

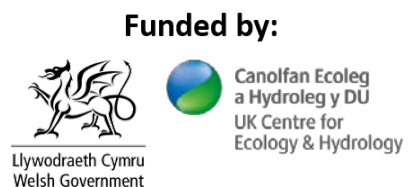
# Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP)

## ERAMMP Report-58: ERAMMP Square Selection Protocol 2021/2022

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### Abbreviations Used in this Report

AWI	Ancient Woodland Indicators
BH	Broad Habitat
BTO	British Trust for Ornithology
CSM	Common Standards Monitoring
ERAMMP	Environment and Rural Affairs Monitoring & Modelling Programme
GMEP	Glastir Monitoring and Evaluation Programme
GWM	Glastir Woodland Management
NFS	National Field Survey
UKCEH	UK Centre for Ecology & Hydrology

Abbreviations and some of the technical terms used in this report are expanded on in the programme glossaries: <https://erammp.wales/en/glossary> (English) and <https://erammp.cymru/geirfa> (Welsh)

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# 1 BACKGROUND & AIM

The ERAMMP 2021/2022 National Field Survey (NFS) sets out to evaluate the Glastir Scheme in terms of contributions to combating climate change, improving water quality, and managing water resources, improving soil quality and management, maintaining and enhancing biodiversity, managing landscapes and historic environments and improving public access to the countryside.

To achieve this, ERAMMP will make use of baseline data created under the Glastir Monitoring and Evaluation Programme (GMEP [www.gmep.wales](http://www.gmep.wales)).

GMEP surveyed vegetation, soils, habitats, freshwaters, birds, pollinators and more across 300 1km squares in Wales. These comprised 150 “wider Wales” squares, representing a stratified-random sample of the Welsh countryside, and 150 “targeted” squares, which were selected to capture land under Glastir management.

The ERAMMP 2021/2022 field survey will aim to resurvey 130<sup>1</sup> of the 300 GMEP squares to evaluate Glastir. This square selection protocol is designed to capture as much Glastir and counterfactual land as possible within those 130 squares.

Analysis revealed considerable coverage of Glastir in both wider Wales and targeted strands of the GMEP survey. As such, this selection protocol operates across the full 300 GMEP squares.

The protocol efficiently captures land to evaluate multiple bundles of Glastir interventions based on multiple environmental outcomes (Figure 1-1). However, maximising power for Glastir evaluation involves a bias towards squares on land that:

1. Is eligible for Glastir bundles of interest, and
2. Tends to successfully receive survey permissions.

This carries a trade-off such that the sample for the ERAMMP 2021/2022 NFS will not provide as robust analysis of national trends, as was done under GMEP. However, future surveys could revisit wider Wales squares which are not selected here. This would re-enable robust reporting of environmental trends across wider-Wales as a whole.

The aim is to maximise power to compare trends on land with bundles of Glastir interventions vs. land without them. For each bundle, up to three treatments will be considered:

- **Intervention.** i.e. in-scheme, in-intervention.
- **Scheme.** i.e. in-scheme, out-of-intervention.
- **Counterfactual.** i.e. out-of-scheme, out-of-intervention.

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<sup>1</sup> Actual number surveyed will depend on practical external factors such as pandemic-restrictions, land-owner permissions and the weather.

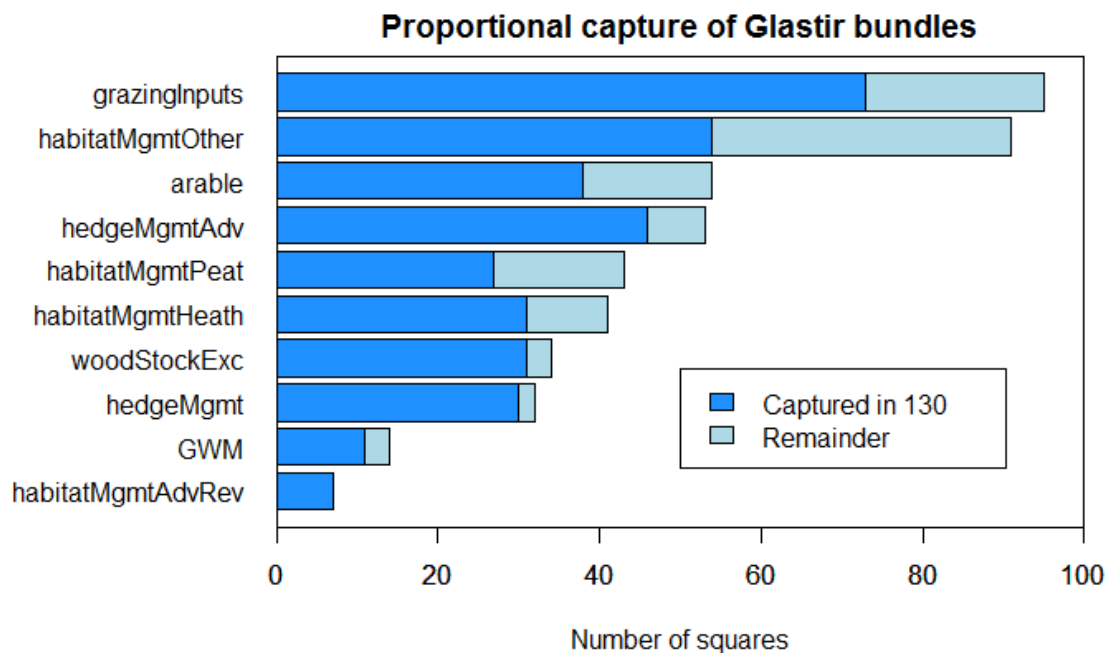


Figure 1-1. Proportional capture of squares containing ten different Glastir bundles. The number of GMEP squares containing each bundle is shown in light blue, while the number captured within 130 selected squares for the ERAMMP NFS in 2021/2022 is shown in darker blue. GWM = Glastir woodland management.

## 2 APPROACH

Selection followed the following overall steps, and further details of phases 1-3 are provided below.

1. Iterate with Welsh Government to prioritise 6-10 intervention bundles for evaluation (Table 2-1).
2. For each bundle, collate relevant environmental measurements taken on *intervention*, *scheme* and *counterfactual* land within each GMEP square.
3. **Phase 1.1 & 1.2 (130 squares):** Select 130 squares to evaluate 10 Glastir bundles.
4. **Phase 2.1 & 2.2 (80 squares):** Select a subset of 80 squares for bird & pollinator surveys.
5. **Phase 3.1 & 3.2 (80 squares):** Select a subset of 80 squares to prioritise for vegetation surveys.

*Table 2-1. Bundles of Glastir interventions for different habitats with Glastir option codes, likely outcomes and the number of GMEP squares with relevant data. Some bundles are common in GMEP (blue) while others are not (red). Numbers 1-10 were prioritised during Phase 1 (green/yellow). Note: CSM stands for Common Standard Monitoring positive indicator plant species. AWI stands for Ancient Woodland Indicator plant species.*

Priority?	Bundle	Habitats	Codes	Outcomes of this bundle:	Num sq.
1	Grazing low/no inputs	Grasslands	15, 15B, 15C, 15D, 159, 160	Biodiversity (CSM+ plants) Soil carbon & bulk density Freshwater quality*	95
2	Habitat management: General	Grasslands; Mountain, moor and heath	19, 19B, 20, 20B, 21, 21B, 22, 25, 25B, 41A, 41B, 44, 104, 106, 109, 115, 116, 117, 118, 119, 120, 123, 124, 128, 133, 139, 140, 143, 148, 175	Biodiversity (CSM+ plants, birds, pollinators) Soil carbon & bulk density Freshwater quality*	91
3	Arable management	Arable	26, 26b, 27, 28, 29, 30, 31, 32, 32b, 33, 34, 34b, 153, 158, 174	Biodiversity (birds, pollinators*)	54 <sup>†</sup>
4	Hedge management	Hedges	4, 4B, 5, 6, 6B, 42A, 42B	Biodiversity (hedge diversity/structure, hedge birds, pollinators*)	53
5	Woodland stock exclusion	Woodlands	40, 100, 103	Biodiversity (AWI plants, bryophytes, graminoid cover, woodland birds)	34
6	Glastir Woodland Management	Woodlands	All	Biodiversity (AWI plants, bryophytes, graminoid cover, woodland birds)	14
7	Advanced hedge management	Hedges	588, 589	Woody feature creation/restoration; hedge presence/structure.	32
8	Adv. habitat mgmt.: Reversion	Grasslands	121, 122, 125, 126, 129, 130, 131, 132, 134, 141, 142, 144, 145, 149, 150, 151	Biodiversity (CSM+ plants)	7
9	Habitat management: Peatland	Peatlands	160; as for "Habitat management: General" but specifically on peat soils	Biodiversity ( <i>Sphagnum</i> cover)*	43
10	Habitat management: Heathland	Heathlands	20, 20B, 115, 116, 117, 118, 656, 657, 683; as for "Habitat	Biodiversity (dwarf shrub cover)*	41



			management: General” but specifically on heathland	Soil carbon & bulk density*	
11	Wildlife corridors/buffers	Refugia	Create: 1, 1B, 2, 2B, 3, 7A, 7B, 9A, 9B, 156, 157 Maintain: 8A, 8B, 173	Biodiversity (CSM+ plants, AWI plants, woody cover)	19
12	Glastir Woodland Creation	Woodlands	All	Woodland creation/ restoration (structure, tree species, woodland birds)	5†
13	Organic management	Grasslands	NA	Biodiversity (CSM+ plants, birds, pollinators) Soil carbon & bulk density Freshwater quality*	49
14	Commons management	Commons	NA	Biodiversity (CSM+ plants)	38
15	Adv. habitat mgmt.: Birds	NA (priority species)	161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171	Biodiversity (relevant bird species)	4†

\* Subject to adequate uptake & adequate counterfactual data

† Effective sample size may be smaller; generous criteria were used to qualify squares

## 2.1 Phase 1.1

Phase 1.1 selected 100 squares based on balanced representation of ten Glastir bundles prioritised by Welsh Government (Table 2-1). Priority was given to low-uptake bundles to ensure adequate sample size. This phase maximised representation of *intervention* and *scheme* data across all bundles, but also captured some *counterfactual* data for many bundles (Table 2-2). The process was to:

1. **Score 300 GMEP squares** (minus 2 for which access was refused in 2020) based on presence of *intervention* data for 10 priority bundles. Scores were weighted based on bundles present, such that the least common bundle was worth twice as much as the most common bundle. In this way, a square with only the most common bundle would have a score of one, while a square with only the least common bundle would have a score of two.
2. **Select the top 100 squares** with the highest scores. Of the remaining squares, the 10 squares with the highest scores were prioritised as Phase 1.1. reserve squares (to be used if any of the 100 Phase 1.1. squares are refused permission for survey).

Table 2-2. Number of “data units” for intervention and counterfactual captured by Phase 1.1.

	Grazing low/no inputs	Hedge mgmt.	Adv. hedge mgmt.	Habitat mgmt.: Heath	Habitat mgmt.: Peat	Habitat mgmt.: Other	Adv. habitat mgmt.: Reversion	Wood-land stock exclusion	Arable mgmt.	Wood-land mgmt.
<i>Inter-vention</i>	136 /186	55 /60	45 /53	42 /58	48 /121	128 /235	11 /11	33 /37	37 /54	12 /17
<i>Counter-factual</i>	119 /618	101 /483	NA /NA	8 /40	11 /50	93 /481	111 /582	49 /222	5 /47	42 /214
Units	Plots	Plots	Squares	Plots	Plots	Plots	Plots	Plots	Squares	Plots

## 2.2 Phase 1.2

Phase 1.2 selected 30 squares to increase the number of *counterfactual* data points across bundles (Table 2-2) while keeping the distribution of broad habitats consistent with Phase 1.1.

1. **Score unselected GMEP squares** based on number of relevant *counterfactual* data points for bundles. Scores were weighted based on the “*counterfactual* deficit” for those bundles. The “*counterfactual* deficit” is the proportion of *intervention* data points without corresponding *counterfactual* data. For example, after Phase 1 the “arable management” bundle had 37 *intervention* and 5 *counterfactual* data points, indicating a high deficit weighting of  $32/37=0.87$  (max 1).
2. **Iteratively add** the highest scoring square, then update scores reflecting newly captured *counterfactual* (i.e. scores will reflect which bundles have the greatest *counterfactual* deficit). We continued this process beyond 30 squares to prioritise five Phase 1.2. reserve squares (to be used if any of the 30 Phase 1.2. squares are refused permission for survey).
3. **Visually assess elevation** of squares across treatments within bundles. Ensure good overlap in elevation range between treatments (Annex-A: Figure 3-1 – Figure 3-10).

Table 2-3. “Data units” for intervention, scheme and counterfactual captured by Phase 1.1 (yellow) and 1.2 (green). Bundles with counterfactual deficits after Phase 1 are shown underlined.

	Grazing low/no inputs	Hedge mgmt.	Adv. hedge mgmt.	Habitat mgmt.: Heath	Habitat mgmt.: Peat	Habitat mgmt.: Other	Adv. habitat mgmt.: Reversion	Wood-land stock exclusion	Arable mgmt.	Wood-land mgmt.
<i>Int- 1.1</i>	136	55	45	42	48	128	11	33	37	12
<i>Sch-1.1</i>	322	206	NA	23	23	208	381	33	NA	NA
<i>Cfa-1.1</i>	119	101	NA	<u>8</u>	<u>11</u>	<u>93</u>	111	49	<u>5</u>	42
<i>Int- 1.2</i>	138	55	46	43	51	140	11	33	38	13
<i>Sch-1.2</i>	347	220	NA	25	23	218	403	35	NA	NA
<i>Cfa-1.2</i>	267	146	NA	29	41	215	253	77	16	70
<b>Units</b>	Plots	Plots	Squares	Plots	Plots	Plots	Plots	Plots	Squares	Plots

## 2.3 Phase 2.1

Phase 2 was used to strategically select 80 of the 130 squares for bird and pollinator surveys. Bird and pollinator responses to management were expected to be difficult to detect, so extra care was taken to select squares with highly relevant Glastir interventions (largely nested within WG prioritised bundles). In Phase 2.1., the BTO selected 60 of 130 squares with relevant Glastir interventions as follows:

1. **Glastir interventions were categorised** by Gavin Siriwardena, BTO (in consultation with Jamie Alison, UKCEH), for those good for birds, pollinators or both birds and pollinators. These were then sub-selected for key interventions, including three Glastir Advanced bird-specific interventions, and incorporating relevant linear feature interventions.
2. **Selected all squares with key Glastir** interventions and/or interventions for both birds and pollinators.
3. **Removed squares** without GMEP bird counts.

4. **Reduced resulting selection** from 64 to 60 by removing squares in geographical clusters across Wales at random, to produce a smoother overall distribution.

## 2.4 Phase 2.2

In Phase 2.2., BTO selected 20 counterfactual Squares without Glastir interventions for birds and pollinators.

1. **Selected squares without** any bird or pollinator interventions.
2. **Removed squares** without GMEP bird counts, as well as two squares with mainly maize as arable cover (making them poor counterfactuals for Glastir arable management).
3. **Reduced resulting selection** from 40 to 20 by removing squares in geographical clusters across Wales at random, to produce a smoother overall distribution.

## 2.5 Phase 3.1

Phase 3 was used to strategically prioritize 80 of the 130 squares for vegetation survey in 2021, given limited botanical surveyor availability due to Covid-19. This was done based on co-occurrence of bundles, to achieve efficient sampling, but also based on the importance of vegetation data for bundle evaluation. Phase 3.1 selected 60 squares to maximise representation of *intervention* and *scheme* for a cohesive subset of relevant bundles.

1. **Identified cohesive subsets of bundles** using a heatmap of co-occurrence (Figure 2-1). The identified subsets are:

Enclosed farmland management package	Habitat land management package
1. Advanced habitat management: Reversion	1. Habitat management: Peatland
2. Hedge management	2. Habitat management: Heathland
3. Habitat management: Other	3. Habitat management: Other
4. Grazing low/no inputs	4. Grazing low/no inputs

The habitat land management package was selected in the interest of surveyor and farmer health during Covid-19 (isolated, upland squares; Figure 2-2).

2. **Select 60 squares**, prioritising presence of *intervention* data for (1) Advanced habitat management: Reversion, (2) Hedge management and (3) Grazing low/no inputs. Ties were broken based on representation of the ten priority interventions (Table 2-1).

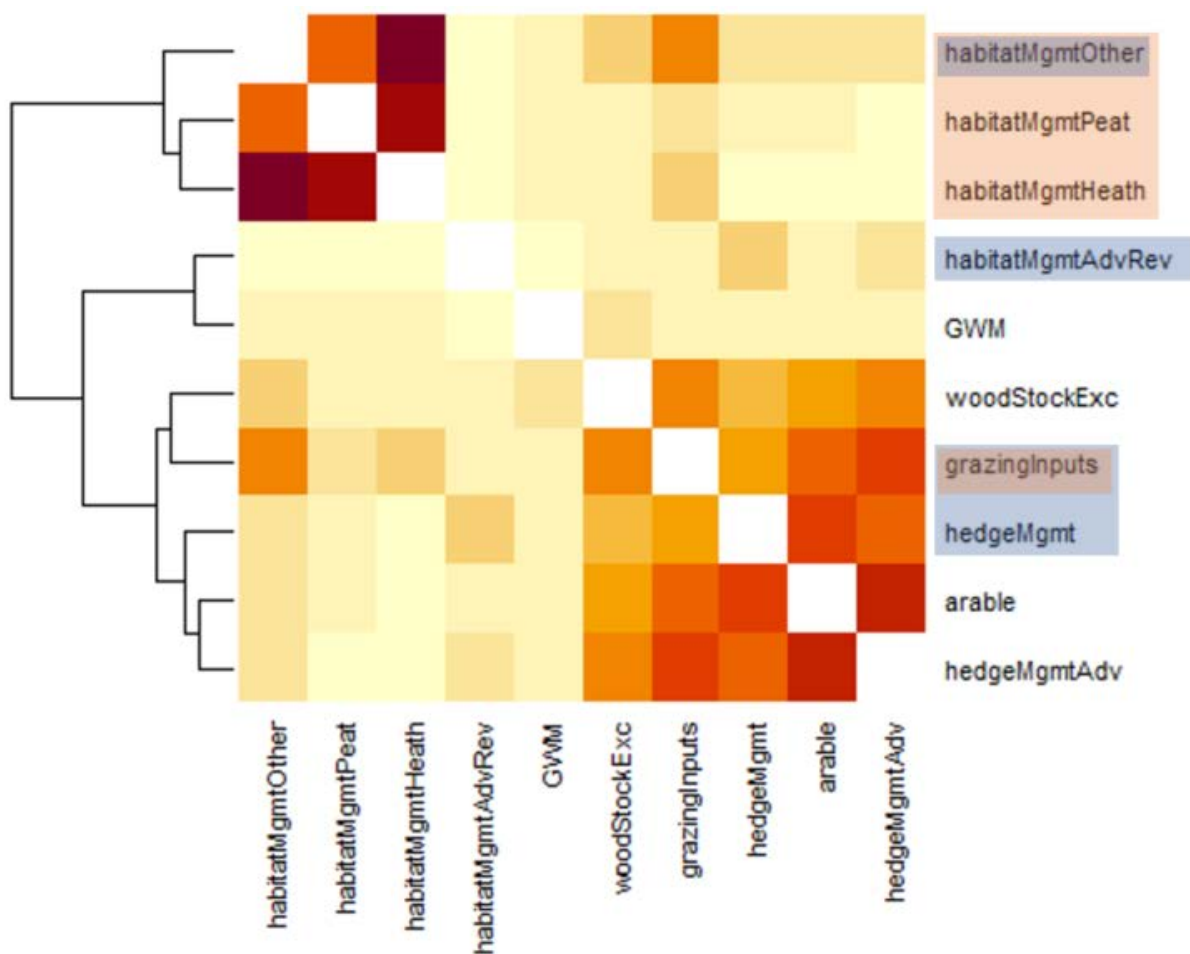


Figure 2-1. Heatmap of co-occurrence of bundles across 130 ERAMMP 2021/2022 squares. Two cohesive subsets of bundles, for which vegetation data are critical for evaluation, were identified (highlighted in peach and blue to the right of the heatmap grid).

## 2.6 Phase 3.2

Phase 3.2 selected 20 squares to increase the number of *counterfactual* data points across bundles while keeping the distribution of broad habitats consistent with Phase 3.1.

1. **Score unselected squares** on number of relevant *counterfactual* data points for bundles. Scores were weighted using the “*counterfactual* deficit” for bundles, as in Phase 1.2. step (1).
2. **Iteratively add** the highest scoring square, then update scores reflecting newly captured *counterfactual* (i.e. scores will reflect which bundles have the greatest *counterfactual* deficit).
3. **Visually assess elevation** of squares across Phase 3.1. and 3.2. (Figure 2-3), as well as the capture of the ten priority bundles (Figure 2-4, Table 2-1).

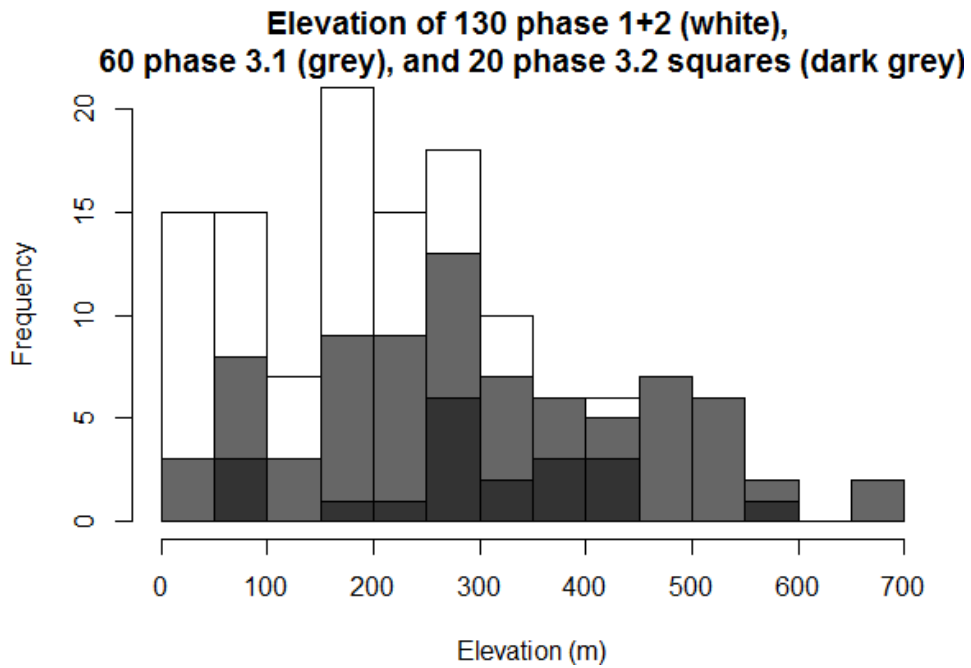


Figure 2-2. Elevation of squares selected by Phase 2 (white), Phase 3.1 (dark grey) and Phase 3.2 (light grey).

## 2.7 Final Distribution of Selected Squares

The proportional capture of different Glastir bundles is shown in Figure 2-3. The spatial distribution of squares across Wales is shown in Figure 2-4.

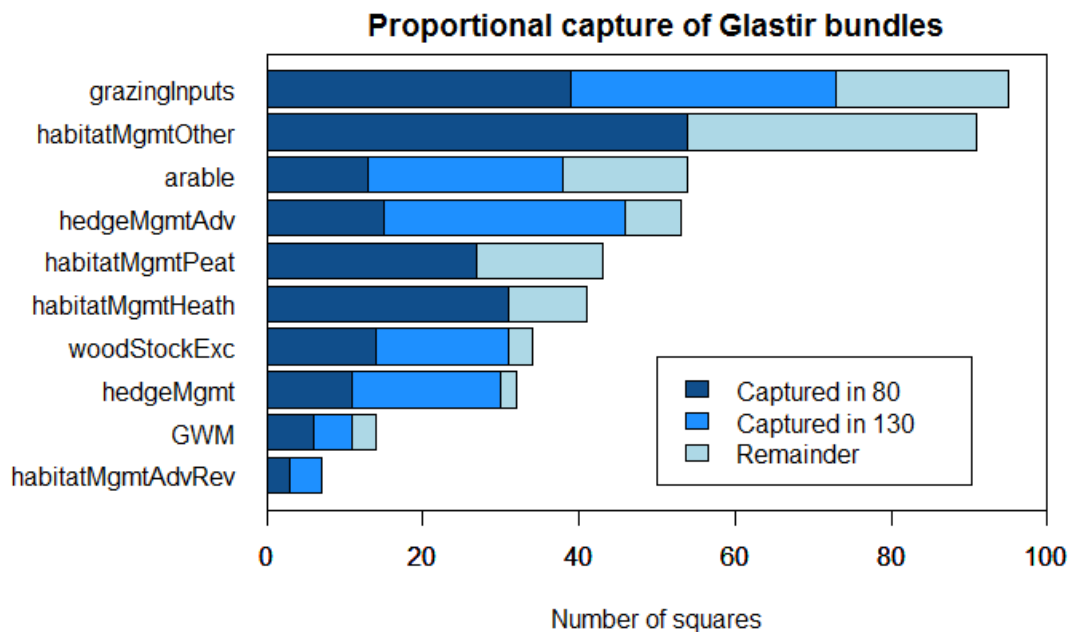


Figure 2-3. Reproduction of Figure 1-1, highlighting bundles captured in the 80 squares prioritized for vegetation surveys in the event of a lack of botanical surveyors due to Covid-19 (dark blue).

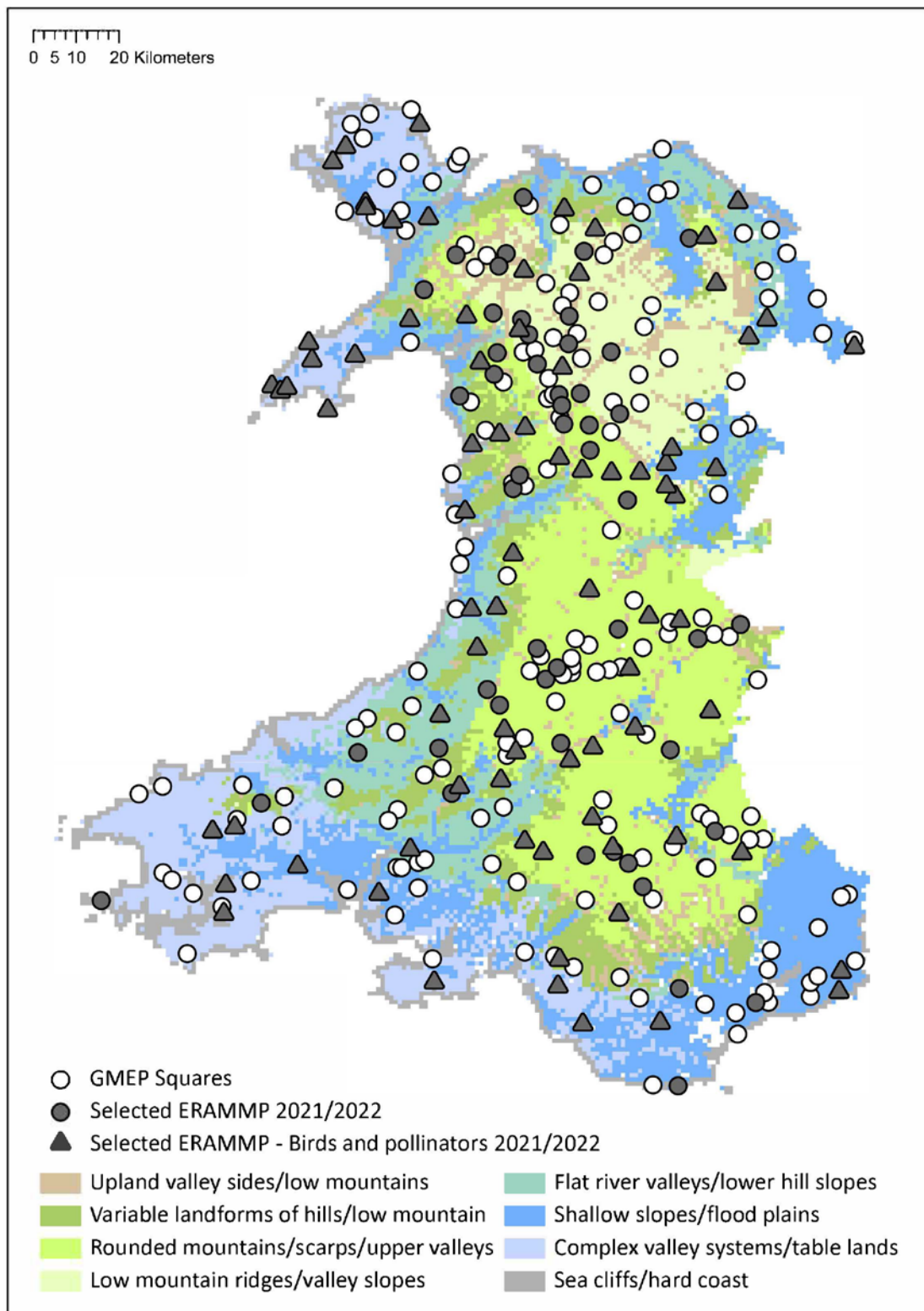


Figure 2-4 Distribution of GMEP squares across eight land classes in Wales, with the selected squares coloured grey and bird & pollinators squares distinguished as triangles.

## 2.8 Process for Replacing Refused Squares

In GMEP, squares were only visited if an adequate area of the square was available for environmental survey (i.e. rural land with permission granted). The criteria were as follows:

Squares containing sea:

- The sea coverage must be less than 90%
- Of the remaining land available for survey, access permissions must be granted for at least 50% of that area
- Access permissions granted must not be less than 10% of the square area

Squares with urban land:

- Must have less than 75% urban land present
- Of the remaining land available for survey, access permissions must be granted for at least 50% of that area
- Access permissions granted must not be less than 25% of the square area

Squares without urban land or sea present:

- Access permissions must be granted for at least 25% of the square area
- Squares with 25-50% permission granted may also be rejected, following a case-by-case discussion

We follow the same criteria for ERAMMP 2021/2022 when information is available on permitted/refused areas.

When replacing refused squares, we use the reserves from Phase 1.1. (10 squares) and Phase 1.2. (5 squares). Squares are replaced by a square which is the same in terms of being (1) a Phase 1.1./Phase 1.2. square and (2) where possible, the same land class. Where two or more reserve squares were tied to replace a refused square (e.g. two reserved squares with the same land class), ties were broken based on elevation (selecting the reserve square closest to the refused square in elevation).

For bird & pollinator surveys, refused squares were replaced manually from within the original 130. Priority was given to squares with (1) appropriate Glastir interventions or counterfactual land, (2) adequate permissions for survey, (3) practical locations with respect to the distribution of surveyors, (4) pollinator surveys occurring under the UK Pollinator Monitoring Scheme and (5) similar elevation to refused squares.

Squares determined to be refused on or after 1<sup>st</sup> April 2021 were not guaranteed to be replaced due to time constraints.

### 3 ANNEX-A

Elevation profiles of selected squares (Phase 1) with data for each of 10 bundles.

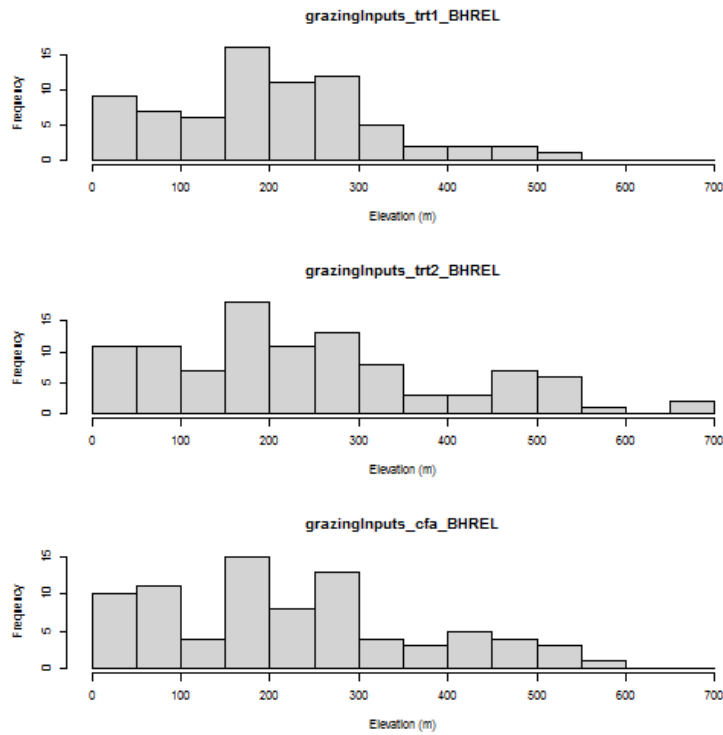


Figure 3-1: Grazing low/no inputs; for three different treatments (trt1 = intervention, trt2 = scheme, cfa = counterfactual)

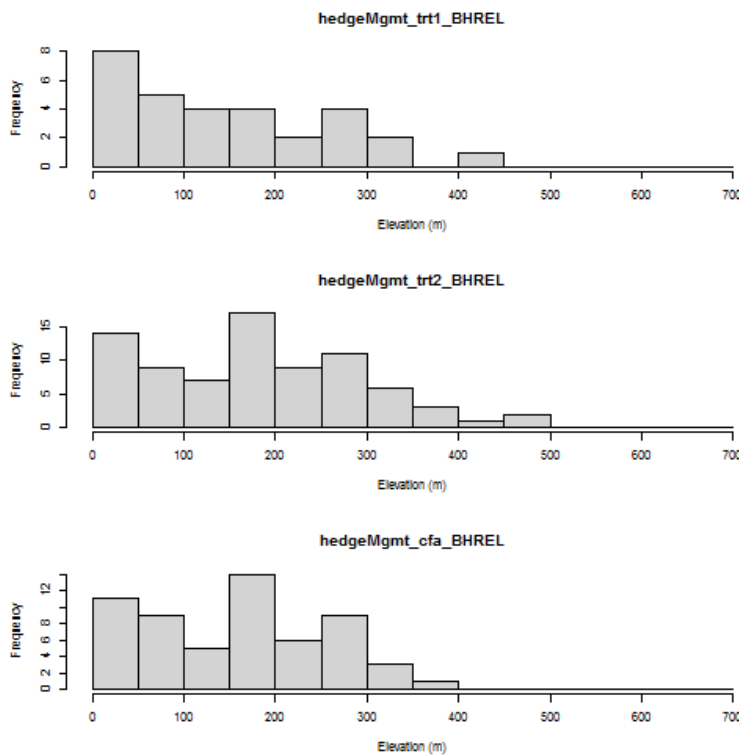


Figure 3-2 Hedge mgmt.; for three different treatments (trt1 = intervention, trt2 = scheme, cfa = counterfactual)



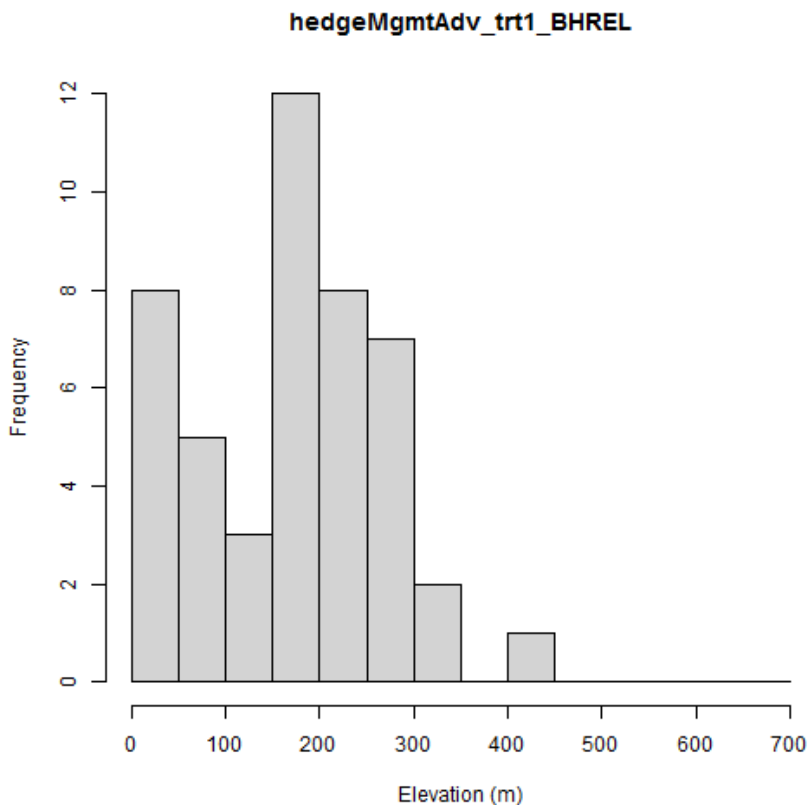


Figure 3-3 Adv. hedge mgmt.; for one treatment (trt1 = intervention)

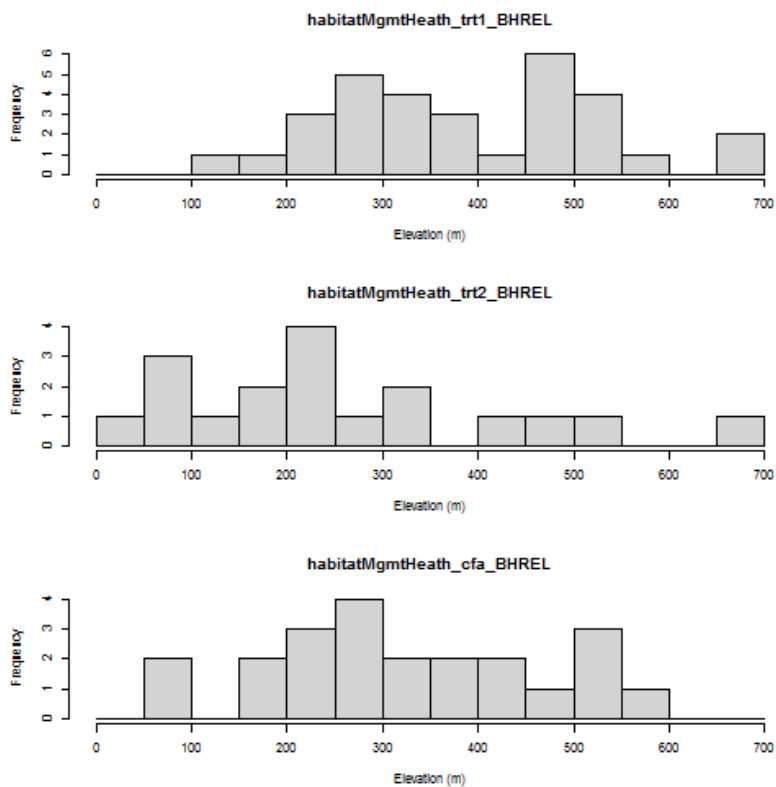


Figure 3-4 Habitat mgmt.: Heath; for up to three different treatments (trt1 = intervention, trt2 = scheme, cfa = counterfactual)

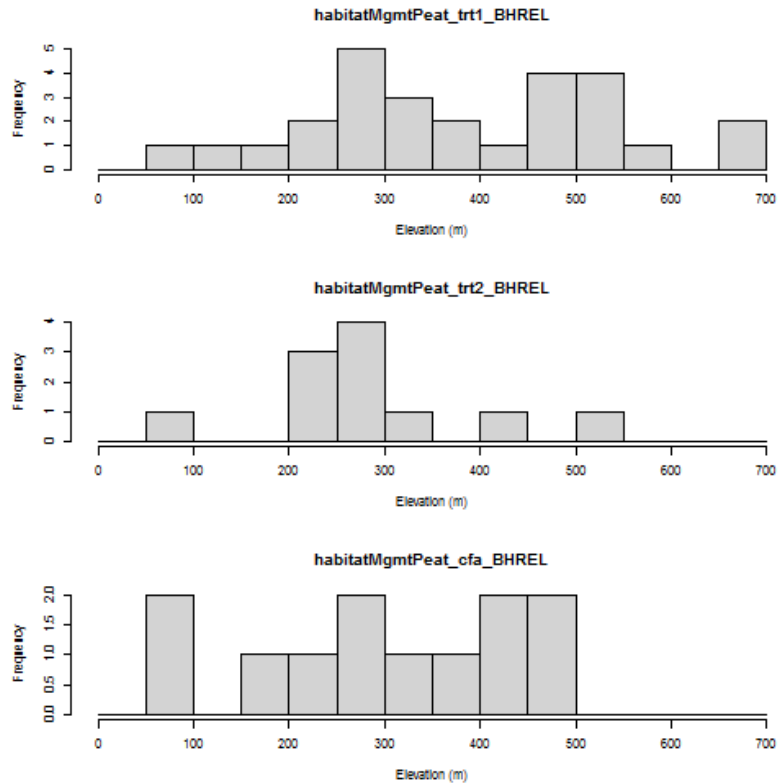


Figure 3-5 Habitat management: Peat; for three different treatments (trt1 = intervention, trt2 = scheme, cfa = counterfactual)

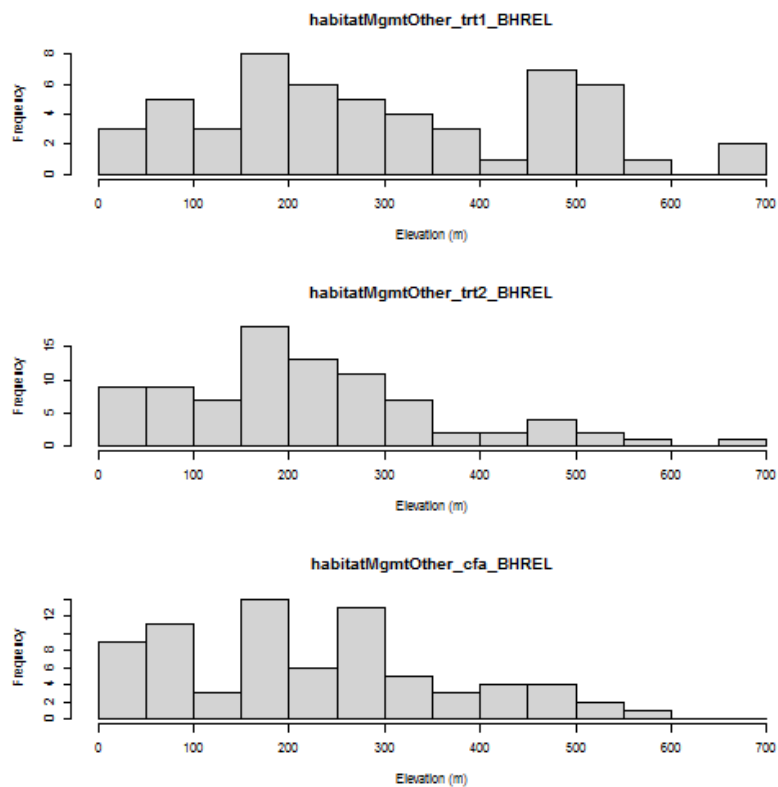


Figure 3-6 Habitat management: Other; for three different treatments (trt1 = intervention, trt2 = scheme, cfa = counterfactual)

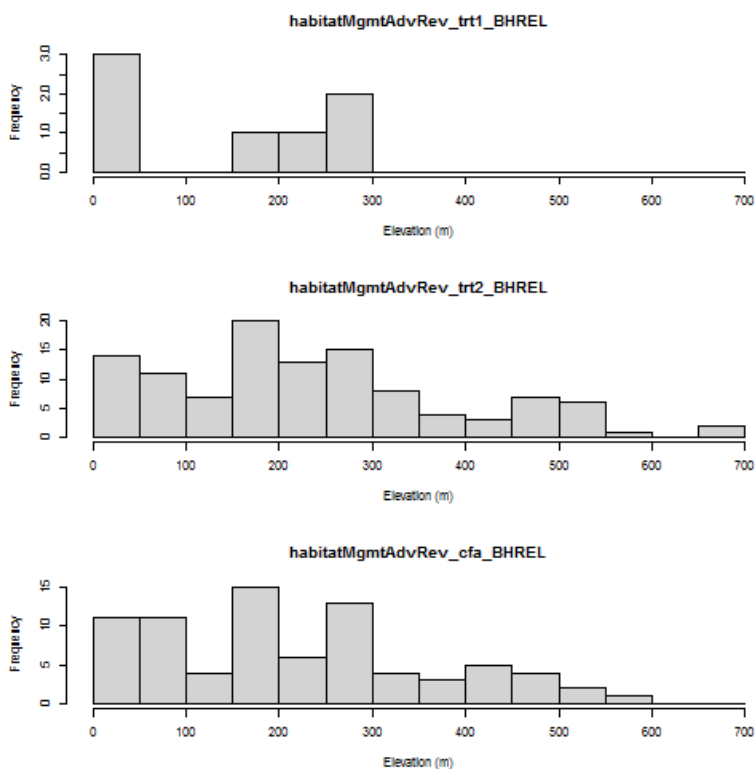


Figure 3-7 Adv. habitat mgmt.: R Reversion; for three different treatments (trt1 = intervention, trt2 = scheme, cfa = counterfactual)

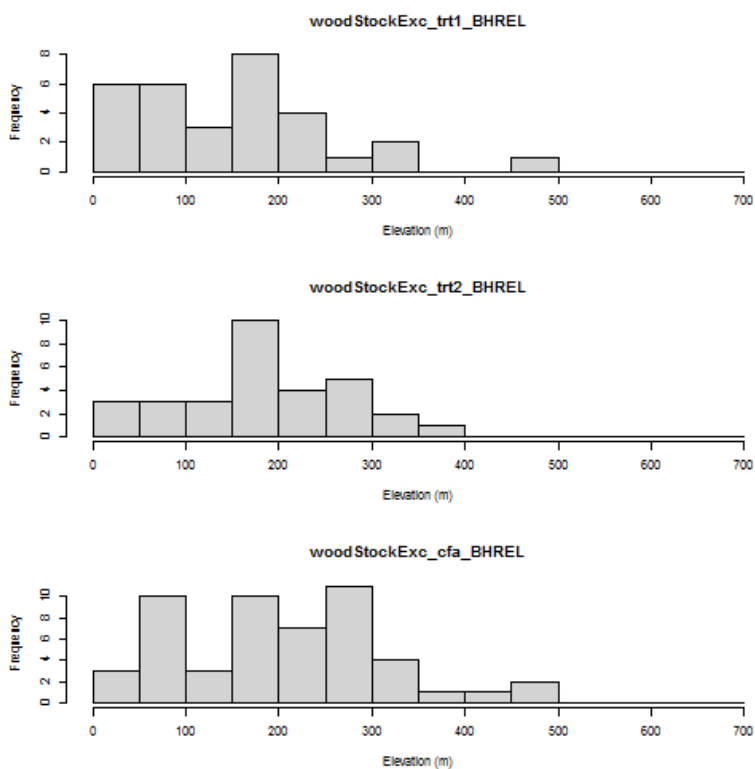


Figure 3-8 Woodland stock exclusion; for three different treatments (trt1 = intervention, trt2 = scheme, cfa = counterfactual)

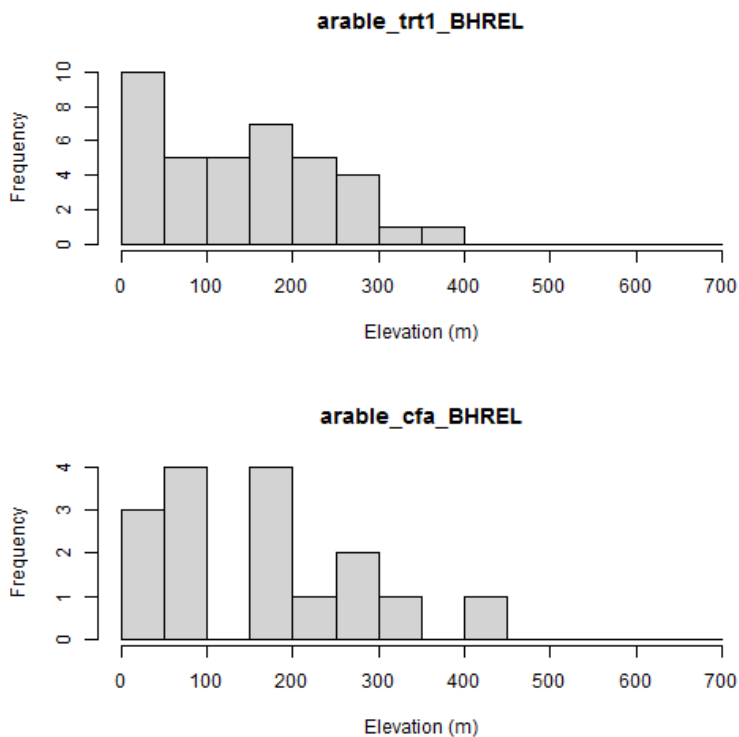


Figure 3-9 Arable management; for two different treatments (trt1 = intervention, cfa = counterfactual)

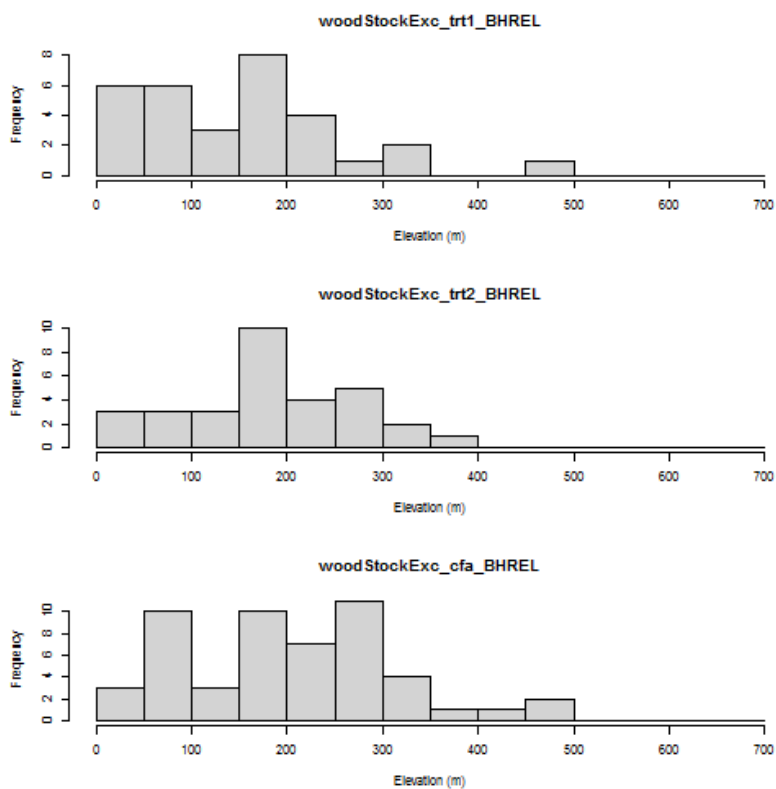


Figure 3-10 Woodland management; for three different treatments (trt1 = intervention, trt2 = scheme, cfa = counterfactual)

## 4 ANNEX-B

Table 4-1. Information on the relevant treatments and “data points” considered for each bundle.

Habitat	Bundle	Primary treatment	Secondary treatments & counterfactuals
Grasslands; Mountain, moor and heath	<b>Habitat management</b> Entry & Advanced	X, Y, U plots in intervention	X, Y, U plots, matched on BH: (1) In scheme (2) Out of scheme
Grasslands	<b>Grazing low/no inputs</b> Entry & Advanced	X, Y, U plots in intervention	X, Y, U plots, matched on BH: (1) In scheme (2) Out of scheme
Arable	<b>Arable management</b> Entry & Advanced	Mapped arable land with interventions present	Mapped arable land out of scheme
Hedges (part of improved land)	<b>Advanced hedge management</b> Advanced	Mapped areas with advanced hedge intervention	Mapped areas without advanced hedge intervention ( <b>Automatically captured</b> )
Commons	<b>Commons management</b> Glastir Commons	X, Y, U plots in scheme	X, Y, U plots out of scheme
Hedges (part of improved land)	<b>Hedge management</b> Entry & Advanced	D, H, B plots in intervention	D, H, B plots: (1) In scheme (2) Out of scheme (filtering needed before analysis to select plots along hedges)
Woodland	<b>Woodland stock exclusion</b> Entry & Advanced	X, Y plots in intervention	X, Y plots matched on BH: (1) In scheme (2) Out of scheme
Connectivity / resilience issues	<b>Wildlife corridors/buffers</b> Entry & Advanced	D, H, B, S plots in intervention	D, H, B, S plots matched on BH: (1) In scheme (2) Out of scheme
Grasslands	<b>Adv. habitat mgmt.: Reversion</b> Advanced	X, Y, U plots in intervention	X, Y, U plots, matched on BH: (1) In scheme (2) Out of scheme (currently serving as more of a “reference” counterfactual; “starting point” counterfactuals can be found before analysis)
Priority species	<b>Adv. habitat mgmt.: Birds</b> Advanced	Mapped land with interventions present	Mapped areas without intervention <b>(Automatically captured)</b>
Organic	Glastir Organic	X, Y, U plots in scheme	X, Y, U plots out of scheme
Woodland	Glastir Woodland Creation	Mapped land with interventions present	Mapped areas without intervention <b>(Automatically captured)</b>
Woodland	Glastir Woodland Management	X, Y plots in intervention	X, Y, U plots, matched on BH: (1) In scheme (2) Out of scheme

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