recreational benefit only considers the value from existing habitat and landscapes, Table 3.5: Evaluation of double-counting and data accuracy risks (high/medium/low)

Table 3.6: Evaluation of double-counting and data accuracy risks (high/medium/low)

Benefits assessed	Evaluation of double-counting and data accuracy	
	Double counting	*Data accuracy*
Carbon sequestration	*Low*	*Medium*
Air quality	*Low*	*High*
Recreation	*Low*	*Medium - Low*
Species recovery	*Low*	*Low*

3.4.2 Data accuracy and availability risks

The different models and data sources that generate the evidence used in this report have different levels of accuracy. Overall, they are considered robust to support the results and interpretation reported. This is particularly the case for including values in policy appraisal, evaluation or accounting. However, their use in policy design should, allow for the following factors.

With respect to **carbon sequestration** figures, the accuracy and availability of the data is good. Valuation methods are recommended by The Green Book (HM Treasury, 2022) and typically used in policy evaluation, appraisal and accounting within government. Carbon sequestration and emissions rates are generally robust even though variation exists due to habitat condition and other localised ecological factors (e.g., species and age of woodland).

The eftec and UKCEH (2019) model for **air quality** (specifically for $PM_{2.5}$) is robust and generates values at the local authority level. The value of air quality regulation is based on an average value per local authority. Local authorities with higher populations have a higher benefit from the removal of PM2.5 as more people receive the associated health benefit. Because of this range the annual average was weighted by the size of the local authority area to more accurately estimate the value of woodland in rural areas (which have lower populations). Even so, the air quality benefit of woodland on agricultural areas may be slightly lower than a weighted national average given their location.

At very localised scales, robust modelling of air quality service becomes more challenging. The effects of vegetation on air quality can depend upon species composition, and the pollutant concentrations. Benefits are understood through local authority values, which are robust in reflecting where vegetation delivers the largest benefits across Wales, but do not reflect even finer scale local variation in values. Air quality benefits are assumed to remain constant over time, so do not reflect changes in medical costs and/or population structure (e.g. average age) over time.

With respect to **recreation,** the data describes general trends in recreation demand and visitor activity (e.g., greater values attributed to areas of high population density), but has some limitations (further discussed in Annex-2: Benefit review). For example, the assumptions of average condition across a given habitat type understates benefits from sites in good condition and overstates benefits attributed to poorly managed sites[15].

In addition, as the recreational benefit is calculated based on all recreational sites in Wales, this method may overstate the value for recreation of farmland. Annex-2 presents the range of annualised PV per hectare which ranges from £1,543 PV75 in Cardiff to £27 PV75 in Powys.

The ONS natural capital account (ONS, 2024) presents expenditure from recreation and tourism in Wales on enclosed farmland (about 1.37 million hectares). This annual value in 2022 was £80 million (2023 prices) out of a total 236 million for all habitats. Tourism expenditure on enclosed farmland is 34% of total tourism expenditure.

The total recreational welfare benefit in this report across agricultural land in Wales is £356 million (2024 prices), which is 48% of total recreational value of Wales for all habitats. This is higher than the % of expenditure attributed to farmland in the ONS figures. This may be because the recreational value attributed to agricultural land may be slightly overstated. However, it may also indicate that local recreation is more likely to take place on agricultural land (i.e. public rights of way that cross farmland or on open access land that is farmed), whereas tourism and leisure activities involving longer trips are more likely to use other ecosystem types (e.g. beaches, mountains, woodlands).

[15] Report-102 also outlined the synergistic outcomes relationship between SFS outcomes and social benefits. This is not in scope for this update, but more information can be found in Dickie and Neupauer (2020). Broadly, there are positive synergies between the universal actions and social benefits. For example, a reduction in livestock density would reduce enteric fermentation (carbon emissions).

Overall, the similar proportions of value attributed to agricultural land in the ONS data and the data derived from ORVal for this report gives confidence that consistent approaches are being applied in the different analyses.

To further assess the degree of accuracy of the application of these recreation values to rural areas, ORVal's heatmap function could be used, which allows users to select an area and test new recreational sites given size and habitat type(s). This exercise would need to be re-run in different areas across the local authorities to estimate an average[16].

The ORVal tool is not explicitly built to test the range of potential values by habitat type, so this degree of accuracy assessment is left for future work. In addition, habitats must be accessible (either directly or as part of the landscape where recreation takes place) for people to receive a recreational benefit.

The **species recovery** estimates are limited by the lack of data on the type of new semi-natural habitat likely to be created under the SFS. It has not been possible to identify and allocate specific areas of different levels of habitat intactness of species recovery, before and after habitat creation, the nuances of the different values of these changes have been lost. This limits the accuracy and increases the uncertainty of the value estimates as Browning et al., (2024) found an increasing WTP for improvements from moderate to high than from changes lower down the scale.

If the Universal Action 8 measures result in species recovery to lower or higher levels of abundance and/or on more distinctive habitats, the estimated values could be an over- or under-estimate (respectively). If the location of temporary habitat in the farm area that delivers the semi-natural habitat requirement moves regularly, this may inhibit the level of biodiversity benefit, particularly for less mobile species.

[16] Note that the tool would assume that the habitats would be accessible and in good condition, and, therefore, may still over (or under) estimate the value of new habitat.

4 CONCLUSIONS

This report has conducted a revised assessment of social values from natural capital in SFS actions, following adjustments to the outline of the scheme. In particular, it has assessed the adjustments to Universal Action8 for a requirement to maintain existing farm woodland and habitat and to reach the 10% habitat scheme rule for semi-natural habitat by creating temporary habitat.

The benefits included those which were material and have robust valuation evidence, as assessed in the previous report, which included: carbon sequestration, air quality regulation, recreation, and species recovery (biodiversity). Species recovery uses an updated approach due to a new method being available but can only be estimated for new semi-natural habitat.

Habitats in scope were existing woodland and semi-natural habitat and new semi-natural habitat, the latter of which was modelled by ADAS assuming an 100% uptake of SFS. Land area data was taken from RPW (2024) for existing habitats as this most closely aligned to land cover used by ERAMMP and was available by local authority level.

Results are reported for 5, 10, 25, 50 and 75 year PV time horizons with HMT discount rates, and 2024 prices. The largest benefit is carbon sequestration via existing woodland at an annualised PV per hectare of £1,103 over 75 years. Other values for existing habitats are £70/ha for air quality and £63/ha for recreation (both over 75 years). For new habitats, annualised PVs are £4/ha for species recovery (over 75 years).

The findings highlight the critical role of existing habitats in delivering immediate and medium-term environmental benefits, particularly due to their larger area and the time-dependent nature of carbon sequestration. While new semi-natural habitats contribute positively, their full benefits, especially for species recovery, can take time to be fully realised. A longer present value (PV) assessment, such as PV75, provides a more comprehensive reflection of these long-term benefits.

Existing woodland habitats receive notable advantages over semi-natural habitats, as they offer both carbon sequestration and air quality regulation benefits, with additional but unquantifiable recreational value. Recreational benefits, while significant, are not strictly tied to agricultural land habitats due to data limitations.

All services have lower annualised PVs per ha the longer the PV, with the exception being species recovery, due to the assumed lag in realising the benefit. This is because physical flow is assumed constant across services and discount rates are applied to calculate the PV (HM Treasury, 2022). Species recovery benefits are initially low due to the time required for habitats to reach higher biodiversity conditions The 10-year lag in species abundance recovery suggests that temporary habitats of less than 10 years will not realise their full biodiversity value, with shorter retention periods further reducing benefits.

Finally, double counting across services is low, suggesting their social value is additive. Data accuracy is medium, and could be improved for recreation with further research, and data on the expected habitat composition for temporary new habitats to value the related species recovery and carbon sequestration benefits.

5 Extension Task

Extension Task

In May 2025, the Welsh Government commissioned an extension to the analysis above, to assess the social benefits of new proposed woodland, hedgerow and other habitat maintenance and creation options, shown in Table 5.1.

Table 5.1: Habitat management and creation options

Option	Uptake Assumption
Bringing existing trees and woodland in active management (as opposed to maintenance of existing woodland)	Assume 10% take up of existing woodland over 4 years = 4,944 ha total
Creating new woodland	Target of either (a) 13,600ha over 5 years at a rate of 3,400ha per year for 4 years or (b) 17,200ha over 4 years at a rate of 4,300ha per year
New hedgerow creation	4 projections of new hedgerow creation growth (10%,20%,30% and 48% of recent rate)
Restoring existing hedges	4 projections of growth in hedgerow restoration (10%,20%,30% and 48% of recent rate)
Manage and enhance existing habitats	41,000 ha over 4 years
Create new temporary and permanent habitats	For cereal farms, a take up of 122ha for margins and wildlife cover crops For grassland 4,000 ha of mixed leys.

The benefits to be evaluated, where possible/feasible, are:

- **Biodiversity benefits**: these are quantified as a change in species abundance across a single level (e.g., from minimal to low, or moderate to high) which aligns to monetary valuation evidence from a household willingness to pay study that generated a valuation model (the 'biodiversity values model').
- **Carbon sequestration benefits**: use estimated rates of additional carbon sequestration to quantify the impacts. Values are calculated using the UK Government guidance on valuation of non-traded carbon (DESNZ 2023).
- **Air quality benefits**: pollutant removal by vegetation is quantified based on previous modelling and valued based on expected resulting reductions in health costs.

Section 5.1 outlines the changes under the management options that are evaluated, and Section 5.2 lays out the evaluation methods in more detail.

5.1 Uptake and Assumptions

This section presents the methodological assumptions made for the evaluation of impacts on biodiversity, carbon and air quality from the six optional actions: woodland management, woodland creation, hedgerow creation, hedgerow restoration, habitat restoration and habitat creation. The definition, scale and impacts of each of these optional actions is described in the following table.

Table 5.2 Uptake and impact assumptions by option

Option	Action(s)	Uptake	Welsh Government Intended Outcomes	Method for benefit evaluation
Existing woodland management	Completion of a woodland management plan	ADAS-led consortium estimates there is 61,880ha of existing woodland on 8,774 full-time farms. • Assuming 10% take up over 4 years equates **to 4,944ha total**, or 1,236ha per year for 4 years.	• Improved water retention leads to water quality improvement and reduced flood risk • Improved biodiversity, recreation & landscape value • Increased carbon sequestration - coppicing and thinning removes carbon stored in wood and encourages new growth	**Biodiversity:** Not assessed as no evidence to quantify a material change & baseline age, species composition and management of woodland is unknown. Change also would not occur in response to completion of a plan. **Carbon:** Assume neutral[17] **Air Quality:** Assume no change as small change to pollution removal function
New woodland creation	Production of a woodland creation plan	• Lower estimate: 13,600ha over 4 years = 3,400ha per year. • Higher estimate; 17,200ha over 4 years = 4,300ha per year.	• Improved water retention leads to water quality improvement and reduced flood risk • Improved biodiversity, recreation & landscape value • Increased carbon sequestration • Woodland creation improves air quality	**Biodiversity:** Use WTP biodiversity values model, with 20-year phase-in lag. **Carbon:** Potential sequestration values (mean) extracted from ESC CARBINE model outputs. **Air Quality:** Value of air pollutant removal by trees estimated from existing modelling

[17] Thinning could reduce carbon stored in on-farm woodland with transfer to harvested wood products. However, this may be offset by other types of management change e.g. in previously under-stocked woodland. Baseline patterns of woodland age, species composition and management are not known, therefore assume neutral.

Option	Action(s)	Uptake	Welsh Government Intended Outcomes	Method for benefit evaluation

New hedgerow creation	• Hedge Laying
	• Hedge Planting
	• Hedge Coppicing
		Four delivery scenarios: 10%, 20%, 30% and 48% uptake
		• Lower estimate (10%):
		  ○ 293.2km
		• Higher estimate (48%):
		  ○ 610km
			• Improved biodiversity, & landscape
			• Improve pollination services, and natural pest control
			• Increased carbon sequestration
			• Water quality improvement and reduced flood risk
				Biodiversity:
				Uses WTP biodiversity valuation model
				Carbon:
				Values based on best available published carbon data and assumptions as documented.
				Air Quality:
				Use AQ model

Existing hedgerow restoration	• Hedge Coppicing
	• Gapping up
	• Restocking
		Four delivery scenarios: 10%, 20%, 30% and 48% uptake
		• Lower estimate (10%):
		  ○ 488.4km
		• Higher estimate (48%):
		  ○ 1,017.2km
			• Improved biodiversity, & landscape
			• Improve pollination services, and natural pest control
			• Increased carbon sequestration
			• Water quality improvement and reduced flood risk
				Biodiversity:
				Not assessed as no evidence to quantify a material change & baseline condition of hedgerows uncertain
				Carbon:
				Values based on best available published carbon data and assumptions as documented
				Air Quality:
				Not assessed as no material change expected

Existing habitat restoration	• Stock exclusion • Re-introduction of light grazing • Enhanced management	ADAS estimate existing area of semi natural habitats on FT farms to be 405,800ha: • 277,700ha of non SSSI farmland semi natural habitat	• Maintained and improved biodiversity - nesting areas, reduced nest predation and red-listed species • Maintained/ improved recreation & landscape quality	**Biodiversity:** Uses biodiversity valuation model **Carbon:** Not assessed as insufficient evidence to quantify

Option	Action(s)	Uptake	Welsh Government Intended Outcomes	Method for benefit evaluation
	• Habitat restoration • Delayed cutting • Management of wetlands • Management of arable land and field margins	• Year 1: 1 000ha = 32 farms • Year 2: 5 000ha = 158 farms • Year 3: 10 000ha = 316 farms • Year 4: 25 000ha = 791 farms TOTAL 41,000ha, 1,297 farms	• Increased carbon sequestration • Sustainable grazing levels on habitats	**Air Quality:** Assume negligible
New habitat creation	• Actions to create new permanent habitat on improved land • Once created, any new permanent habitat will need to be managed appropriately as per the requirements of UA7	Habitats assume uptake over first 4 years is ***1,000ha per year*** • Grassland, 4,000 ha of mixed leys • Cereal crops (122 ha), inc: ○ Unharvested, unsprayed cereal margins ○ Unsprayed cereal and protein crop ○ Wildlife cover crop. retained for 2 years	• Maintained and improved biodiversity- positively association with the abundances of bird species of high conservation concern • Increased carbon sequestration- cover crops could increase soil organic carbon • Improved pollination and reduced use of fertilizers and pesticides	**Biodiversity:** Uses biodiversity valuation model (arable margins only). **Carbon:** Not assessed as insufficient evidence to quantify **Air Quality:** Assume negligible

5.2 Benefit Evaluation Methods

The three main benefits have been evaluated as follows

Biodiversity

The same methodology as in Section 2.3.1 has been used for valuing biodiversity uplift from the proposed actions, with some variations, shown in Table 5.3. The 'transferable' values (Browning et al., 2024) for 'native mixed deciduous woodland' have been applied to areas of woodland creation and those for 'generic' or non-specific habitat have been applied to areas of hedgerow and semi-natural habitat creation, and to areas of semi-natural habitat maintenance and management.

Table 5.3: Biodiversity WTP assumptions used

Action	Transfer value used	Benefit lag	Duration
Woodland creation	Native woodland	20 years	Over 75 years
Hedgerow creation	General habitat	5 years	Over 75 years
Managing & enhancing existing habitats	General habitat	2 years	Over 75 years
Temporary arable habitat creation	General habitat	2 years	2 years

For existing habitats, maintenance is unlikely to result in an improvement in species abundance. It is assumed that half of the interventions listed in Action 5 will be for enhancement, and of those it is assumed that only half the enhancement measures will increase species abundance. Hence, we assume that only a quarter of the action 5 area (10,250 ha) will produce an uplift in species abundance. The full area allocation for the other actions has been used in the analysis, as shown in Table 5.2.

The lag period (time taken for the full value of a benefit to be realised following a habitat creation action) used in Section 2 of this report was 10 years for all habitats, as woodland creation was an optional action under semi-natural habitat creation and so was not valued. In this extension task the different actions all have different lag periods for both when the intervention occurs and for when the benefits are realised. The duration of benefits also varies with habitat.

Caveat: The transferable values are higher for the generic, or non-specific habitats as these are a weighted average of transferable values for all habitats. The Browning et al study (2024) from which these values come, estimated the willingness-to-pay (WTP) in England for an improvement in species abundance in each habitat type. Respondents were informed of the scarcity of each habitat, resulting in a higher WTP per hectare of more scarce habitats. The scarcity of deciduous woodland in England differs from Wales so this may change the WTP in Wales for improvement in this habitat. This has not been taken into account in this analysis.

Carbon sequestration - Woodland creation

Annual carbon sequestration rates for woodland creation were generated using the Forest Research forest carbon accounting model CARBINE, and include sequestration into forest woody biomass, soil, deadwood, litter and harvested wood products, and emissions from management operations. Values are for near-native broadleaf woodland creation on Welsh farms. The woodland management specification is for continuous cover forestry with an initial planting density of 1,600 stems per hectare.

The species composition comprises 65% main broadleaf species; 20% secondary broadleaf species; 5% woody shrubs; and 10% open space. Species are selected based on ecological suitability as assessed by the Ecological Site Classification model (Pyatt *et al.,* 2001), from the following list: silver birch, downy birch, common oak, sessile oak, small leaved lime, rowan, aspen, common alder, wild cherry, willow, beech, hornbeam, and sycamore. Areas for which there was spatial data indicating woodland planting restrictions, which were agreed with Welsh Government in consultation with NRW are excluded. The restrictions were as follows: deep peat; SSSI areas (300m buffer, no buffer for rivers); NRW Sensitive/Priority land; Sensitive Arable Plants; Ground nesting birds; grassland fungi; Fritillary butterfly; Upland Special Protection Areas (no buffer); Scheduled Ancient Monuments; World Heritage Sites. The ESC model is used to estimate the growth rate (Yield Class) of woodland creation according to site and climate conditions, with spatial carbon sequestration data generated through the coupling of the ESC and CARBINE models.

Values are from the most recent woodland creation data produced by FR for the IMP model chain in August 2024, using specifications agreed with Welsh Government policy and forestry teams. The most recent IMP model run represents universal SFS actions and did not include woodland creation, so there is no estimate of carbon sequestration potential associated with projected spatial patterns of uptake. Because the model captures spatial variation in carbon sequestration, values for a given area of uptake will be strongly driven by the spatial pattern of that uptake. To capture some of the drivers of uptake, low ecological suitability land (<0.3) and best agricultural land (ALC grades 1&2) are removed from the data, then the mean value is extracted.

All carbon values are time-period annual averages aggregated to time-periods used for IMP modelling: Year 1 to 8; 9 to 24; and year 25 onwards.

Carbon sequestration – Hedgerows

Hedgerow carbon sequestration rates are the best available estimates using values in the published literature; however the current evidence base is limited, hence estimates are subject to change as more data becomes available. Rates have been applied to the hedgerow management specifications and the results have been sense checked and fall within the range of measured data and those applied in the UK Greenhouse Gas Inventory.

Hedgerow above ground biomass estimates take a central value from the literature (Biffi *et al.,* 2023) applied to the volume of hedgerow woody material, as specified by height and width. Values account for recorded rates of growth to estimate time taken to reach the specified width and height. Below ground biomass in the coarse and fine roots is estimated at 50% of above ground biomass (reviewed in Gregg *et al.,* 2021).

Soil carbon sequestration rates for soil under hedgerows use published values (reviewed in Gregg *et al.,* 2021). which are provided per hectare. These rates are applied to the area under the hedgerow biomass, which expands as the hedge grows; we do not assume any reduction of sequestration rates towards the edge of the aboveground hedge area, or additional sequestration outside of that area, as there is insufficient evidence.

Note that the available data and hedgerow management guidance largely applied to hedgerows of 2m width, which requires 2 rows of planting; we apply an assumption that hedges are capable of reaching 3m with the same biomass density and rates of root turnover and soil carbon sequestration, allowing for an extended time period to reach full size (5yrs to reach 2m height, 13yrs to reach 3m width) accounting for hedgerow growth rates.

For all hedge carbon estimates, annual sequestration rates are calculated using an assumption that hedges are laid every 25 years, hence dimensions and carbon stocks reduce at this time and then regenerate. Data are supplied as long-term (25-year) annual averages smoothed to the time periods used for valuation, which removes some of the sharp variability driven by this assumption. Different average sequestration rates are used for creation and restoration and for the time periods 1-5 years, 6-10 years, 11-25 years and years 26 onwards (steady state). In addition:

- Hedgerow creation - we assume hedgerows reach 2m height and 3m width.
- Hedgerow restoration - we assume 80% require replanting and 20% are restored by laying.
    - For hedgerow laying we assume hedgerows are cut to a starting size of 1m x 1m with lower carbon density due to gaps, with laying in year 1 and size increase to 2m tall and 3m wide (5yrs to reach 2m height, 18yrs to reach 3m width).
    - For hedgerow replanting and gap filling we assume additional planting in year 1 with, size increasing to 2m tall and 3m wide. We assume that the impacts of gapping up, coppicing and regrowth are similar to replanting, due to extensive gaps and the declining condition of any material not suitable for laying.
    - We do not subtract the counterfactual carbon sequestration which may have occurred under these hedgerows without restoration; this may be assumed to be limited for hedgerows in very poor condition.

The current results produce cumulative carbon sequestration results that are very similar per km for creation and restoration - values for hedgerows managed by laying are slightly higher, but they only represent 20% of restored hedgerows. Hedgerows managed with laying have higher initial volumes of above and below ground living material, and initial sequestration rates are higher as there is existing above ground material from which it can regenerate and also a greater established rooting area, which provides higher inputs to the soil. With hedgerow creation, there is neither the existing above- or below- ground rooting structure, which takes time to establish. These models are based on the best currently available evidence, but it is acknowledged that the uncertainty is high, hence confidence is low. Given that ERAMMP report 105 suggests average hedge widths of 2.29 and height of 1.86, with the majority of hedges <10% gaps, the assumptions about baseline hedge dimensions and condition behind the carbon analysis may lead to over-estimation of benefits. However, hedge restoration benefits are small in comparison to other benefits assessed here.

Air quality

For woodland, we have applied the same methods as described in Annex-2 and assume that woodland creation is in the same distribution as existing native woodland cover by Local Authority in Wales (i.e. rural areas will provide the greatest area for new woodland creation).

For hedgerow creation, the air quality benefit has been assessed by converting km of new hedgerow to an equivalent woody area (using a simple area-based conversion of 6.7 km to a ha). This benefit is very small relative to the other benefits evaluated for hedgerow creation, so it was not considered material to make adjustments for height and density to assess air pollution removal benefit. The assumption has been taken for pragmatic reasons due to shortage of time and data but provides a rough order of magnitude for this benefit.

5.3 Extension Results

The results of the social value assessment are given by each option below. As requested, all figures are quoted in 2023 prices to facilitate comparison with previous evaluations.

Woodland in active management

This option funds production of a woodland management plan and capital works but has been considered negligible for wildlife benefits above and beyond the base maintenance activity. Benefits assessed as follows:

- Biodiversity: Not assessed as no material change expected in response to completion of a plan.
- Carbon: Thinning could reduce carbon stored in on-farm woodland with transfer to harvested wood products. However, this may be offset by other types of management change e.g. in previously under-stocked woodland. Baseline patterns of woodland management are not known, therefore assume neutral.
- Air Quality: Negligible change on pollution removal function. Assume no change

Woodland creation

The overall benefits of woodland creation are presented in the tables below for both the low (13,600 ha) and high (17,200 ha) of native woodland creation.

Table 5.4: PV of benefits over 5, 10, 25, 50, and 75 years, for low woodland creation scenario (13,600 ha). (£ million, 2023 prices)

PV period	Total Benefit	Biodiversity	Carbon	Air Quality
5	-22.3	3.1	-25.7	0.4
10	-25.3	13.3	-40.0	1.5
25	267.6	57.2	201.8	8.6
50	560.6	76.1	457.2	27.3
75	751.5	81.6	627.0	42.9

Table 5.5: PV of benefits over 5, 10, 25, 50, and 75 years, for high woodland creation scenario (17,200 ha). (£ million, 2023 prices)

PV period	Total Benefit	Biodiversity	Carbon	Air Quality
5	-28.2	3.9	-32.5	0.5
10	-31.9	16.9	-50.6	1.9
25	338.4	72.3	255.3	10.8
50	709.1	96.3	578.2	34.6
75	950.4	103.1	792.9	54.3

Key features:

- Woodland creation is modelled as giving net emissions for the first 8 years of implementation, because it takes time for carbon sequestration in trees and soils to offset losses from soil disturbance and energy use during planting. Hence the carbon and total benefit PVs for five and ten years are negative. Carbon sequestration has the greatest value and hence dominates the total benefit picture and takes 50 years to realise substantial net value.

- For woodland creation, biodiversity benefits and air quality take time to realise (20-year lag to reach full biodiversity value, and nearly 40 years for air pollution removal benefit).

Annualised present values are shown for the high woodland creation scenario in Table 5.6.

Table 5.6: Annualised PV of benefits over 5, 10, 25, 50, and 75 years, for high woodland creation scenario (17,200 ha) (£'000s, 2023 prices)

PV period	Total Benefit	Biodiversity	Carbon	Air Quality
5	-5,638	776	-6,508	93
10	-3,193	1,685	-5,064	186
25	13,536	2,892	10,210	433
50	14,181	1,925	11,564	692
75	12,672	1,375	10,573	724

Finally, the annualised PV values per ha are shown in Table 5.7. Note that, with the available appraisal evidence, the values per hectare are the same regardless of scale of planting. The confidence range is derived from the high and low estimates of the constituent benefits; ranges of value being calculated for biodiversity and carbon only (see section 5.4).

Table 5.7: Annualised PV, (£ per ha) of benefits over 5, 10, 25, 50, and 75 years, for high woodland creation scenario (21,500 ha) (2023 prices)

PV period	Total Benefit	Confidence Range	Biodiversity	Carbon	Air Quality
5	-487	+/- 46%	53	-547	6
10	-20	+/- 46%	107	-139	12
25	873	+/- 46%	173	674	26
50	862	+/- 46%	113	708	41
75	761	+/- 46%	80	638	43

Table Note: confidence in biodiversity +/-38%, carbon+/- 50%. Composite weighted by value is +/- 46%. (see section 5.4)

Key features of woodland creation:

- It takes around 11 years for discounted carbon sequestration benefits to become net positive, and 25-50 years before peak annualised PV is realised. To smooth out variation, average sequestration rates have been used for years 1-8, 9-24 and from 25 years onwards, and planting has been staggered over 4 years, however this is smoothing is representative of the expected pattern of peak sequestration around years 9-24.
- Biodiversity benefits per year peaks at around 25 years, reflecting the 20-year assumed phase in for full biodiversity benefit to be realised.
- Air quality benefit rises steady until year 40, then stabilises, but is relatively small compared to carbon.

Hedgerow Creation

Hedgerow creation has been modelled for a range of uptake scenarios, but the highest scenario of creation (610.4 km) is shown in Table 5.8. Benefits are expected to be delivered progressively and are substantial up to the 25-year horizon and stabilise thereafter. This is because the carbon data used are long term averages (see section 5.2) which smooth out the fluctuations of carbon removal and sequestration with cycles of re-laying but capture the ongoing additional benefit of sequestration in soils.

Table 5.8: PV of benefits over 5, 10, 25, 50, and 75 years, for high hedgerow creation scenario (610.4 km) (£ million, 2023 prices)

PV period	Total Benefit	Biodiversity	Carbon	Air Quality
5	1.4	0.1	1.2	0.0
10	3.8	0.4	3.4	0.0
25	7.5	0.9	6.5	0.1
50	9.2	1.0	7.9	0.3
75	10.3	1.0	8.7	0.6

Annualised benefits are shown in Table 5.9. with carbon sequestration being the greatest benefit.

Table 5.9: Annualised PV of benefits over 5, 10, 25, 50, and 75 years, for high hedgerow creation scenario (610.4 km) (£'000s, 2023 prices)

PV period	Total Benefit	Biodiversity	Carbon	Air Quality
5	272	23	248	1
10	379	40	338	1
25	300	36	260	3
50	183	19	158	6
75	137	13	116	8

Table 5.10: Annualised PV per km of benefits over 5, 10, 25, 50, and 75 years, for high hedgerow creation scenario (610.4 km) (£/km 2023 prices)

PV period	Total Benefit	Confidence Range	Biodiversity	Carbon	Air Quality
5	731	+/- 40%	143	587	1
10	911	+/- 40%	227	681	2
25	653	+/- 40%	194	455	4
50	377	+/- 40%	103	268	6
75	273	+/- 40%	70	197	6

Table Note: confidence in biodiversity +/-16%, carbon+/- 50%. Composite weighted by value is +/- 40%.

Key features of hedgerow creation:

- Carbon sequestration benefits dominate in value and are highest in the first 10 years and start to decline steadily in PV terms from year 25 onwards due to lower steady state sequestration (see section 5.2).
- Biodiversity benefits are assumed to take 5 years to reach full value and hence the annualised value per km peaks at year 10.

Hedgerow Restoration

Hedgerow restoration has been modelled for range of uptake scenarios, but the highest scenario of creation (1017.2 km) is shown in Table 5.11**. *The only benefit evaluated for hedgerow restoration is carbon sequestration***, hence Table 5.11 shows the total PV (£'m), annualised PV (£'k/year) and annualised value per ha.

Table 5.11: PV, Annualised PV and £/km value of carbon sequestration benefits over 5, 10, 25, 50, and 75 years, for hedgerow restoration (2023 prices).

PV period	Total PV (£'m)	Confidence Range	Annualised PV (£'k)	Ann PV/km £
5	3.2	+/- 50%	638	907
10	6.9	+/- 50%	694	802
25	11.5	+/- 50%	460	479
50	14.0	+/- 50%	279	285
75	15.6	+/- 50%	207	211

Table Note: Confidence range is as the range for carbon (see section 5.4)

Key features of hedgerow restoration:

- Carbon sequestration is the only benefit valued, and annualised PV/ha is highest in the first 10 years.

Manage/enhance existing habitats

Only the species abundance benefit of enhancing existing habitats has been evaluated. Table 5.12 shows the total PV (£'m), annualised PV (£'k/year) and annualised value per ha.

Calculation is based on the following assumptions:

- Half the habitat area is subject to enhancement measures, and half of that achieves an increase in the level of species abundance (UKCEH's previous ERAMMP modelling has often shown a significant % of areas subject to habitat enhancement measures won't achieve that improvement).
- This means that for the target area for enhancement/management (approx. 41,000), we can attribute a monetary value for an increase in species abundance to a quarter of it (10,250 ha). Note that the value per ha is calculated across the target area (41,000 ha), as this is area assumed to be receiving payments.

Table 5.12: PV, Annualised PV and £/ha value of biodiversity benefits over 5, 10, 25, 50, and 75 years, for enhancement of existing habitats (2023 prices).

PV period	Total PV (£'m)	Confidence Range	Annualised PV (£'k)	Ann PV/ha £
5	20.3	+/-16%	4,058	151
10	55.3	+/-16%	5,526	157
25	112.4	+/-16%	4,497	114
50	117.7	+/-16%	2,353	58
75	119.1	+/-16%	1,588	39

Table Note: Confidence range is as the range for biodiversity (see section 5.4)

Biodiversity value per ha peaks at around 10 years as benefits build steadily with implementation and then decline gradually beyond this time frame.

Create new temporary and permanent habitats

The creation of mixed leys may produce a soil sequestration benefit but, in the time available, no robust assumption could be established. Only the biodiversity benefit of arable margin creation has been evaluated, and this uptake is considered small (122 ha over 4 years). Benefits are shown in Table 5.13.

Table 5.13: Total (PV, £'m) of benefits over 5, 10, 25, 50, and 75 years, Create new temporary and permanent arable margins (122 ha) (2023 prices).

PV period	Total PV (£'m)	Confidence Range	Annualised PV (£'k)	Ann PV/ha £
5	0.1	+/-16%	29	526
10	0.1	+/-16%	14	588
25	0.1	+/-16%	5	443
50	0.1	+/-16%	2	228
75	0.1	+/-16%	1	153

Table Note: Confidence range is as the range for biodiversity (see section 5.4)

The biodiversity value per ha per year is significant, but its impact is short term.

5.4 Sensitivity Analysis

Benefits are subject to uncertainty and a range of biodiversity and carbon values are provided in Tables 5.14 and 5.15. These ranges are based on the ranges of monetary values provided in the valuation evidence applied in this analysis.

Table 5.14: Variation of Biodiversity values by management option (PV 25, Ann PV £/unit, 2023 prices)

Option	Unit	Low	Central	High	%
Woodland creation	Per ha	107.12	172.77	238.42	+/- 38%
Hedgerow creation	Per km	163.46	193.94	224.42	+/- 16%
Hedgerow restoration	Per km	n/a	n/a	n/a	n/a
Maintain existing habitat	Per ha	96.28	114.23	132.18	+/- 16%
Create new habitat	Per ha	373.52	443.16	512.80	+/- 16%

The range of uncertainty for woodland creation (+/-38%) is higher than that for general habitat (+/- 16%). This reflects the smaller sample size for woodland compared to the general biodiversity assumption which is an average of all habitats.

Table: 5.15 Variation of Carbon values by management option (PV 25, Ann PV £/unit, 2023 prices)

Option	Unit	Low	Central	High	%
Woodland creation	Per ha	337.16	674.32	1,011.48	+/- 50%
Hedgerow creation	Per km	227.49	454.98	682.47	+/- 50%
Hedgerow restoration	Per km	239.29	478.58	717.87	+/- 50%
Maintain existing habitat	Per ha	n/a	n/a	n/a	n/a
Create new habitat	Per ha	n/a	n/a	n/a	n/a

This range in uncertainty uses the range of UK Government (DESNZ 2023) non-traded carbon values and allows for uncertainty in both the quantity and value of carbon sequestered.

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7 Annex-1: Note on the Scope of This Report and other ERAMMP Work

ERAMMP Report-105

New ERAMMP programme evidence on agri-environment scheme outcomes (ERAMMP Report-105) was published after some of the analysis for this report (e.g. for existing farmland habitats in Section 4.1) were completed. Policy development timescales did not allow for the analysis in this report to be updated to reflect the new evidence. It is not expected that doing so would have materially changed the results or conclusions of this report. However, it does mean that the latest available evidence is not always referenced in the assumptions and analysis.

ERAMMP Modelling of SFS7

ERAMMP Report-110 [this document] and the Integrated Modelling Platform (IMP) universal SFS modelling run (SFS7) both provide projections for Ecosystem Services delivery and valuation associated with land on Welsh farms. However, there are key differences in what is captured by these separate sets of work, and as a result the estimated values will differ.

The IMP models only benefits resulting from changes in agriculture due to the SFS and CoAP, whereas Report-110 aims to also capture the delivery of benefits from existing on-farm habitat and woodland. Specifically, Report-110 includes modelling of benefits delivered by existing woodland on farms in terms of air quality regulation and ongoing carbon sequestration. These benefits are modelled for the current woodland extent and management and assumed not to be affected by woodland maintenance actions under the SFS. Report-110 also models recreation benefits for existing on-farm woodland and other habitat, which are likewise assumed to persist regardless of whether a farm enters the SFS.

The IMP has only been applied to the universal SFS whereas Report-110 also estimates benefits from optional and collaborative actions of: woodland creation and management; hedge creation and management; habitat creation and management. Report-110 estimates benefits based on these SFS optional and collaborative actions using estimated uptake areas provided by the Welsh Government. In any future IMP model runs on the optional and collaborative SFS actions, uptake would be projected within the modelling system, in the context of other agricultural costs, commodity prices and other agricultural scheme payments and uptake. Thus, projected uptake areas are likely to differ from those used in Report-110, due to differences in how they are derived.

Assumptions for IMP modelling runs are iteratively co-developed between the IMP consortium and Welsh Government to allow plausible representation of actions and projected scheme uptake. However, there has not been sufficient time to develop these assumptions as part of the process of producing this report, and the SFS optional and collaborative scheme specification of these actions has not yet been modelled by IMP, therefore agreed assumptions and other choices related to data and coefficients used in the modelling are not in place. These may differ from Report-110 when co-developed for future IMP runs leading to differences in estimates of ecosystem service delivery and valuation.,

There will also be differences in the land areas considered between the IMP runs and Report-110 (e.g. for the area of semi-natural land and SSSIs) because the IMP only models a subset of agricultural land (covering the main relevant farm types with greater than1 FTE labour). The definition of semi-natural land may also differ between the IMP and the ERAMMP National Trends and Glastir Evaluation report, making it difficult for this report to be aligned with both.

8 ANNEX-2: BENEFIT REVIEW

This annex presents further technical details on the valuation evidence and methods used for the benefits assessed in this report. It discusses how the benefits are valued from an economics perspective, how these benefits are delivered physically, and how (or if) the values vary spatially. The benefits discussed are:

- Atmospheric carbon reduction
- Air quality
- Recreation
- Species recovery

8.1 Area data

As discussed in Section 2.2, the analysis uses area data generated by ADAS (2024) using data collected from SRUC *et al* (2022) and RPW (2024). This was compared to data provided by ERAMMP Table 2.2.

Table A1.1 presents the total existing woodland and semi-natural habitat areas broken down by local authority.

Table A1.1: Existing woodland and semi-natural habitat by local authority (ha)

Local Authority	Woodland	Semi-natural habitat
Blaenau Gwent	253	421
Bridgend	718	780
Caerphilly	902	1,006
Cardiff	154	161
Carmarthenshire	11,177	12,276
Ceredigion	5,065	5,874
Conwy	3,089	3,367
Denbighshire	2,226	3,206
Flintshire	1,130	1,229
Gwynedd	9,371	11,105
Isle of Anglesey	1,178	1,292
Merthyr Tydfil	197	204
Monmouthshire	3,503	3,790
Neath Port Talbot	1,242	1,351
Newport	275	300
Pembrokeshire	6,530	6,866
Powys	20,467	24,424
Rhondda Cynon Taf	1,248	1,315
Swansea	919	1,031
Torfaen	255	260
Vale of Glamorgan	837	843
Wrexham	1,140	1,380
Total	*71,876*	*82,481*

Table note: Woodland includes deciduous and conifer trees.

8.2 Carbon sequestration

8.2.1 How the benefit is assessed

Many habitats sequester carbon at different rates across space and time. The value of carbon sequestered in habitats is estimated using sequestration rates for each habitat (tonnes CO_2-e per hectare) and the non-traded price of carbon (DESNZ, 2023). There is a steady upward trend in the monetary value of carbon over time (from a central value of £256 in 2024 to £378 in 2050) to reflect the increasing value to society of reaching carbon reduction goals. The value per tonne is the same for all locations in a given year, so the variation in value is entirely driven by the different impacts of habitats on atmospheric carbon over time. These impacts can be from sequestration into soil, or emissions from carbon stored in the soil.

In this assessment, an average annual sequestration rate of 5.15 tCO_2e/ha/year (ONS2022) is used over the assessment period for existing woodland. This rate is applied to all woodland within scope (broadleaved and coniferous). This is due to uncertainty concerning the share of tree types, and the rate is an average of a broad range of woodland types. The UK rate was used as the makeup of Welsh woodland is similar to the average UK woodland makeup. A

The total amount of CO_2-e sequestered by a given habitat in a given location in Wales is estimated by multiplying these per hectare rates with the total hectares of the respective habitat type. The amount of CO_2-e sequestered is then valued following DESNZ (2023) for the non-traded central price, £253 per tonne of CO_2-e in 2022. Future flows of carbon are valued using the DESNZ (2023) carbon values series until 2050. Following DESNZ (2023) advice, a real annual growth rate is then applied starting at the most recently published value for 2050 and into the future.

The non-traded prices of carbon are ranges for each year which demonstrate uncertainty around the social costs of (and therefore benefits of reducing) carbon emissions. These ranges are demonstrated in

Table A1.2. For instance, for 2024 the value ranges from £134 to £403 per tonne of CO_2-e with a central value of £269. There is a steady upward trend in the value of carbon (from a central value of £253 in 2020 to £398 in 2050) to reflect the increasing value to society of reaching carbon reduction goals. This approach to valuation is recommended and cited by The Green Book (HM Treasury, 2022) and is used by the Office of National Statistics in the UK (and therefore Welsh) natural capital accounts (ONS, 2022).

Table A1.2: Carbon values per tonne of CO2-e (£, 2022 prices)

Year	Low series	Central Series	High Series
2020	127	253	380
2021	129	257	386
2022	130	261	391
2023	132	265	397
2024	134	269	403
2025	137	273	410
2026	139	277	416
2027	141	281	422
2028	143	286	429
2029	145	290	435
2030	147	294	442
2031	149	299	448
2032	152	304	455
2033	154	308	462
2034	156	313	469
2035	159	318	476
2036	161	322	484
2037	164	327	491
2038	166	332	499
2039	169	337	506
2040	171	343	514
2041	174	348	522
2042	176	353	529
2043	179	358	537
2044	182	364	545
2045	185	369	554
2046	187	375	562
2047	190	380	570
2048	193	386	579
2049	196	392	587
2050	199	398	596

8.3 Air quality

8.3.1 Air pollutant removal

8.3.1.1 *How the benefit is assessed*

Air quality benefits arise from the ability of different types of vegetation to remove pollutants from the air. This benefit is estimated for the amount of $PM_{2.5}$ removed by woodland (which makes up more than 70% of this benefit in the UK (Jones *et al.*, 2017)) and the human health benefits of this removal.

Jones *et al* (2017) modelled this benefit for the UK national accounts using data on the variety of different levels of $PM_{2.5}$ concentration, types and extent of vegetation and density of human population across the country.

An update to this study has produced estimates of $PM_{2.5}$ removal per hectare of woodland by local authority. The kilograms of $PM_{2.5}$ removed by hectare of woodland (eftec and UKCEH, 2024) is multiplied by the total woodland area in a given local authority in Wales. The $PM_{2.5}$ removal per hectare of mature (i.e., existing) woodland is estimated to be falling over the period of 2015 to 2030 based on the assumption that emissions and concentrations are falling over time.

That is, the physical quantity of this service hinges on three primary factors:

- The amount of background pollution, notably particulate pollutants.
- The type, amount, and location of vegetation.
- The density of population potentially benefitting from reduced exposure to pollution.

The economic value of this benefit is estimated as the willingness to pay to avoid Life Years Lost due to illness, expressed as a £ value per avoided Life Year Lost (eftec and UKCEH, 2024). The value of the benefit as £ per hectare of new woodland (in 2024 prices) for a given local authority is then the healthcare cost avoided multiplied by the total new created woodland area in that local authority.

The eftec and UKCEH (2024) modelling of future benefits declines in line with lower emissions/ concentrations assumption mentioned above and are discounted using the lower health discount rates (HM Treasury, 2020). The mean value is weighted by the area of woodland per local authority (captured in Table A1.1). Table A1.4 presents the per hectare and total average annual PV (75) of air quality benefits per local authority.

Table A1.3: Average annualised value of air quality benefits per hectare (£, 2024 prices)

Welsh local authority	Average annualised value of air quality benefits (£) PV75 years	
	per hectare	**Total**
Blaenau Gwent	513	215,961
Bridgend	282	220,412
Caerphilly	315	316,893
Cardiff	1,685	270,891
Carmarthenshire	39	481,151
Ceredigion	23	133,982
Conwy	58	195,748
Denbighshire	70	224,233
Flintshire	343	422,160
Gwynedd	21	232,423
Isle of Anglesey	117	151,124
Merthyr Tydfil	272	55,671
Monmouthshire	82	310,591
Neath Port Talbot	76	102,693
Newport	690	207,061
Pembrokeshire	41	280,429
Powys	21	504,413
Rhondda Cynon Taf	211	276,979
Swansea	323	333,395
Torfaen	579	150,553
Vale of Glamorgan	322	271,718
Wrexham	324	446,564
Average	70	263,866

8.3.2 Policy context

ERAMMP Report-102 provided an overview of the policy context surrounding the removal of pollutants from the air. The report reviewed the three most relevant policies relating to air quality improvements:

- The Clean Air Plan for Wales
- Net Zero Wales
- The Environment (Air Quality and Soundscapes (Wales) Bill 2023

These policies will influence how data are collected, measured and reported, including monitoring of indicators to enable temporal and spatial valuation of benefits from reduction of emissions in the air.

8.4 Recreation

Recreation benefits arise from visits to the natural environment that improve the welfare of visitors.

8.4.1 Access to green space

8.4.1.1 *How the benefit is assessed*

Recreational benefit is measured in terms of number of visits to accessible greenspaces, and the average welfare value associated with these visits. Welfare values are assessed based on a modelled demand function for recreation, which includes an assessment of the costs incurred to travel to a recreation site. The likelihood of visiting a site and the decision of whether to travel by car or foot is significantly influenced by the distance between the recreational site and the individual's home. For distances between 200m to 10km, the number of visits and the value derived decreases as the site gets further from an individual's home.

The ORVal[18] tool is used to estimate the number and welfare value of visits to the accessible open spaces within a given area. Estimates can be produced for various spatial breakdowns, including individual sites, local authorities, and national parks. ORVal also breaks down the estimated number of visits and associated welfare value by socio-economic group.

ORVal modelling is based on MENE data (Natural England, 2019)[19] and The Welsh Outdoor Recreation Survey (WORS), which assessed participation in outdoor activities and attitudes towards biodiversity in Wales. It provides information on participation in a range of outdoor activities, from climbing to picnics, which take place in all areas from local parks to mountains

[18] ORVal is a spatial model that shows the recreational sites, number of visits and the benefit to visitors using data from mapping tools, Monitor of Engagement in Natural Environment (MENE) survey and economic valuation literature. University of Exeter (2018) ORVal v2.0 - The Outdoor Recreation Valuation Tool. Available at: https://www.leep.exeter.ac.uk/orval/

[19] See here for details about MENE data: https://www.gov.uk/government/collections/monitor-of-engagement-with-the-natural-environment-survey-purpose-and-results

and the sea, it does not take into account visits by children or overseas visitors to the UK, only domestic visits (Day and Smith, 2018).

Data from ORVal consider the location of the recreation asset, surrounding population, habitat type(s), and local alternatives. It does however make the assumption that accessible green space is in average condition for its type (e.g., all woodland is in the same condition). Areas where condition differs significantly from the average will have higher/lower values for both the number and welfare value of visits.

In the case of recreation, location plays a dual role; urban green spaces are more valuable due to limited alternatives and a significant number of potential users, but the value may be compromised by negative factors such as pollution or overuse. As mentioned above, ORVal struggles to factor such condition assessments into its values. Recreational value also has an economic impact, both directly and indirectly. Direct effects include increased property values adjacent to high-quality green spaces, while indirect effects result from attracting tourism and promoting outdoor leisure activities, generating revenue and creating jobs. However, these benefits are vulnerable to development or infrastructure that harms green spaces and are outside the scope of ORVal's valuation model.

Table A1.5 presents the per hectare and total annualised value of recreation benefits (PV75) for agricultural land per local authority

Table A1.4: Value of recreation benefits (£, 2024 prices)

Welsh local authority	Average annualised value of recreation benefits per hectare (£) PV75 years	Average annualised value of recreation benefits (£) PV75 years
Blaenau Gwent	407	961,182
Bridgend	445	5,220,405
Caerphilly	457	4,967,868
Cardiff	1,543	2,556,148
Carmarthenshire	55	8,497,569
Ceredigion	43	5,542,014
Conwy	135	10,953,884
Denbighshire	118	6,427,735
Flintshire	243	5,876,289
Gwynedd	51	9,305,586
Isle of Anglesey	107	5,377,656
Merthyr Tydfil	243	662,394
Monmouthshire	106	5,572,754
Neath Port Talbot	288	3,879,401
Newport	499	4,123,717
Pembrokeshire	85	9,644,612
Powys	27	9,443,757
Rhondda Cynon Taf	266	4,429,862
Swansea	650	8,615,441
Torfaen	506	1,212,724
Vale of Glamorgan	596	11,533,504
Wrexham	173	5,254,472

8.5 Species recovery

Understanding biodiversity in terms of its economic value presents complex challenges, as it is difficult to define and difficult to measure. Species abundance is often a preferred proxy as it is relatively easier to measure and interpret than measures based on composition. According to the Convention on Biological Diversity (CBD), biodiversity is defined as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and ecosystems." Variability is difficult to measure, and can be proxied by composition, richness or abundance of species, which all have different practical measurement challenges depending on the ecosystem, biome and context.

Irrespective of these measurement challenges, society places value on biodiversity (proxied here by species recovery) for its role in supporting functioning ecosystems and resilience to external pressures, as well as its non-use (existence & bequest) values. The value attributed to biodiversity can significantly vary depending on habitat type, the types of benefits valued, and the methodology employed for valuation.

8.5.1 The valuation evidence

Browning *et al.*, (2024) have used a stated preference method to estimate households' willingness to pay for species recovery outcomes in England. Their approach involved a large scale (n=5,000) national survey conducted online supported by 130 focus group participants. The survey results and focus group responses indicated that households place significant value on species recovery outcomes. Specifically, the results are linked to both quality and quantity changes in habitat cover, enabling them to be applied to physical data reflecting these two dimensions. To demonstrate an "improvement" in species abundance, habitat areas must show an increase that is sufficient to move between the levels of habitat intactness defined in the Browning et al., (2024) valuation study.

Browning et al. (2024) relates species recovery outcomes with the level of habitat intactness, which is defined as the community of species expected to occur at a particular site or habitat relative to a reference condition (complete native species presence within that habitat). Species recovery outcomes are defined at four states of native species presence – minimal, low, moderate and high – which are associated with a percentage of species presence and compared against a reference condition (complete native species presence within a habitat). The qualitative information shown to respondents was based on underlying quantitative data. Figure A1.0-1 presents the quantitative levels of species recovery for two example habitats (lowland hay meadows and semi-natural grassland) – see Table A1.6 for a breakdown of all habitats included in Browning et al., (2024). Each state has an associated percentage of habitat intactness - for lowland hay meadows, minimal species presence is defined as improved grassland at 10% species intactness, while complete native species presence is lowland hay meadows (100% species intactness).

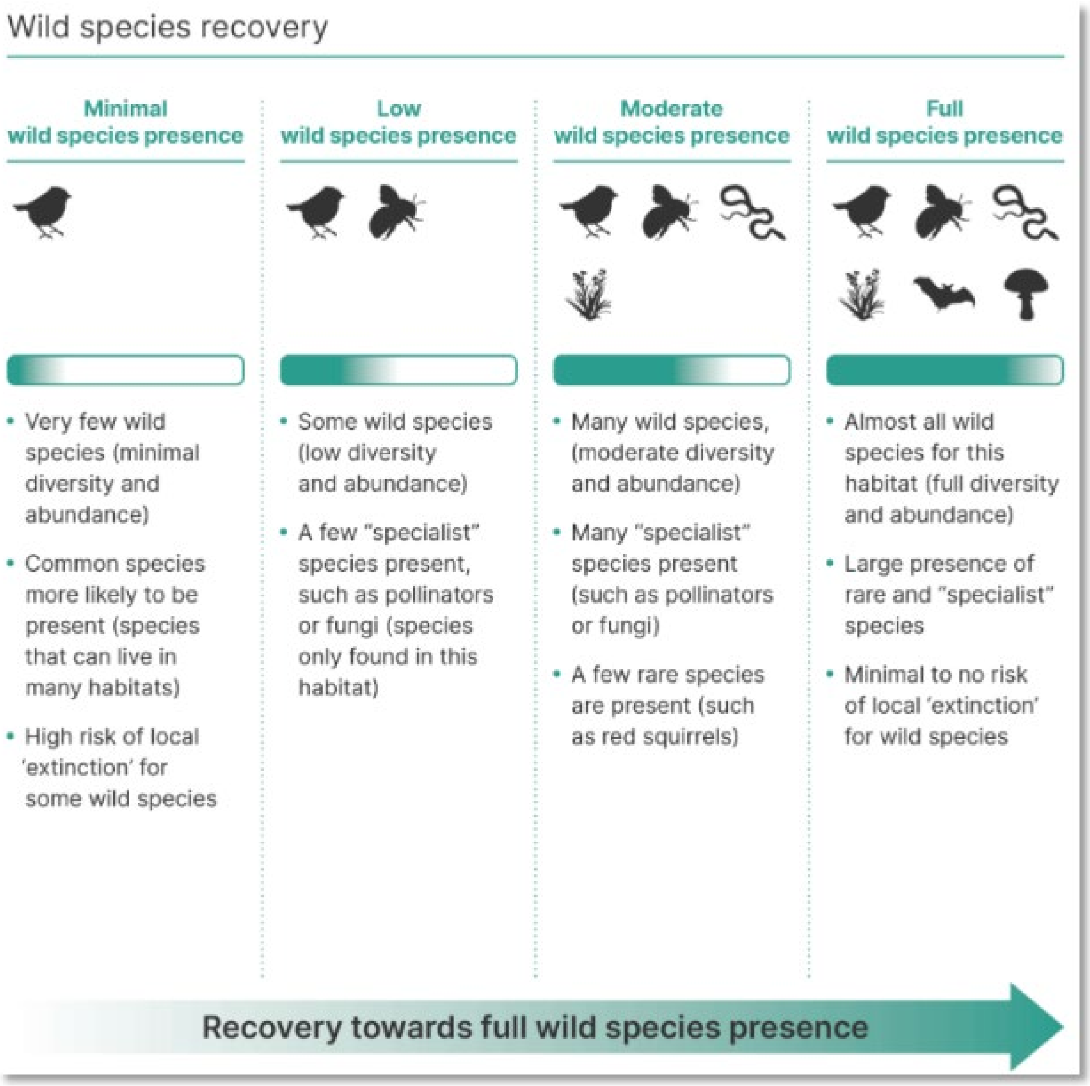

Figure A1.0-1: General representation of species recovery shown to survey respondents

Table A1.5: Grassland examples of species recovery along a gradient where 100% equates with fully restored, intact habitat.

Species presence	Lowland hay meadows	Semi-natural grassland
Minimal	Improved grassland/ pasture (10%)	Improved grassland/ pasture (10%)
Low	Degraded lowland hay meadow (50%)	Degraded/ over-grazing semi-natural grassland (50%)
Moderate	Partially restored lowland hay meadow (80%)	Partially restored semi-natural grassland (80%)

Source: Browning et al., 2024. Annex 3

8.5.2 Monetary measure

Browning et al. (2024) captures values for both changes in the quality of species recovery outcomes (amount recovery increases by, measured in terms of both species diversity and abundance) and quantity of species recovery outcomes (i.e. area over which improved recovery occurs).

8.5.2.1 Calculation of household WTP for national level policy scenarios

8.5.2.1.1 General expression of household WTP

The per household value of a species recovery policy package – measured in terms of the demand or individual level willingness to pay (WTP) - is defined as:

$$Household\ WTP\ (£/hh/yr)\ =\ f(Q_n, Q_l, S) \tag{1}$$

Where:

Q_n *represents the "quantity" improvements*

Q_l *represents the "quality" improvement,*

S *represents a set of socioeconomic and demographic characteristics of the household.*

Given that the survey was large and nationally representative, S is ignored here when considering national average values. The resultant unit value estimate can be multiplied over the national level population to provide an annual aggregate benefit estimate for policy appraisal applications.

The models available to estimate per household values are of two types – models that give the relationships between scale of action and household WTP, and models that give the relationships between habitat type, level of recovery (both scale of action and predicted resulting change in species abundance), and household WTP.

8.5.2.1.2 WTP and quantity of habitat improved

To determine the relationship between household WTP and Q_n, a best fit equation for the diminishing marginal benefit relationship was plotted across all habitat types, using a WTP-space pooled model that included the amount of habitat improved (in hectares) as a regressor. The line of best fit for that relationship generally followed a logarithmic shape. Two variables, β_1 and β_2, were estimated from the observed points from the WTP-space pooled model to define both the rate of curve of the function and an intercept point. If the model focuses on quantity – the resulting expression is:

$$WTP\ for\ quantity\ \ improved = \left(\beta_1 * ln\left(\frac{Q}{500}\right) + \beta_2\right) * 100 \tag{2}$$

Where:

$Q = Area\ of\ species\ recovery\ in\ thousands\ of\ hectares$

$\beta_1 = Dimishing\ marginal\ benefit\ factor$

$\beta_2 = Quantity\ "zero\ intercept"\ point$

The equation is also normalised to a national level ambition for species recovery corresponding to improvements across 500k hectares, which was the target presented to respondents in the stated preference valuation scenario.[20] It is scaled by 100 as the WTP observed was generally in £100s.

[20] Note that even if the policy targets an alternative scale of action, respondents were given this habitat extent as a framing to their responses, and therefore it provides the context of what a "whole" policy would look like. In subsequent research, this type of "reference" value could be modified or included as a parameter of the choice, to reflect differing policy ambitions or targets.

8.5.2.1.3 WTP and quality of habitat improved

Further models estimated the relationship between the quality of improvement and household WTP. In these expressions, some amount of scaling due to quantity is still necessary, resulting in:

$$WTP\ for\ quality\ of\ improvement\ = \left(\beta_1 \ln\left(\frac{Q}{500}\right) + 1\right) \times ((\gamma_{low}\vartheta_{low}) + (\gamma_{mod}\vartheta_{mod}) + (\gamma_{high}\vartheta_{high})) \quad (3)$$

Where:

$$\beta_1 = Dimishing\ marginal\ benefit\ factor$$

$$\gamma = proportion\ of\ habitat\ changing\ to\ a\ certain\ quality\ (x)$$

$$\vartheta = the\ value\ for\ the\ change\ in\ species\ presence\ to\ that\ quality\ (x)$$

This expression takes the proportion (expressed as a percentage of the total) of habitat that is being improved to each level (minimal to low, low to moderate, moderate to good), and multiplies these by the θ value, which is the relative WTP for that quality of improvement. As the θ weights come from a model where WTP for amount of habitat improved was estimated separately, this value can be considered to be additional to Equation (2), as long as the overall expression is still scaled based on the quality. As the relationship in the modelling was additive, $WTP\ (Q_n)$ and $WTP\ (Q_l)$ can be combined by adding those two components of the value.

$$Household\ WTP\ (£/hh/yr)\ =\ WTP for\ Quantity + WTP\ for\ Quality \quad (4)$$

8.5.2.1.4 WTP weight for habitat types improved

The entire value as expressed in (4) can be scaled to account for the habitat types being improved if that information is known. This is done by taking the proportion of the improvement that is occurring on each habitat and then using the relative preferences for those respective habitats to scale the overall value up or down (i.e. improvements to rivers are worth more than improvements to organic arable land). Conceptually, this is expressed as:

$$Weighted\ Household\ WTP\ = preferenceweight * \ (WTP for\ Quantity + WTP\ for\ Quality)$$

8.5.3 How the valuation evidence is used

Table A1.7 maps the characteristics of the study (the species recovery values from (Browning et al., 2024) to the policy (the SFS habitat scenarios) based on several criteria following (eftec, 2009) value transfer guidelines. Overall, it shows a good match from the eftec et al study to the SFS scenarios being analysed.

Table A1.6: Comparison of policy and study contexts

Criteria	Policy (SFS scenario)	Study (2024)
Source:	***WG policy scenarios***	***eftec-led study (Browning et al., 2024)***
The good itself	Species recovery on Welsh habitats and area of habitat created	Species recovery from English priority habitats
The change	Change in the habitat type and intactness across 10,000s of ha of improved habitats	Change in the populations of species (recovery) species across 10,000s to 100,000s of ha of improved habitats
The location	Wales	England
The affected populations	Welsh households	English households
The number and quality of substitutes	Other UK habitats.	Other UK habitats
The market constructs	The policy context is concerned with changes in biodiversity as a result of creating and managing different habitats	The study uses a hypothetical market (DCE) to estimate WTP for species recovery outcomes (one category of which is plants)
Quantitative measure	Habitat area (hectares) and change in the type or level of intactness (categorical) for priority habitats	Habitat area and change in the level of intactness (categorical) for priority habitats
Monetary measure	n/a	WTP for quality and quantity changes in species recovery outcomes
Study quality	n/a	A peer-reviewed and published study with a full account of validity and potential biases in estimates. Number of respondents = 5,000

Table note: A discrete choice experiment (DCE) is a type of stated preference method. It asks respondents to make a series of choices about the provision of the good/service of interest (e.g. species recovery outcomes). The choice tasks usually involve trade-offs between improved, maintained, or deteriorated levels of good/service provision, and other variables (such as related to household spending) that allow a monetary value to be calculated. The choices that survey respondents make reveal their priorities (demand) for the provision of the good or service; (i.e. what they want and care about the most, and how much they are willing to pay to have it).

8.5.4 Sensitivity to lag-factors in species recovery tool

A 5-year and 20-year lag factor was used to test the sensitivity of the benefit values to the amount of time a habitat takes to reach a change in species recovery. The results are shown in Table A1.8.

Table A1.7: Average annualised present value (PV) per ha of species recovery benefits over 5, 10, 25, 50, and 75 years for different lag factors

Species Recovery	Average annualised PV by time horizon (£ per ha, 2024 prices)[1,2]				
Lag factor	**5PV**	**10PV**	**25PV**	**50PV**	**75PV**
10 years (Central estimate)	249	444	556	424	380
5 years (Sensitivity A)	498	659	650	470	415
20 years (Sensitivity B)	125	222	397	347	321

Table notes:
1. Average annual figures are annualised present values, which is calculated by dividing the PV by the time horizon
2. Discount rates are from HM Treasury (2022) and IMP modelling. The rate is 3.5%, reducing to 3% from year 31.

The 5-year lag factor (Sensitivity A) demonstrates the greater value of creating fast-recovering habitats, such as some grassland habitats, which can achieve full species recovery quickly. The annualised PV5 per hectare is twice that for habitats in the main scenario, which take 10 years to improve in species intactness, while the annualised PV10 per hectare is 50% greater. After this, the annualised values even out as both habitats have reached a full change in species intactness and so have an equal annual per hectare value. This is reflected in the convergence of the annualised PVs per hectare, over time.

A 20-year lag-factor is used to represent slow-growing habitats such as ancient woodland in Sensitivity B. The annual value of species recovery rises in a linear fashion from Year 1 to Year 20, after which it remains static. After this time, the value is gradually eroded by discounting. The annualised PVs per hectare in Sensitivity B are 50% of those for the main scenario habitat after both 5 and 10 years as species recovery continues in both habitat types, over that time. After 10 years when the full value of a change in species recovery has been realised in the main scenario, the values in Sensitivity B continue to increase until year 20. Although the annualised PVs per hectare will rise to 25PV, they will begin to converge with the main scenario after this time.

8.5.5 Other biodiversity valuation approaches

There are number of studies which offer key insights into methods required to place a monetary value on biodiversity. ERAMMP Report-102 provided an overview of biodiversity valuation approaches using work by Dickie and Neupauer (2020). The differences in these studies can be described as a) the specific component or bundle of biodiversity valued, and b) how the value is elicited. Dickie and Neupauer (2020). The differences in these studies can be described as a) the specific component or bundle of biodiversity valued, and b) how the value is elicited.

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