Integrated Modelling Platform

Assessment of impacts in this section uses analysis from the Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP) Integrated Modelling Platform[1] (IMP).

The IMP is a tool for exploration of the effects of policy and management interventions on farm viability, land use and environmental outcomes in Wales. It takes an integrated approach, recognising that interventions have multiple impacts and policy effects in one sector have indirect effects in other sectors. It comprises a chain of specialised, state-of-the-art models covering agriculture, forestry, land use allocation decisions, water, air, soils, biodiversity, ecosystem services and valuation.

The IMP is applied to full-time farms (> 1 Full Time Equivalent (FTE) labour). Changes in land use are driven by on-farm economics and land suitability. They do not take into account skills, or cultural and behaviour responses.

The economic baseline for the IMP is 2023. Farm Business Survey (FBS) data for 2022-23 is a key input into the modelling alongside cost and commodity prices from the John Nix Management Pocketbook (2023).

Full assumptions that underpin the modelling are included in ERAMMP Report 60[2].

The modelling estimates impacts for 7,401 full-time farms in Wales. This model population accounts for:

- 30%[3] of the c. 24,608 active farms in the June agricultural survey,
- 73% of all cattle (78% of beef and 69% of dairy) in Wales;
- 83% of all sheep in Wales;
- 67% of rough grazing, 61% of crop land and 50% of improved grass, of which 76% of temporary grass and 46% of permanent grass.

Table 1 shows the number of farms by farm type, and the total area represented by each of these farm types. Specialist sheep, Dairy and SDA mixed farms account for the largest shares of farms in the model. In terms of aggregate farm area, Specialist sheep, SDA mixed and Dairy account for the largest total areas.

[1] https://erammp.wales/en/42
[2] ERAMMP Report-60 IMP Land Use Scenarios Final Report_en.pdf
[3] The shortfall represents both part time/micro farms and uncertainties in the allocation of LPIS to full time farms. Data limitations prevented the identification of all full time farms and also all land associated with full time farms in Wales.

Table 1. IMP Full-time farm numbers and area by farm type

Farm type	Total No of Farms	Total area (includes non-agricultural areas[4])	Average farm size (ha)
Cereals	97	20,842	215
General Cropping	52	7,109	137
Dairy	1,260	163,485	130
Lowland cattle & sheep	679	63,665	94
Mixed[5]	255	33,824	133
Other[6]	317	18,383	58
Specialist Sheep (SDA)	2,257	342,804	152
Specialist Beef (SDA)	184	34,007	185
SDA mixed	1,139	164,305	144
DA mixed grazing	1,161	124,854	108
Total	**7,401**	**973,278**	**132**

Description of modelling scenarios: Baseline, scenario description and comparison to Counterfactual (BAU)

Baseline

The scenarios are introduced on top of a baseline. This indicates the conditions in which model farms are simulated to be operating ahead of the modelling scenario being introduced.

The baseline for the scenarios covered in this analysis is one where:

- BPS is being paid[7], with no taper
- Rural Investment/ SFS Preparatory schemes are not included
- Standards of good agricultural and environmental condition (GAECs) apply

[4] Non agricultural areas consist of bare rock, buildings, yards, sand dunes, mud flats. These areas are excluded from the modelling calculations
[5] Mixed: holdings for which no single category accounts for more than two thirds of total Standard Output
[6] Other: Holdings that do not fit into any of the defined categories. This category includes non-classifiable holdings
[7] Excluding payments on common land and Young Farmer top-up

- The Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021 are not in force (CoAP)
- the Universal layer of the SFS is not available.

Preferred Way Forward (PWF) Scenario

This scenario is that whereby the SFS Universal layer is introduced. Two payment rate scenarios (PWFa and PWFb) are modelled (see next section). In addition to the modelled introduction of the Universal layer, the following elements are also simulated within the scenario:

- BPS removed in full
- Rural Investment/ SFS Preparatory schemes are not included (no change from baseline)
- GAECs continue to apply (no change from baseline)
- The Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021 are in force for all farms, including costs of compliance
- SFS Universal layer introduced (Optional and Collaborative actions are not modelled).

Counterfactual scenario (BAU)

The Counterfactual scenario (BAU) is that against which the impacts of the PWF scenario can be compared. For this modelling, the Counterfactual is designed to offer insight into potential impacts if the SFS were not introduced, and BPS was continued. In this modelling scenario, the following elements are simulated:

- BPS paid, no taper
- Rural Investment/ SFS Preparatory schemes are not included (no change from baseline)
- GAECs continue apply (no change from baseline)
- The Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021 are in force for all farms, including costs of compliance
- The Universal layer of the SFS is not available

Interpretation of outputs

The baseline and two scenarios together mean specific effects can be explored by varying comparison across the model outputs.

The simulated impact of the Counterfactual (BAU) scenario is estimated from the change against the baseline.

The simulated impact of the PWF scenarios can be estimated by calculating the change difference between the Counterfactual (BAU) and each of the PWFs where possible i.e. difference between the projected value for the PWFs and that of the Counterfactual. This allows the impact of the SFS Universal layer to be separated from other factors in the modelling (e.g. the regulatory environment). Where the change under the Counterfactual is minimal, or where cumulative change is being calculated, changes for the PWFs may be presented against the baseline. This is explained in the analysis where this is the case.

Description of PWF modelling scenario: SFS Universal layer payments

This section outlines the approach to modelling the estimated impacts arising from the SFS Universal layer under two payment scenarios (PWFa and PWFb).

Table 2 shows the payment rates included in the modelling, and which payments were not modelled. All payments are modelled as a flat-rate i.e. they do not vary according to the action undertaken, or any farm-specific factors such as size. Capping or tapering of payments is not included. The only difference between the two scenarios is the value of the Social Value payment (£115 per ha under PWFa, £70 per ha under PWFb).

The following points in relation to payments should be noted when interpreting the results of these SFS Universal Layer scenarios:

- Payments eligible on common land were not modelled. The IMP does not model common land as it cannot be reliably linked to the other farm data sets (June Survey and the Land Parcel Identification System, LPIS) used in the model.
- The transition period whereby farms will have the option between 2026 and 2029 to receive either reduced BPS or payments under SFS was not modelled.
- The Optional and Collaborative layers of the scheme were not modelled, and therefore any payment from actions which may be undertaken under these layers of the scheme are not represented.

The scenarios should therefore be taken as an estimation of potential Universal layer impacts:

- Once BPS has been completely phased out.
- In a scenario where the choice for farms is to either join the Universal layer of SFS or operate outside of all WG schemes.
- Of scheme payments and action on land within the farm gate only. For farms with common rights, payments beyond the farm gate may represent a substantial source of additional payment beyond those modelled in the IMP.

The outputs should not be interpreted as representing potential impacts arising in 2026, or any year where farms may choose to receive BPS as an alternative to joining the Universal layer of the SFS.

Table 2. SFS Universal payment rates for modelling

Payment	Description	PWFa (£/ha)	PWFb (£/ha)
Maintenance of existing woodland	Payment value for each hectare of existing woodland that is managed.	62	62
Habitat maintenance (farmland)	Payment value for each hectare of semi-natural habitat managed, and/or each additional hectare of temporary habitat up to the required 10%, once created.	69	69
Whole Farm Payment	Payment value for each hectare covering all other Universal Actions on the total eligible area.	31	31
Social Value Payment (SVP)	This payment is per hectare in addition to any costs incurred and income forgone. Applied to the whole farm.	115	70
BPS Taper		Not modelled	Not modelled

Description of PWF modelling scenario: representation of Universal Actions

This section describes how the Universal Actions were incorporated into the PWF modelling scenarios. Assumptions are based on the November 2024 scheme version[8].

Representation of scheme actions within the modelling was the result of an iterative process between Officials and the IMP modelling team to ensure action representation appropriately reflected the policy intent. All assumptions were documented and approved by the SFS SRO, in line with AQUA Book guidance[9].

Table 4 gives an overview of the key costs modelled for each Universal Action (UA) and how the action influences modelled impacts. Costs are applied to model farms to understand, alongside the simulated payment rates, whether it is of economic benefit to enter the scheme but also influence the economic optimisation of model farm structures (e.g. land use, stocking).

UAs vary in terms of which aspects of the model they influence. Actions which mainly incur a time cost, e.g. benchmarking, influence model farm FBI but do not directly result in changes in land use, stocking, or nutrient inputs unless the business takes further action beyond the UA. These actions, marked with an asterisk in Table 4, therefore do not have a direct effect on modelled environmental impacts.

UA9 woodland maintenance is modelled as cost and impact neutral due to uncertainty in the existing baseline management and condition of on-farm woodland, and the on-site variability in actions which may be undertaken under UA9 as a result.

Table 3. Universal Layer Modelling Assumptions

	Action	**Modelling cost assumptions**	**Representation in impacts**
-*	Habitat Baseline Review	Regarded as part of the application process. No cost represented in the modelling	-
-*	Carbon calculator	1 day per year of farmer time	Costs incurred influence farm FBI
UA1*	Soil Health	Per field: 18 minutes plus analytical cost of testing Includes land which has previously received, or may receive inputs	Costs incurred influence farm FBI

[8] Sustainable Farming Scheme: proposed scheme outline (2024) | GOV.WALES
[9] The Aqua Book: guidance on producing quality analysis for government

UA1*	Nutrient management plan/records	2 days per year of farmer time	Costs incurred influence farm FBI
UA1*	Nutrient management reporting	1 day per year of farmer time	Costs incurred influence farm FBI
UA2*	Integrated Pest Management (IPM)	2 days per year of farmer time	Costs incurred influence farm FBI
UA3*	Benchmarking	1 day per year of farmer time	Costs incurred influence farm FBI
UA4*	Continuous Professional Development (CPD)	Minimum 7-year hours per year. 6 hours + mandatory H & S	Costs incurred influence farm FBI
UA5	Habitat Maintenance	Livestock reduction of 1 ewe (or direct beef equivalent) per hectare on rough grazing if baseline stocking exceeds habitat-based guidance threshold. This is a simplifying assumption to reflect that, whilst some habitat land may be more than 1 ewe per ha over the guidance levels, some stock is likely to be moved elsewhere on the farm rather than removed but this is not a response which is modelled. Pond maintenance: cost/m2/yr irrespective of pond size	Costs incurred and income foregone due to changes in stocking influence farm FBI
UA6	Temporary habitat creation on improved land	Land out of production on arable and intensive grassland to meet 10% habitat scheme rule. Modelled as: Temporary rough grass margins on arable Mixed Leys on improved (rotational and permanent) grassland	Land use change influences stocking and nutrient inputs and has downstream impacts on environmental outcomes Costs incurred and income foregone due to changes in stocking influence farm FBI
UA7*	Designated Site Management Plan	1 day per year of farmer time	Costs incurred influence farm FBI Maintenance of sites included under UA5

			Delivering specific action under the plan is an Optional layer action and not included here.
UA8	Hedgerow management	Planting of new hedgerow trees in hedgerows not in management at baseline Hedgerows in management at baseline assumed to contain saplings which can be left to grow	Change in hedgerow condition, and new hedgerow trees, has downstream impacts on environmental outcomes Costs incurred influence farm FBI
UA9	Woodland maintenance	Cost neutral due to uncertainties in baseline management and condition and variability in potential action which could be taken	No influence on farm FBI
UA10*	Tree and Hedgerow Planting Opportunity Plan	1 day per year of farmer time	Costs incurred influence farm FBI
UA11*	Historic Environment	1.5 days per year of farmer time	Costs incurred influence farm FBI
UA12*	Animal Health and Welfare	0.5 days per year of farmer time to complete Mobility and Body Condition Scoring	Costs incurred influence farm FBI
	Animal Health Improvement Cycle (AHIC)	1 day per year of farmer time, 0.5 days per year of vet time to complete AHIC	Costs incurred influence farm FBI
	Biosecurity	0.5 days per year of farmer time, 0.5 days per year of vet time to complete Animal Biosecurity Assessment	Costs incurred influence farm FBI

Description of PWF modelling scenario: responses of model farms

Each of the 7,401 full-time model farms is presented with two ‘choices’ in the PWF modelling scenario:

(1) Join the Universal layer of the SFS in return for payment, and implementation of all applicable universal actions
(2) Do not join the Universal layer, and operate without any government funding

Farms are modelled as entering the Universal layer if the business is simulated to generate £1 more profit within the scheme than if they were to operate without any funding. Potential behavioural drivers not considered, as these are too diverse to account for with enough confidence in the modelling.

Model farms are not able to transition to a more profitable farm type within the scenarios. Outcomes and impacts should therefore be considered as those which may arise over the shorter term, rather than indicative of any industry re-structuring which could occur over a longer period.

Simulated scheme uptake

This section outlines the simulated uptake under each PWF scenario, and the differences in uptake between the scenarios, in terms of:

- Farm numbers
- Farm area
- Habitat area
- Hedgerow length
- Woodland area
- Livestock numbers

Farms

99% and 97% of model farms are simulated to join the Universal layer of the scheme (as opposed to receiving no WG funding) under PWFa and PWFb respectively (Table 4). High simulated uptake is attributable to the loss of BPS. Modelled uptake is higher under PWFa due to the larger Social Value payment.

By scenario and farm type, uptake is simulated to be highest in SDA mixed farms (99.6%) in the higher payment scenario and Specialist Beef (99.5%) in the lower payment scenario. Simulated uptake across both scenarios is lowest in the Other farm type (89.0% under the higher rate and 78.6% under the lower rate).

Table 4. Simulated uptake by farm type

Farm type	Total No of Farms	PWFa % of farms adopting	PWFb % of farms adopting
Cereals	97	97.9	94.9
General Cropping	52	98.1	94.2
Dairy	1,260	99.2	95.0
Lowland cattle & sheep	679	99.1	96.2
Mixed	255	97.7	97.7
Other	317	89.0	78.6
Specialist Sheep (SDA)	2,257	98.8	98.2

Specialist Beef (SDA)	184	99.5	99.5
SDA mixed	1,139	99.6	99.3
DA mixed grazing	1,161	99.2	98.1
Total	**7,401**	**98.6**	**96.7**

Farm area

Given that the majority of full-time farms simulated to join the Universal layer under both payment scenarios, uptake by total area is high.

Across both scenarios, over 99% of the total model area (including non-agricultural areas) is simulated to enter into the Universal Layer. Under PWFa, 99.7% of the modelled area is simulated to be within the scheme, compared to 99.1% under PWFb (Table 5).

Specialist Sheep (SDA), SDA mixed grazing farms and Dairy farms have the greatest area in the Universal layer, reflecting their large numbers (31%, 15% and 17% of total model farms respectively) and their large area (35%, 17% and 17% of total model farm area respectively).

Table 5. Simulated uptake by farm area

Total Farm Area (ha)	Baseline total farm area (ha) (including non-agricultural areas)	Total area under PWFa	% of farm area under PWFa	Total area under PWFa	% of farm area under PWFb
Cereals	20,842	20,692	99.3	20,524	98.5
General Cropping	7,109	6,947	97.7	6,916	97.3
Dairy	163,485	163,072	99.8	159,898	97.8
Lowland cattle & sheep	63,665	63,355	99.5	62,856	98.7

Mixed	33,824	33,356	98.6	33,356	98.6
Other	18,383	18,097	98.4	17,671	96.1
Specialist Sheep (SDA)	342,804	342,024	99.8	341,577	99.6
Specialist Beef (SDA)	34,007	33,997	100.0	33,997	100.0
SDA mixed	164,305	164,112	99.9	163,744	99.7
DA mixed grazing	124,854	124,612	99.8	124,159	99.4
Total Farm Area (ha)	**973,278**	**970,264**	**99.7**	**964,698**	**99.1**

Habitat entering Universal layer: UA5 Habitat Maintenance

Under UA5 Habitat Maintenance, all habitat land entering the Universal Layer is brought under this action. For semi-improved and rough grassland habitat land, this is modelled as 1 ewe (or beef equivalent) in stock reduction per hectare where the habitat is modelled as being over the guidance stocking limits. Livestock removed from habitat land is removed from the farm business entirely, rather than being displaced elsewhere on the farm. In practice, farms may re-locate stock to other areas of the farm but this is not a response which is captured in the modelling. Therefore the 1 ewe per ha was chosen as a simplifying assumption to reflect that, where an area of habitat is stocked above the guidance level, some livestock may be displaced rather than removed entirely but also that there could be economic impacts where livestock is removed.

In line with the high simulated uptake across both scenarios, the areas of existing habitat simulated to be under UA5 are also high (Table 6). Across both scenarios, the majority of all model habitat land is brought into the Universal layer (99.8% under PWFa, 99.7% under PWFb).

Table 6.UA5 Habitat Maintenance: area of habitat simulated to enter Universal layer

UA5 habitat	**Baseline total area (ha)**	**Total under PWFa (ha)**	**Total under PWFb (ha)**	**Percentage of baseline area under PWFa**	**Percentage of baseline area under PWFb**
Ponds	84	66	58	78.6	69.1
Semi-improved grassland	127,123	126,976	126,881	99.9	99.8
Rough grassland	157,629	157,516	157,500	99.9	99.9
Non-agricultural habitat land [10]	2,607	2,539	2,536	97.4	97.3
Non-woodland SSSI on Arable, Improved Grassland and non-agricultural land	10,202	10,129	10,112	99.3	99.1
Broadleaved woodland >0.1ha	54,744	54,515	54,262	99.6	99.1
Total (existing habitat)	**352,389**	**351,741**	**351,349**	**99.8**	**99.7**

Hedgerows entering Universal layer: UA8 Hedgerow Management

Hedgerows are distinguished in the baseline according to whether they have previously been under management or created within a Welsh Government agri-

[10] Land Cover Map classes of supralittoral rock, supralittoral sediment (e.g. sand dunes and salt marsh).

environment scheme (AES, e.g. Glastir). This distinction is used in the modelling to make assumptions about hedgerow condition and the presence of saplings which can be left to grow in line with the requirements of the action (Outcomes section).

The majority of hedgerows (97.5%) are not recorded as being in previous schemes and therefore assumed to be narrower, shorter and without available saplings on entry to the scheme (Table 8). This is a simplifying assumption for the purposes of the modelling.

High adoption under both payment scenarios means the majority of the baseline hedgerow area is brought into UA8 (99.6% under PWFa and 98.8% under PWFb).

Table 7.UA8 Hedgerow Management: Length of hedgerows simulated to enter Universal layer

Length of hedge (km)	**Baseline Length**	**Length within Universal Layer PWFa**	**Length within Universal Layer PWFb**	**% of baseline Length PWFa**	**% of baseline Length PWFb**
Hedge in AES at Baseline	565	564	560	99.8	99.2
Hedge not in AES at Baseline	22,086	22,007	21,815	99.6	98.8
Total hedge (km)	**22,651**	**22,571**	**22,375**	**99.6**	**98.8**

Woodland entering Universal Layer: UA9 Woodland Maintenance

There is 82,857ha of on-farm woodland in the baseline (Table 8). This represents 8.5% of the total model area. The majority of farm woodland (>0.1ha, excluding conifer over 30ha[11]) is brought into maintenance under both payment scenarios (99.7% under PWFa and 99.2% under PWFb).

Table 8. UA9 Woodland Maintenance: area of woodland simulated to enter Universal layer

	Baseline Area	**Area within Universal Layer PWFa**	**Area within Universal Layer PWFb**	**% of baseline area PWFa**	**% of baseline area PWFb**

[11] Conifer over 30ha is assumed to be under commercial management

Area of woodland (ha)	82,857	82,573	82,171	99.7	99.2

Livestock simulated to enter Universal layer

In line with the high simulated uptake in terms of farm numbers and area under each payment scenario, the proportion of baseline Grazing Livestock Units (GLUs) simulated to be brought under the Universal layer is also high with marginal difference between the two (Table 9). Table 9 does not consider any changes in absolute stock numbers, these are explored in the Outcomes section.

Table 9. Proportion of baseline livestock simulated to enter Universal layer

GLUs	**Baseline total**	**PWFa livestock in Universal**	**PWFb livestock in Universal**
Beef	261,637	252,449	251,315
Sheep	411,249	384,765	383,911
Dairy	293,860	254,871	249,672
Total	966,746	892,084	884,898
Percentage (%)	100	92.3	91.5

Simulated WG payments to farms

This section outlines the simulated Welsh Government spend across the Counterfactual and PWF scenarios in terms of:

- Aggregate spend within each scenario
- Aggregate spend by farm type
- Average payment by farm type

The IMP models full time farms only, and does not include payments or action on common land. Simulated spend is therefore smaller than it would be if the full farm population, and associated land, was included and should not be taken as the full cost of the Universal layer to WG.

Aggregate Spend

Under the Counterfactual scenario, a total of £143.5m in BPS is simulated to be paid to model farms (Table 10). In the PWF scenarios, BPS is removed and model farms join the SFS Universal layer if it is more profitable to do so than operating without government funding.

Total simulated WG spend under PWFa is 18% higher than in the Counterfactual, and under PWFb it is 13% lower.

Table 10. Total simulated WG payments to full time farms, by payment type

Total simulated payments to full-time farms (£m)	**Counterfactual**	**PWFa**	**PWFb**	**% of total payment PWFa**	**% of total payment PWFb**
BPS	143.5	0	0	-	-
Whole Farm Payment	0	30.0	29.9	17.8	24.0
Habitat maintenance	0	22.9	22.8	13.5	18.3
Woodland maintenance	0	4.5	4.5	2.7	3.6
Social Value Payment	0	111.5	67.5	66.0	54.1
Total	**143.5**	**168.9**	**124.6**	**100**	**100**

Note. Modelled BPS payments exclude common land and Young Farmer top up

Between the payment scenarios, total simulated SFS Universal layer payments to full-time farms are 26% higher under PWFa (£169 million) than PWFb (£125 million).

The difference in total simulated payment between the two PWF scenarios is primarily due to the larger Social Value Payment (SVP, Table 10) but also the additional 140 farms and 5,556ha simulated to join the Universal layer under PWFa (Tables 5 and 6).

Across both scenarios, the largest proportion of payments is from the SVP. In PWFa, 66% of payments are the SVP, 18% for the whole farm payment, 14% for habitat maintenance and 3% for woodland maintenance. Under PWFb, 54% of payments are the SVP with 24% for the whole farm, 18% for habitat, and 4% for woodland maintenance.

Generally, differences in simulated expenditure across the other payment types are small due to the fact that the only payment rate to vary across the scenarios is the SVP, and the higher uptake under PWFa is marginal (an additional 5,556ha of land under management represents <1% of the full model area).

In PWFb, the whole farm payment represents a larger proportion of total simulated payments (24%), due to the lower contribution from the SVP and the fact that this payment is paid across the farm, whilst other payment elements are paid on specific areas only (e.g. woodland).

Spend by Farm Type

By farm type, the highest simulated expenditure under both the Counterfactual and PWF scenarios is towards Specialist Sheep (SDA), SDA mixed grazing and Dairy (Table 11). This is reflective of the larger numbers and area of these farms, and high uptake.

Total simulated payments across both payment scenarios show a similar distribution across farm types to the BPS spend in the Counterfactual scenario.

Under PWFa, all farm types receive higher simulated aggregate payments than under the Counterfactual scenario with the exception of Lowland Cattle and Sheep farms who receive £0.37million less in total payment.

Under PWFb, all farm types receive lower simulated aggregate payments than under the Counterfactual scenario with the exception of Specialist Sheep who receive marginally more in aggregate (£0.02million).

For all farm types, and under both scenarios, the SVP represents the largest payment (Figure 1), reflective of the fact that this payment is higher in value than the other payment elements across both scenarios plus paid over the full eligible farm area.

Table 11. Simulated aggregate spend by farm type

Aggregate simulated payments (£m)	**BPS**	**Total PWFa payment**	**Total PWFb payment**
Cereals	2.6	3.4	2.4
General Cropping	1.0	1.1	0.8
Dairy	25.0	26.0	18.3
Lowland cattle & sheep	10.4	10.0	7.1
Mixed	5.0	5.5	4.0
Other	2.9	3.0	2.1
Specialist Sheep (SDA)	48.8	64.3	48.9
Specialist Beef (SDA)	4.7	6.0	4.5
SDA mixed	23.6	29.3	21.9
DA mixed grazing	19.5	20.4	14.8

Total	143.5	168.9	124.6

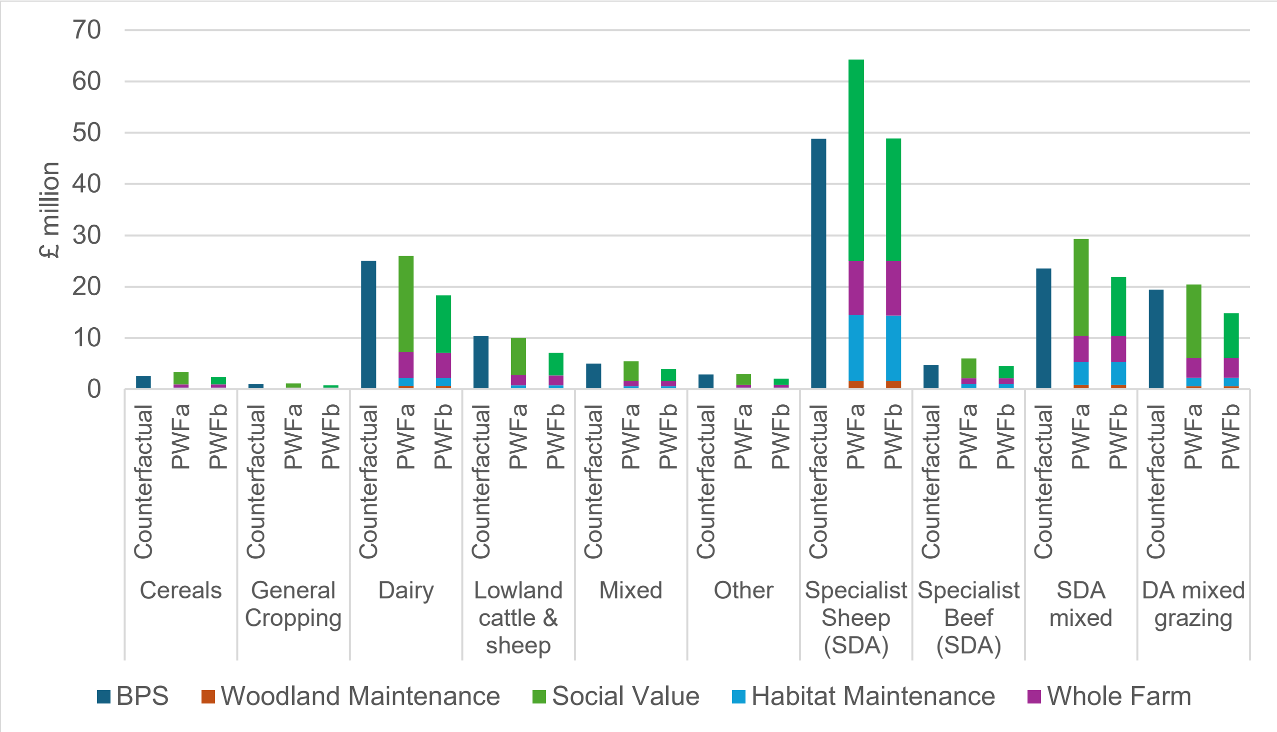

Figure 1. total payments by farm type

Average payments

Average simulated payments do not include any payments on common land and, in the case of BPS, also exclude the Young Farmer top-up.

Across both payment scenarios, Cereal farms receive the largest average Universal payment (Table 12). This is due to the relatively small number of these farms in the model (97) but a comparatively high average farm size (Table 1, average farm size of 215ha compared to 131ha for all model farm types) meaning comparatively larger social value and whole farm payments. Farms in the Other category receive the lowest average payment across both scenarios, reflective of the smaller average size of these farms in comparison to that of the full model population (58ha compared to 132ha).

Between scenarios, cereal farms see the largest change in average payment between the higher and lower SVP. Farms in the Other category see the lowest reduction between the two payment scenarios.

In comparison to BPS, all farm types receive a higher average payment under PWFa than under BPS, reflective of the larger simulated WG spend. Under PWFb, average payments are lower than under the Counterfactual for all farm types with the exception of Specialist Sheep (SDA) farms which have a marginally higher average payment than under the Counterfactual.

Table 12. Average simulated payments by farm type

Average Universal Payment (£)	**BPS**[12]	**PWFa**	**PWFb**	**Difference PWFa to PWFb (£)**
Cereals	27,177	35,239	26,077	-9,161
General Cropping	19,074	21,660	16,088	-5,572
Dairy	19,869	20,786	15,290	-5,496
Lowland cattle & sheep	15,290	14,878	10,888	-3,990
Mixed	19,684	21,891	15,869	-6,022
Other	9,194	10,484	8,415	-2,069
Specialist Sheep (SDA)	21,636	28,841	22,045	-6,796
Specialist Beef (SDA)	25,468	32,944	24,594	-8,350
SDA mixed	20,688	25,806	19,317	-6,490
DA mixed grazing	16,751	17,737	12,980	-4,756
Total	19,483	23,027	17,156	-5,870

[12] Simulated BPS payments do not include common land payments or the Young Farmer top up.

Outcomes

Model outcomes represent the changes to land use, stocking and nutrients which drive downstream environmental impacts.

The following sections present outcomes from the two PWF payment scenarios in comparison to outcomes from the Counterfactual.

Changes as a result of the Counterfactual scenario are calculated against the baseline.

Changes as a result of the PWF scenarios are calculated against the Counterfactual change. Results for the PWFs therefore indicate the simulated additional change in outcomes relative to those seen in the Counterfactual scenario. Where the Counterfactual change is negligible, PWF change is calculated against the baseline in order that percentage changes more accurately reflect the absolute change which is simulated.

Outcomes are represented for:

- Land Use (including temporary habitat creation under Universal Action 8)
- Hedgerow management
- Livestock numbers
- Nutrient inputs

Land Use

Under the Counterfactual scenario, there are very small modelled changes in total crop area (0.19% reduction) and the area of rotational grass (0.11% increase). No other changes in productive area are seen (Table 13).

In comparison to the Counterfactual, modelled land use changes under the PWF scenarios are larger due the requirements of the 10% Habitat Scheme Rule and UA6 Temporary Habitat Creation but remain small as overall proportion of the total modelled productive areas. Changes due to UA6 on temporary grass and arable are modelled as temporary changes.

Under PWfa, in comparison to the Counterfactual, an additional 0.67% of crop area is simulated as undergoing land use change to temporary habitat , rotational grass reduces 5.28% and the area of improved permanent grass reduces by 1.84%. For PWFb there is a marginally lower reduction in the area of rotational and permanent grass. Rough grass undergoes no change in either payment scenario.

Table 13. Simulated percentage change in land use

% change in land use	Crop	Rotational Grass	Permanent Grass	Rough Grass
Baseline to Counterfactual	-0.19	0.11	0.00	0.00
Counterfactual to PWFa	-0.67	-5.28	-1.84	0.00
Counterfactual to PWFb	-0.66	-5.08	-1.82	0.00
PWFa compared to PWFb	0.01	0.22	0.02	0.00

As a result of this projected land use change the total area of temporary habitat created under UA6 is 16,018ha for SFS7a and 15,673ha for SFS7b, a difference of 2.16% (Table 14).

Temporary habitat creation under UA6 represents an additional 4.5% on top of the baseline habitat area under PWFa, and 4.4% under PWFb.

Most of the temporary habitat is mixed leys created on permanent grass (Intensive Grassland). This accounts for 60% in PWFa, mixed leys on rotational grass account for 38% and rough grass margins on arable 3%.

Table 14. UA6 Temporary habitat creation: total area created by land use category

Temporary habitat created (ha)	PWFa	PWFb	PWFa compared to PWFb %
Temporary habitat (crop)	459	450	1.9
Temporary habitat (rotational grass)	6,001	5,767	3.9
Temporary habitat (permanent grass)	9,559	9,456	1.1
Total	**16,018**	**15,673**	**2.2**

Of the 16,018ha of temporary habitat created in PWFa and the 15,673 in PWFb, the largest proportion is created on dairy farms (Table 15). This is reflective of their large numbers and area in the model, and lower proportion of existing habitat area. Temporary habitat on general cropping farms represents the lowest proportion of area created across both scenarios, reflective of the lower number of this farm type in the model (52 farms) and therefore lower aggregate total area in comparison to other farm types (Table 1).

Table 15. UA6 Temporary Habitat creation: area created by farm type

	PWFa		**PWFb**	
Temporary habitat creation by farm type	**Total created (ha)**	**% temporary habitat created**	**Total created (ha)**	**% temporary habitat created**
Cereals	614	3.8	606	3.9
General cropping	221	1.4	220	1.4
Dairy	6,070	37.9	5,829	37.2
Lowland cattle & sheep	2,500	15.6	2,477	15.8
Mixed	863	5.4	863	5.5
Other	494	3.1	477	3.0
Specialist Sheep (SDA)	941	5.9	937	6.0
Specialist Beef (SDA)	272	1.7	272	1.7
SDA Mixed	910	5.7	892	5.7
DA Various	3,133	19.6	3,100	19.8
Total	**16,019**	**100**	**15,673**	**100**

Hedgerow changes

Under the Counterfactual, no changes to baseline hedgerows are modelled.

Under UA11, hedgerows entering the Universal layer undergo two key changes depending on the baseline condition:

1) Increase in width to 3 by 2m from 1m by 1m if not managed in baseline, or from 2 by 2m if assumed to already be managed
2) The cultivation of saplings in hedgerows every 50metres. Saplings are planted where the hedgerow is assumed unmanaged (and therefore in

worse condition) in the baseline, but assumed to be already present to cultivate within the hedgerow if managed at baseline.

There is an overall increase of hedgerow area of 192% in PWFa and 190% in PWFb in comparison to the baseline (Table 16). A total of 373,891 samplings are simulated to be cultivated under PWFa, and 370,728 under PWFb (Table 17). Differences between the two scenarios are minor, reflecting high uptake under both. The increase in area should be considered an overestimate due to uncertainty over the baseline width and height of modelled hedgerows.

Most saplings are modelled as actively planted, as opposed to already present in the hedge to allow to grow, as the majority of hedgerows in the baseline are modelled as unmanaged. The number of saplings actively planted should be assumed an overestimate due to uncertainty over the baseline condition of modelled hedgerows.

Table 16.UA11 Hedgerow Maintenance: simulated increase in hedgerow area

Hedgerow metrics	**Baseline and Counterfactual (CF)**	**PWFa**	**PWFb**	**%difference CF to PWFa**	**%Difference CF to PWFb**	**%Difference PWFa to PWFb**
Hedgerow area (m2)	23,215,920	67,793,000	67,405,800	192.01	190.34	-0.57

Table 17 UA11 Hedgerow Maintenance: simulated number of saplings cultivated

Saplings cultivated	**PWFa**	**PWFb**	**%Difference PWFa to PWFb**
Number of non-planted saplings	7,997	7,950	-0.59
Number of planted saplings	365,894	362,778	-0.85
Total	**373,891**	**370,728**	**-0.85**

Livestock changes

Under the Counterfactual there is an overall 2.8% modelled reduction in Grazing Livestock Units (GLUs) in comparison to the baseline. This is due to a 9.0% reduction in Dairy GLUs due to the limits and requirements related to the CoAP regulations (Table 18). Beef (0.11% reduction) and Sheep (0.00% change) GLUs are unaffected.

In comparison to the Counterfactual, under PWFa and PWFb there is an additional 4.8% and 4.7% modelled reduction in total GLUs respectively. The largest reductions are seen in sheep (6% reduction in both scenarios) followed by dairy GLUs (4% reduction in both scenarios) and beef (3% reduction), reflecting the larger areas of habitat on sheep farms which are therefore subject to Universal Action 5. The creation of temporary habitat under UA6 on permanent and rotational grassland influences stocking across all GLU categories.

Differences in stock changes between PWFa and PWFb are marginal (0.07% overall), reflecting similar levels of uptake across the scenarios.

Table 18. Simulated percentage change in Grazing Livestock Units (GLU)

% Change in GLUs	**Beef**	**Sheep**	**Dairy**	**Total**
Baseline to Counterfactual	-0.11	0.00	-9.01	-2.77
Counterfactual to PWFa	-3.02	-6.20	-4.40	-4.81
Counterfactual to PWFb	-2.99	-6.19	-4.23	-4.74
% difference in GLUs				
PWFa compared to PWFb	0.03	0.01	0.18	0.07

Nutrient Inputs

Changes in nutrient inputs are driven by modelled changes in stocking and land use.

Under the Counterfactual, there is an overall 5.8% reduction in nutrient inputs (Table 19). This is driven by a 14.5% reduction in N fertiliser and a 9% reduction in dairy excreta. The reduction in dairy excreta is associated with the 9% reduction in dairy GLUs as a result of the change to nutrient loadings within the farm under the CoAP regulations. Beef and sheep excreta are unaffected.

In comparison to the Counterfactual, the payment scenarios see additional modelled reductions in nutrient inputs of 4.4% under PWFa and 4.3% under PWFb. Reductions occur across all input categories.

In line with the stocking reductions described in the previous section, the largest modelled changes in inputs under the payment scenarios are seen in sheep excreta (6.2% reduction across both scenarios).

There are minor differences between the two scenarios. PWFb sees a slightly lower reduction in overall inputs, due to marginally lower decreases in stocking and land use change compared to PWFa.

Table 19. Simulated percentage change in nutrient inputs

% change in nutrient input	**N fertiliser**	**Dairy excreta**	**Beef excreta**	**Sheep excreta**	**Total**
Baseline to Counterfactual	-14.50	-8.99	-0.14	0.00	-5.76
Counterfactual to PWFa	-2.81	-4.40	-3.02	-6.20	-4.35
Counterfactual to PWFb	-2.73	-4.23	-2.99	-6.19	-4.28
% difference in nutrient input					
PWFa compared to PWFb	0.09	0.18	0.03	0.01	0.07

Impacts

This section describes the simulated economic and environmental impacts arising from the modelled scenarios. It considers impacts on:

- Farm Business Income
- Carbon stocks and Greenhouse gas emissions
- Water Quality
- Air Quality
- Biodiversity

Assumed longevity of scheme changes

All actions are delivered under 1-year agreements. However, for the purposes of projecting the long-term impacts of changes associated with the scheme, IMP assumes that actions and associated management remain in place for the modelled period. This is with the exception of temporary habitat creation, since a farmer could shift these temporary habitat features around the farm, and they are therefore not included in the land use change areas which act as inputs for the Ecosystem Services models.

Aggregate FBI

Under the baseline, aggregate Farm Business Income (FBI) from the full-time model farms is £345.9 million (Table 20). Dairy farms account for the largest proportion (59%), followed by Specialist Sheep (12%) and DA Mixed Grazing (9%). The sectors representing the smallest shares are General Cropping (0.4%), Cereals (1%) and Other (1%). This reflects the lower numbers and area of these farms.

Under the Counterfactual, aggregate FBI reduces 13.6% from the baseline. This is mainly due to a reduction in Dairy Grazing Livestock Units (GLUs) in relation to the CoAP regulations, the costs of Nitrogen export these farms face as a result of Nitrogen application limits, and the application limits themselves. Farms which stock beef and sheep are not affected by these limits but do incur some of the additional costs of the regulations such as closed periods for spreading and record keeping.

In comparison to the Counterfactual, the introduction of the Universal layer increases aggregate simulated FBI a further 2.5% under PWFa. This is reflective of the larger total simulated WG spend on SFS Universal under PWFa (£25 million additional) than on BPS under the Counterfactual. Specialist Sheep SDA (26.8%) and Specialist Beef SDA (20.2%) see the largest percentage increases in aggregate FBI in comparison to the Counterfactual. Lowland Cattle and Sheep (17.2%) and Other (15.1%) see the largest percentage decreases.

In comparison to the Counterfactual, the introduction of the Universal layer decreases aggregate FBI by 12.1% under PWFb (Table 21). This is reflective of the lower spend under PWFb (£19 million lower) in comparison to the Counterfactual.

Between the two payment scenarios, the lower SVP under PWFb reduces simulated aggregate FBI by 14% (£43.5m) in comparison to PWFa. Dairy FBI is least impacted by the lower SVP in PWFb (4.4% reduction in PWFb compared to PWFa). Lowland Cattle & Sheep, Specialist Sheep (SDA) and Specialist Beef (SDA) see the greatest reduction in simulated aggregate FBI when the SVP is lower (32.3%, 28.2% and 27.8% respectively).

Table 20. Simulated aggregate FBI by Farm type

Total simulated FBI from full time farms (£m)	Baseline	Counterfactual	PWFa	PWFb
Cereals	3.9	3.5	3.9	3.0
General Cropping	1.5	1.3	1.3	1.0
Dairy	205.5	171.3	166.7	159.4
Lowland cattle & sheep	10.7	10.5	8.7	5.9
Mixed	8.4	7.4	7.3	5.8
Other	4.6	4.1	3.4	2.6
Specialist Sheep (SDA)	44.5	43.0	54.5	39.1
Specialist Beef (SDA)	5.6	4.6	5.5	4.0
SDA mixed	29.1	25.1	28.6	21.2
DA mixed grazing	32.3	28.1	26.5	20.9
Total	**345.9**	**298.9**	**306.4**	**262.9**

Table 21. Percentage Change in aggregate FBI by farm type

% change in total simulated FBI from full time farms	%Change Baseline to Counterfactual	%Change Counterfactual to PWFa	%Change Counterfactual to PWFb	%Change PWFa to PWFb
Cereals	-10.5	11.7	-15.0	-23.9
General Cropping	-11.0	-1.4	-24.7	-23.6
Dairy	-16.7	-2.7	-6.9	-4.4
Lowland cattle & sheep	-1.3	-17.2	-44.2	-32.6
Mixed	-11.8	-1.8	-22.1	-20.7

Other	-11.3	-15.1	-34.9	-23.4
Specialist Sheep (SDA)	-3.4	26.8	-9.0	-28.2
Specialist Beef (SDA)	-18.0	20.2	-13.2	-27.8
SDA mixed	-13.5	13.6	-15.7	-25.8
DA mixed grazing	-12.9	-5.7	-25.6	-21.1

Carbon Stocks and Greenhouse Gas Emissions

Carbon stock

For carbon stocks (LULUCF soil and biomass carbon stock, hedge carbon stock), changes occur non-linearly over time in response to a change in the system. Modelled change occurs in the scenarios in response to modelled land use or management change, or hedge maintenance.

The change represents a transfer of carbon from being stored in the soil and biomass "pool", to the atmospheric "pool" (or vice versa).

Because of the non-linear rates of change, numbers are reported only as a total change to 2030, rather than as an annual average. Negative values indicate sequestration (i.e. a reduction in the atmospheric carbon pool).

Under the Counterfactual scenario, due to the marginal lmodelled land use change the modelled loss of carbon stocks from the baseline is smaller than the level of uncertainty in the modelling chain and should be considered zero (Table 22).

Given the stock changes under the Counterfactual should be considered zero, reporting percentage change for the PWFs as a proportion of the change under the Counterfactual gives values which do not appropriately reflect the level of change which has occurred. Change for the PWFs is therefore reported against the baseline. Under the PWF scenarios, there is a projected increase in carbon stock of 0.02% to 2030 in comparison to baseline stocks. This is primarily due to the additional carbon sequestration arising from the increase in hedgerow height/width and the addition of trees into hedgerows under UA8 Hedgerow Management. Therefore modelled changes in carbon stocks are strongly dependant on assumptions around baseline hedge dimensions, and how these might change under the scheme, as well as the data used to estimate associated carbon stock change. The impacts of this on overall confidence in the outputs are limited, since these carbon stock changes are very small compared to modelled changes in agricultural GHG.

Again, there are negligible areas of land use change projected which result in modelled loss of carbon stocks smaller than the level of uncertainty in the model which should be considered zero. These small modelled losses have currently been accounted for in the reported net carbon stock change values and are offset by the gains from hedgerows.

Differences between the two PWF scenarios are negligible due to the high levels of uptake across both, but there is marginally higher sequestration under PWFa.

Table 22. Modelled carbon stock changes 2023 to 2030

Note. negative values indicate sequestration	**Counterfactual**	**PWFa**	**PWFb**
Carbon stock change from baseline (ktCO2e)	0.78	-92.34	-91.53
Carbon stock change difference from counterfactual (ktCO2e)	-	-93.11	-92.31
Carbon stock change from baseline (%)	0.00	-0.02	-0.02

Greenhouse Gas Emissions: Annual

Annual emissions for agricultural and wetland GHG are modelled and the cumulative change over time is calculated. These systems create emissions annually, and the modelling assumes a direct relationship between the management of them and the emissions released.

Modelled changes in emissions occur in response to modelled changes in land use and agricultural management (including livestock and fertiliser use). Negative values indicate avoided emissions.

Changes are assumed to occur immediately and remain consistent over time. This assumption may over-estimate benefits for wetland GHG, however these make up a negligible proportion of the GHG benefits.

Table 23 shows the annual wetland (peat) and agricultural GHG emissions under each scenario, the change for each against the baseline, and the change for the PWF scenarios against the Counterfactual.

Under the Counterfactual, there are minimal modelled changes to wetland GHG due to negligible land use change on peatland areas. There is a simulated annual reduction in agricultural GHG flux of 5.5% in comparison to the baseline. This decrease reflects the modelled 2.8% reduction in GLUs (primarily Dairy) and associated excreta, and reduction in N fertiliser inputs (14.5%), leading to overall reduction in N inputs of 5.8%. There is also a minor influence from the marginal projected changes in land use (0.19% reduction in crops, 0.11% increase in rotational grass) and a small reduction in the indirect N_2O emissions due to modelled CoAP impacts on nitrate leaching (see water quality section). Of the change in agricultural GHG flux, the simulated reduction in methane is greater than N_2O when expressed as CO_2-e, but proportionally more reduction is seen in N_2O (a reduction of 4% in methane compared to 13% in N_2O). These benefits are therefore dependant on the modelled changes in livestock and fertiliser as well as our modelling assumptions about changes in management in response to CoAP.

Compared to the Counterfactual, there are also minimal modelled changes in wetland GHG, again reflective of minimal land use change on peatland areas. There is an additional 4.3% annual reduction in modelled agricultural GHG flux from the Counterfactual under PWFa and 4.2% under PWFb. Of this, the PWF scenarios see an additional 3.3% (PWFa) and 3.2% (PWFb) reduction in modelled N_2O in comparison to the Counterfactual. For methane, the PWF scenarios see an additional modelled reduction of 4.5% (PWFa) and 4.4% (PWFb) compared to the Counterfactual. For methane, these changes are primarily driven by the additional livestock reduction (additional 4.7 to 4.8 % of Counterfactual GLUs) seen under the PWF scenarios, whilst for N_2O the N fertiliser reduction (additional 2.7 to 2.8 % of Counterfactual fertiliser) is also important. These modelled benefits are therefore strongly dependant on the modelled changes in livestock and fertiliser inputs, and the modelling assumptions underpinning this response to the scheme. Because the CoAP delivers a large proportion of these modelled benefits, they are also dependant on the modelling assumptions and projected response to the CoAP.

Differences in emissions reduction between PWFa and PWFb should be considered minimal.

Table 23. Modelled annual agricultural emissions

				Breakdown of Agricultural GHG	
Annual agricultural (fertiliser and livestock) and wetland GHG changes	**Scenario**	**Wetlands (4D) flux (KtCO2eq /yr)**	**Agricultural GHG flux total (KtCO2eq /yr)**	**Agricultural GHG flux as N2O (KtCO2eq /yr)**	**Agricultural GHG flux as methane (KtCO2eq /yr)**
Annual emissions	Baseline	509	4,063	658	3,405

	Counterfactual	509	3,838	571	3,268
	PWFa	509	3,674	552	3,122
	PWFb	509	3,677	553	3,124
% Difference from Baseline	Counterfactual	-0.02	-5.53	-13.28	-4.03
	PWFa	-0.02	-9.57	-16.10	-8.31
	PWFb	-0.02	-9.49	-16.04	-8.23
Difference from Counterfactual	PWFa	0.00	-164	-19	-146
	PWFb	0.00	-161	-18	-143
% Difference from Counterfactual	PWFa	0.00	-4.29	-3.25	-4.47
	PWFb	0.00	-4.20	-3.18	-4.38

Stocks and GHG Emissions: cumulative change to 2030

Cumulative modelled change in stocks and GHG for the Counterfactual and PWF scenarios are reported against the baseline.

Agricultural GHG reductions, as opposed to increases in carbon stocks, deliver most of the modelled carbon benefits to 2030 across the Counterfactual and both PWF scenarios (Table 24). These reductions are driven by modelled changes in livestock and N inputs.

For carbon stocks in soils and biomass, there is no change to 2030 under the Counterfactual due to minimal land use change. Under both PWF scenarios there are modelled increases of 0.02% in carbon stocks due to UA8 Hedgerow Management. Which are strongly dependant on assumptions and data used to make these projections.

To 2030, the Counterfactual scenario sees a modelled cumulative reduction of 5.53% from the baseline in agricultural GHGs, due to modelled reductions in livestock (9% reduction in dairy GLUs) and N fertiliser (14.5% net reduction). These benefits are therefore dependant on the modelled changes in livestock and fertiliser.

The PWF scenarios see modelled reductions of 9.6% (PWFa) and 9.5% (PWFb) from the baseline, this is an additional reduction of 4.2% (PWFb) and 4.3% (PWFa) of Counterfactual agricultural GHG to 2030. This is driven by the modelled additional livestock reduction (additional 4.7 to 4.8 % of Counterfactual GLUs) and N fertiliser reduction (additional 2.7 to 2.8 % of Counterfactual fertiliser) seen under the PWF scenarios. These modelled benefits are therefore strongly dependant on the modelled changes in livestock and fertiliser inputs, and the modelling assumptions underpinning this response to the scheme. Because the CoAP delivers a large proportion of these modelled benefits, they are also dependant on the modelling assumptions and projected response to the CoAP.

Table 24. Modelled cumulative change in carbon stocks and GHG 2023 to 2030

Note: negative numbers indicate sequestration or avoided emissions	**Scenario**	**Wetlands (4D) flux (KtCO2eq/yr)**	**Agricultural GHG flux total (KtCO2eq/yr)**	**Losses from carbon stocks in land use change and forestry + harvested wood products (KtCO2eq)**
Cumulative change in emissions from baseline to 2030	Counterfactual	-0.81	-1,796.1	0.78
	PWFa	-0.81	-3,112.0	-92.34
	PWFb	-0.81	-3,086.0	-91.53
Cumulative change from baseline to 2030 as: % of baseline stock (Losses from carbon stocks) or of baseline GHG emissions (agricultural and wetland GHG)	Counterfactual	-0.02	-5.53	0
	PWFa	-0.02	-9.57	-0.02
	PWFb	-0.02	-9.49	-0.02

Water Quality

Pollutant loads for N, P and sediment are influenced by changes in livestock, fertiliser and land use. Data on non-agricultural sources of pollutants, plus pollutants from farms or land not considered in the IMP farm modelling, are included in calculations of water quality concentrations but may have lower confidence and are modelled as not responding to the scenario.

Data reflect modelling of a new long-term average as a result of modelled land use and management under each scenario and do not account for any time lags in a new equilibrium being reached. This use of the new long-term average may be less appropriate over shorter time periods (i.e. to 2030). These long-term averages smooth out peaks which may occur due to significant weather events causing increased erosion and pollutant losses.

In comparison to the baseline, the Counterfactual shows modelled reductions of 7% in both nitrate and phosphorous load (Table 25). These changes reflect modelled reductions in livestock units (2.8% reduction in GLUs, primarily Dairy), fertiliser inputs (14.5 % reduction in N fertiliser and 1.94% reduction in P fertiliser) and the modelled impacts of CoAP (reducing nitrate and phosphorus losses associated with manure and fertiliser applications, through improved timing and application). These benefits are therefore dependant on the modelled changes in livestock and fertiliser as well as our modelling assumptions about changes in management in response to CoAP. Reduction in sediment load is marginal and, given the small change value, should be considered zero. This reflects minimal land use change.

In comparison to the Counterfactual, the PWF scenarios see a further modelled reduction in Nitrate load of 3.0%. Modelled Phosphorous load reduces an additional 1.7% in both PWF scenarios in comparison to the Counterfactual. These changes are driven by the additional modelled reductions in: livestock (additional 4.7 to 4.8 % of Counterfactual GLUs); N fertiliser (additional 2.7 to 2.8 % of Counterfactual); P fertiliser (additional 2.05 to 2.09 % of Counterfactual). These modelled benefits are therefore strongly dependant on the modelled changes in livestock and fertiliser inputs, and the modelling assumptions underpinning this modelled response to the scheme. Because the CoAP delivers a large proportion of these modelled benefits, they are also dependant on the modelling assumptions and projected response to the CoAP. Similarly to the Counterfactual, there is no change in sediment load, reflecting a general absence of land use change at the aggregate scale. Differences between the PWF scenarios should be considered negligible.

Table 25. Modelled changes in N, P, and Sediment load

Annual average pollutant load	**Scenario**	**Nitrate load kt NO3 N /yr**	**Phosphorus load kt P /yr**	**Sediment load kt Z /yr**
Simulated load	**Baseline**	23.03	0.41	147.55

	Counterfactual	21.40	0.38	147.29
	PWFa	20.76	0.37	147.30
	PWFb	20.77	0.37	147.30
% Difference from Baseline	**Counterfactual**	-7.08	-7.15	-0.18
	PWFa	-9.87	-8.73	-0.17
	PWFb	-9.82	-8.70	-0.17
Difference from Counterfactual	**PWFa**	-0.64	-0.01	0.01
	PWFb	-0.63	-0.01	0.01
% Difference from Counterfactual	**PWFa**	-3.00	-1.70	0.01
	PWFb	-2.94	-1.67	0.01

Drinking Water Nitrate Status and WFD Phosphorus Status

Modelled water quality pollutants (N, P, sediment) are aggregated to Water Framework Directive (WFD) sub-catchment scale to calculate total loading at that level. These are accumulated downstream, accounting for downstream links between the sub-catchments and available data on non-agricultural pollutants, and then converted to concentration. Modelled concentration is then used to assign N drinking water status and WFD P status for each catchment. Modelled change in status can occur with marginal water quality improvements if the baseline concentration was close to the status threshold.

Of 879 catchments, 5 are modelled as failing for drinking water Nitrate status[13] in the baseline (Table 26).

Under the Counterfactual, no change is simulated in the number of catchments failing.

[13] Nitrate status is based upon EU Nitrate Directive target of 50 mg l^{-1} Nitrate, or 11.3 mg l^{-1} NO_3-N

Under both PWF scenarios, one catchment is projected to improve.

Table 26. Modelled WFD catchment level drinking water Nitrate status

Group	Scenario	Pass	Fail
Simulated status	Baseline	872	5
	Counterfactual	872	5
	PWFa	873	4
	PWFb	873	4

WFD Phosphorus status is assigned using catchment specific thresholds which vary with elevation, alkalinity as well as being lower in areas designated as SAC. We assess P status based on the concentration at the outflow of each WFD sub-catchment, and therefore we use the most downstream threshold available for each catchment. Modelled baseline status and changes in status reflect the spatial pattern of these thresholds as well as modelled changes in pollutant loading.

Under the Counterfactual scenario, there is a modelled 10% reduction in the number of catchments with moderate WFD P status in the baseline, and an increase in catchments with good (2%) and high (3%) status (Table 27). No catchments are simulated to decline in status. Improvements are related to the modelled reductions in dairy livestock units and P fertiliser inputs seen under this scenario and are therefore dependant on these modelled changes, as well as our modelling assumptions about changes in management in response to CoAP.

In comparison to the Counterfactual, both PWF scenarios see a lower increase in the number of catchments modelled as increasing to Good status (1% less than under the Counterfactual) but a higher increase in the number moving to High status (additional 1%). No catchments are simulated to decline. Improvements reflect the modelled additional reductions in P load due to additional reductions in livestock (additional 4.7 to 4.8 % of Counterfactual GLUs) and P fertiliser (additional 2.05 to 2.09 % of counterfactual). These modelled benefits are therefore strongly dependant on the modelled changes in livestock and fertiliser inputs, and the modelling assumptions underpinning this response to the scheme. Because the CoAP delivers a large proportion of these modelled benefits, they are also dependant on the modelling assumptions and projected response to the CoAP.

Table 27. Modelled catchment WFD Phosphorus status

	Scenario	High	Good	Moderate	Poor	Bad
Simulated status	Baseline	279	264	131	7	0
	Counterfactual	287	269	118	7	0
	PWFa	290	266	118	7	0
	PWFb	290	266	118	7	0
Difference from Counterfactual	PWFa	3	-3	0	0	0
	PWFb	3	-3	0	0	0
% Difference from Counterfactual	PWFa	1	-1	0	0	NA
	PWFb	1	-1	0	0	NA
% Difference from Baseline	Counterfactual	3	2	-10	0	NA
	PWFa	4	1	-10	0	NA
	PWFb	4	1	-10	0	NA

Air Quality: Ammonia

Modelled changes in ammonia emissions are driven by modelled changes in land management, including stocking and Nitrogen inputs.

Under the Counterfactual scenario there is a 6.8% reduction in modelled ammonia emissions (Table 28), driven by the modelled livestock reduction (2.8% reduction in GLUs, primarily Dairy), and 14.5 % reduction in modelled N fertiliser inputs.

Compared to the Counterfactual, the PWF scenarios see an additional 3.7% (PWFa) and 3.6% (PWFa) reduction in ammonia emissions. These further reductions reflect the additional reductions in livestock (additional 4.7 to 4.8% of Counterfactual GLUs) and N fertiliser (additional 2.7 to 2.8 % of Counterfactual) under the PWF scenarios.

Differences between the two payment scenarios are marginal, due to high simulated uptake across both.

Table 28. Modelled changes in ammonia emissions

Group	**Scenario**	**Ammonia emissions (kt NH3 N /yr)**
Simulated emissions	Baseline	15.53
	Counterfactual	14.47
	PWFa	13.94
	PWFb	13.96
Difference from Baseline	Counterfactual	-1.06
	PWFa	-1.59
	PWFb	-1.58
% Difference from Baseline	Counterfactual	-6.82
	PWFa	-10.23
	PWFb	-10.14
Difference from Counterfactual	PWFa	-0.53
	PWFb	-0.51
% Difference from Counterfactual	PWFa	-3.66
	PWFb	-3.56

Air Quality: $PM_{2.5}$ and Health Impacts

Modelled changes in $PM_{2.5}$ concentration are linked to the modelled changes in ammonia emissions as well as modelled pollutant removal by additional vegetation which can intercept emissions, particularly trees and woodland.

Removal rates vary with modelled initial pollution concentrations and the spatial location of vegetation in relation to concentration.

Across both the Counterfactual and PWF scenarios, modelled decreases in $PM_{2.5}$ concentrations follow the pattern of modelled ammonia emissions decrease (Table 29).

Under the PWF scenarios, there is an additional modelled benefit from the expansion in hedgerow height and width under UA8 Hedgerow Management, and the increase in hedgerows trees but the primary impact is as a result of the modelled reduction in livestock units and inputs.

Health impacts are modelled as a function of change in exposure of the population to $PM_{2.5}$ and therefore vary spatially. Areas with higher population density have more people to benefit from any reduction in exposure to $PM_{2.5}$.

Mortality from exposure to $PM_{2.5}$ is calculated in terms of Life Years Lost. This estimate refers to the aggregate years lost to premature death across the population.

Benefits from improvements in air quality are projected in terms of the reduction in Life Years Lost across the population. For the PWF scenarios, the modelled change in PM2.5 and LYL benefits are representative of the timepoint when the trees and hedges are fully grown, before which the component of the benefits relating to removal by vegetation would not be delivered.

Under the Counterfactual, there is a minor modelled reduction of 5.3 years Life Years Lost in relation to $PM_{2.5}$ exposure across the full population of Wales.

In comparison to the Counterfactual, the PWF scenarios show an additional modelled reduction of approximately one third. Differences between the two payment scenarios are negligible.

Table 29. Modelled changes in $PM_{2.5}$ concentration and Life Years Lost

Group	**Scenario**	**Average pop weighted change in $PM_{2.5}$ concentration**	**Life Years Lost (LYL)**

	Counterfactual	-0.003	-5.3
	PWFa	-0.0051	-9.08
	PWFb	-0.0050	-9.02
Difference from Counterfactual	PWFa	-0.0021	-3.78
	PWFb	-0.0020	-3.72
% Difference from Counterfactual	PWFa	-41%	-42%
	PWFb	-40%	-41%

Plant Biodiversity

The plant biodiversity modelling assumes that soil changes resulting from changes in land use, or the implementation of specific interventions, drive correlated changes in habitat suitability for plant species.

The simulated land use change for the Counterfactual scenario involved very minor changes in cropland towards improved rotational grass (<1% of modelled land changing use). Therefore, the impact on plant biodiversity has not been modelled for the Counterfactual.

Whilst not modelled, it is relevant to note that the simulated reduction in livestock units under the Counterfactual occurred almost entirely in Dairy GLUs on improved grassland, where increases in plant biodiversity are unlikely.

Under the PWF scenarios, plant biodiversity impacts are simulated for UA5 Habitat Maintenance and UA8 Hedgerow Management only. The effects of other UAs are not modelled, specifically:

- UA6 Temporary Habitat Creation: the actions modelled (rough grass margins on arable and mixed leys on improved grassland) are specified as temporary and are not fixed to a specific location and are therefore unlikely to persist at a site for long enough to have a lasting impact on plant biodiversity specifically.
- UA9 Woodland maintenance: woodland maintenance may result in variable environmental impacts depending on the baseline condition, age and type of woodland. Uncertainty over these baseline factors and lack of information on what maintenance would be applied or if this

would represent a change means that impacts are not modelled, including plant biodiversity.

Under UA5 Habitat Maintenance, 1 ewe per hectare (or direct beef equivalent) is removed where the land parcel is simulated to be above the guidance stocking level. The reduction is 1 ewe/beef equivalent regardless of how many livestock units the parcel is stocked above the recommended level. Stocking densities are associated with vegetation height which in turn is linked to condition.

There are no differences in simulated uptake between the PWF scenarios across the surveyed habitat plots used in the modelling. Results for modelled impact are therefore the same under both scenarios.

In the baseline, the majority of habitat plots have unfavourable vegetation height and therefore are in sub-optimal condition (Table 30). The introduction of UA5 Habitat Maintenance, and the associated modelled reduction in livestock on habitat land, simulates an increase in vegetation height across all broad habitats and therefore a decrease in the number of locations in sub-optimal condition. However, the impact is small with 11% of plots simulated to shift into having favourable potential vegetation height as a result of the stock reduction.

By broad habitat type, the greatest modelled impact is seen in Bog. This is because the reduction of 1 ewe per hectare is expected to result in zero stocking density in many cases reflecting very low grazing pressure to start with. This is inferred from the observed vegetation height where in vegetation that was observed to be in Blanket Bog or Bog in the baseline survey, vegetation height was close to optimal and required very little change in stocking density to move into optimal height.

Table 30. UA5 Habitat Maintenance: simulated impact on vegetation height

Broad habitat	**Scenario**	**Percent of modelled plots below optimal vegetation height**
Acid grassland	Baseline	83
	PWF	77
Dwarf Shrub Heath	Baseline	100
	PWF	99
Fen, Marsh & Swamp	Baseline	100
	PWF	96
Bog (including Blanket Bog)	Baseline	99
	PWF	61
Total	Baseline	92
	PWF	81

The decrease in the number of locations in sub-optimal condition, whilst minor, does drive some changes in the modelled habitat suitability across upland habitats, lowland wetland and lowland heath for some positive indicator Common Standards Monitoring (CSM) plant species.

Across all species, in both PWF scenarios, 41% of modelled plant species see no significant change in simulated frequency of occurrence across the habitat plots (Table 31). 35% are simulated to increase in frequency whilst 23% are simulated to decrease. Increases are seen as a result of increased habitat suitability for common dwarf shrubs and other heath and bog species, whilst decreases are seen in species of grazed acid grassland.

Table 31. UA5 Habitat Maintenance: Modelled change in plant species

Response of plant species to UA5 Habitat Maintenance	PWFa and PWFb count of species	PWFa and PWFb percentage %
Increasing frequency	44	35
Decreasing frequency	29	23
Not significant	51	41
Total	124	100

Under UA8 Hedgerow Management, modelled increases in hedge width and height are applied over field boundary plots next to existing hedgerows. Changes in habitat suitability for Ancient Woodland Indicator (AWI) plant species for Wales, nectar plants and positive indicator CSM species for lowland grassland are modelled.

47% of modelled species show no significant change simulated in response to PWFa and PWFb. Increases in frequency are simulated for 21% of species, as a result of increases in habitat suitability for common woodland and edge species (Table 32). Decreases are simulated for 31% of modelled species, related to decreased suitability for improved and semi-improved grassland species. These changes assume there is no grazing pressure preventing the widening of the hedge base.

Table 32. UA8 Hedgerow Management: Modelled change in plant species

Response of plant species	PWFa and PWFb count	PWFa and PWFb percentage %
Increasing frequency	21	21
Decreasing frequency	31	31
Not significant	47	47
Total	99	100

Bird Biodiversity

Population change as a percentage of the baseline population is simulated for 80 species associated with different habitats across Wales under the Counterfactual and PWF scenarios.

Modelled changes in population (species specific counts) are driven by modelled land use and management changes that influence the availability and suitability required for successful breeding conditions.

Under the Counterfactual, bird biodiversity impacts are simulated as a result of changes in livestock, minor shifts in land use, and changes in farming intensity as a result of the scenario.

Under the PWF scenarios, bird biodiversity impacts are additionally modelled for specific action under UA5 Habitat Maintenance, UA6 Temporary Habitat Creation and UA8 Hedgerow Management only. The effects of other UAs are not modelled, specifically:

- UA9 Woodland maintenance: woodland maintenance may result in variable environmental impacts depending on the baseline condition, age and type of woodland. Uncertainty over these baseline factors means that impacts for woodland maintenance are not modelled, including bird biodiversity.

Across the PWF scenarios, 94% of modelled bird species exhibit no change in response to the scenario, meaning that any current trajectories of increase, stability or decline are projected to remain the same (Table 33).

Under the Counterfactual, population size is simulated to increase for one bird species and an additional three are simulated to increase for the PWF scenarios. One species is simulated to decrease in population size under the PWFs. The changes are marginal and should be considered lower than the level of uncertainty in the model. The dominant outcome is one of no modelled response from the 80 bird species in response to any of the scenarios.

Whilst not reflected in the modelled response, it could be expected that the increase in hedgerow condition (height and width) under UA8 Hedgerow Management would have a small to moderate positive impact on hedgerow-nesting species such as Lesser Whitethroat, Bullfinch and House Sparrow. The lack of response from these species in the modelling may be related to a combination of methodological factors linked to the likelihood of such species being identified in hedgerows of similar condition in the baseline survey data, but also the location and suitability of the wider landscape around these hedgerows. Increased hedgerow condition is likely to offer wider benefits where hedgerows are situated in a landscape already more favourable for the species of question.

Table 33. Modelled changes in bird population size

Number of species	**Counterfactual Count**	**PWFa and PWFb Count**	**Counterfactual Percentage**	**PWFa and PWFb Percentage**
Very likely to increase	1	2	1	2.5
Likely to increase	0	2	0	2.5
No change	79	75	99	94
Likely to decrease	0	1	0	1
Total	80	80	100	100

very likely to increase = Population increases in > 97.5% of simulations

likely to increase = Population increases in > 89.5% of simulations

no change= None of the above are true, so no change is assumed to be projected as a result of the scenario, or confidence in a change is low.

Monetary Valuation of Change in Ecosystem Services 2023 to 2030

Modelled changes in air quality, water quality, carbon stocks and GHG emissions are valued in monetary terms to 2030. The monetary values are therefore underpinned by the dependencies and assumptions from the physical modelling. Appraisal approaches and assumptions are HMT Green Book Compliant. Table 34 shows the physical measure for each benefit valued.

With the exception of temporary habitat creation measures, all changes for the Counterfactual and PWF scenarios are assumed to remain in place for the modelled period, for the purposes of projecting the long-term impacts. All modelled physical benefits and economic valuations are based on this assumption.

Modelled physical values for water quality are for a new long term annual average. The shorter the time period over which benefits are being valued, the less reasonable to assume that improvements in in-stream water quality have occurred, due to lags in the system (nutrient retention in soils and influence of groundwater in some catchments). This should be noted when considering benefits.

Table 34. Physical measure for each benefit valued

Benefits	Units	Type of value
Air Quality	Life Years Lost (LYL) each year	Reduction in costs of health impacts from air pollution (Jones et al[14])
Water Quality	Expected changes in WFD status due to changes in P and N	Benefit to people from knowing of/ enjoying higher quality freshwater environments (NWEBS values from Metcalfe, 2012 and updates[15])

[14] Jones, L., Vieno, M., Morton, D., Cryle, P., Holland, M., Carnell, E., Nemitz, E., Hall, J., Beck, R., Reis, S., Pritchard, N., Hayes, F., Mills, G., Koshy, A., Dickie, I. (2017). Developing Estimates for the Valuation of Air Pollution Removal in Ecosystem Accounts. Final report for Office of National Statistics, July 2017.

[15] Metcalfe, P. (2012) Updating the National Water Environment Benefit Survey Value. Report for Defra.

Metcalfe, P. (2012). Update of CRP WFD Benefit Value - Economic Component, report for the Environment Agency.

GHGs	Net change in atmospheric TCO2eq over 8 years	Benefit of reducing atmospheric GHG concentrations from non-traded sources (DESNZ, 2023[16])

Figures represent an estimate of the value of the change in wellbeing to people in Wales over 8 years (2023-2030) under each modelled scenario.

The Counterfactual scenario is simulated to generate a total of £483 million pounds in additional benefits to 2030 (Table 35). PWFa generates an additional £376 million of modelled benefits to 2030 (a total of £858 million) and PWFb generates an additional £369million (total of £851 million) modelled over the same period.

Of the modelled benefits delivered under the Counterfactual, the greatest value is derived from a reduction in GHG emissions (£477 million). Across both PWF scenarios, the largest modelled benefit is also derived from reductions in GHG emissions (£851 million under PWFa and £844million under PWFb). Across all scenarios, modelled avoided GHG emissions from agriculture as a result of changes in livestock and inputs dominate this impact, with negligible contribution from land use change and limited contribution from hedge maintenance in the PWF scenarios (Table 36).

Water quality benefits contribute the second largest modelled value across all scenarios. Under the Counterfactual, modelled benefits from improved water quality are valued at £4.8 million to 2030. Modelled benefits under the PWF scenarios are marginally higher (£5.21 million under both), due to larger modelled reductions in stocking and inputs in comparison to the Counterfactual.

Air quality benefits contribute the least to the total estimated valuation of additional benefits to 2030 across all scenarios. Under the Counterfactual, the modelled benefit to 2030 is valued at £0.8 million, due to avoided ammonia emissions from the reduction in dairy livestock units and inputs. Under the PWF scenarios, modelled air quality benefits are valued at £2 million across both scenarios. This additional benefit is driven by the increases in hedgerow area and the numbers of hedgerow trees, alongside additional stock reductions.

It should be noted that the relative values of the air quality and water quality effects change over time up to 2123 for the PVF. This is due to the lag effect applied in the valuation of the physical air quality benefit modelled, to reflect that the physical values are representative of the timepoint when the trees and hedges are fully

[16] DESNZ. (2023). Valuation of energy use and greenhouse gas. Supplementary guidance to the HM Treasury Green Book on Appraisal and Evaluation in Central Government. Data tables 1 to 19: supporting the toolkit and the guidance. https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal#history

grown. This is 5 years for benefit delivered by hedgerows and 40 years for benefit delivered by trees, during which time the benefit increases to its full potential, and after which it remains stable.

Table 35. Summary of ecosystem service values under the Counterfactual and PWF scenarios to 2030.

Benefits 2023 to 2030	**Counterfactual**		**PWFa**		**PWFb**	
	Physical measure	**Present value, 8 yrs, £m**	**Physical measure**	**Present value, 8 yrs, £m**	**Physical measure**	**Present value, 8 yrs, £m**
Air Quality	5.3 LYL	0.84	9.08 LYL	1.94	9.02 LYL	1.93
Water Quality	21 Improve, 0 Deteriorate	4.8	25 Improve, 0 Deteriorate	5.21	25 Improve, 0 Deteriorate	5.21
GHGs	Decrease of 1.796m tCO_2e	477	of 3.205m tCO_2e	851	Decrease of 3.178m tCO_2e	844
Grand total benefits (£m)	-	482.6	-	858.1	-	851.1

Table 36. Breakdown of Greenhouse Gas (GHG) ecosystem service values for the Counterfactual and PWF scenarios to 2030

GHG Benefits 2023 to 2030	Counterfactual Present value, £m	PWFa Present value, £m	PWFb Present value, £m
Agriculture	477	827	820
Land use	-0.22	25	24
Wetlands	0.21	0.22	0.22
Total GHG	477	851	844