

# Assessing impacts of the Agricultural Reform Programme measures on biodiversity

## Annexes

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**RESAS**

Rural & Environmental Science  
and Analytical Services



University of  
St Andrews

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# Annex A

## Detailed methods

### QEIA scoring methodology

Each action in the QEIA is scored against 53 ES indicators. The scores consist of four components: 1) a cell code, a colour code, a magnitude score and a letter code (Figure A1). The Cell contents for each combination of action and ES indicator contains a combination of these four components.

### Integrated Assessment Table Coding Key

#### Cell code

R	Already covered by regulation; not assessed further
B or S	Too big to review so split and reviewed under individual actions
M	Merged actions can be reviewed together for a specific outcome as evidence does not support more granular approach
N or no letter	No impact on ES was expected by review teams
X	The action is linked to a theme that was not included in the review team's original remit

#### Ecosystem services (ES) indicator

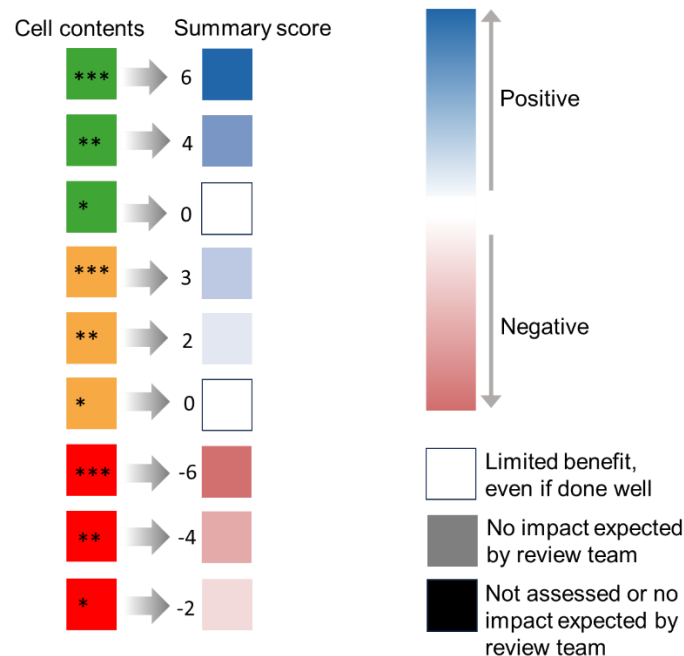
Colour code (RAG)	Magnitude score (*)	Contextual issues (letters)
Green	*** Action can have major benefit if done well ** Action can have moderate benefit if done well * Action has limited benefit even if done well	<b>T</b> only used for two types of action: <ul style="list-style-type: none"> <li>• creation of plans</li> <li>• monitoring and measurement</li> </ul>
Amber	*** Action can have major positive benefits if done well ** Action can have moderate positive benefit if done well * Action has limited benefit even if done well	<b>L</b> Limited evidence for benefit but is consistent with evidence logic chain <b>T</b> Contextually dependent benefits and / or requires targeting to be effective <b>D</b> There are some disbenefits to some services within this indicator Note: 'no impact' does not make a box an amber if all other sub-indicators are green - it should be green if nothing disbenefits
Red	*** Action can have major disbenefit ** Action can have moderate disbenefit * Action has limited impact disbenefit	<b>T</b> Only used where there was a context dependency for the Food and Fibre

**Figure A1 QEIA Assessment coding key.** Reproduced from Emmett, B.A. et al. (2023). Qualitative impact assessment of land management interventions on Ecosystem Services ('QEIA'). Report-2 Annex: Integrated Assessment Table (Defra ECM\_62324/UKCEH 08044)

### Calculating an overall score for QEIA Cell contents

To calculate a score for each cell, merged actions (Cell code M) were identified and the associated action code's cell contents was used for further analysis. Green, red and amber cells were scored with 2, 1 and -2 respectively. The cell magnitude was converted into a numerical score of 1, 2, or 3 by counting the number of stars in the cell. Green and amber cells with cell magnitude = 1 were recoded to zero because this category was given to actions that were deemed to have 'limited benefit, even if done well.' Red cells with cell magnitude = 1 were retained to highlight potential disbenefit,

even if they were deemed to have a ‘limited impact disbenefit.’ The final score for each cell was calculated by multiplying the cell colour score and the cell magnitude score. White cells with the letter code N were retained and coded to produce a grey cell in the plots to highlight where the reviewing team considered the action to have no impact on the ES indicator (Figure A2), and white cells that contained no letter were retained and coded black to highlight that either no assessment was made or no impact was expected.



**Figure A2 Data from the QEIA can be used to highlight the potential positive or negative impacts of actions on ES indicators.** (A) Each action in the QEIA is assessed against 53 ES indicators, with the ‘Cell contents’ providing information on the potential impact. There are various ways to convert the Cell contents into a score. Here, the RAG and Cell Magnitude (\*, \*\*, \*\*\*) components are combined into a single value as indicated by the grey arrows to produce the corresponding Summary score (See Appendix XX for detailed methods). (B) The summary score is then represented as a red (negative impact) to blue (positive impact) colour to indicate the strength and direction of the potential impact. White indicates where the review team assessed the impact as ‘Limited benefit, even if done well’, grey indicates where the review team expected no impact of the action on the ES indicator, while black indicates either where no assessment was made, or the review team expected no impact of the action on the ES indicator.

### Summarising the QEIA

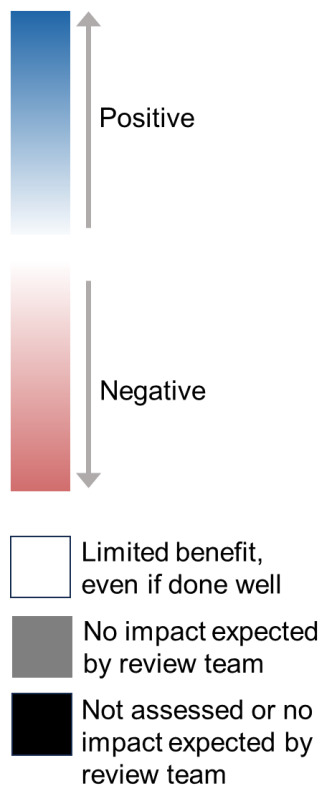
The resulting scores for each cell were summarised at two levels. Firstly, the scores were aggregated at the theme level for each QEIA action. This was achieved by summing the scores for each ES indicator within each theme, and then dividing the result by the number of ES indicators in the respective themes (the aim of this step was

to standardise the theme-level scores). Secondly, the scores were presented for all the ES indicators within the biodiversity theme. For this summary, the summary scores for each cell were used (i.e., any further processing and standardisation was unnecessary since the summary scores were not aggregated again as they were in the first analysis).

The processing steps were carried out in R (version 4.3.1) and VS Code (version 1.88.0). The code is available at: [https://github.com/rpatchett/biodiversity\\_impacts](https://github.com/rpatchett/biodiversity_impacts)

## Annex B

ES indicator scores at the theme-level for QEIA actions relevant to the proposed ARP list of measures



**Figure B1 The scale to be used alongside the plots within Annex B**

# ARP measure

## Arable and Silage/Hay Crop Margins

Leave uncut margins in meadows to provide refugia for invertebrates and birds, to be aftermath grazed or cut late -

Enhance / manage flower-rich and species rich grass margins, field corners, and plots -

Create flower-rich and species rich grass margins, field corners, and plots -

QEIA actions

Air -

Biodiversity -

Carbon\_GHG -

Food\_Production -

Soil -

Water -

QEIA Theme



# ARP measure

Arable/ley rotations (transition from arable to arable/livestock mix)

QEIA actions

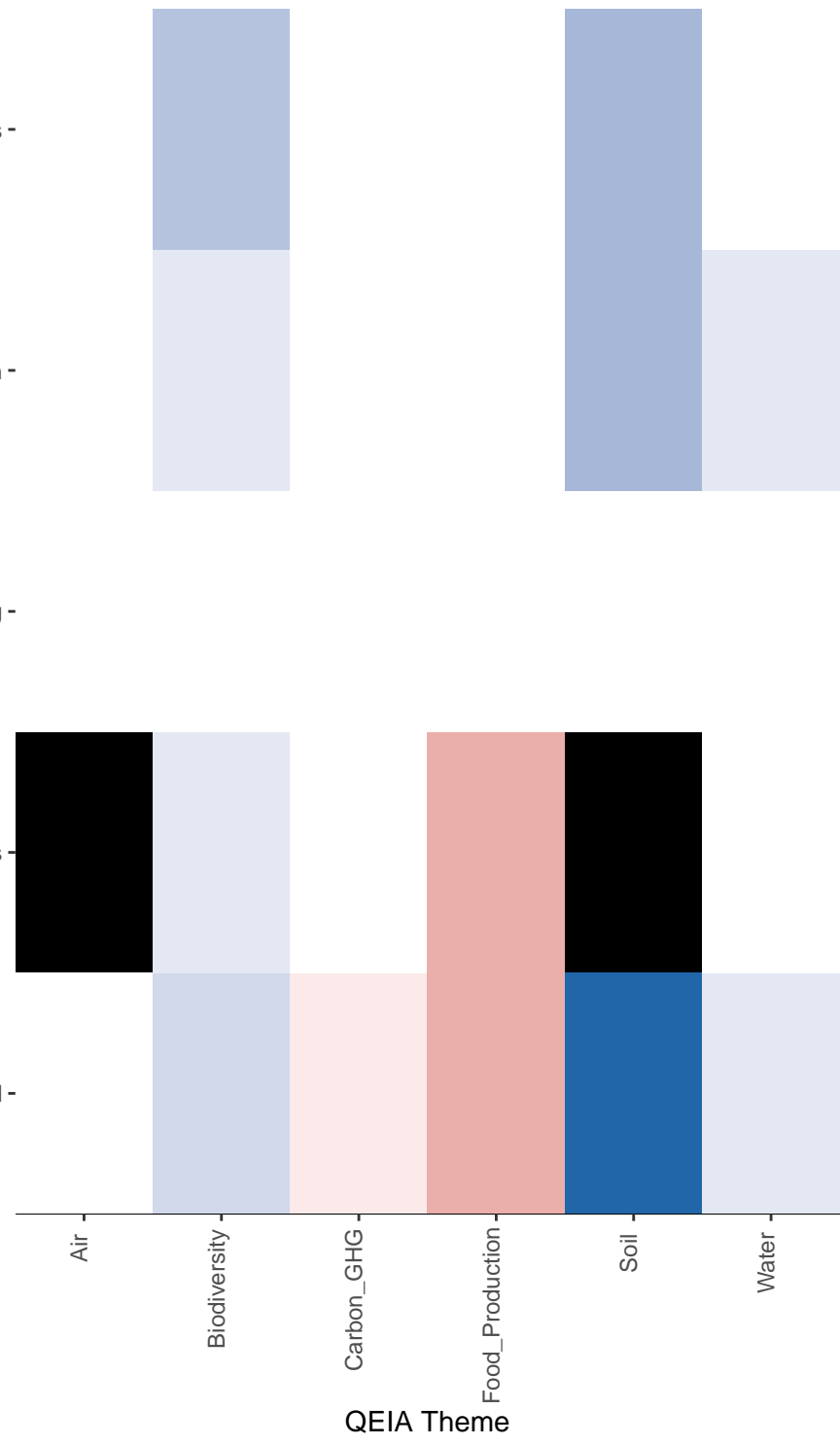
Use grass or encourage natural regeneration where this can be efficiently incorporated into the rotation -

Use herbal and grass leys -

Mob grazing -

Conversion to a more extensive system including reversion from high risk forage to grass and whole crop and reduced inputs -

Arable reversion to grassland -

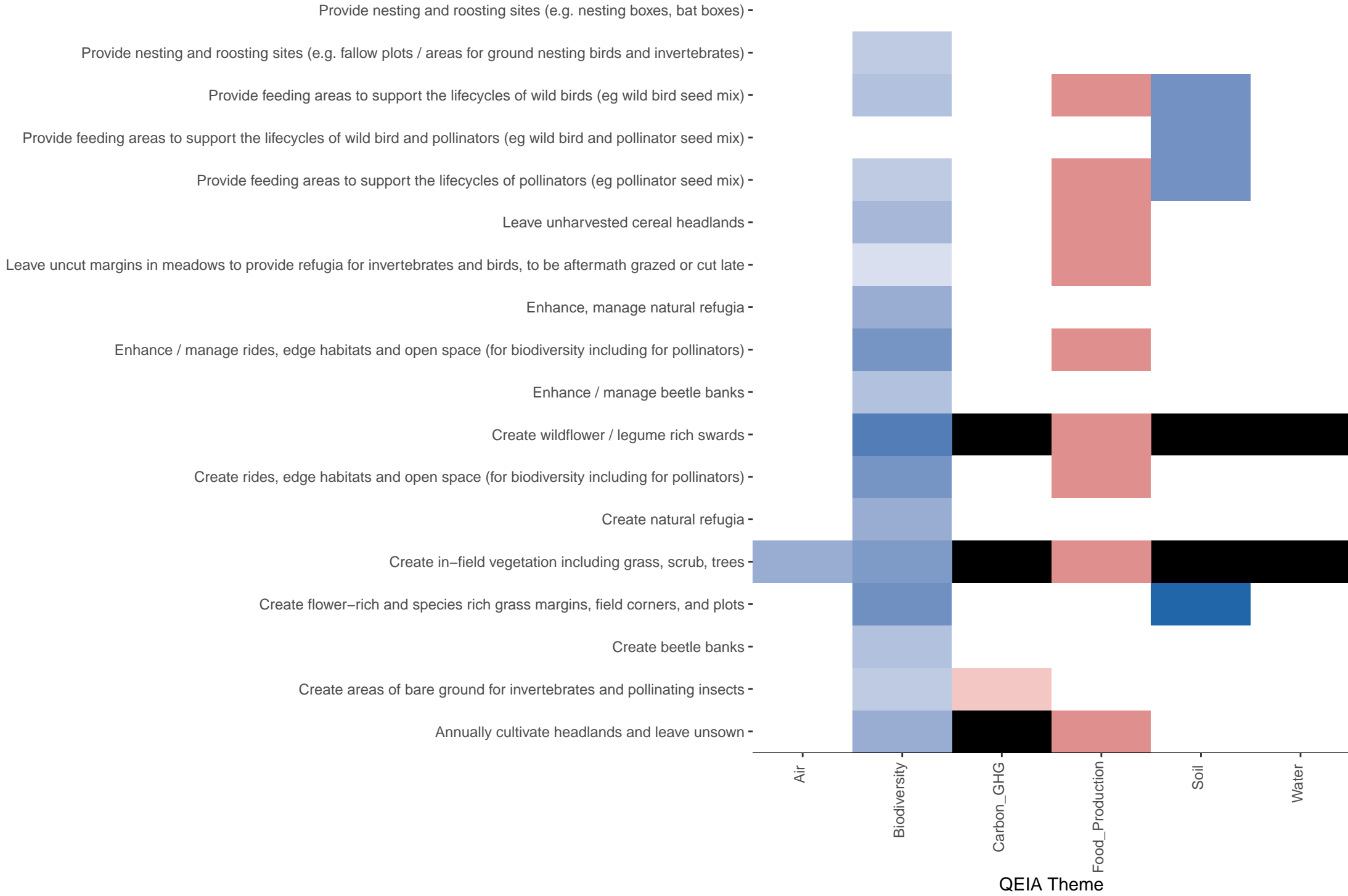


QEIA Theme



# ARP measure

## Biodiversity cropping



ARP measure  
Bird friendly Crop Operations

QEIA actions

Use targeted habitat management for species with highly specialised requirements -

Air -

Biodiversity -

Carbon\_GHG -

Food\_Production -

Soil -

Water -

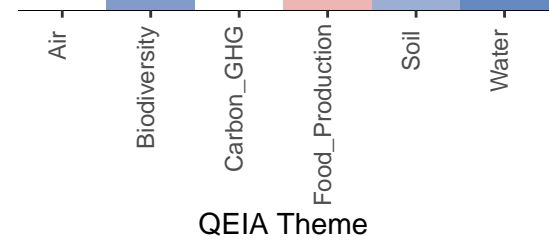
QEIA Theme



# ARP measure

Coastal or River embankment breaching, lowering or removal

QEIA actions



# ARP measure

## Control of Invasive Non-native Species

QEIA actions

Weed wiping, precision or spot spraying to control injurious weeds and invasive plants to help manage habitats

Monitor and control damaging terrestrial plant species

Monitor and control damaging riparian plant species

Monitor and control damaging aquatic plant species

Monitor and control damaging aquatic animal species

Control invasive plant species by chemical means to help manage archaeological sites

Control invasive plant species by chemical means to help manage and restore habitats

Air -

Biodiversity -

Carbon\_GHG -

Food\_Production -

Soil -

Water -

QEIA Theme



# ARP measure

Converting land at risk of erosion/flooding to low-input grassland

Enhance, manage floodplain meadows -

Create water meadows -

Air -

Biodiversity

Carbon\_GHG

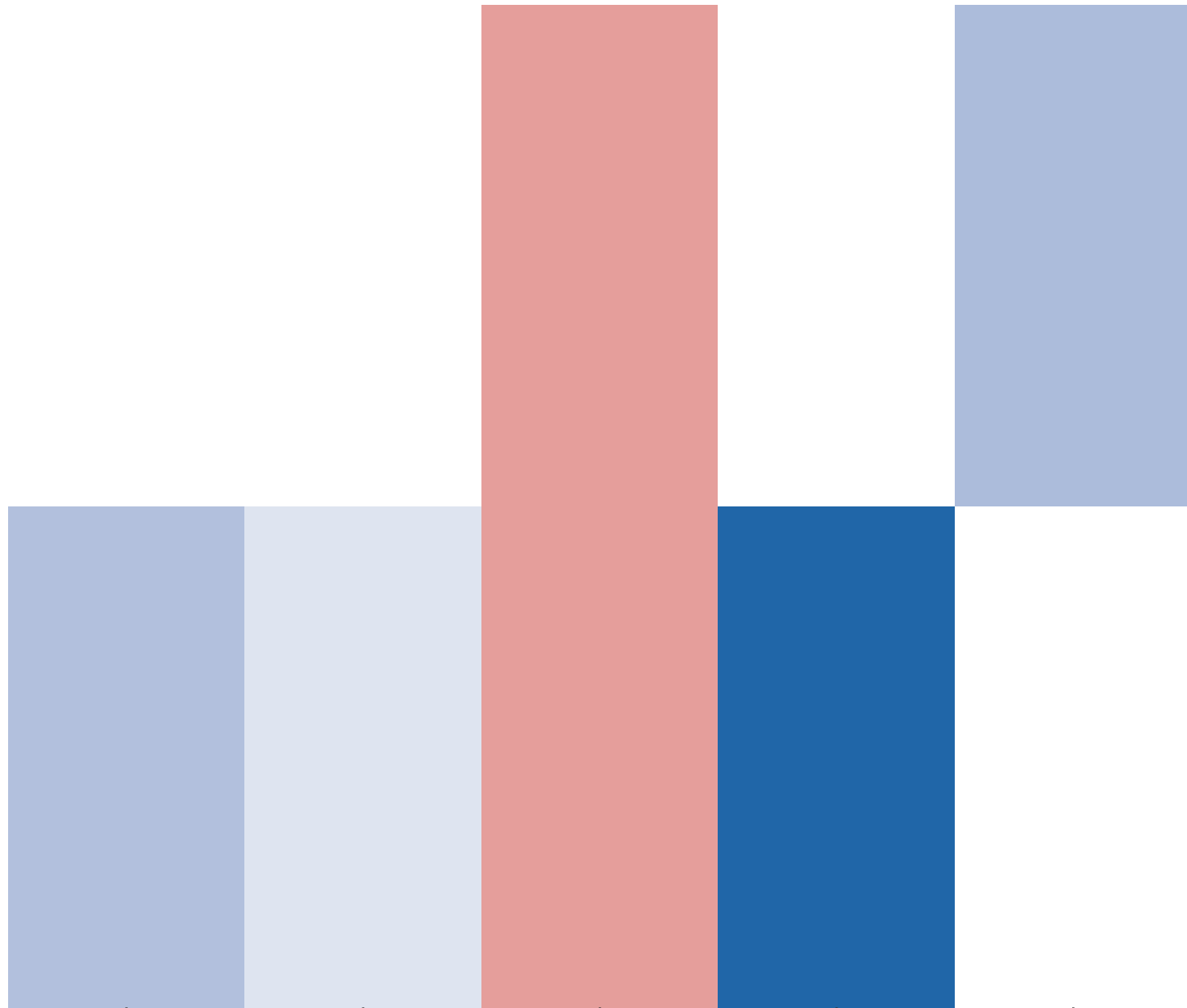
Food\_Production

Soil

Water -

QEIA Theme

QEIA actions



# ARP measure

Create and maintain habitats specific for the target species

Undertake targeted measures to recover populations of rare, threatened or otherwise vulnerable species (.) -

Use targeted habitat management for species with highly specialised requirements -

QEIA actions

Air -

Biodiversity -

Carbon\_GHG -

Food\_Production -

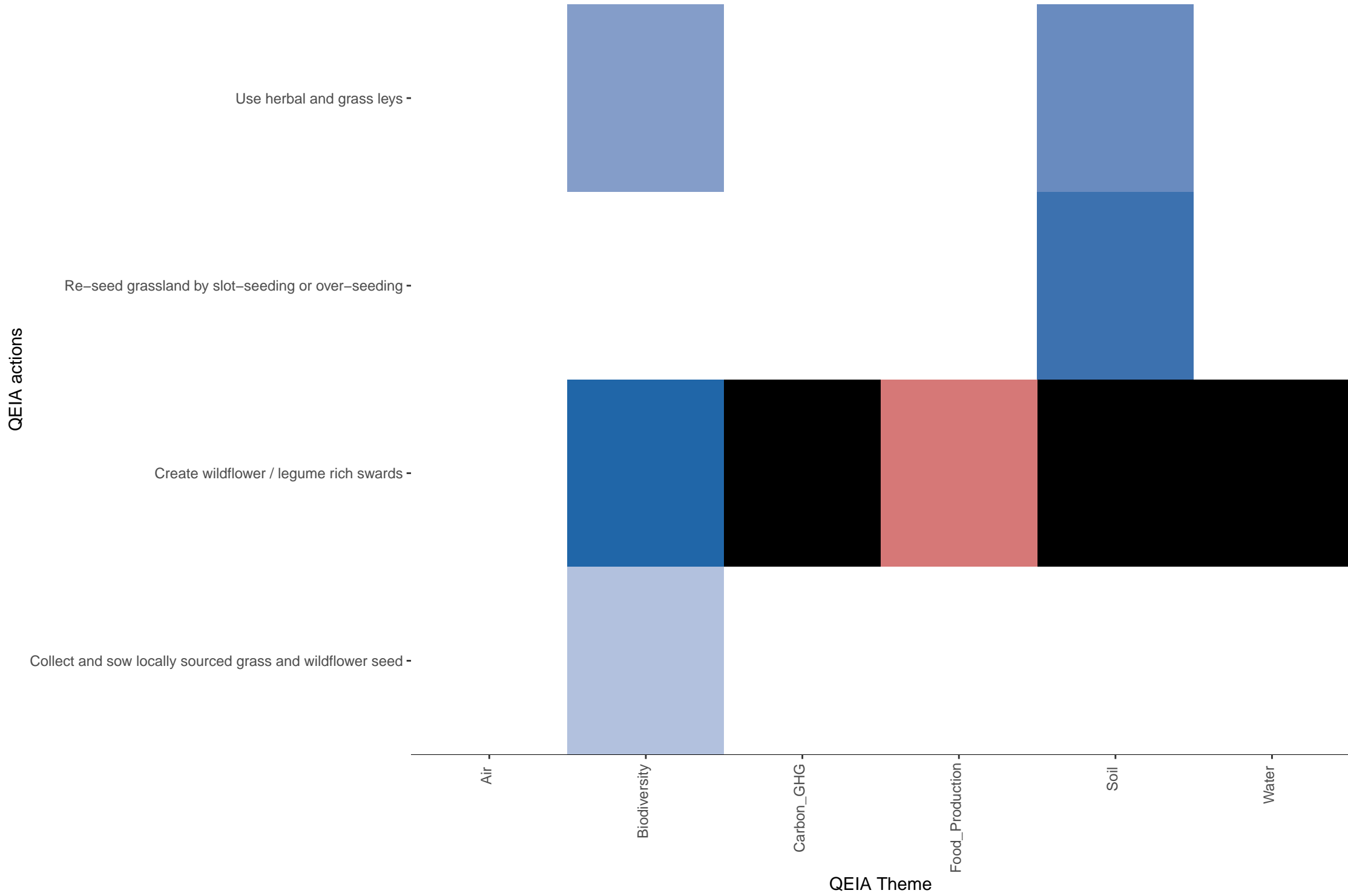
Soil -

Water -

QEIA Theme

# ARP measure

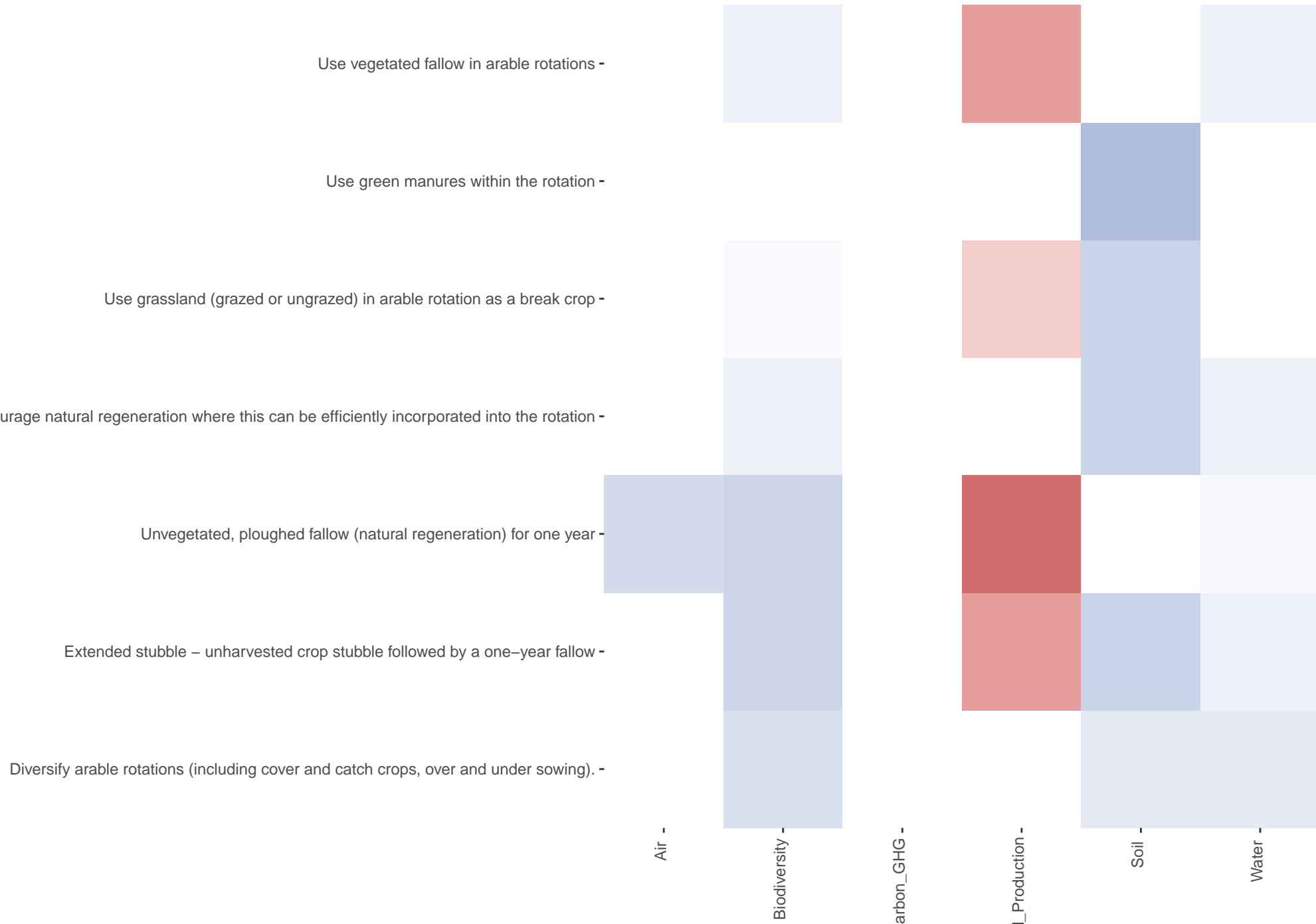
Diverse sward species content (legumes-herb-grass mixtures) and use of herbal leys



# ARP measure

Diversify crop rotation and break crop rotation period (esp. for root crop)

QEIA actions



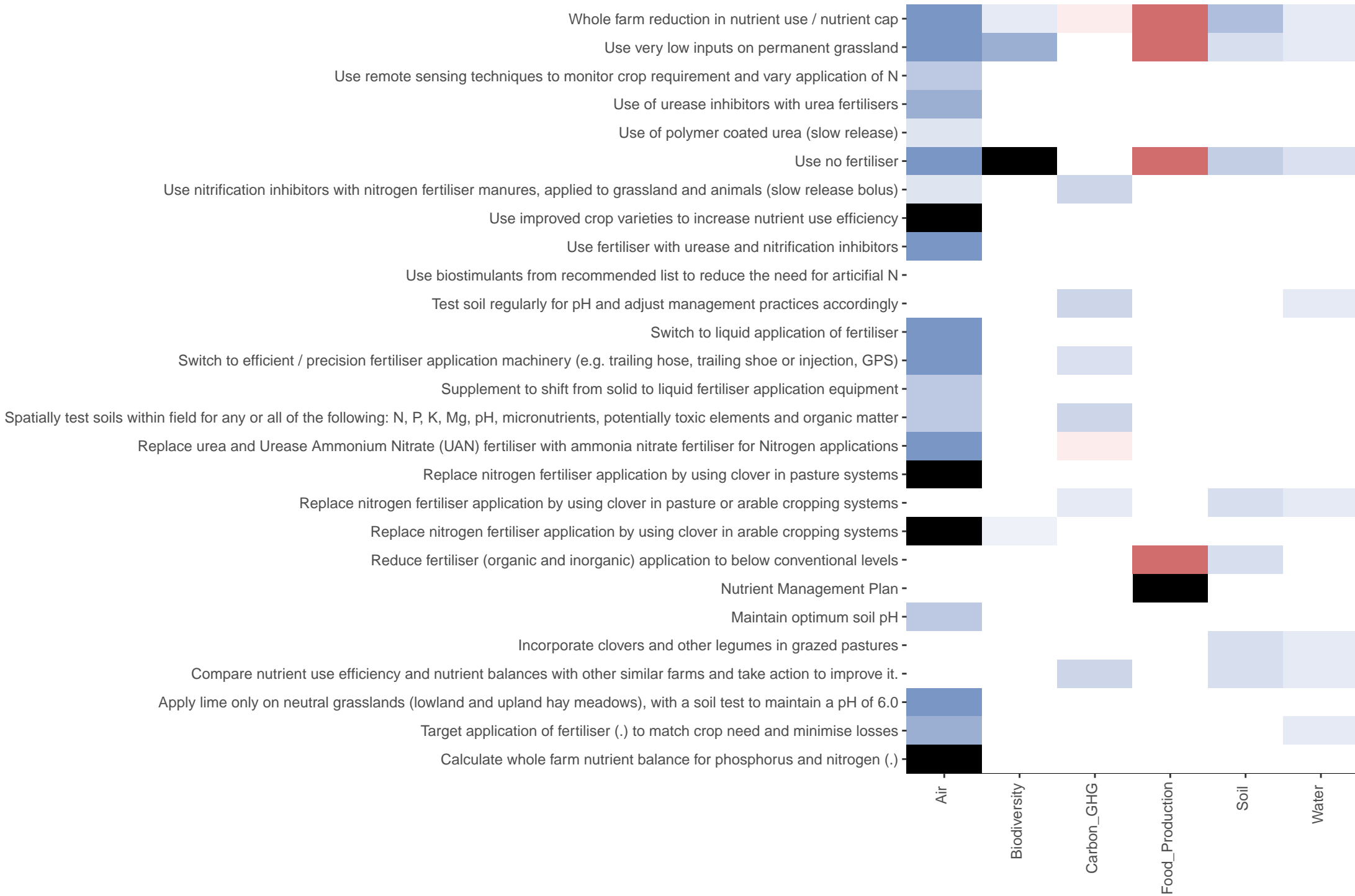
QEIA Theme



# ARP measure

## Efficient / Reduced use of inorganic fertilisers and lime

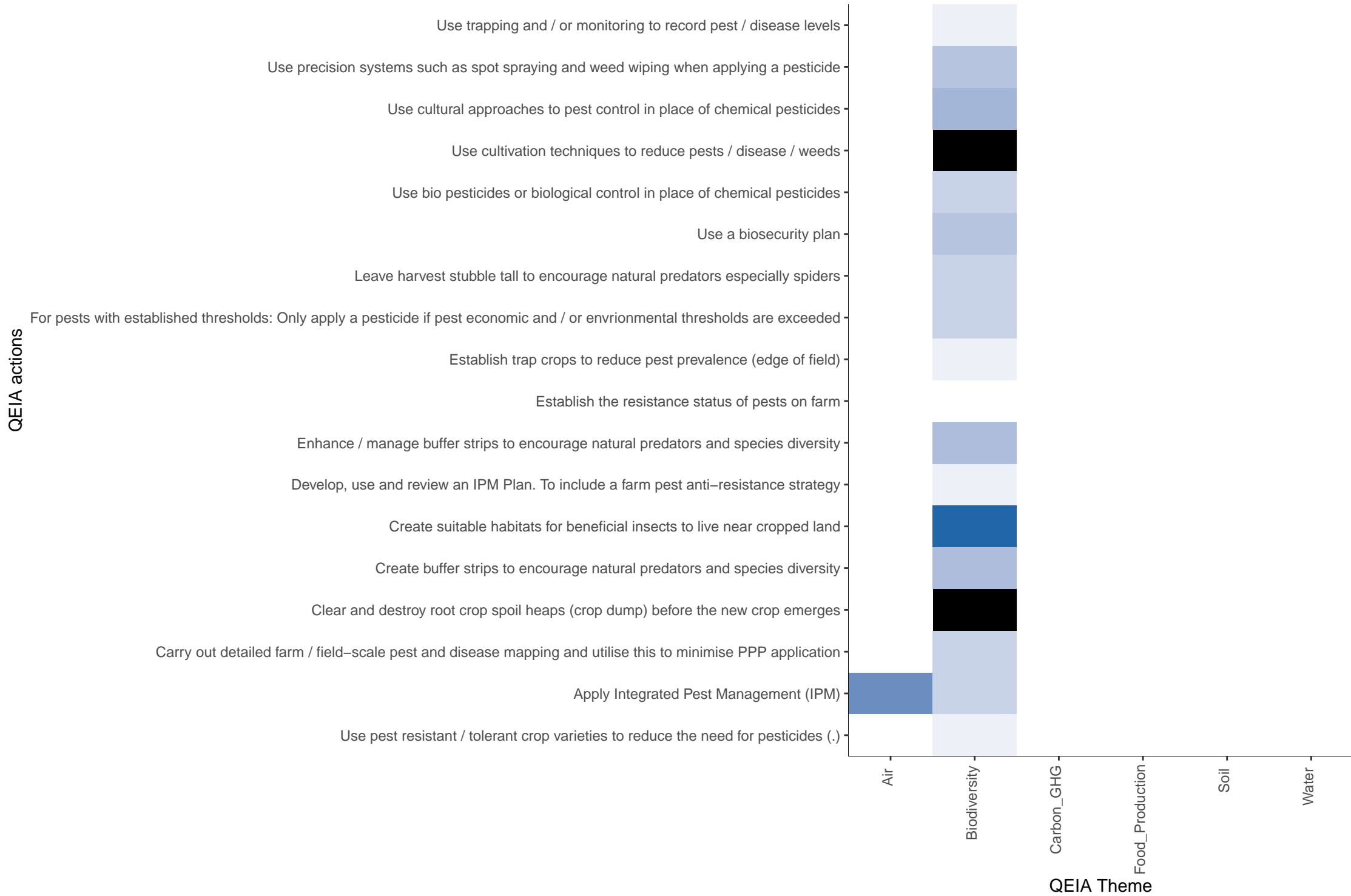
QEIA actions



QEIA Theme

# ARP measure

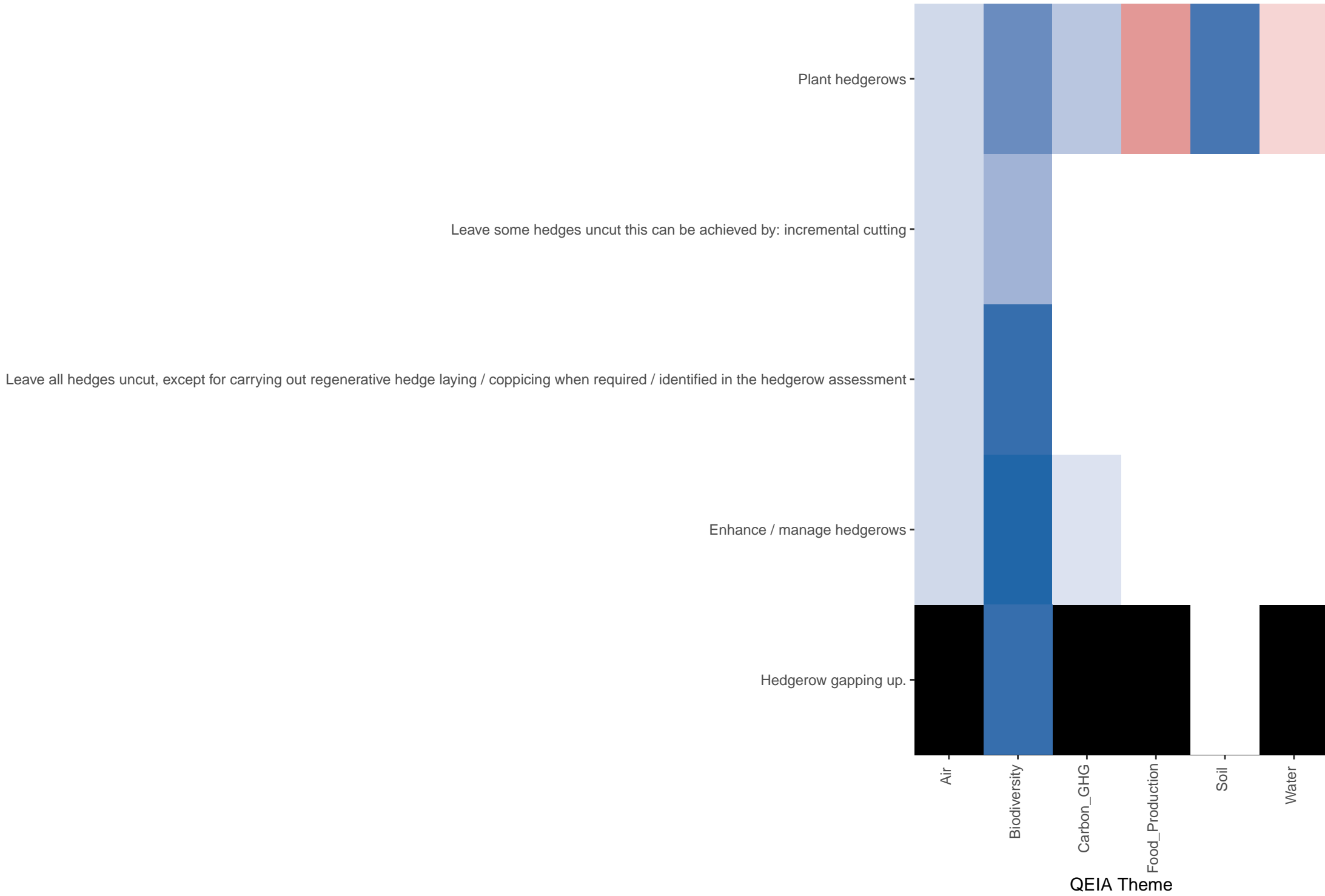
## Efficient / Reduced use of synthetic pesticides



# ARP measure

## Enhance Hedgerows

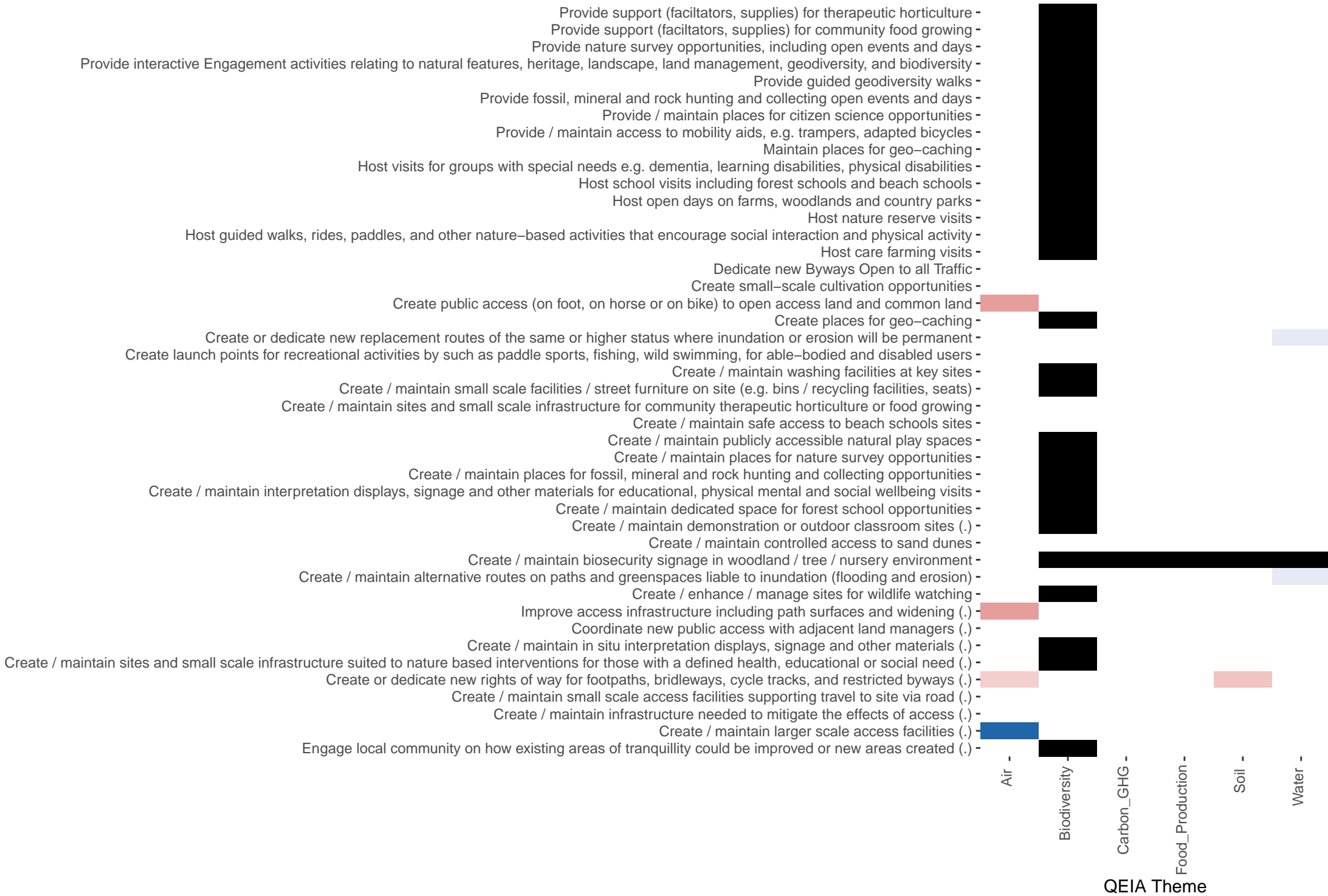
QEIA actions



# ARP measure

## Improving public access capital items menu

QEIA actions



QEIA Theme

# ARP measure

Inter-cropping, under-cropping and mixed cropping (e.g. peas and barley) and avoid monoculture

QEIA actions

- Use under and over sowing -
- Use intercropping -
- Establish a spatial spread of crops by not block cropping -
- Diversify arable rotations (including cover and catch crops, over and under sowing). -

Air

Biodiversity

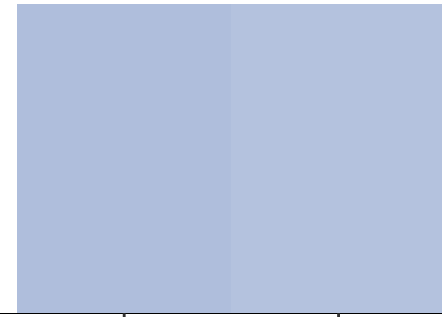
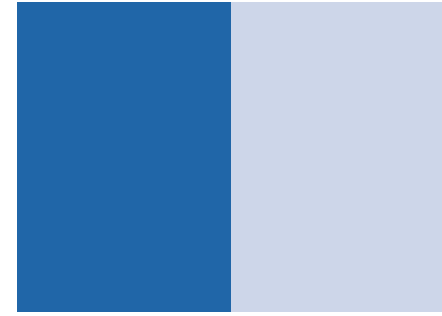
Carbon\_GHG

Food\_Production

Soil

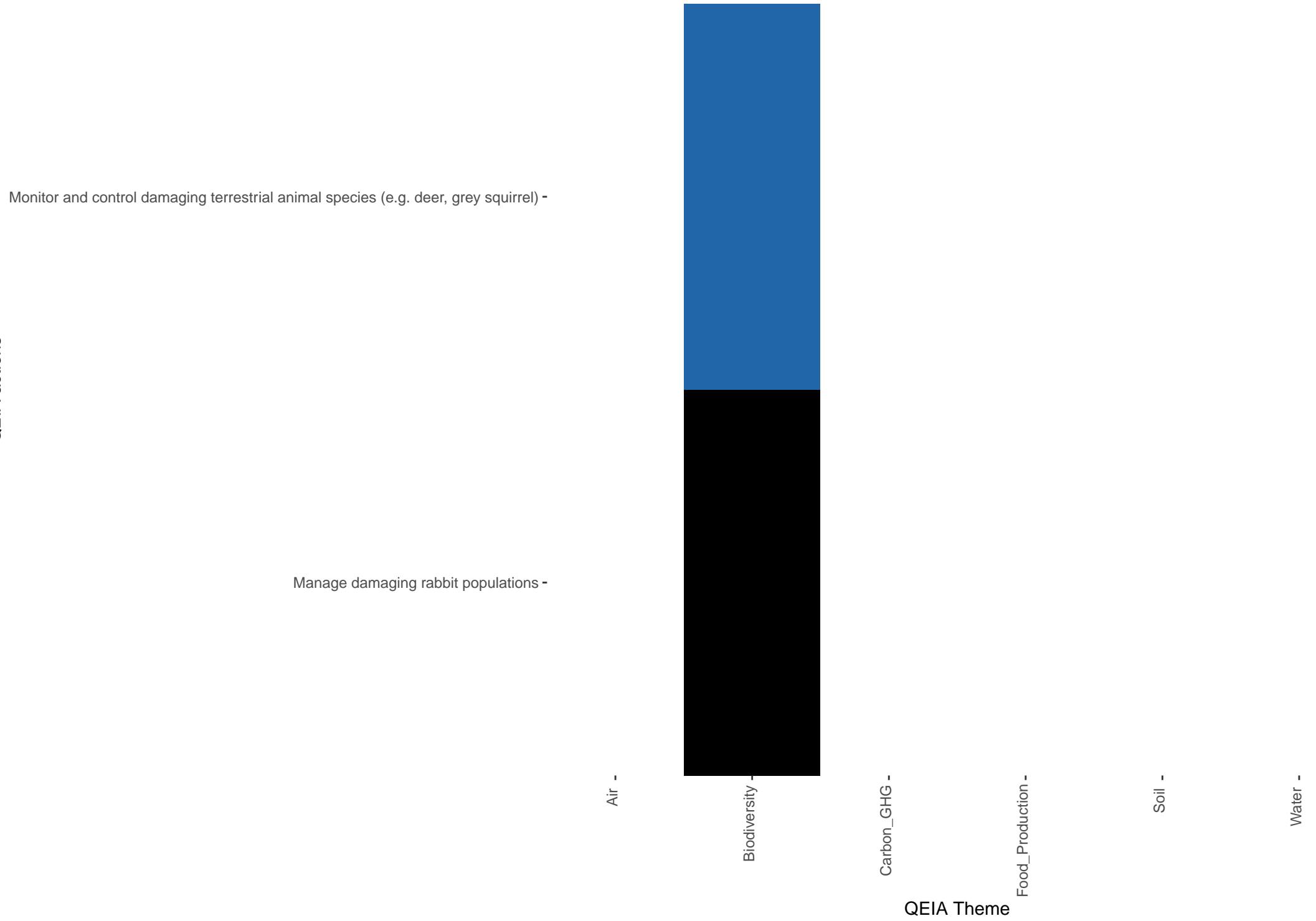
Water

QEIA Theme



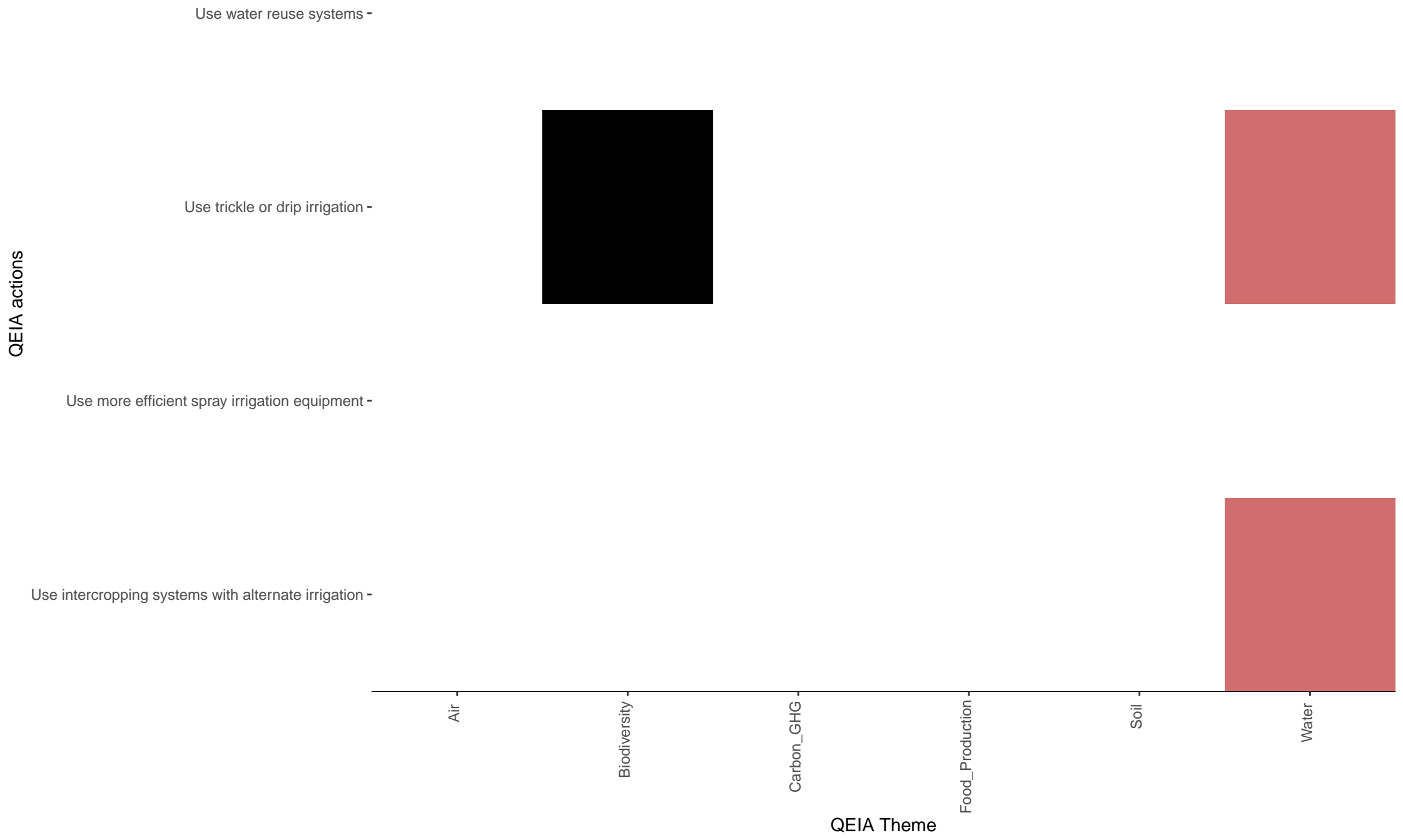
# ARP measure

## Interventions to reduce species impacts on land management activities



# ARP measure

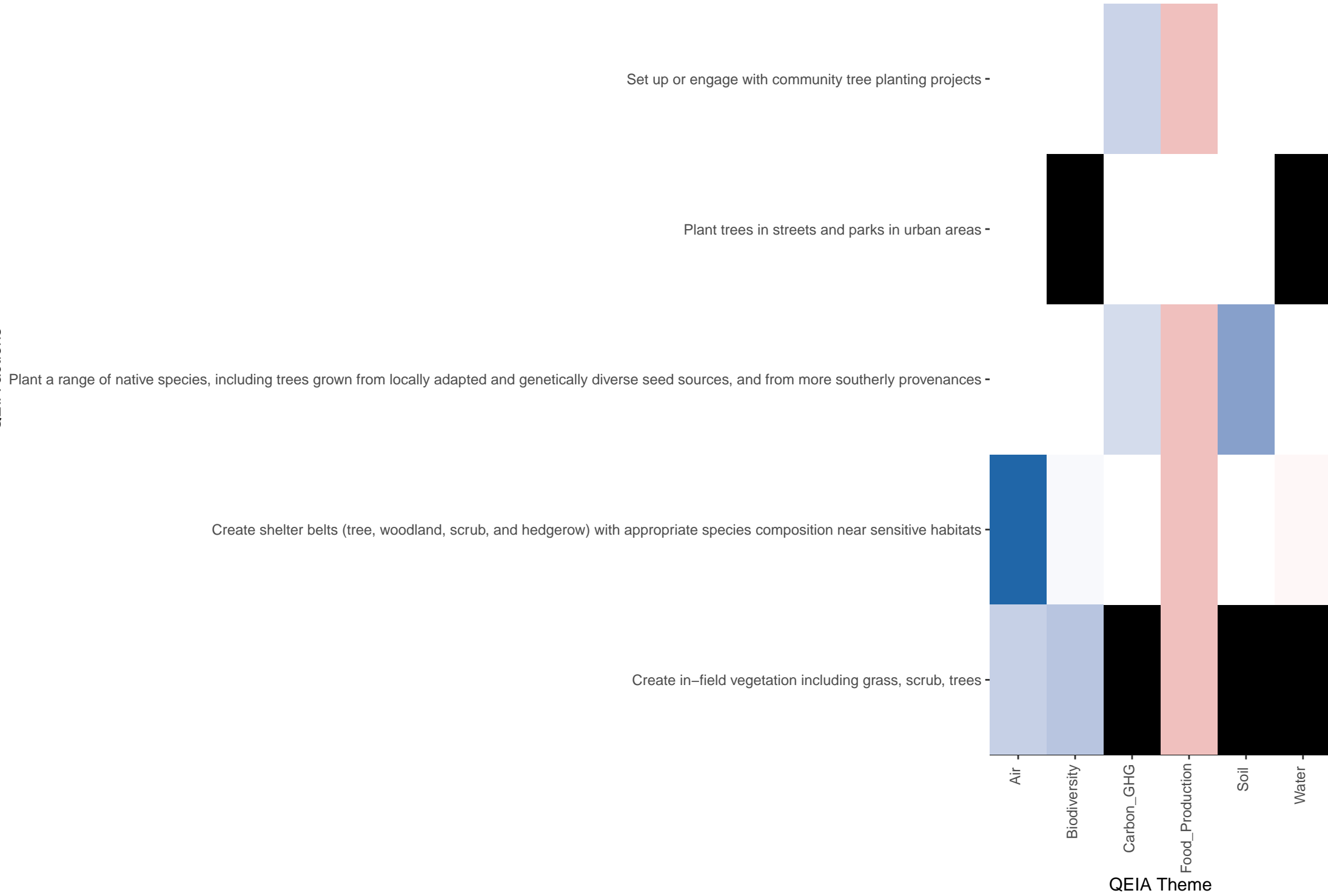
## Introduction of alternative efficient watering systems



# ARP measure

## Introduction of Small-Scale Tree and Shrub Planting

QEIA actions



QEIA Theme



# ARP measure

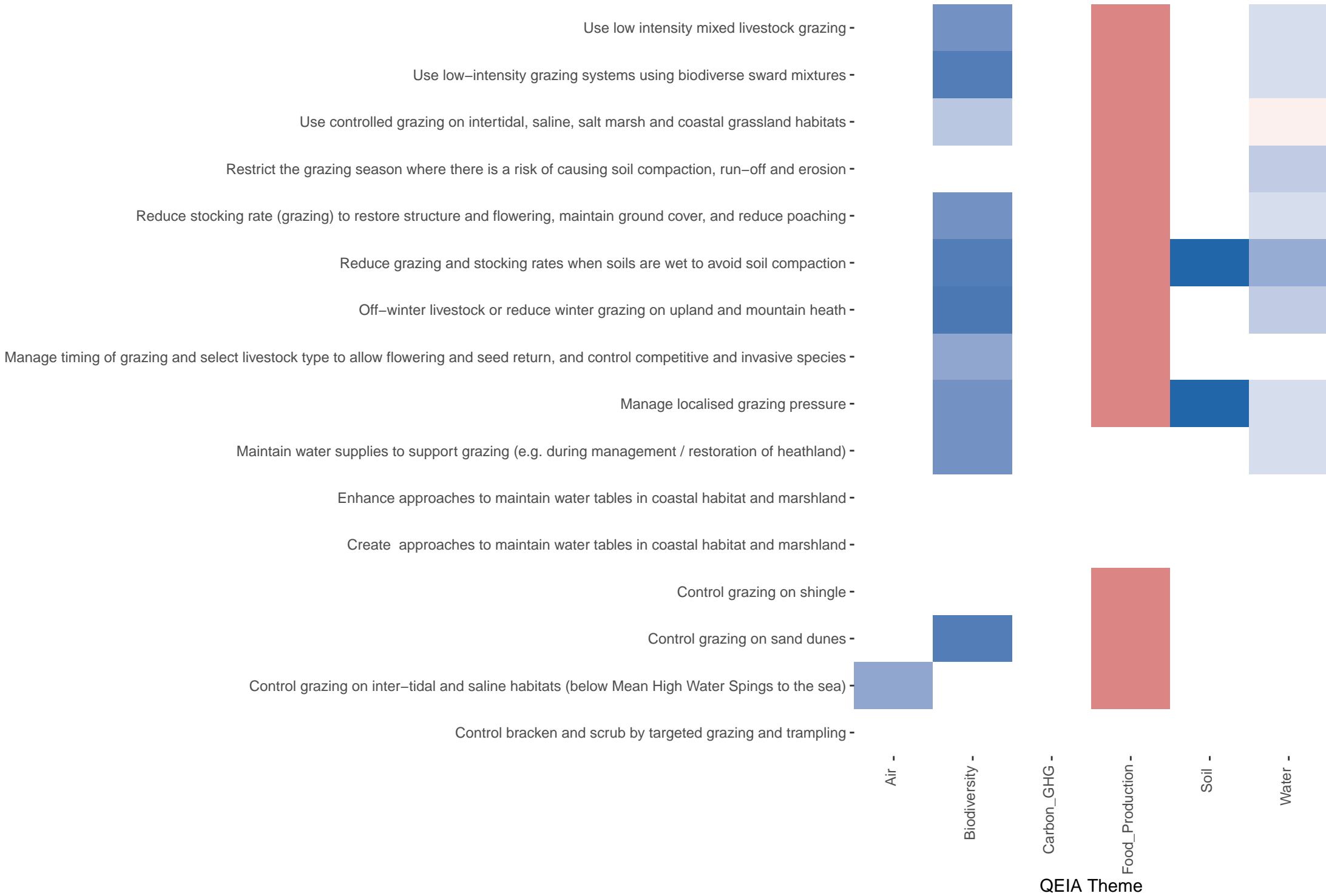
## Introduction of sustainable drainage systems



# ARP measure

## Manage Grazed Habitats

QEIA actions



QEIA Theme

# ARP measure

Management of deer populations to meet habitat condition targets

QEIA actions

Monitor and control damaging terrestrial animal species (e.g. deer, grey squirrel) -

Air -

Biodiversity -

Carbon\_GHG -

Food\_Production -

Soil -

Water -

QEIA Theme

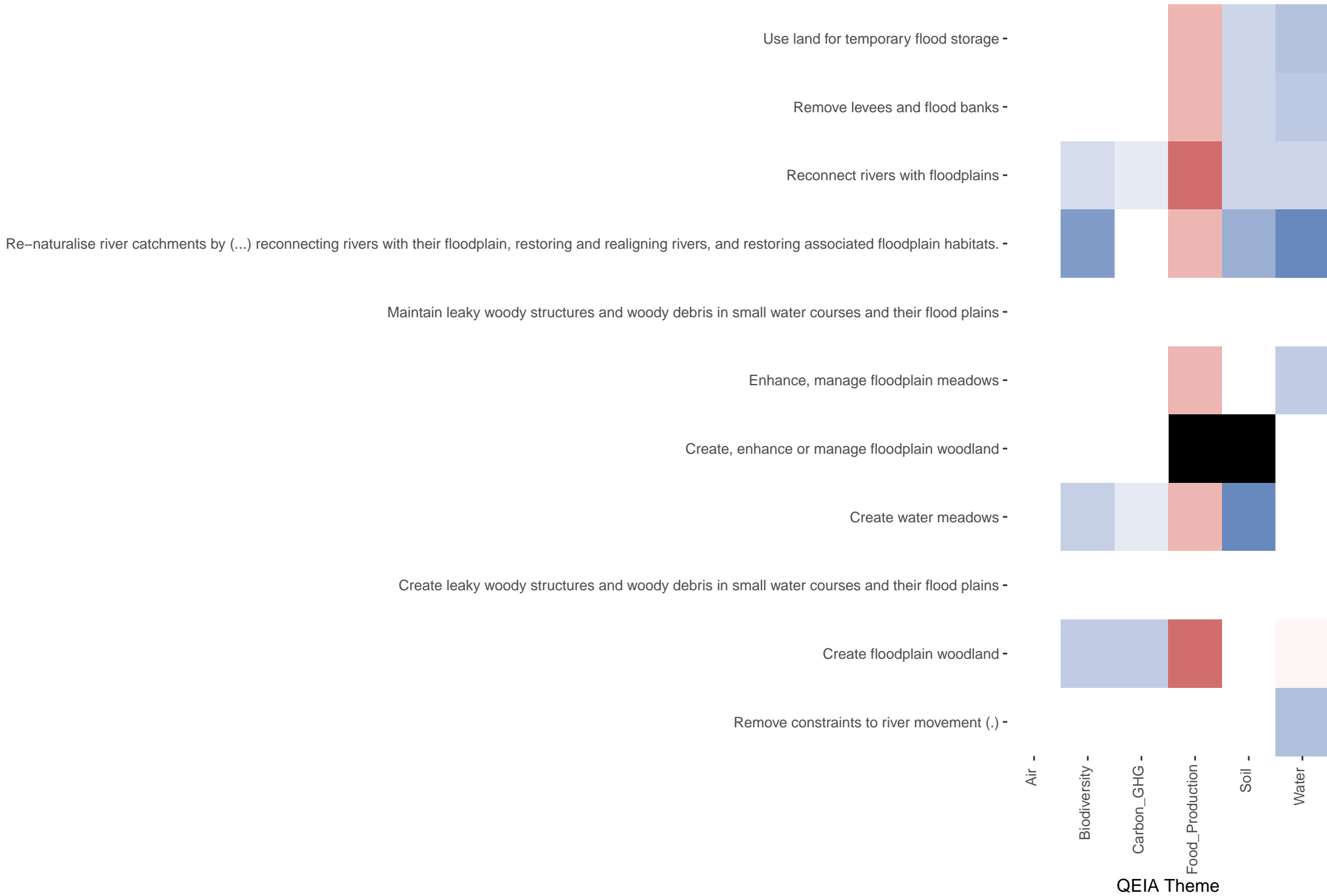




# ARP measure

## Management of floodplains

QEIA actions



QEIA Theme

ARP measure  
Minimum/No Till

Use no-till cultivation on agricultural lowland peatland -

Use minimum-tillage or no-tillage cultivation -

Use direct drilling into crop stubble or cover crops -

Air -

Biodiversity -

Carbon\_GHG -

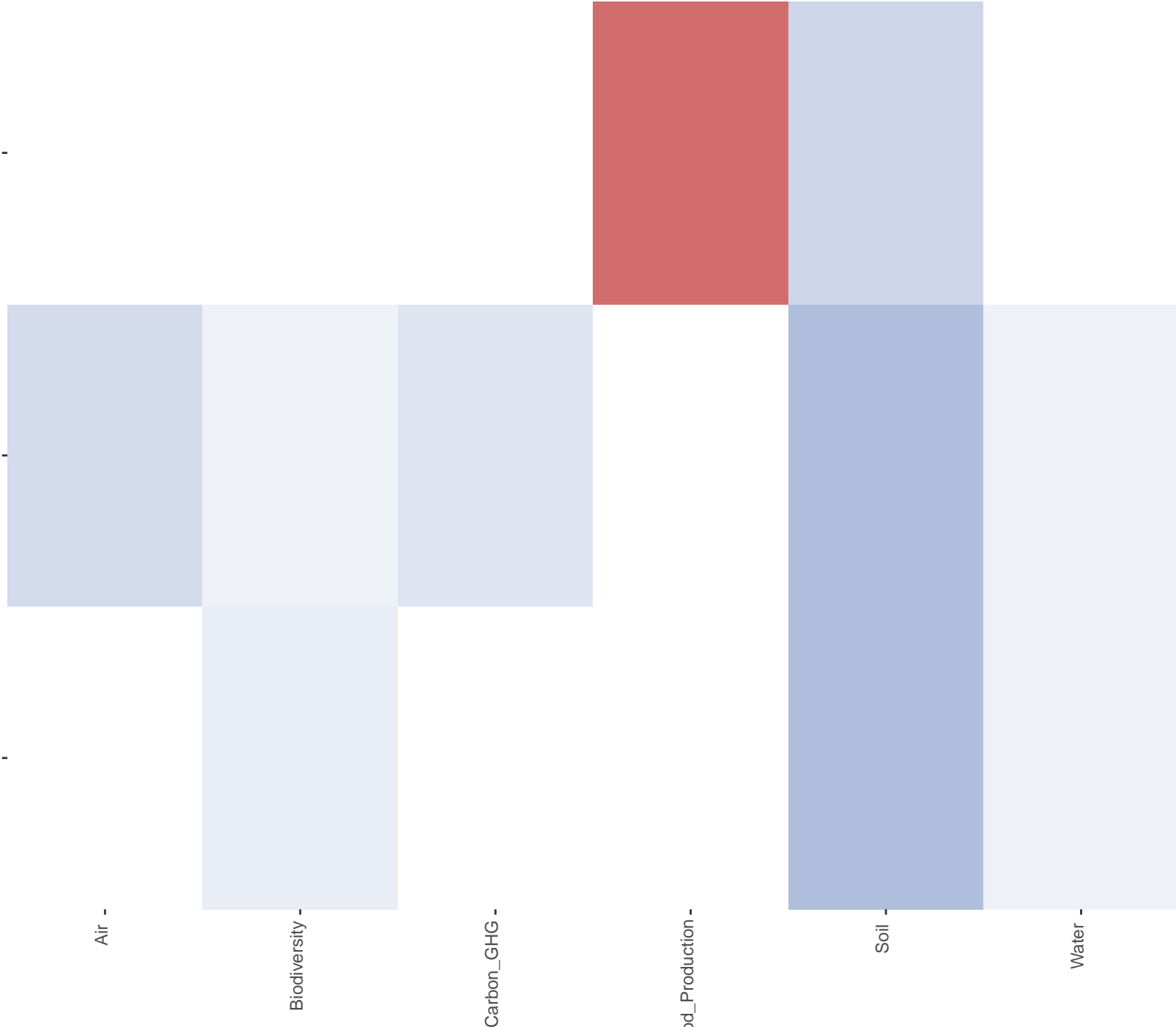
Food\_Production -

Soil -

Water -

QEIA Theme

QEIA actions



# ARP measure

Predator control to protect priority species

QEIA actions

Manage predation sustainably -

Air -

Biodiversity -

Carbon\_GHG -

Food\_Production -

Soil -

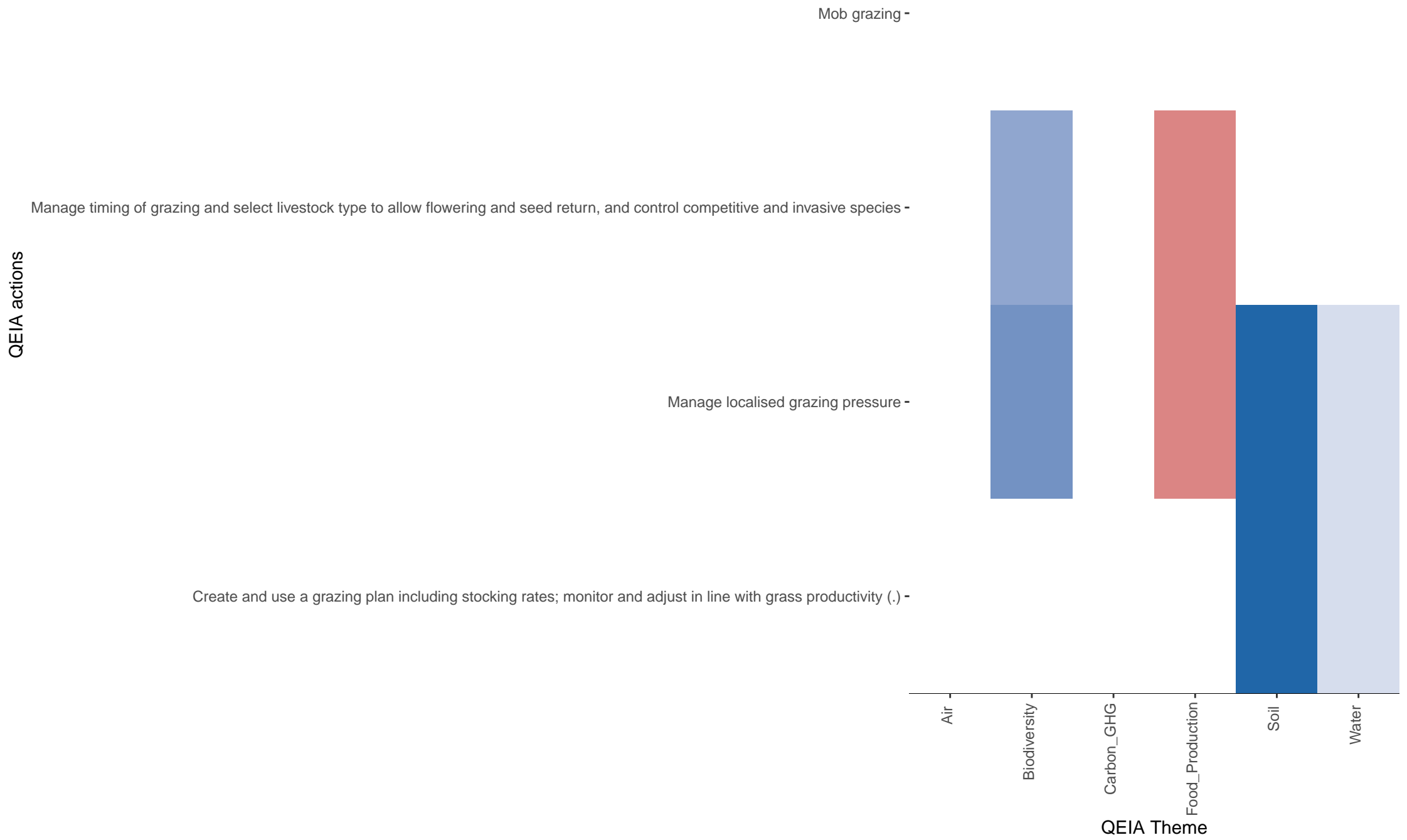
Water -

QEIA Theme



# ARP measure

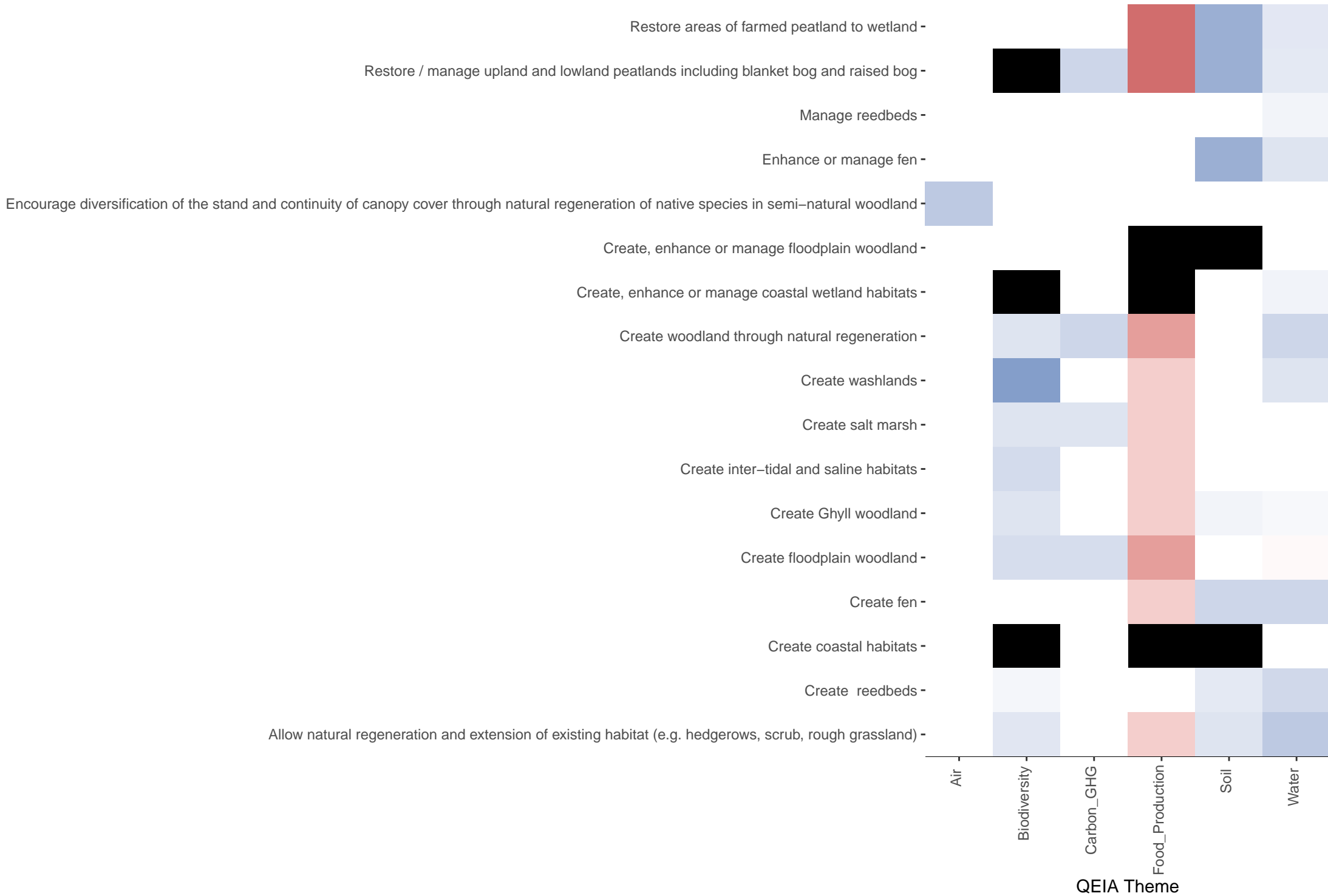
Regenerative grazing (mob, strip, adaptive multi-paddock grazing) on improved grassland





# ARP measure

## Restoration of natural habitats – peatland, natural woodlands, natural grasslands



ARP measure  
Restoring (protecting) river banks

Fence off rivers, streams, lakes and ponds from livestock (.) -

Use willow spiling -

Maintain check dams -

Create check dams -

QEIA actions

Air

Biodiversity

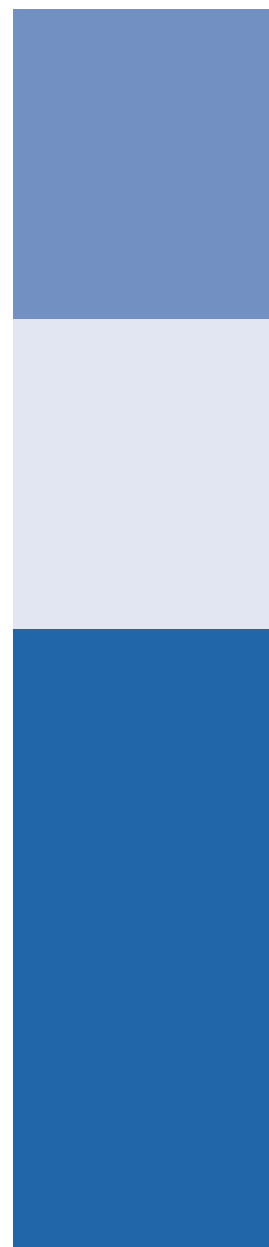
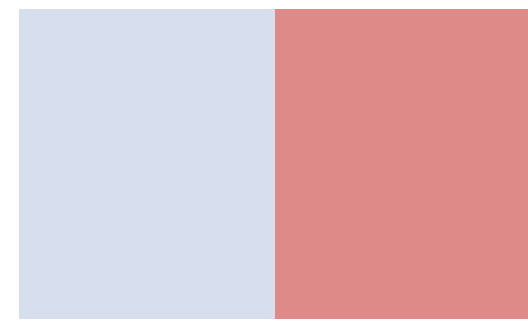
Carbon\_GHG

Food\_Production

Soil

Water

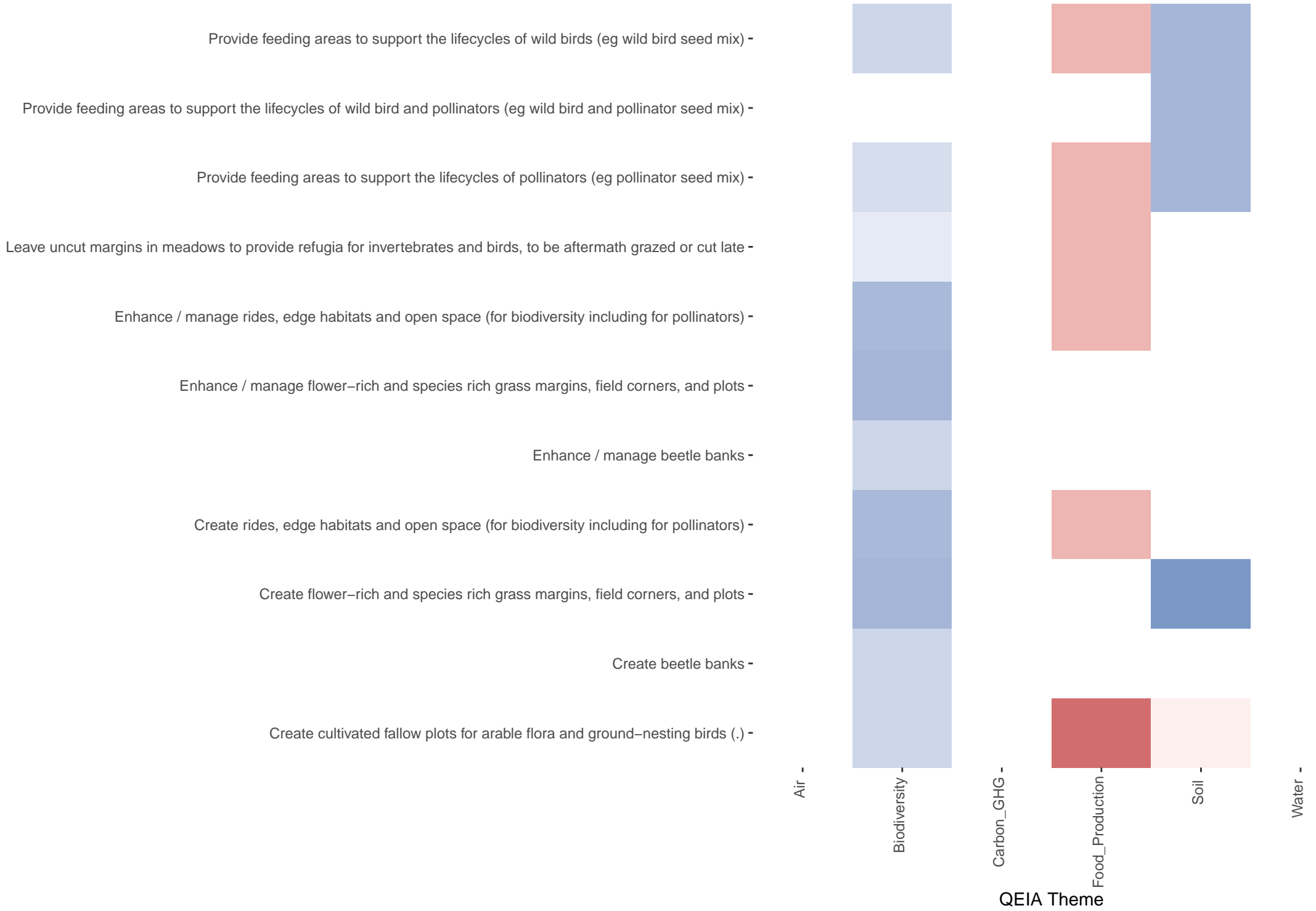
QEIA Theme



# ARP measure

## Retain and Enhance In Field Biodiversity Cropping and Features

QEIA actions



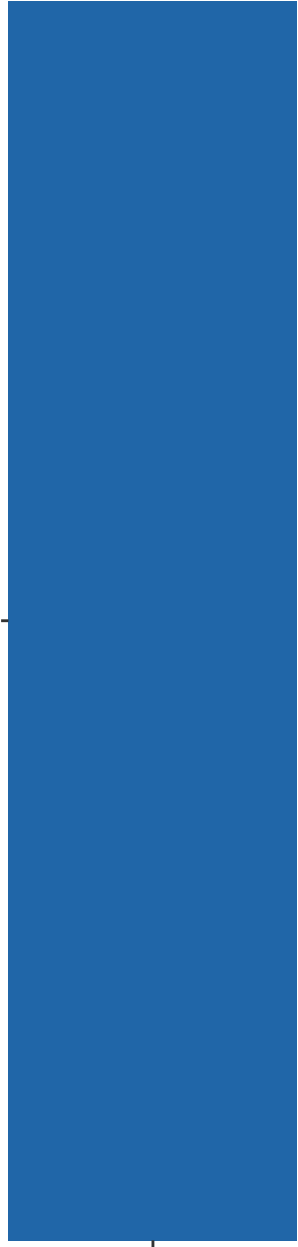
QEIA Theme

# ARP measure

## Retain Traditional Cattle Small Holdings

QEIA actions

Use rare breeds for conservation grazing



Air

Biodiversity -

Carbon\_GHG -

Food\_Production -

Soil -

Water -

QEIA Theme

ARP measure  
Summer Hill Cattle Grazing

QEIA actions

Off-winter livestock or reduce winter grazing on upland and mountain heath -

Air -

Biodiversity -

Carbon\_GHG -

Food\_Production -

Soil -

Water -

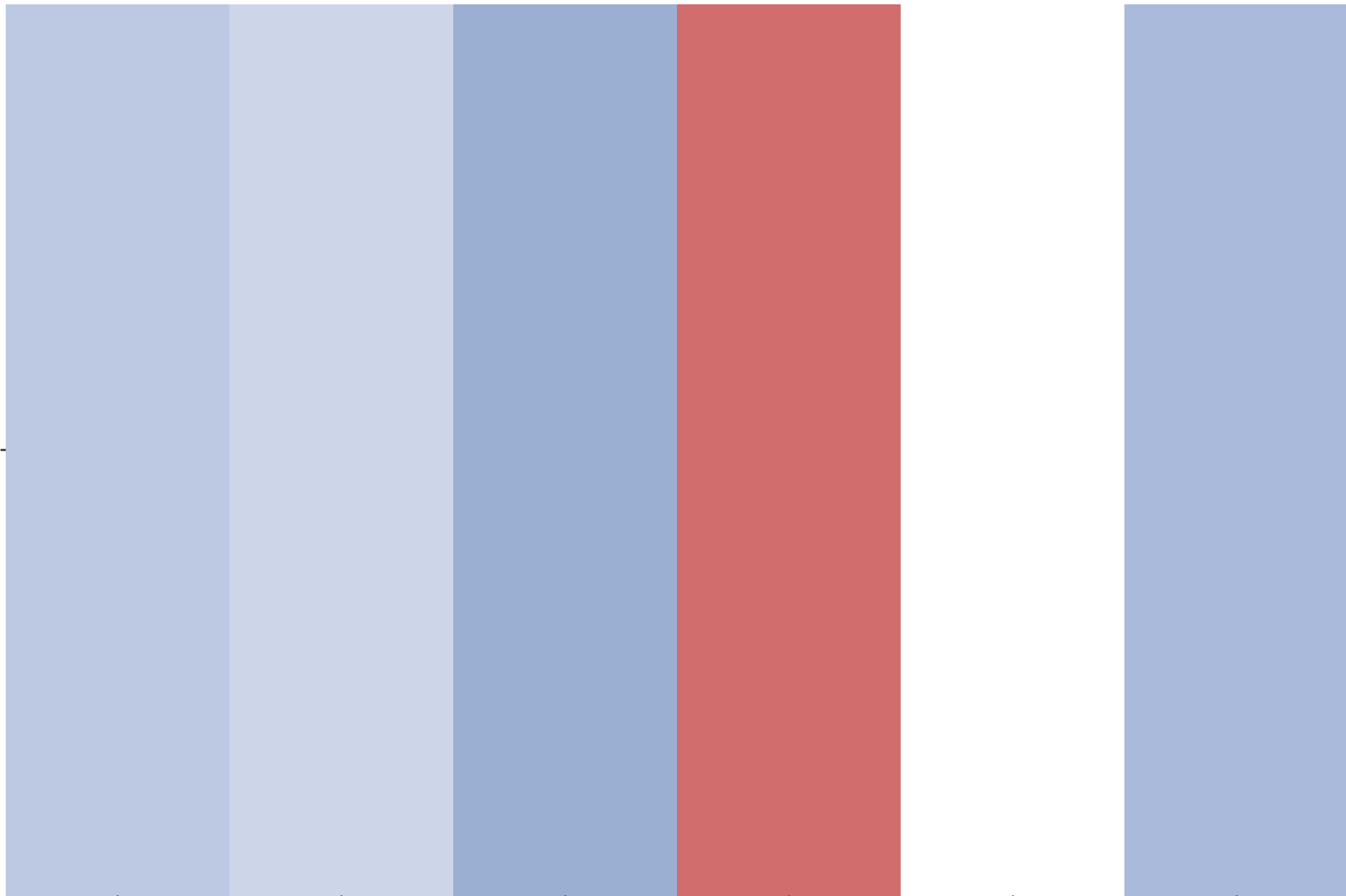
QEIA Theme



ARP measure  
Sylvo-arable systems

QEIA actions

Create agroforestry systems



Air

Biodiversity

Carbon\_GHG

Food\_Production

Soil

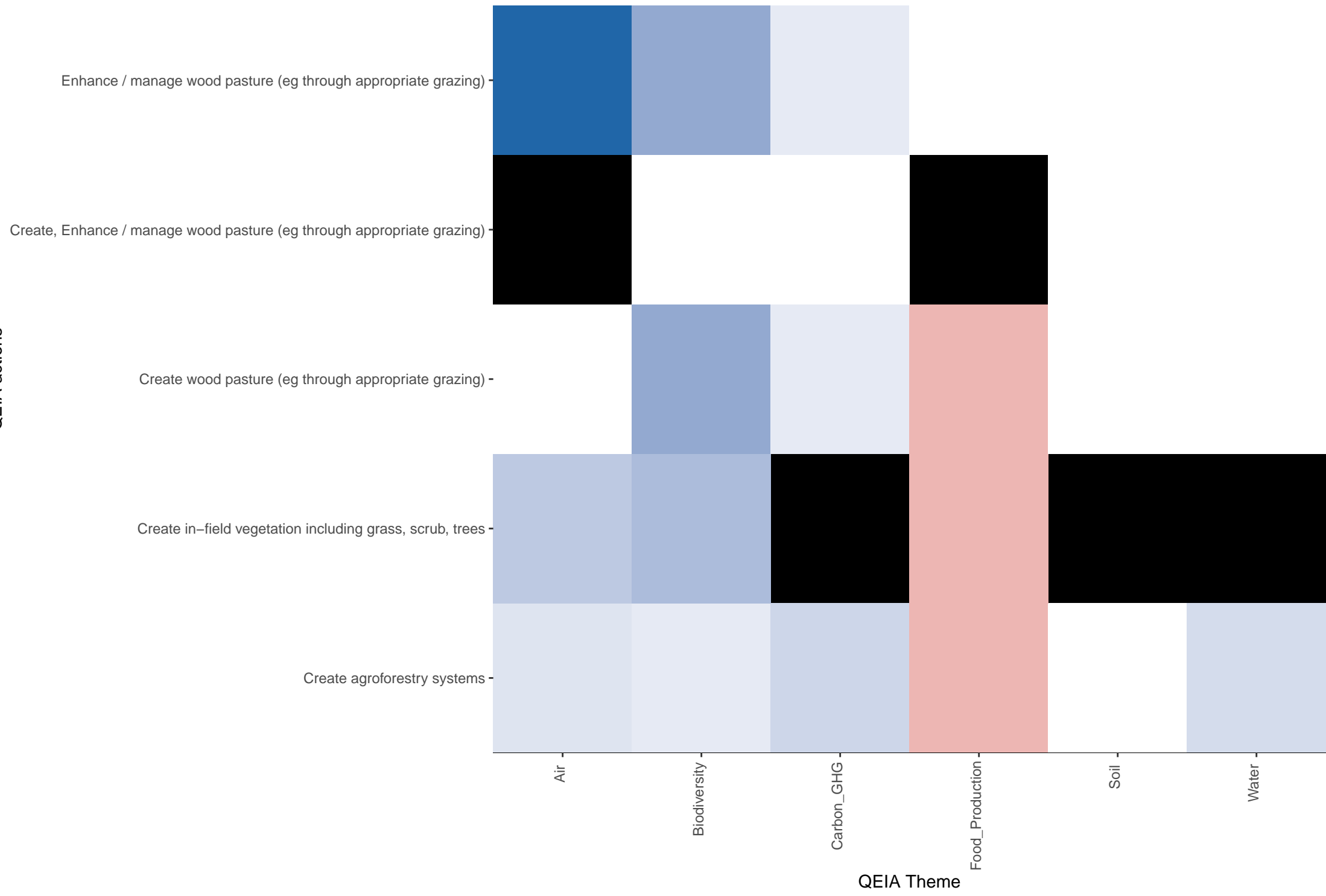
Water

QEIA Theme

# ARP measure

## Sylvo-pastures

QEIA actions



QEIA Theme

ARP measure  
Use of N fixing crops

QEIA actions

Replace nitrogen fertiliser application by using clover in pasture systems

Replace nitrogen fertiliser application by using clover in arable cropping systems

Incorporate clovers and other legumes in grazed pastures

Air

Biodiversity

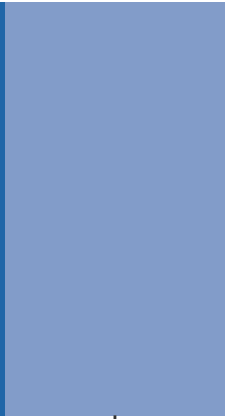
Carbon\_GHG

Food\_Production

Soil

Water

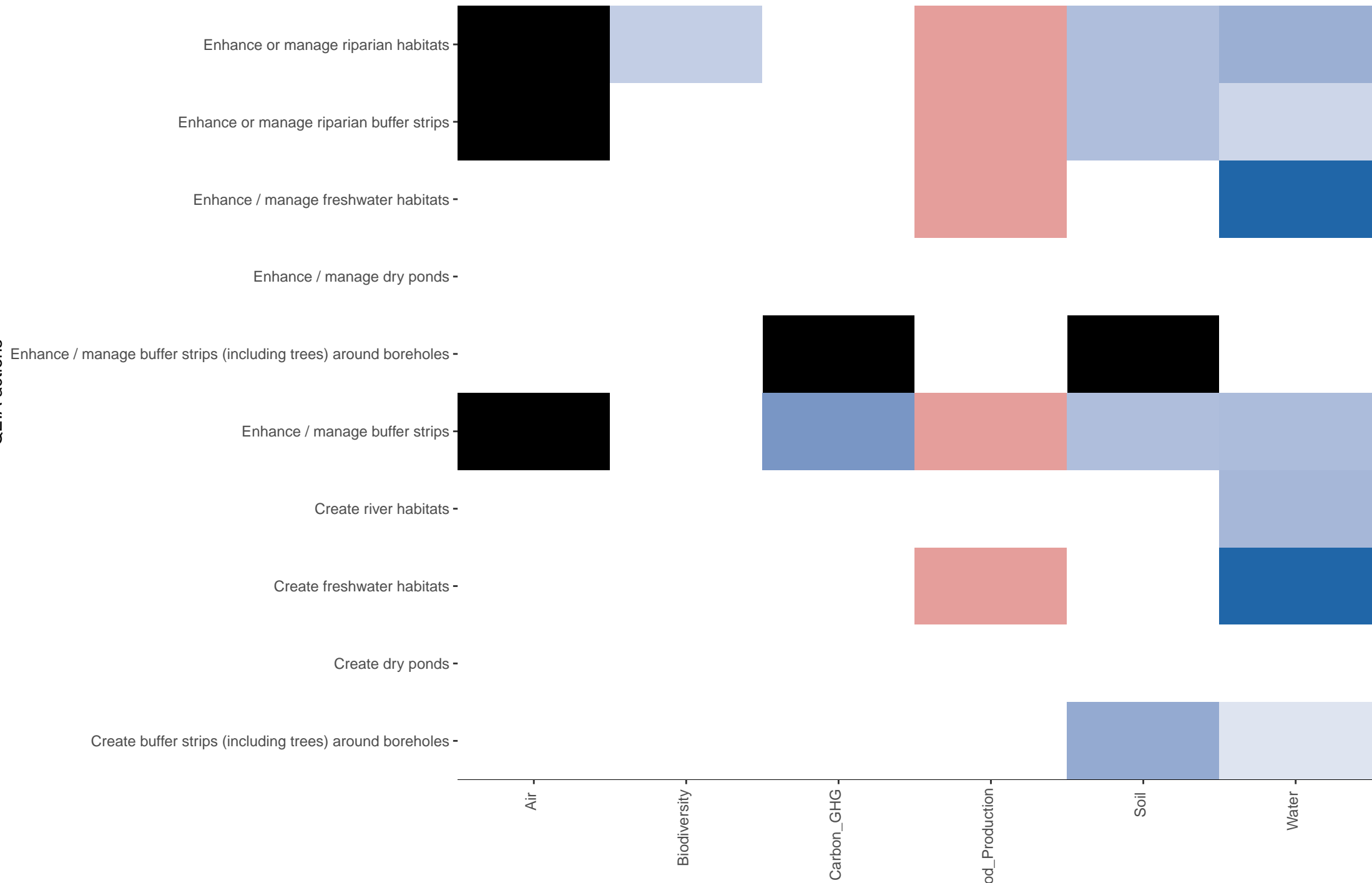
QEIA Theme





ARP measure  
Water Margins

QEIA actions



QEIA Theme

# ARP measure

## Winter cover

QEIA actions

Use restorative vegetation cover following destoning or lifting of root crops -

Use cover crops -

Minimise bare soil to reduce soil loss e.g. cover crops, crop residues, trees coppice etc

Enhanced overwinter stubble -

Air

Biodiversity

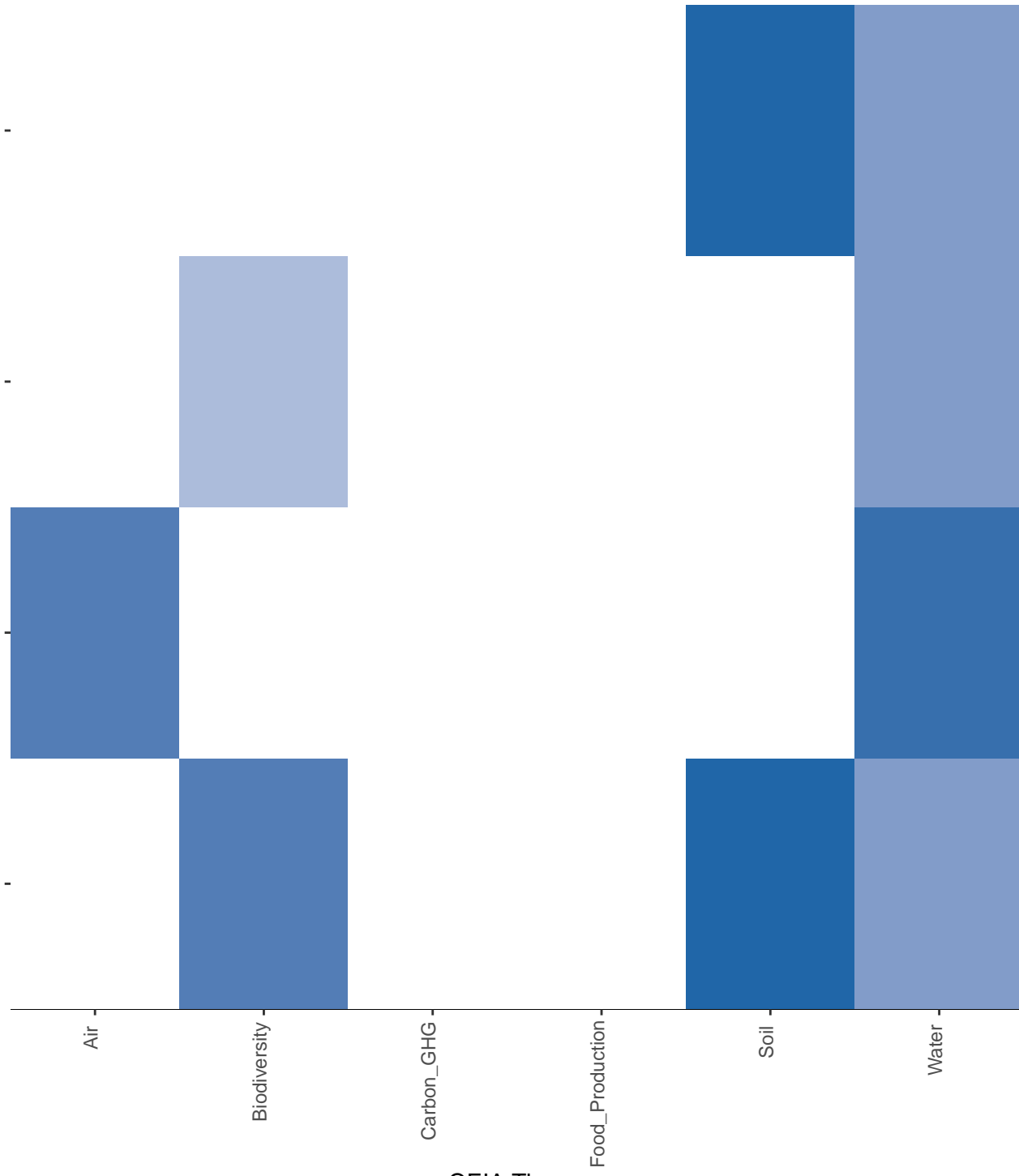
Carbon\_GHG

Food\_Production

Soil

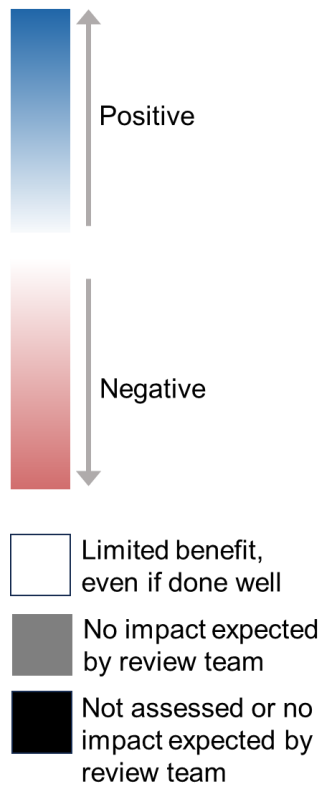
Water

QEIA Theme



## Annex C

ES indicator scores related to the biodiversity theme for QEIA actions relevant to the proposed ARP list of measures



**Figure C1 The scale to be used alongside the plots within Annex C.**

# ARP measure

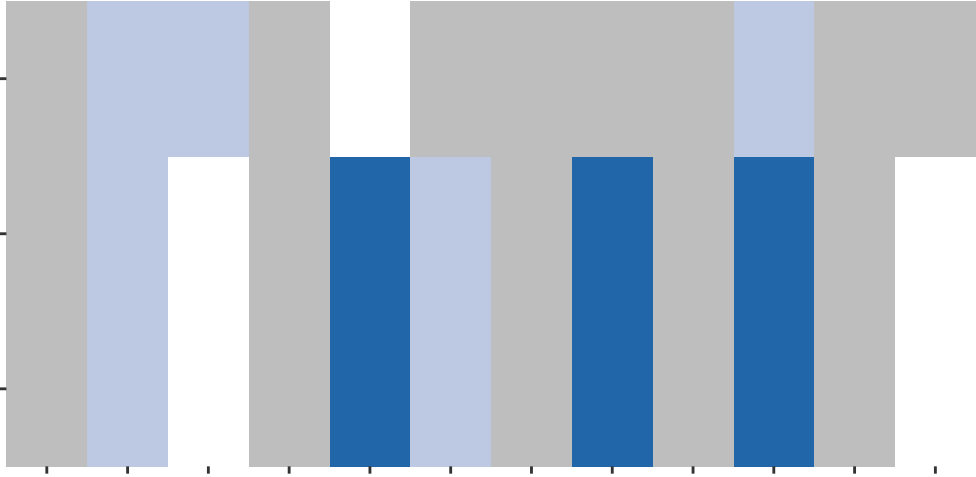
## Arable and Silage/Hay Crop Margins

QEIA actions

Leave uncut margins in meadows to provide refugia for invertebrates and birds, to be aftermath grazed or cut late

Enhance / manage flower-rich and species rich grass margins, field corners, and plots

Create flower-rich and species rich grass margins, field corners, and plots

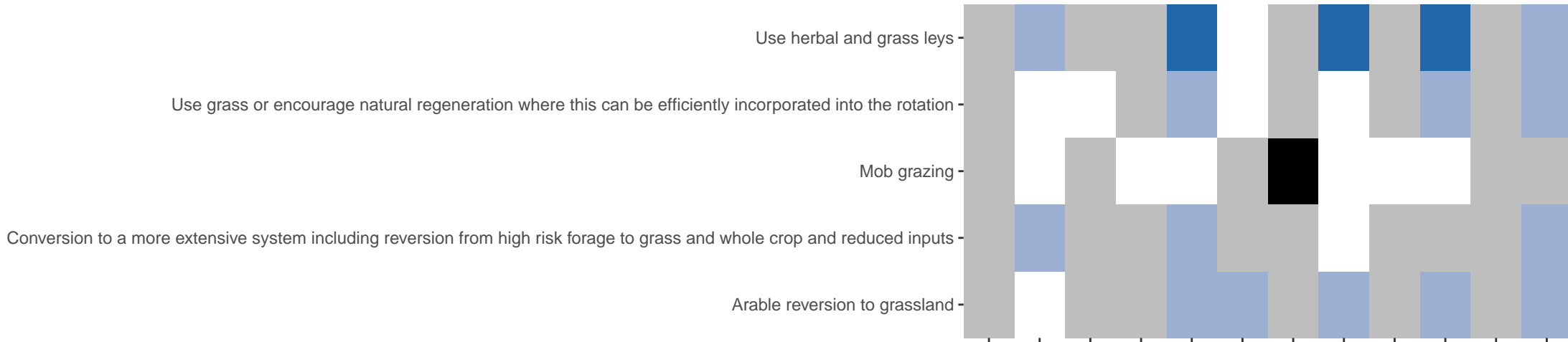


QEIA ES indicator

# ARP measure

Arable/ley rotations (transition from arable to arable/livestock mix)

QEIA actions

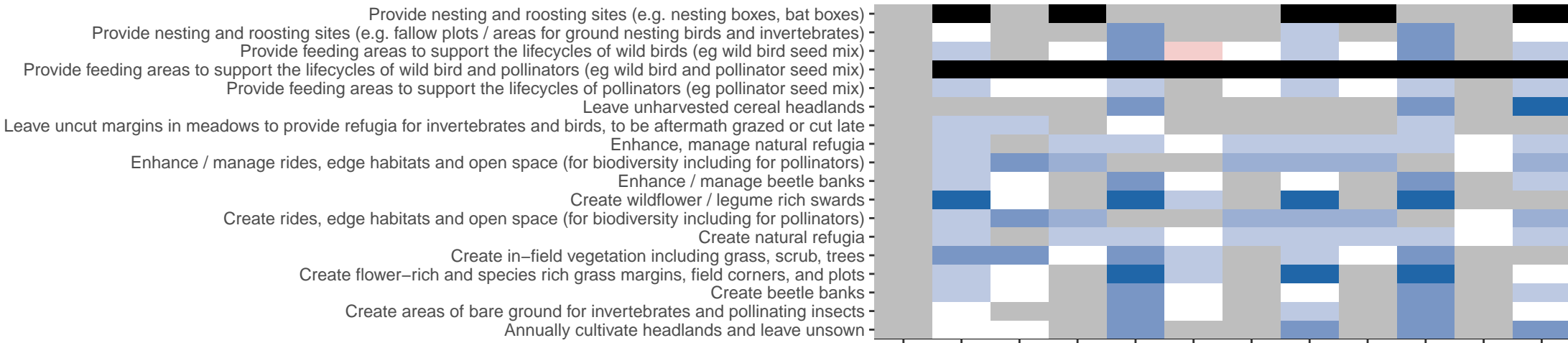


QEIA ES indicator

# ARP measure

## Biodiversity cropping

QEIA actions



Atmospheric deposition of N and exceedance of critical loads

Biodiversity adaptation – maintaining / enhancing biodiversity under a changing climate

Connectivity of small 'feature' habitats

Enhance abundance and species richness of semi-natural habitat

Enhance abundance and species richness of wider farmland biodiversity

Evidence of outbreaks of pests and disease

Favourable condition of SSSIs

Increased abundance, distribution and species richness of pollinators and seed dispersers

Maintain abundance and species richness of semi-natural habitat

Maintain abundance and species richness of wider farmland biodiversity

National species occurrence

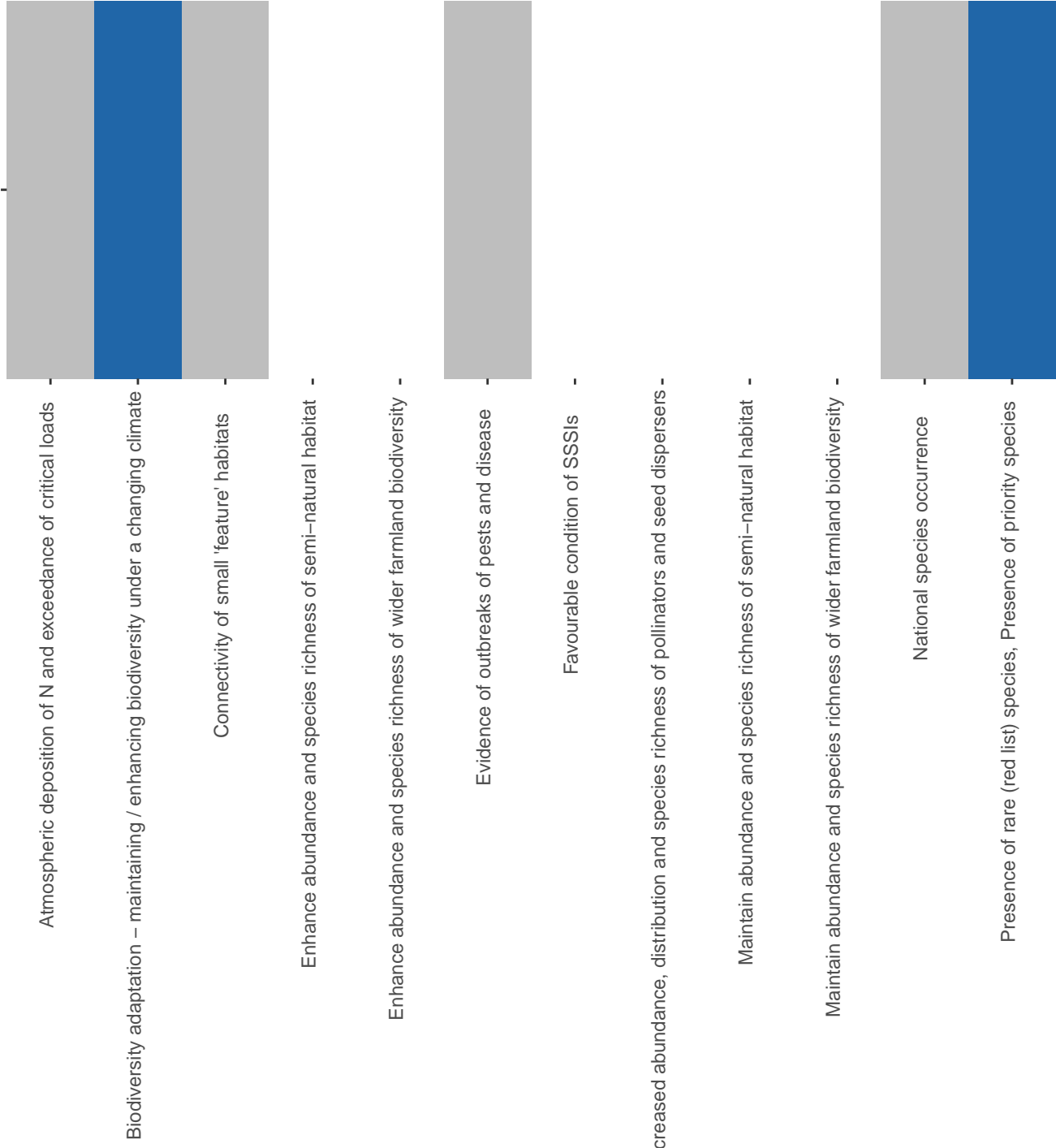
Presence of rare (red list) species, Presence of priority species

QEIA ES indicator

QEIA actions

ARP measure  
Bird friendly Crop Operations

Use targeted habitat management for species with highly specialised requirements



QEIA ES indicator

# ARP measure

## Coastal or River embankment breaching, lowering or removal

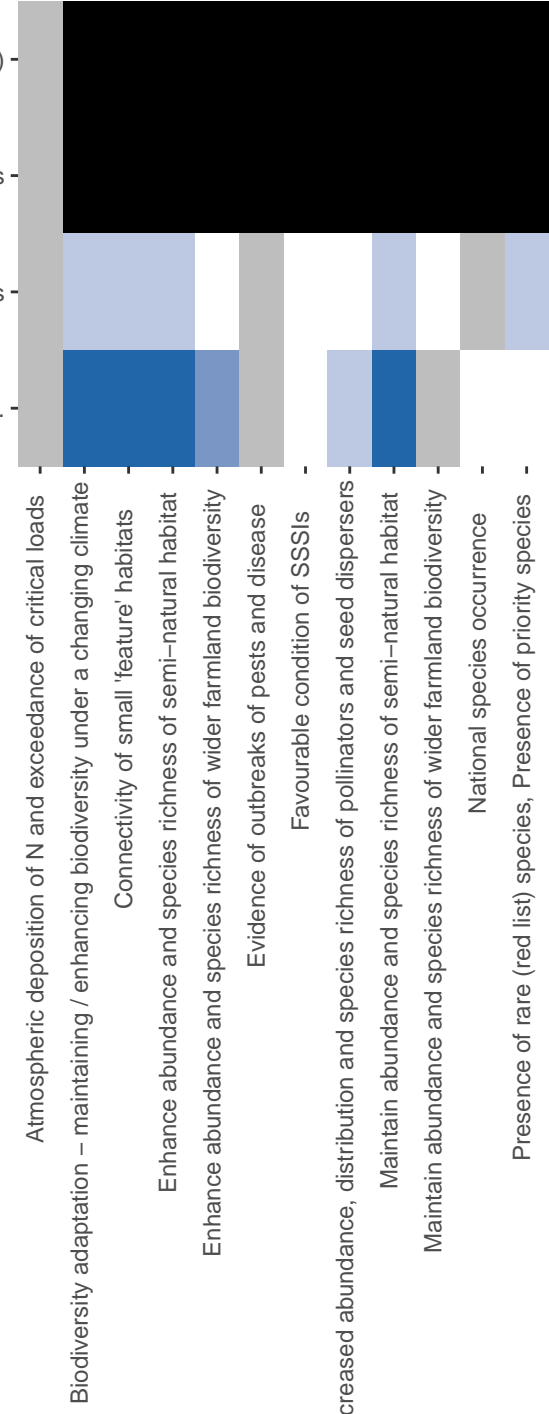
QEIA actions

Re-naturalise river catchments by (...) reconnecting rivers with their floodplain, restoring and realigning rivers, and restoring associated floodplain habitats.

Remove constraints to river movement (.)

Remove levees and flood banks

Reconnect rivers with floodplains



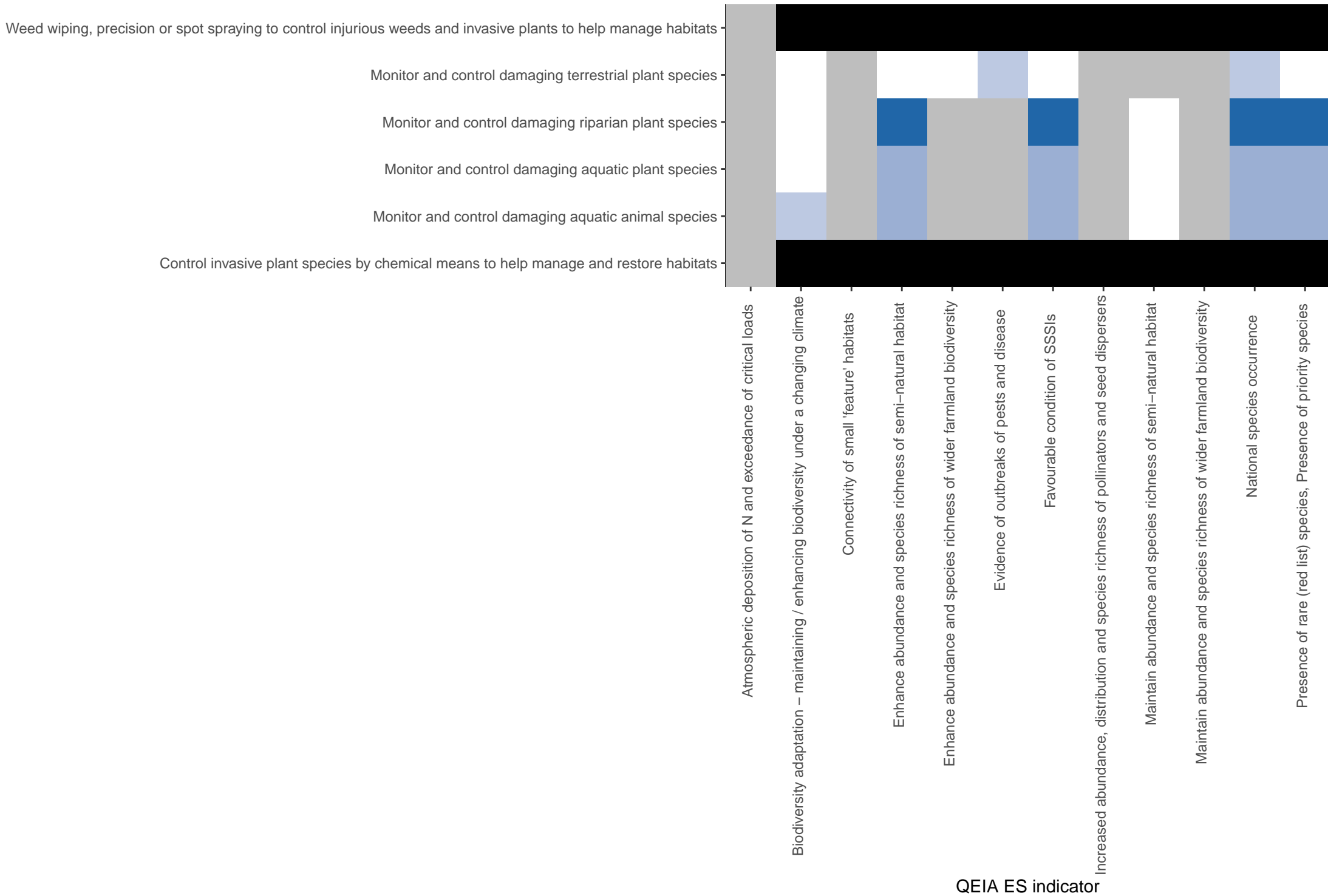
QEIA ES indicator



# ARP measure

## Control of Invasive Non-native Species

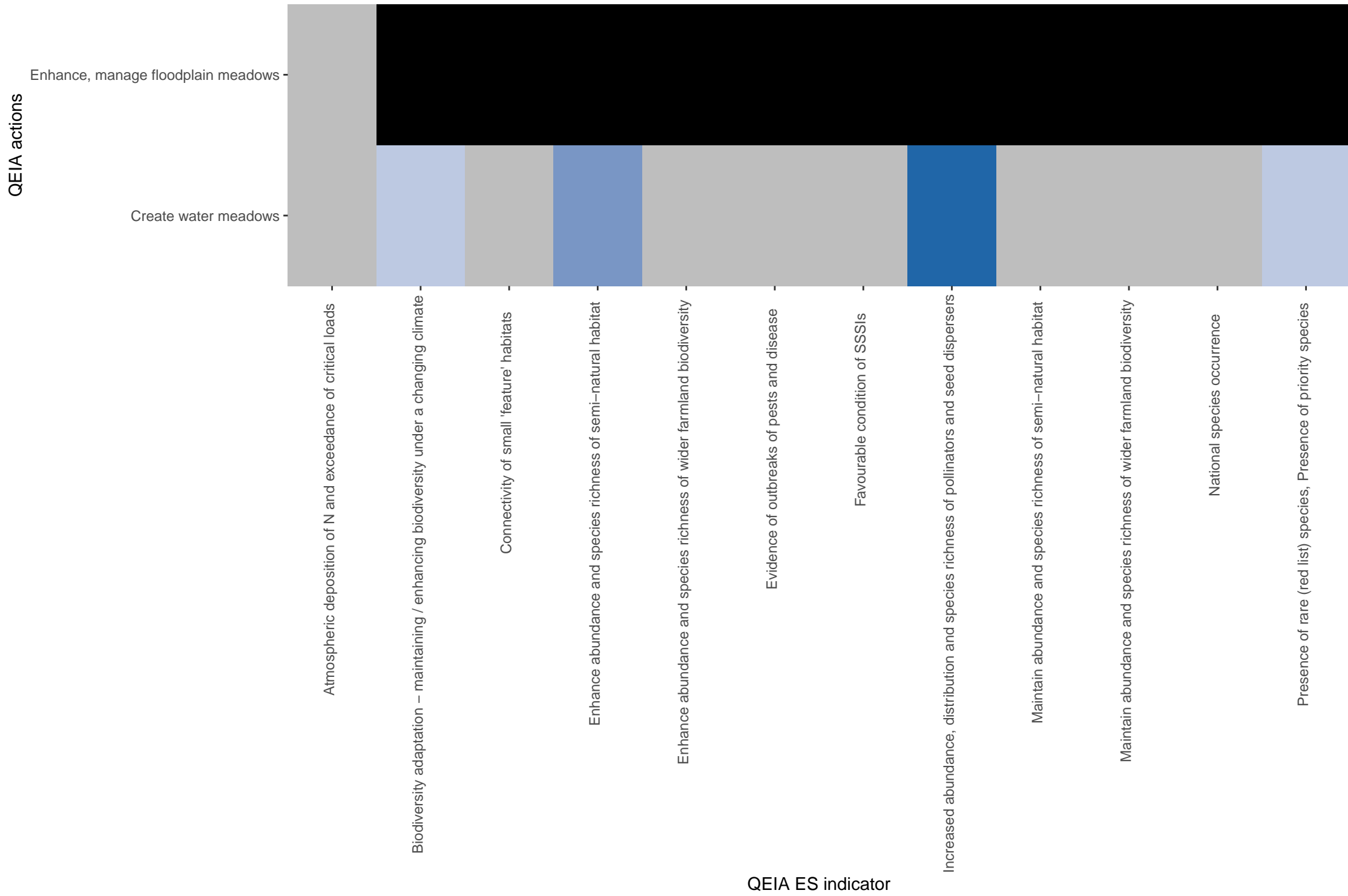
QEIA actions



QEIA ES indicator

# ARP measure

## Converting land at risk of erosion/flooding to low-input grassland



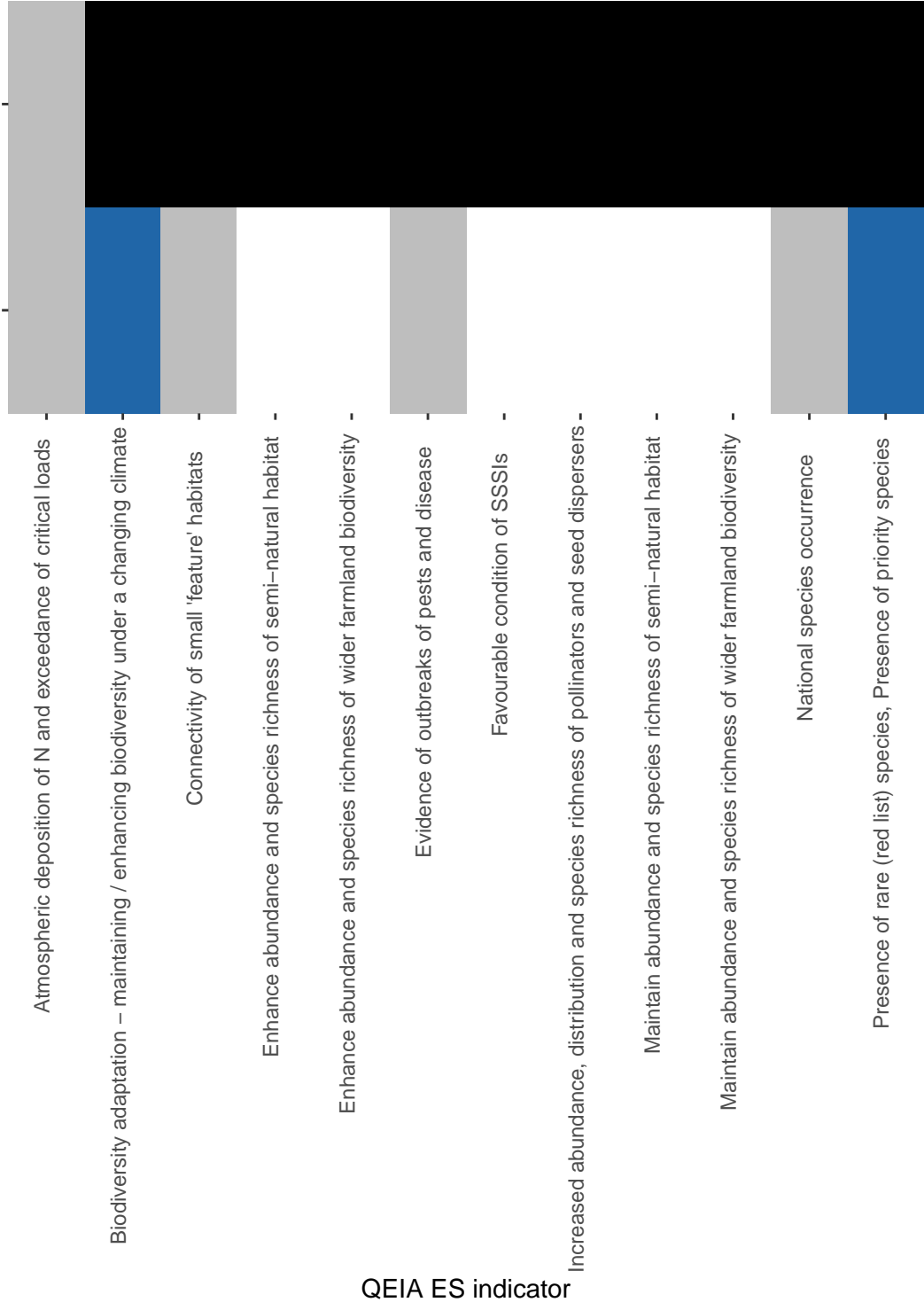
# ARP measure

Create and maintain habitats specific for the target species

QEIA actions

Undertake targeted measures to recover populations of rare, threatened or otherwise vulnerable species (.)

Use targeted habitat management for species with highly specialised requirements

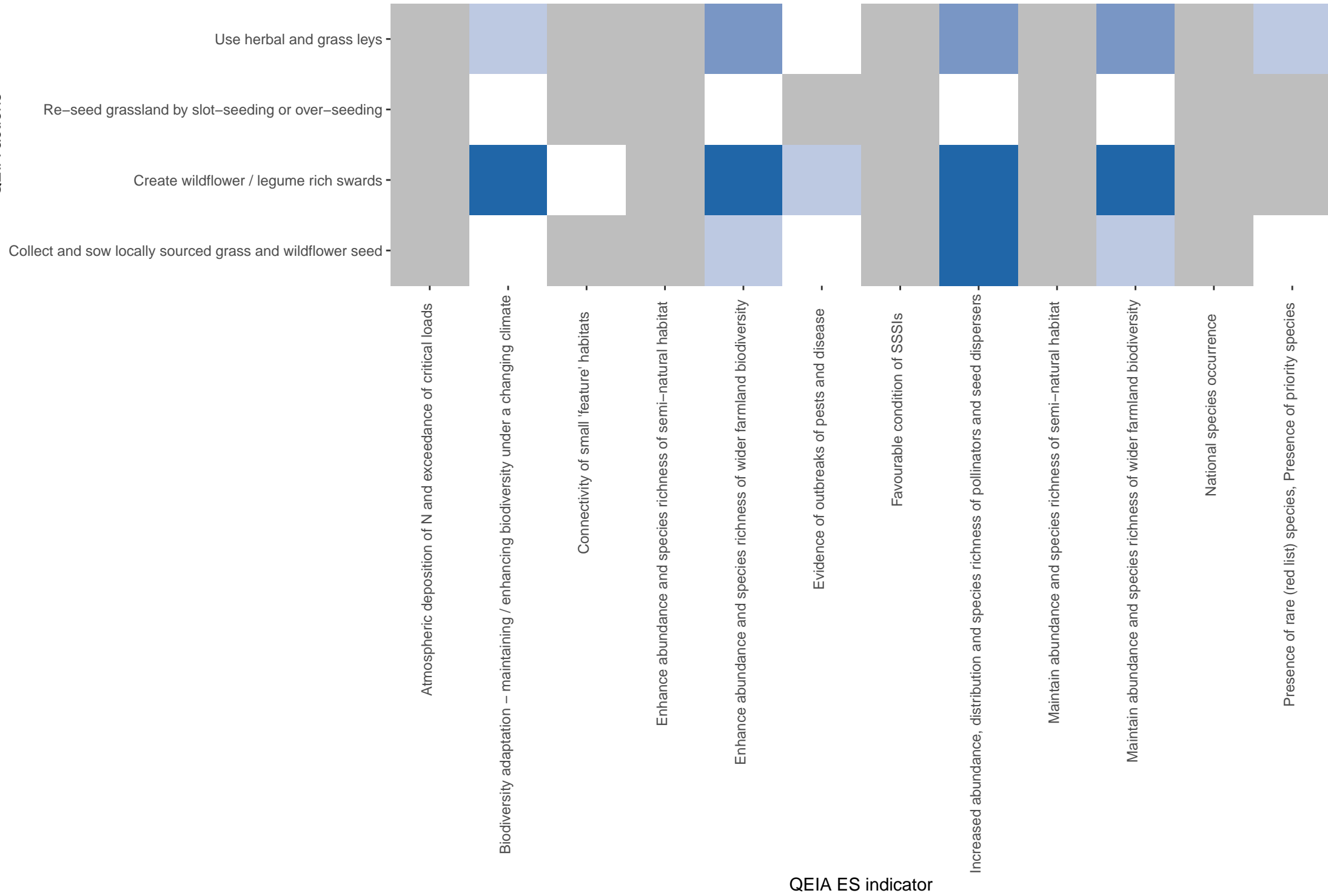


QEIA ES indicator

# ARP measure

## Diverse sward species content (legumes–herb–grass mixtures) and use of herbal leys

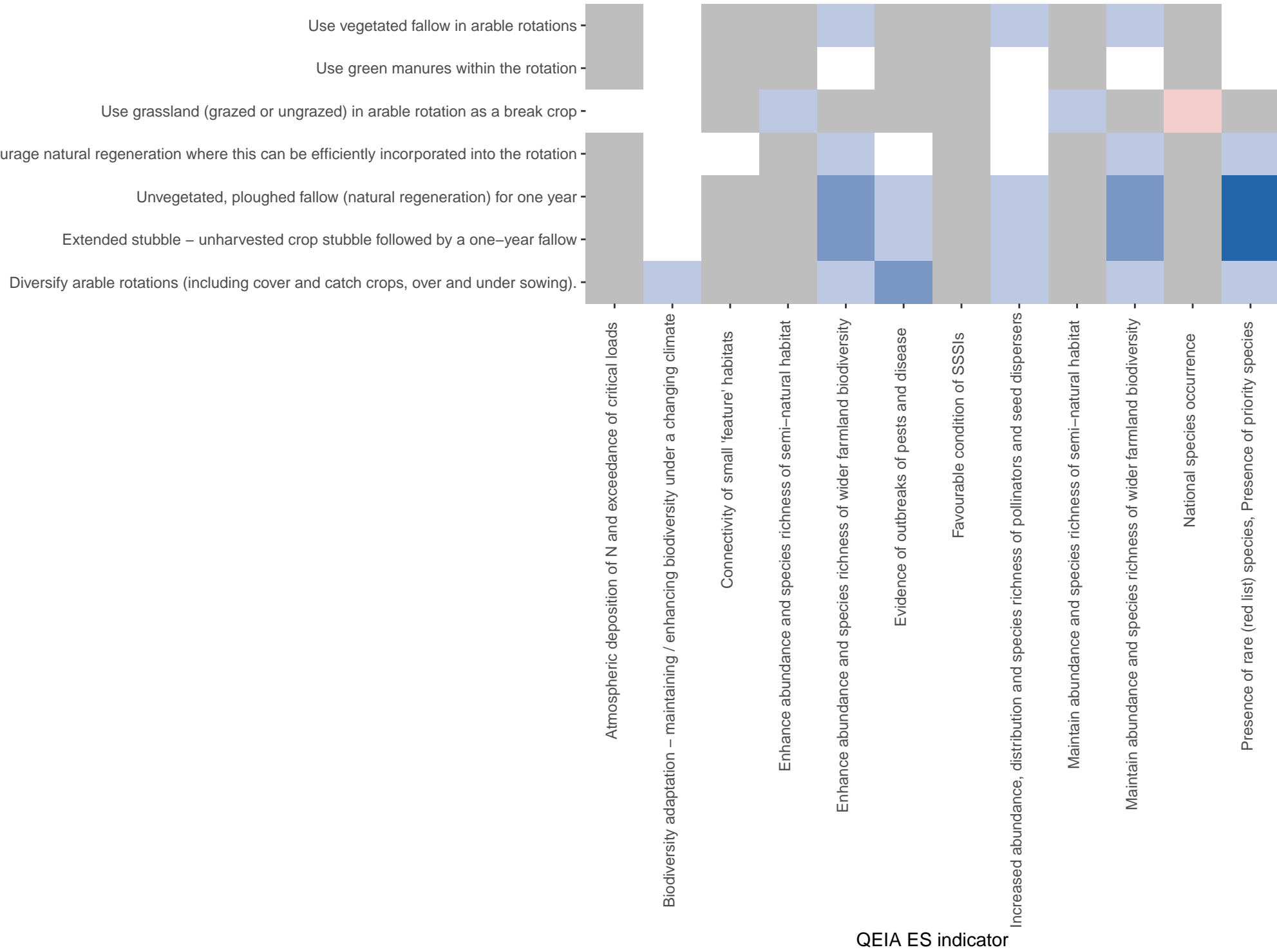
QEIA actions



# ARP measure

## Diversify crop rotation and break crop rotation period (esp. for root crop)

QEIA actions



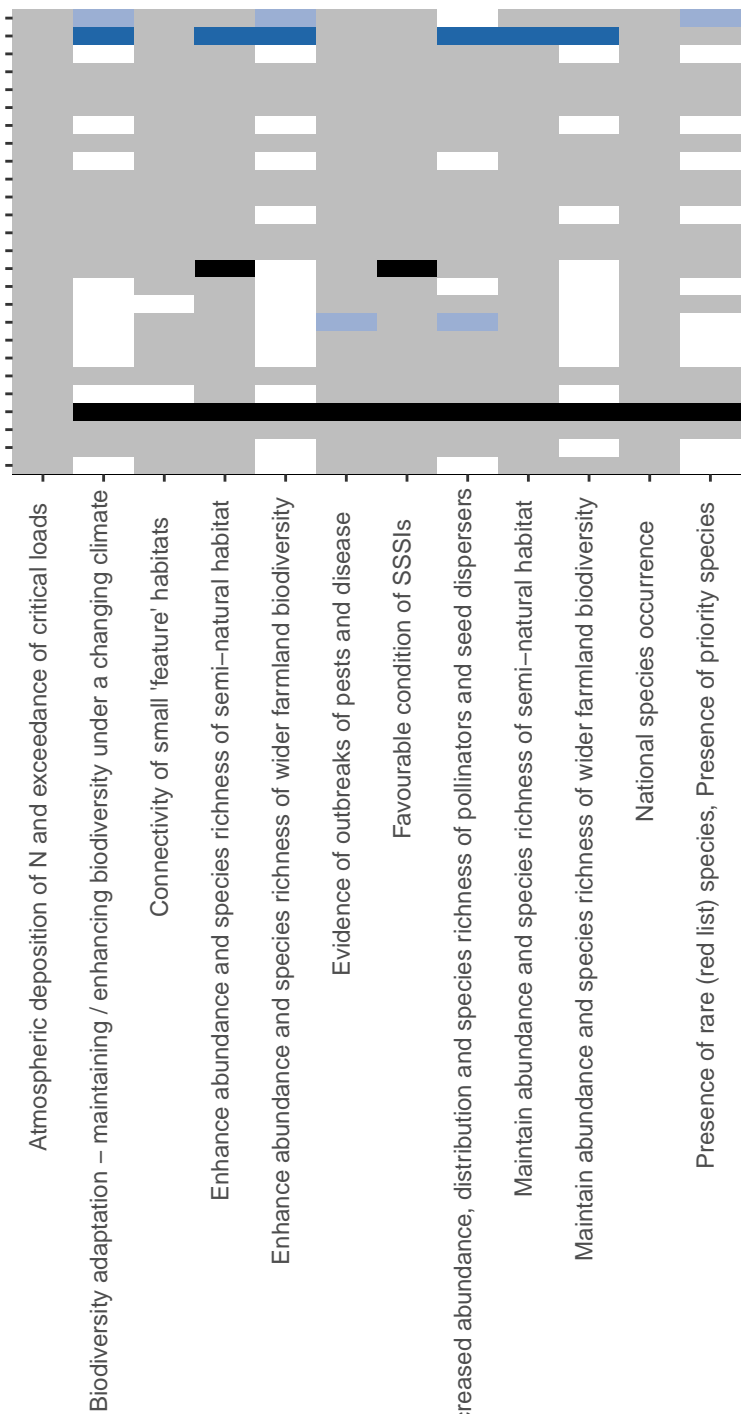
QEIA ES indicator

# ARP measure

## Efficient / Reduced use of inorganic fertilisers and lime

QEIA actions

- Whole farm reduction in nutrient use / nutrient cap
- Use very low inputs on permanent grassland
- Use remote sensing techniques to monitor crop requirement and vary application of N
- Use of urease inhibitors with urea fertilisers
- Use of polymer coated urea (slow release)
- Use nitrification inhibitors with nitrogen fertiliser manures, applied to grassland and animals (slow release bolus)
- Use improved crop varieties to increase nutrient use efficiency
- Use fertiliser with urease and nitrification inhibitors
- Use biostimulants from recommended list to reduce the need for artificial N
- Test soil regularly for pH and adjust management practices accordingly
- Switch to liquid application of fertiliser
- Switch to efficient / precision fertiliser application machinery (e.g. trailing hose, trailing shoe or injection, GPS)
- Supplement to shift from solid to liquid fertiliser application equipment
- Spatially test soils within field for any or all of the following: N, P, K, Mg, pH, micronutrients, potentially toxic elements and organic matter
- Replace urea and Urease Ammonium Nitrate (UAN) fertiliser with ammonia nitrate fertiliser for Nitrogen applications
- Replace nitrogen fertiliser application by using clover in pasture systems
- Replace nitrogen fertiliser application by using clover in pasture or arable cropping systems
- Replace nitrogen fertiliser application by using clover in arable cropping systems
- Reduce fertiliser (organic and inorganic) application to below conventional levels
- Nutrient Management Plan
- Maintain optimum soil pH
- Incorporate clovers and other legumes in grazed pastures
- Compare nutrient use efficiency and nutrient balances with other similar farms and take action to improve it
- Apply lime only on neutral grasslands (lowland and upland hay meadows), with a soil test to maintain a pH of 6.0
- Target application of fertiliser (.) to match crop need and minimise losses
- Calculate whole farm nutrient balance for phosphorus and nitrogen (.)

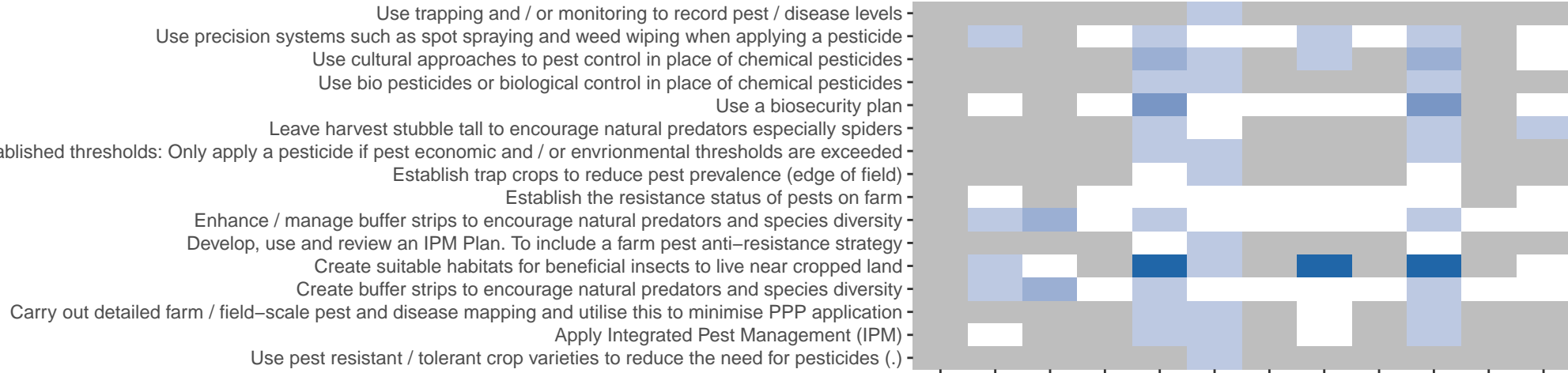


QEIA ES indicator

# ARP measure

## Efficient / Reduced use of synthetic pesticides

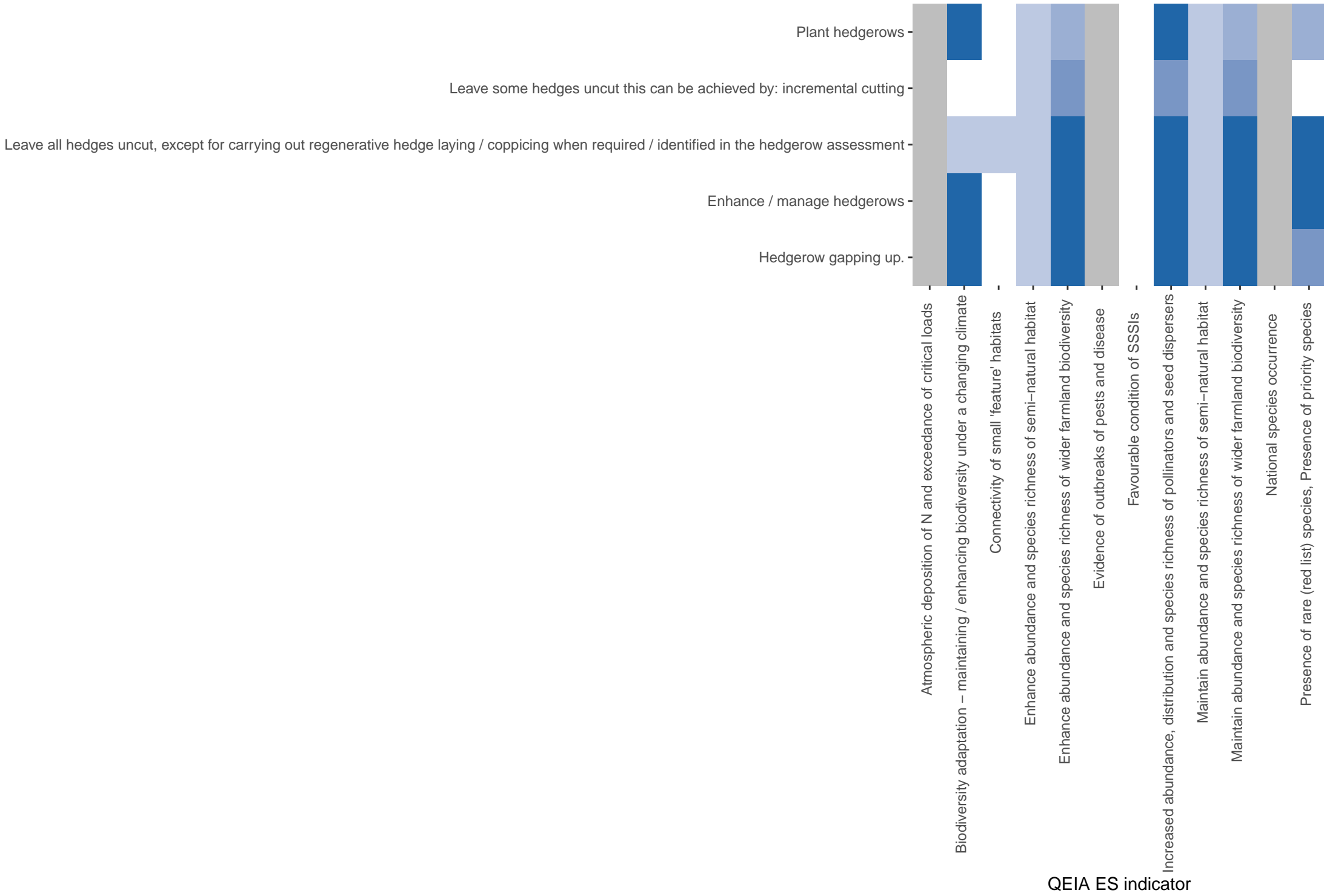
QEIA actions



QEIA ES indicator

# ARP measure Enhance Hedgerows

QEIA actions



QEIA ES indicator

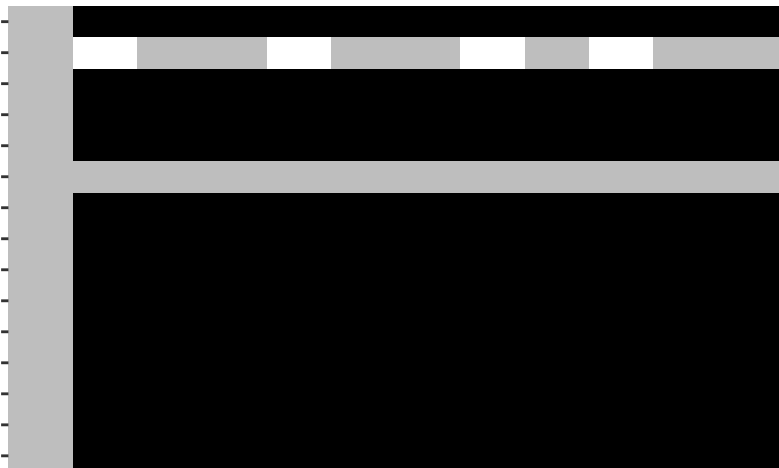


# ARP measure

## Improving public access capital items menu

QEIA actions

- Dedicate new Byways Open to all Traffic
- Create small-scale cultivation opportunities
- Create public access (on foot, on horse or on bike) to open access land and common land
- Create or dedicate new replacement routes of the same or higher status where inundation or erosion will be permanent
- Create launch points for recreational activities by such as paddle sports, fishing, wild swimming, for able-bodied and disabled users
- Create / maintain sites and small scale infrastructure for community therapeutic horticulture or food growing
- Create / maintain safe access to beach schools sites
- Create / maintain controlled access to sand dunes
- Create / maintain small scale access facilities supporting travel to site via road (.)
- Coordinate new public access with adjacent land managers (.)
- Create / maintain alternative routes on paths and greenspaces liable to inundation (flooding and erosion)
- Create / maintain larger scale access facilities (.)
- Create or dedicate new rights of way for footpaths, bridleways, cycle tracks, and restricted byways (.)
- Create / maintain infrastructure needed to mitigate the effects of access (.)
- Improve access infrastructure including path surfaces and widening (.)



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Evidence of outbreaks of pests and disease

Favourable condition of SSSIs

Increased abundance, distribution and species richness of pollinators and seed dispersers

Maintain abundance and species richness of semi-natural habitat

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National species occurrence

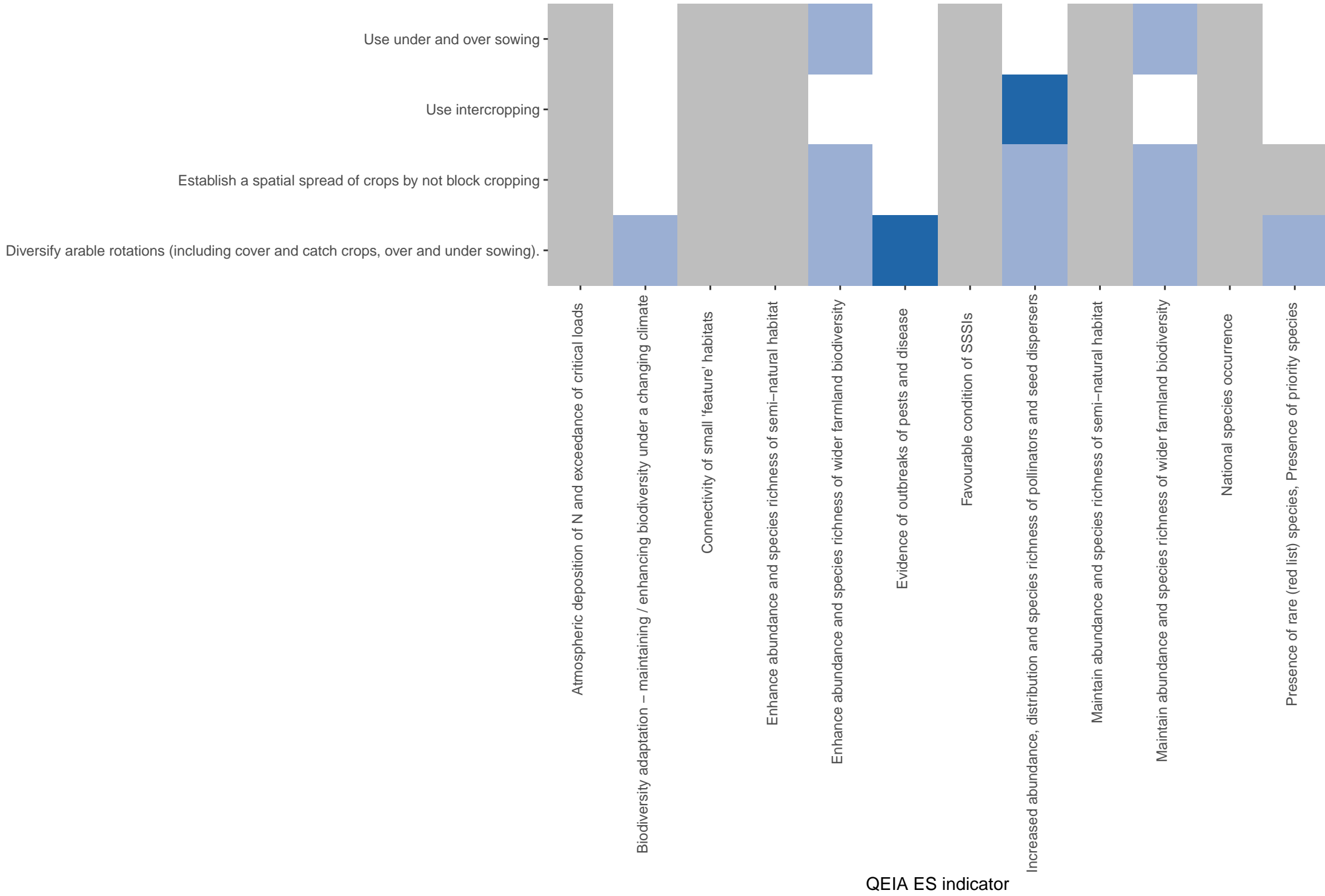
Presence of rare (red list) species, Presence of priority species

QEIA ES indicator

# ARP measure

Inter-cropping, under-cropping and mixed cropping (e.g. peas and barley) and avoid monoculture

QEIA actions



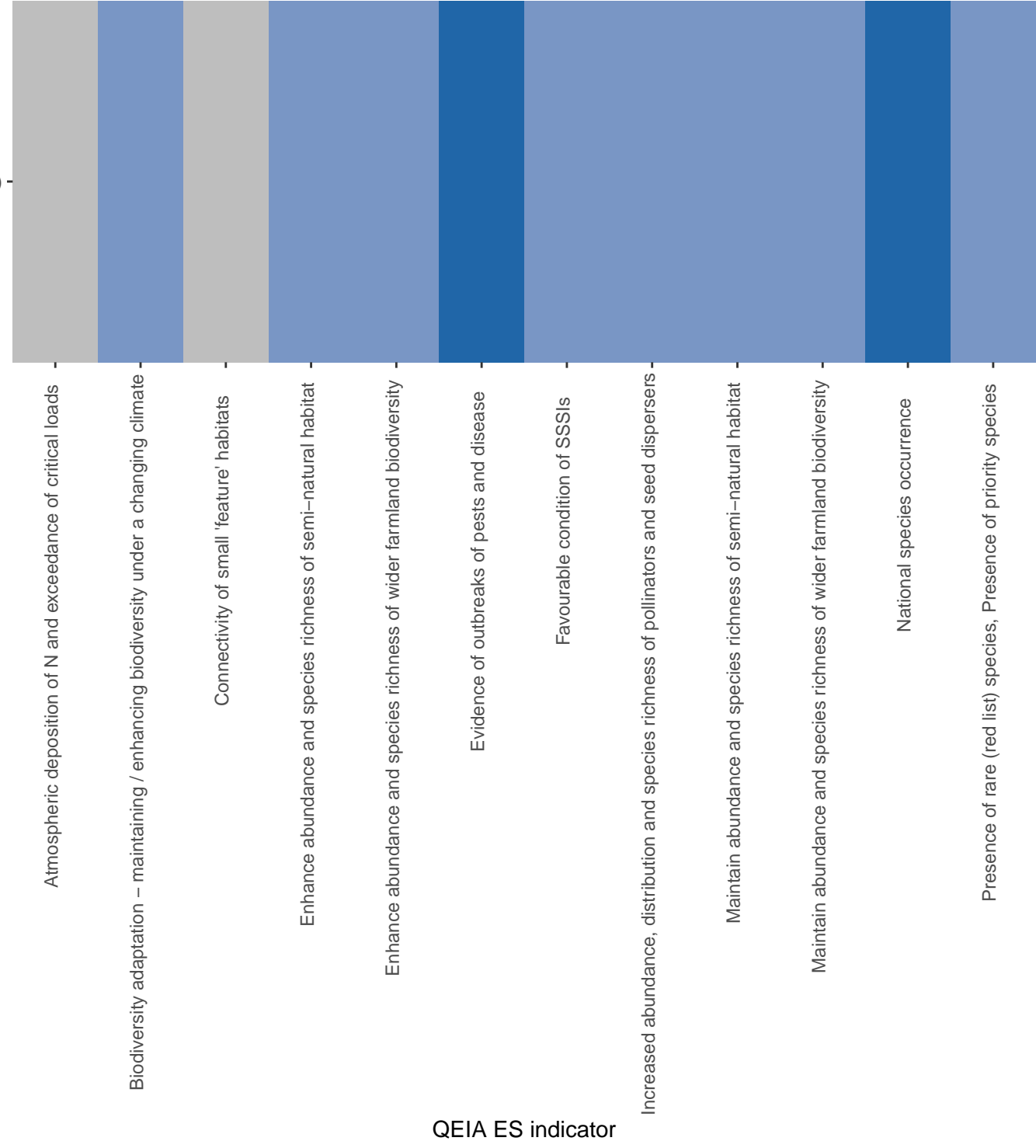
QEIA ES indicator

# ARP measure

## Interventions to reduce species impacts on land management activities

QEIA actions

Monitor and control damaging terrestrial animal species (e.g. deer, grey squirrel)



QEIA ES indicator

# ARP measure

## Introduction of alternative efficient watering systems

QEIA actions

Use water reuse systems

Use more efficient spray irrigation equipment

Use intercropping systems with alternate irrigation

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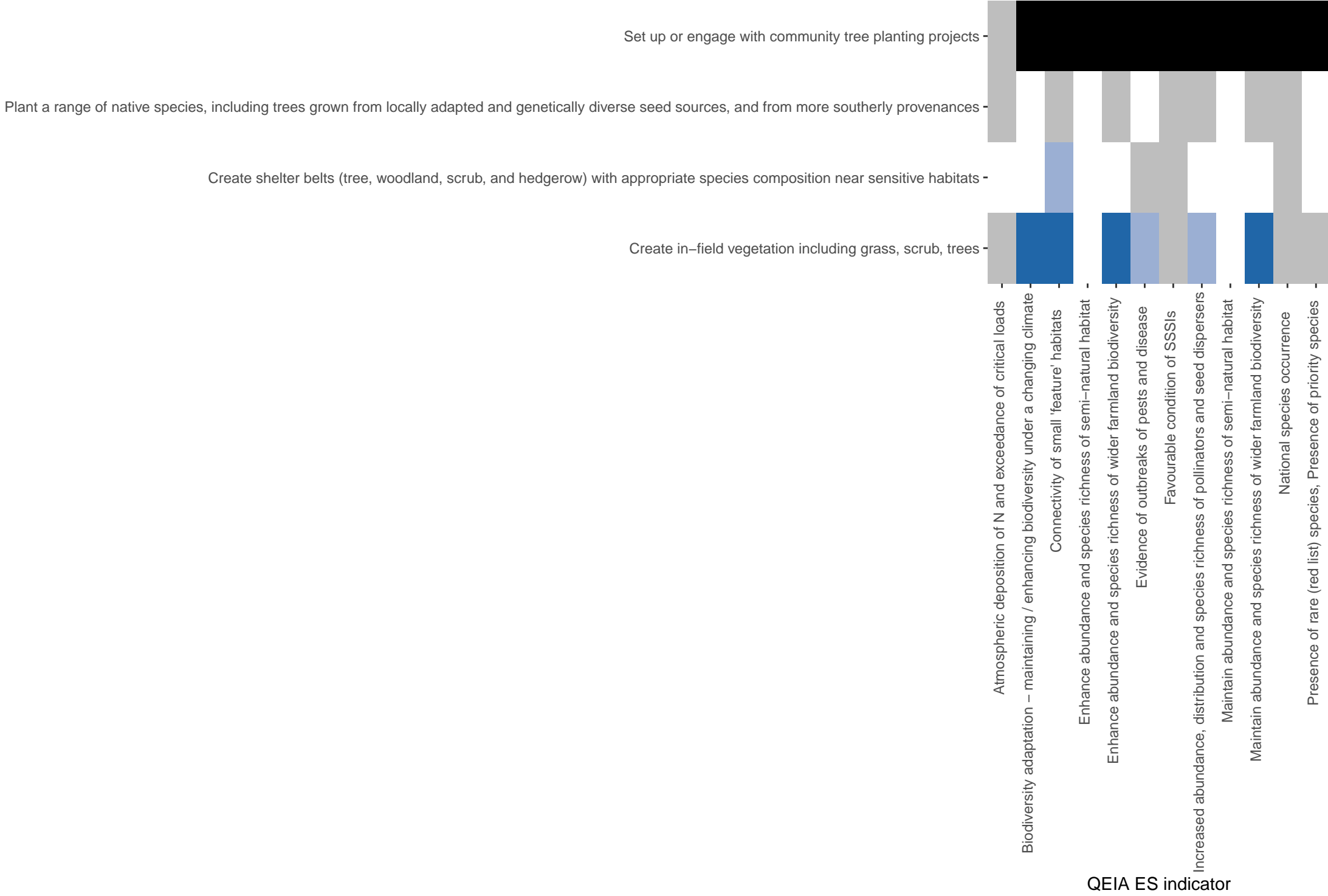
Presence of rare (red list) species, Presence of priority species

QEIA ES indicator

# ARP measure

## Introduction of Small-Scale Tree and Shrub Planting

QEIA actions



QEIA ES indicator

# ARP measure

## Introduction of sustainable drainage systems

QEIA actions

- Use cultivations / shaping of beds in potatoes and vegetable crops to direct water into beds and reduce run off (.)
- Use tied ridges (dammer dykes) in row crops
- Retrofit Sustainable Drainage Systems
- Maintain leaky woody structures and woody debris in small water courses and their flood plains
- Install bioreactor (straw) into field drainage system
- Install / maintain yard inspection pits
- Enhance / maintain green roofs and walls
- Cultivate and drill across the slope (where appropriate)
- Cross drains and underground drainage
- Create leaky woody structures and woody debris in small water courses and their flood plains
- Create green roofs and walls
- Create / enhance / maintain rain gardens

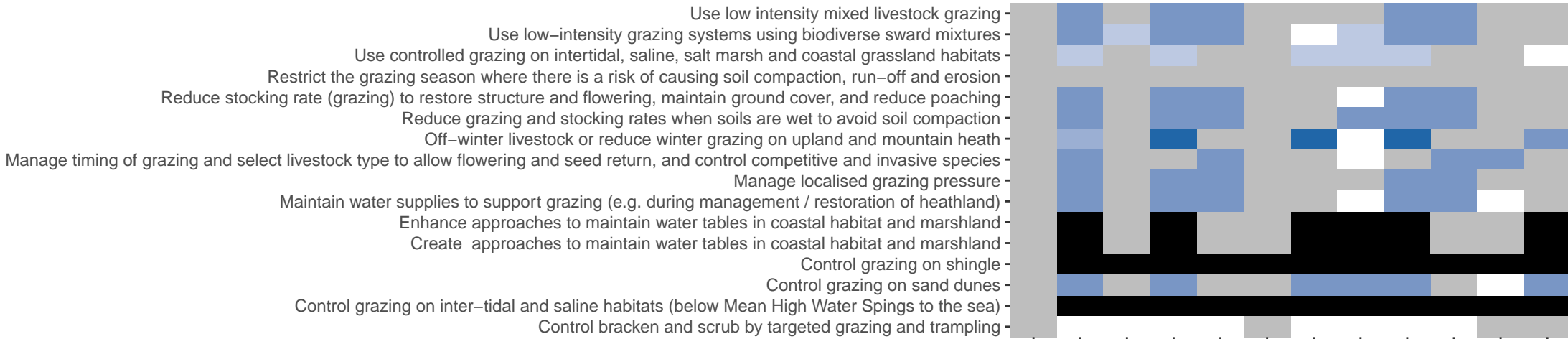


QEIA ES indicator

# ARP measure

## Manage Grazed Habitats

QEIA actions



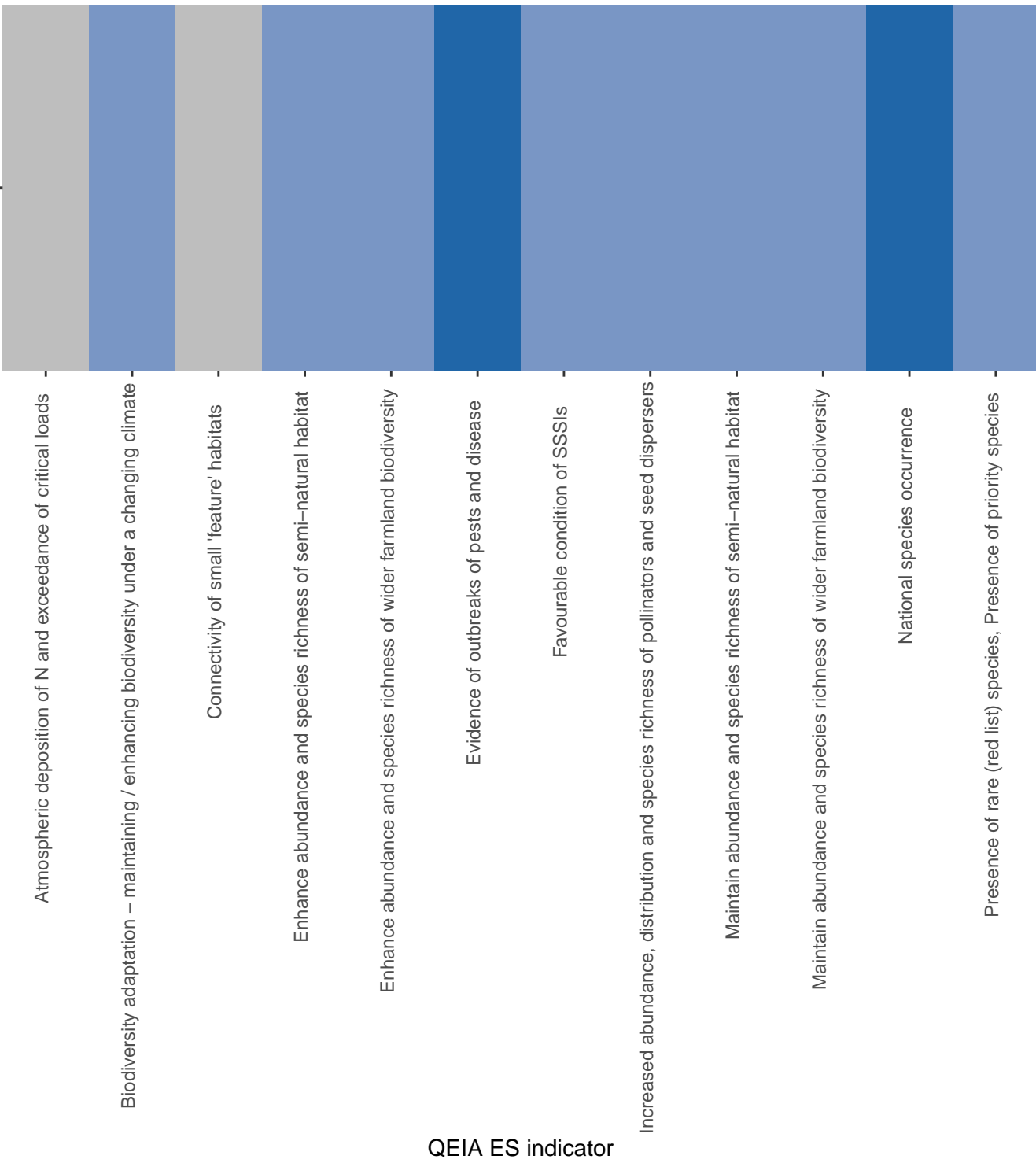
QEIA ES indicator

# ARP measure

## Management of deer populations to meet habitat condition targets

QEIA actions

Monitor and control damaging terrestrial animal species (e.g. deer, grey squirrel)



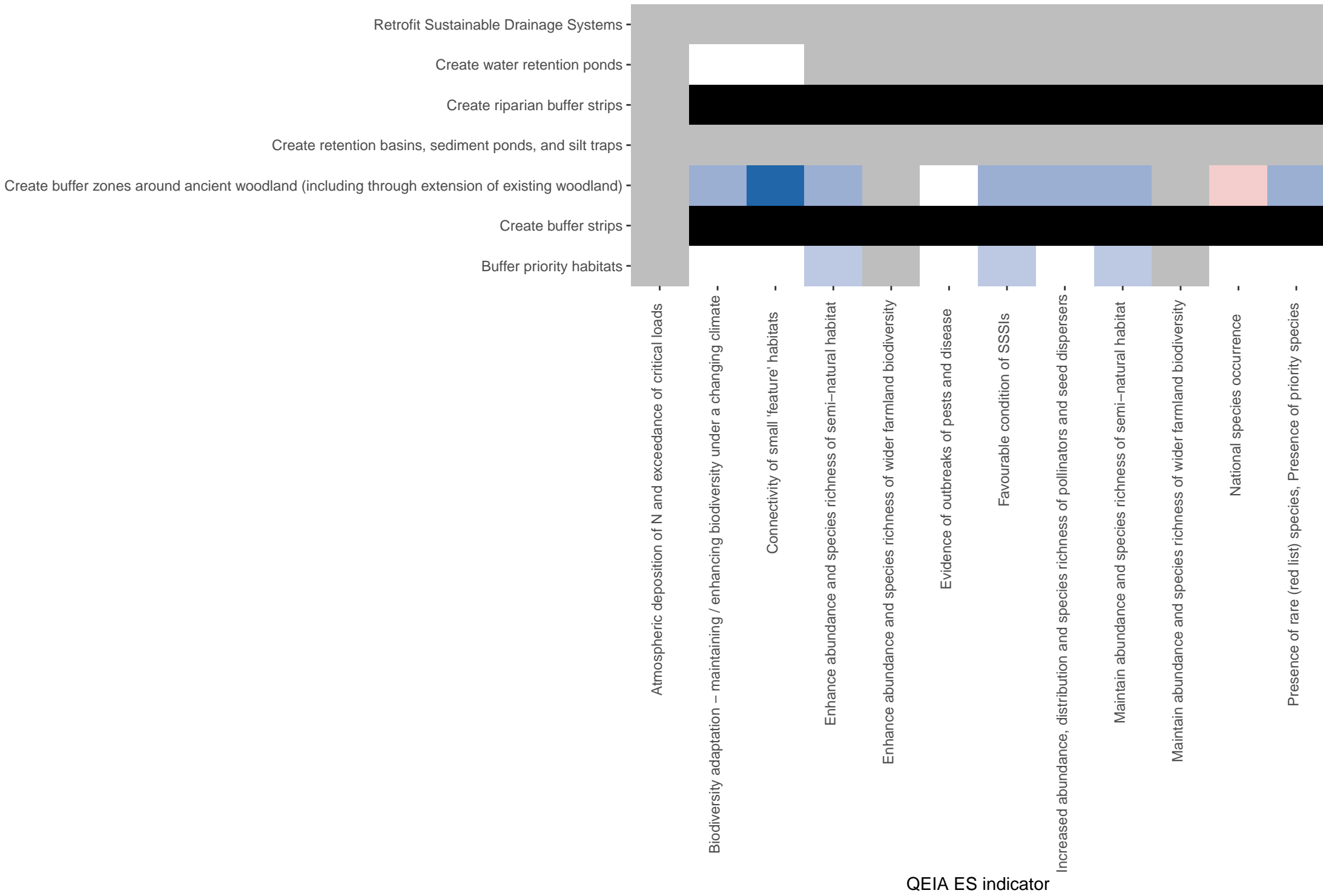
QEIA ES indicator



# ARP measure

## Management of diffuse pollution sources

QEIA actions

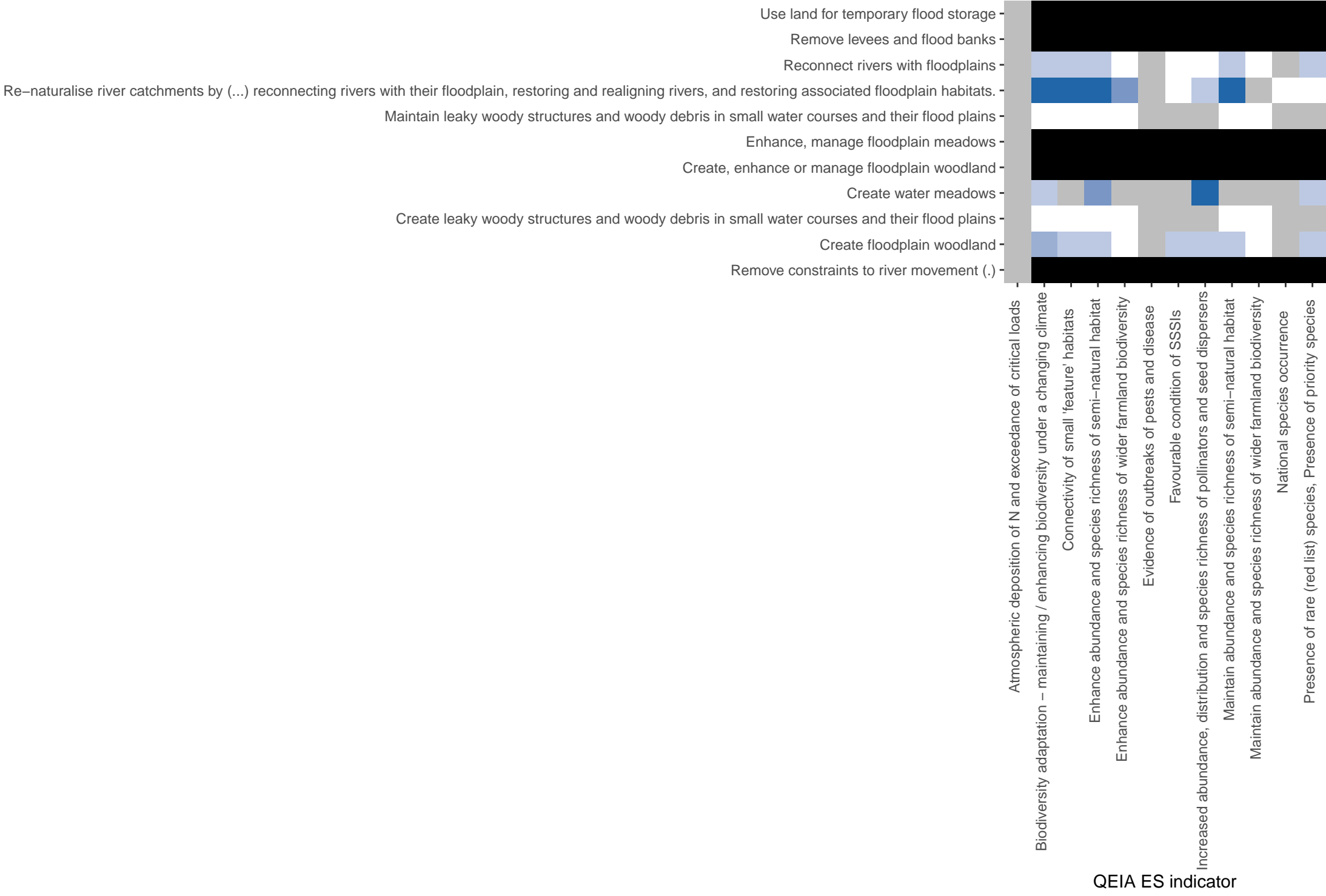


QEIA ES indicator

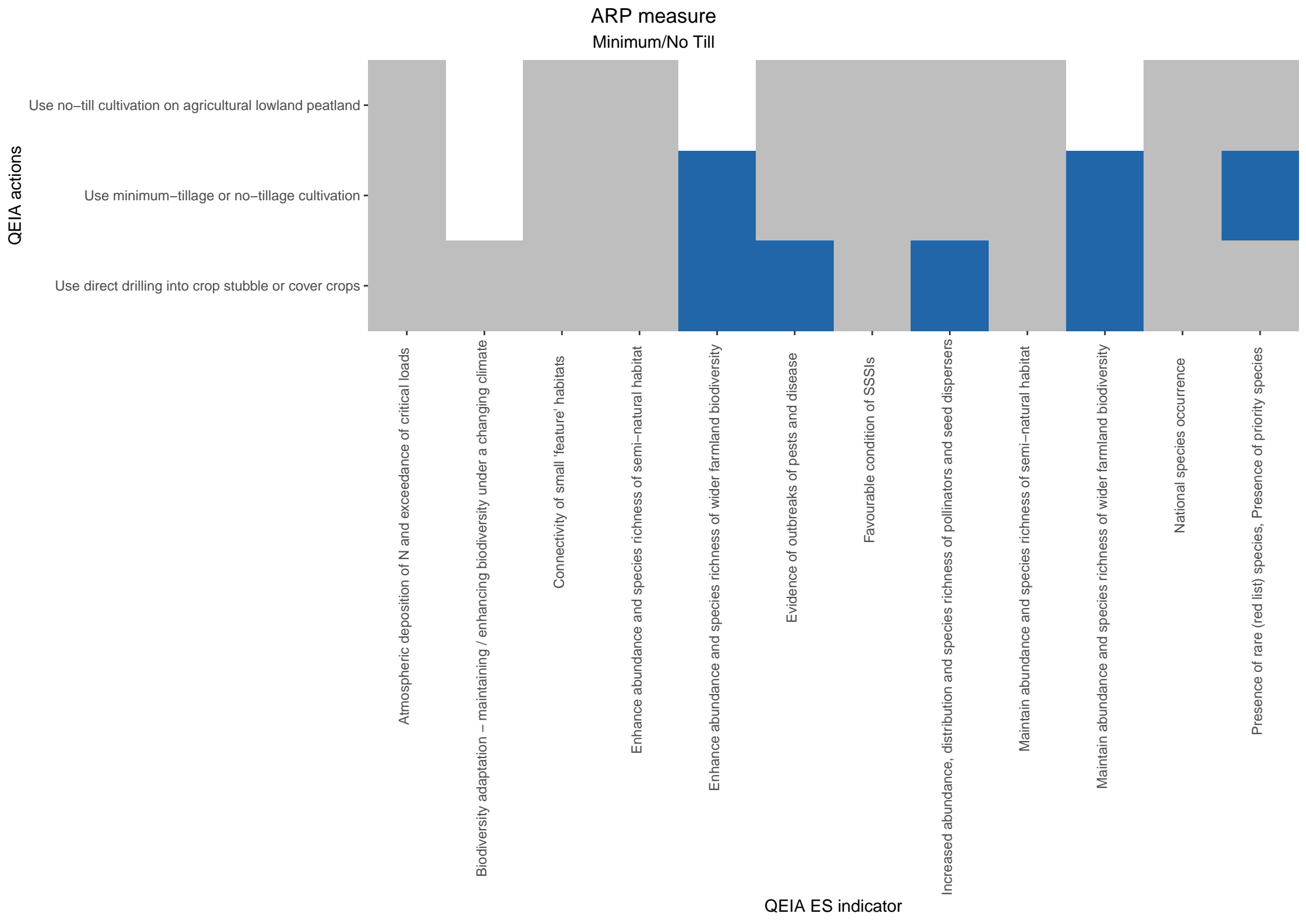
# ARP measure

## Management of floodplains

QEIA actions



QEIA ES indicator



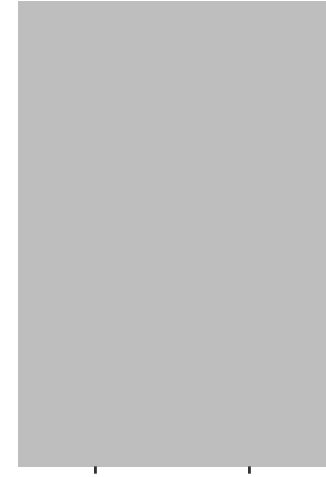
QEIA actions

Manage predation sustainably



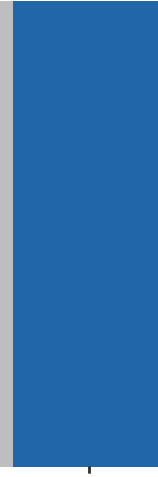
Atmospheric deposition of N and exceedance of critical loads

Biodiversity adaptation – maintaining / enhancing biodiversity under a changing climate



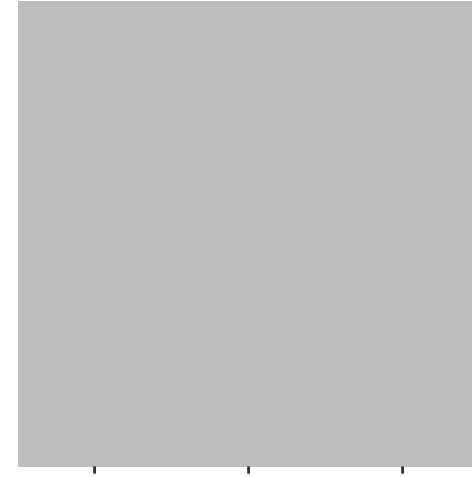
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National species occurrence



Presence of rare (red list) species, Presence of priority species

ARP measure

Predator control to protect priority species

QEIA ES indicator

# ARP measure

## Regenerative grazing (mob, strip, adaptive multi-paddock grazing) on improved grassland

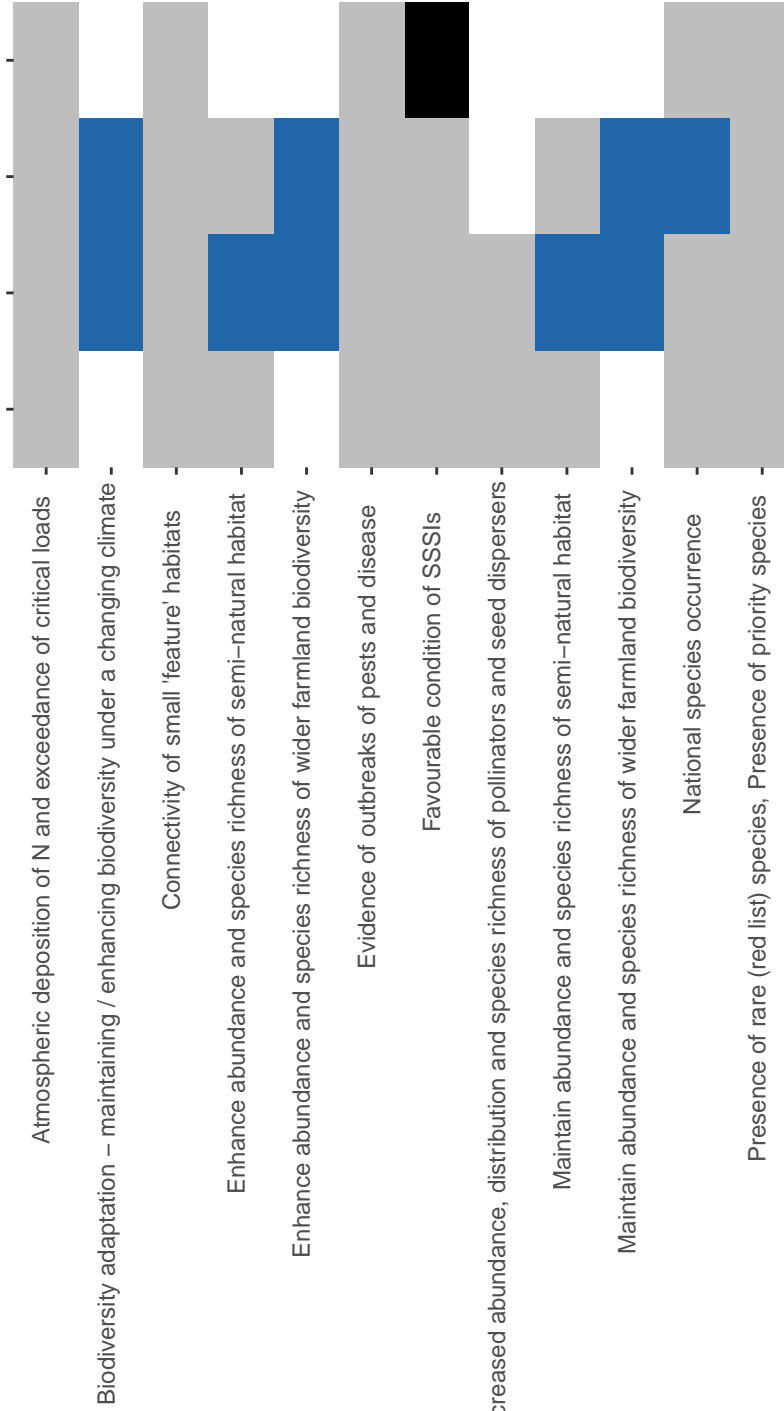
QEIA actions

Manage timing of grazing and select livestock type to allow flowering and seed return, and control competitive and invasive species

Manage localised grazing pressure

Create and use a grazing plan including stocking rates; monitor and adjust in line with grass productivity (.)

Mob grazing

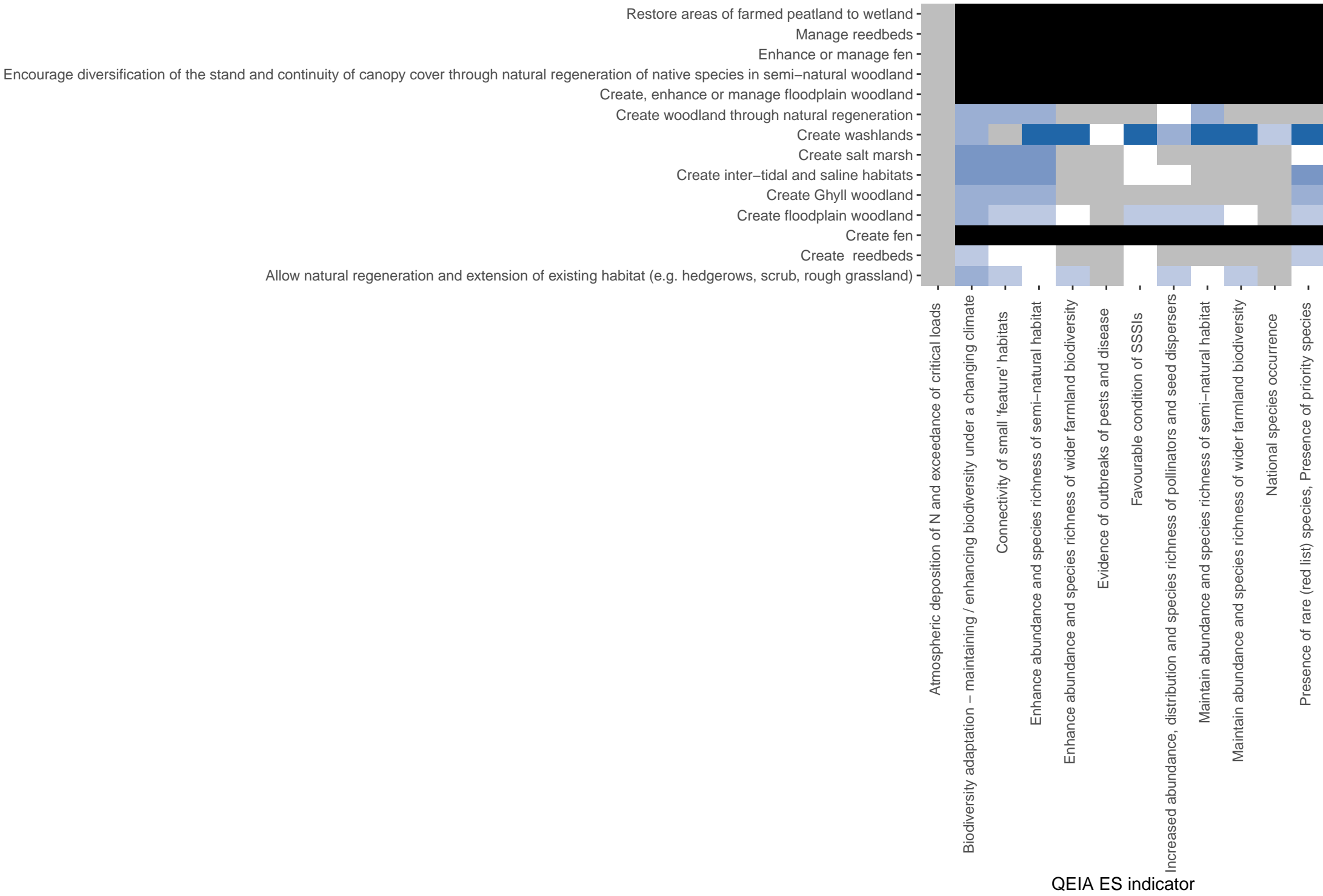


QEIA ES indicator

# ARP measure

## Restoration of natural habitats – peatland, natural woodlands, natural grasslands

QEIA actions



QEIA ES indicator

# ARP measure

## Restoring (protecting) river banks

QEIA actions

Fence off rivers, streams, lakes and ponds from livestock (.)

Use willow spiling

Maintain check dams

Create check dams

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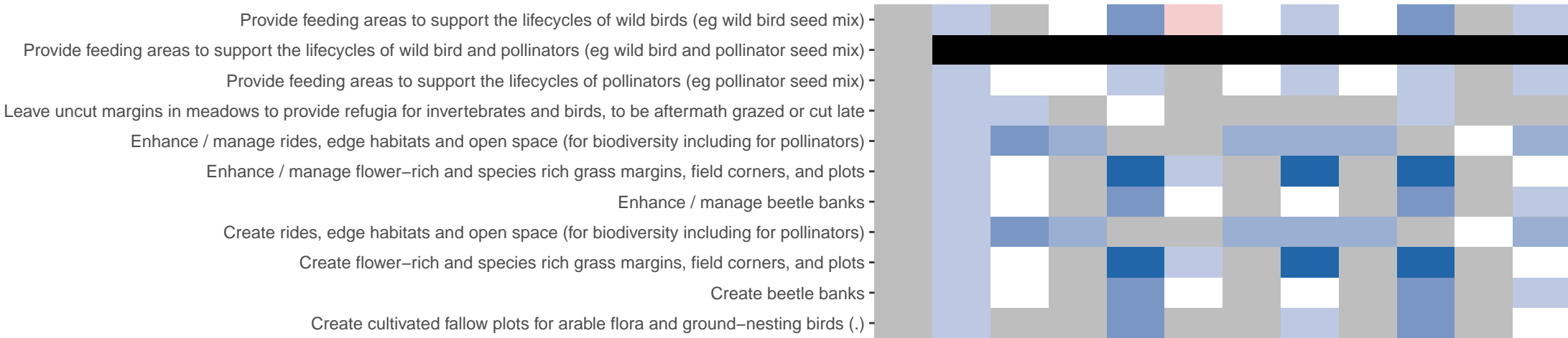
Presence of rare (red list) species, Presence of priority species

QEIA ES indicator

# ARP measure

## Retain and Enhance In Field Biodiversity Cropping and Features

QEIA actions



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QEIA ES indicator



# ARP measure

## Retain Traditional Cattle Small Holdings

QEIA actions

Use rare breeds for conservation grazing



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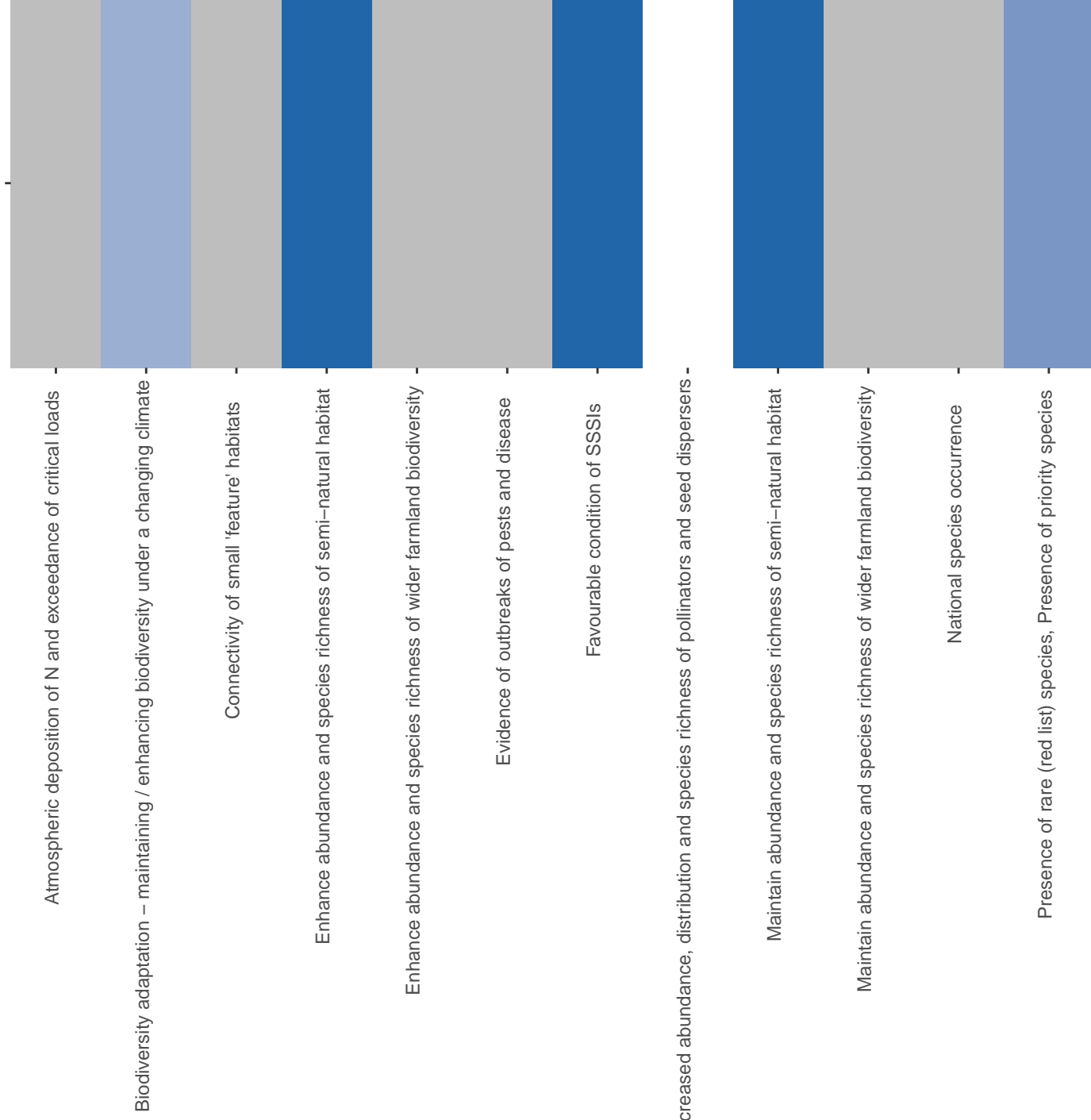
QEIA ES indicator

# ARP measure

## Summer Hill Cattle Grazing

QEIA actions

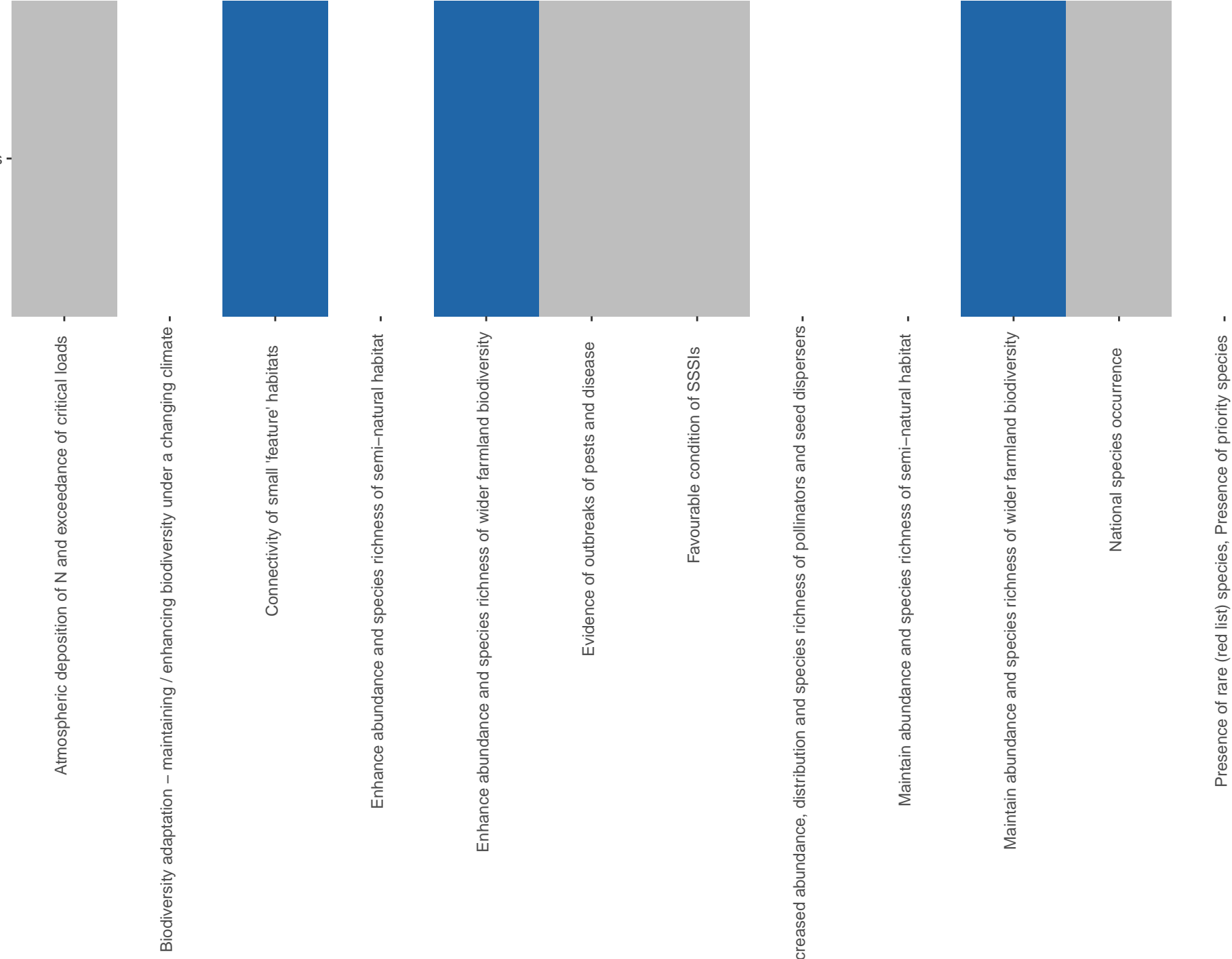
Off-winter livestock or reduce winter grazing on upland and mountain heath



QEIA ES indicator

QEIA actions

Create agroforestry systems



QEIA ES indicator

# ARP measure

## Sylvo-pastures

QEIA actions

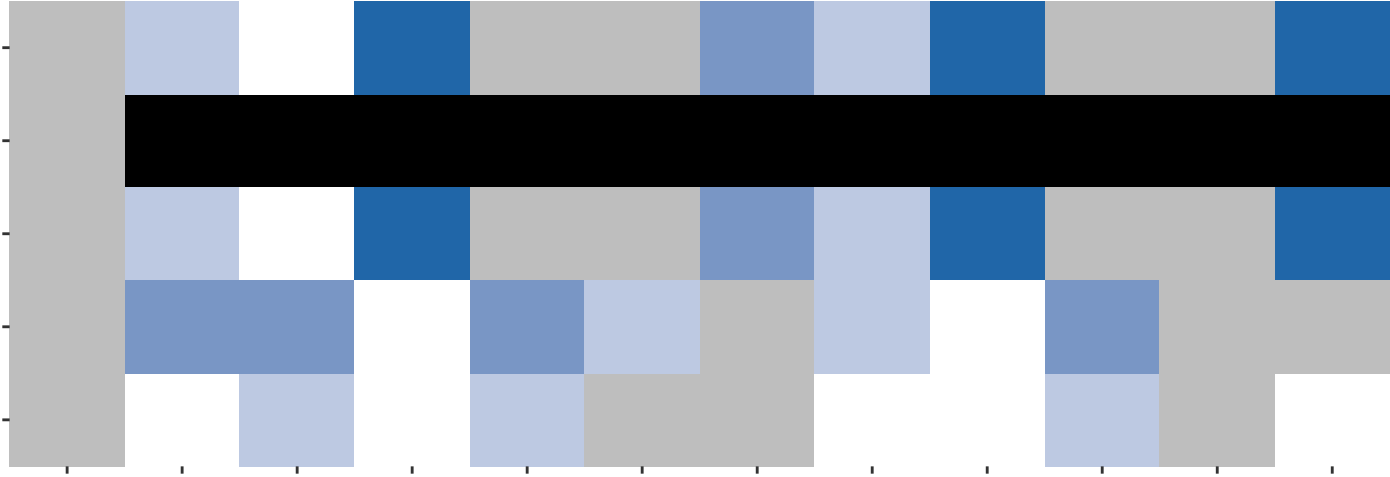
Enhance / manage wood pasture (eg through appropriate grazing)

Create, Enhance / manage wood pasture (eg through appropriate grazing)

Create wood pasture (eg through appropriate grazing)

Create in-field vegetation including grass, scrub, trees

Create agroforestry systems



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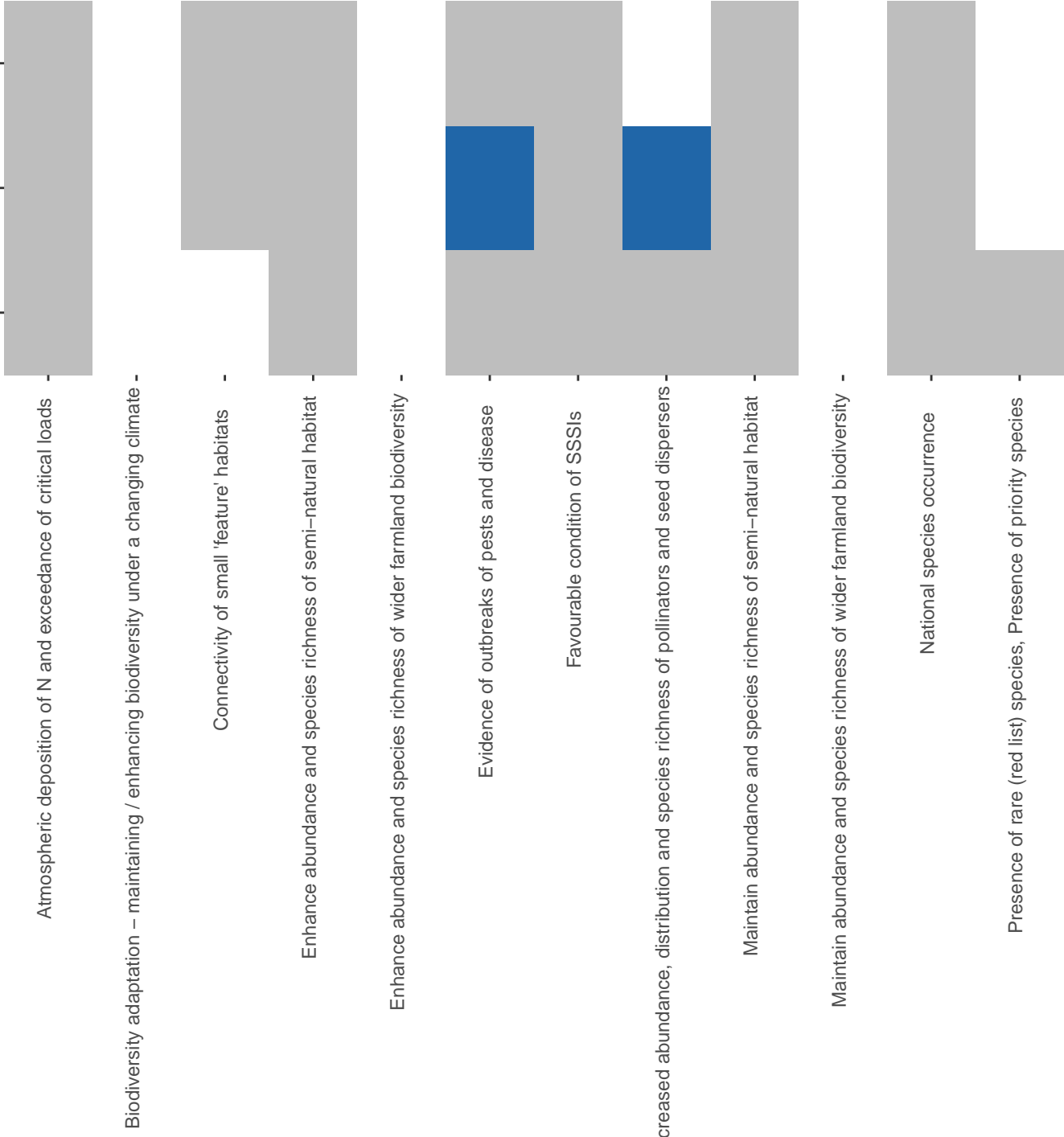
QEIA ES indicator

# ARP measure

## Use of N fixing crops

QEIA actions

- Replace nitrogen fertiliser application by using clover in pasture systems
- Replace nitrogen fertiliser application by using clover in arable cropping systems
- Incorporate clovers and other legumes in grazed pastures



QEIA ES indicator

# ARP measure

## Water Margins

QEIA actions



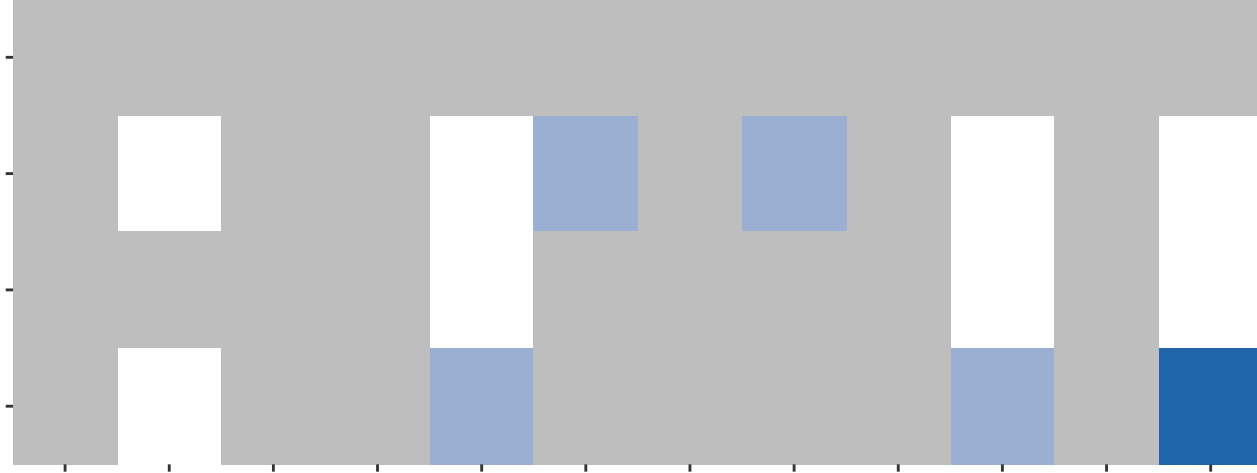
QEIA ES indicator

# ARP measure

## Winter cover

QEIA actions

- Use restorative vegetation cover following destoning or lifting of root crops
- Use cover crops
- Minimise bare soil to reduce soil loss e.g. cover crops, crop residues, trees coppice etc
- Enhanced overwinter stubble



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