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

## ERAMMP Report-59TA1:
## SMS Natura 2000 Restoration Award Evaluation Technical Annexes 1-4

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**Approved by**

## Abbreviations Used in this Report

| | |
|---|---|
| ARC | Amphibian and Reptile Conservation |
| BTO | British Trust for Ornithology |
| DECCA | Diversity, Extent, Condition. Connectivity and Adaptability |
| ERAMMP | Environment and Rural Affairs Monitoring & Modelling Programme |
| IEEP | Institute for European Environmental Policy |
| IMP | Integrated Modelling Platform |
| LIFE | L'Instrument Financier pour l'Environment<br>*(the EU's funding instrument for the environment and climate action)* |
| N2K | Natura 2000 |
| NRW | Natural Resources Wales |
| NRW/CCW | Natural Resources Wales/Countryside Council for Wales |
| PIP | Prioritised Improvement Plan |
| RIVPACS | River Invertebrate Prediction and Classification System |
| SAC | Special Areas of Conservation |
| SFARMOD | Silsoe Whole Farm Model |
| SFS | Sustainable Farming Scheme |
| SMNR | Sustainable Management of Natural Resources |
| SPA | Special Protection Areas |
| 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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# TECHNICAL ANNEX-1: DETAILS OF 34 PROJECTS IN THE 15 APPROVED APPLICATIONS

**Key:**

The 34 projects and sub-projects selected for detailed analysis

| No. | Name | Main focus of project | Approx. num. actions | Num. Natura 2000 sites affected | Grant applied for (£K) | Type of applicant (employees FTE) | Other funding sought for this project | Collaboration (Y/N) |
|---|---|---|---|---|---|---|---|---|
| 1 | Aberbargoed grasslands | Marsh fritillary habitat | 6 | 1 SAC | 49 | Public sector - Borough Council (-) | N | N |
| 2 | Creating a 100-acre habitat corridor | Marsh fritillary habitat | 8 | 1 SAC | 95 | Ltd company (5) | N | Y |
| 3 | Enhancing SPA wetlands | Saline and freshwater lagoons | 9 | 1 SAC<br>1 SPA | 106 | Charity (461) | N | N |
| 4 | Eryri N2K | | | 3 SAC | 571 | Public sector - National Park Authority (118) | N | Y |
| 4a | Traditional boundaries and stock-proofing | Traditional field boundaries and stock-proofing | 2 | | | | | |
| 4b | R'Ynys | Riparian | 3 | | | | | |
| 4c | Gwaith Powdwr | Bat spp (also reptiles and nesting birds | 2 | | | | | |
| 4d | Ancient woodlands | ancient woodlands and PAWS | 2 | | | | | |
| 5 | Fritillaries and damselflies | Marsh fritillary and Southern damselfly habitat | 3 | 2 SAC | 69 | Public sector - National Park Authority (115) | N | Y |
| 6 | Gilfach | Grassland and heathland management | 6 | 1 SAC<br>1 SPA | 92 | Charity (3) | N | N |
| 7 | Globe Way | Great Crested Newt habitat | 2 | 1 SAC | | Charity (35) | N | Y |
| 8 | Montgomery canal | Pondweed habitat | 3 | 1 SAC | 254 | Charity (1500) | N | Y |
| 9 | Mynydd Mallaen | Restoration of dry heath | 4 | 2 SAC<br>1 SPA | 115 | Other - Grazing Association (0) | N | N |
| 10 | Natura 2000 resilience and biodiversity | | | 9 SAC<br>2 SPA | 276 | Charity (55) | Y | N |
| 10a | Skomer Island | Biosecurity of ground nesting birds. Visitor infrastructure | 4 | | | | | |
| 10b | Skokholm Island | Habitat management | 2 | | | | | |
| 10c | Pengelli Forest | Barbastelle bat. Old sessile oak woodland | 3 | | | | | |
| 10d | Llangloffan Fen | Pond clearance. Visitor infrastructure. | 3 | | | | | |
| 10e | West Williamston | Saltmarsh. | 2 | | | | | |

| No. | Name | Main focus of project | Approx. num. actions | Num. Natura 2000 sites affected | Grant applied for (£K) | Type of applicant (employees FTE) | Other funding sought for this project | Collaboration (Y/N) |
|---|---|---|---|---|---|---|---|---|
| | | Visitor infrastructure. | | | | | | |
| 10f | Teifi Marshes | Habitat management / Visitor infrastructure. | 5 | | | | | |
| 10g | Kilvrough Woods | *Tilio-acerion* woodland.<br>INVASIVE SPECIES | 2 | | | | | |
| 10h | South Gower Coast | Vegetated sea cliffs, limestone grassland/dry heath | 1 | | | | | |
| 10i | Pwll y Wrach | In-channel and riparian habitats | 2 | | | | | |
| 10j | Vicarage Meadows | Habitat management for red kite, merlin and peregrine falcon | 2 | | | | | |
| 11 | RESOW | Seagrass restoration | 8 | 2 SAC | 312 | Charity (2) | N | Y |
| 12 | Rivers of Pembrokeshire | Habitat resilience, fish passage, water quality | 4 | 2 SAC | 203 | Charity (3) | N | N |
| 13 | Supporting Natura 2000 restoration in Wales | | | 9 SAC<br>3 SPA | 425 | Charity (170 in Wales) | N | N |
| 13a | Welsh woodlands | Atlantic oak woodland and dependant assemblages (lichen, bryophytes and key bird spp) | 4 | | | | | |
| 13b | Ramsey Island | Nesting seabirds).<br>Heathland. | 2 | | | | | |
| 13c | South Stack | Habitat management for chough.<br>Heathland management. | 4 | | | | | |
| 13d | Ynys-hir | Habitat management for Greenland white fronted geese. | 4 | | | | | |
| 13e | Tanrallt | Habitat management for hen harrier, merlin | 1 | | | | | |
| 13f | Cors Ddyga | Habitat management for Lapwing, bittern, marsh harrier, curlew | 2 | | | | | |
| 13g | Llyn Dinam/Valley wetlands | Habitat management for breeding and wintering wildfowl and bittern | 3 | | | | | |
| 13h | Multiple Natura 2000 sites | Monitoring habitats and species. | 2 | | | | | |
| 14 | Tywydd Tywi Weather | Afon Tywi water quality | 1 | 1 SAC | 77 | Charity and limited company (518) | N | N |
| 15 | Wye Valley Woodland | Woodland management | 9 | 2 SAC | 171 | Charity (25) | N | N |

**Key: Evidence for potential impact of actions on features of Natura 2000 site(s) relevant to that project**

| | |
|---|---|
| | Blue: Well tested at multiple sites with outcomes consistent with accepted logic chain etc. |
| | Amber: Agreement in the expert community that there is an intervention logic chain, but evidence is limited/trade-offs exist |
| | Pink: Logic chain not supported/impractical/significant trade-offs/negligible positive impact |
| | Light grey: No link |
| | Dark grey: Action not at relevant Natura 2000 site |
| P | Preliminary step towards impact, which would be dependent on additional actions being taken |
| U | Unclear to which, if any, SAC features the action might apply |
| + | Additional potential benefit of this action |

# TECHNICAL ANNEX-2: ANALYSIS OF EVIDENCE FOR POTENTIAL BENEFITS OF 17 PROJECTS, BY TYPE OF ACTION

**Key: Definitions of potential additional benefits**

*Additional biodiversity in the application area*
Benefits to species, habitats or biodiversity features at the site of the action, which are not listed in the Prioritised Improvement Plan matrix for relevant N2K sites.

*Landscape scale*
Benefits to biodiversity or ecosystem services occurring at scales larger than the application area. Includes improvements to the diversity, extent, connectivity, condition and adaptability of ecosystems (DECCA ecosystem resilience framework). For example, increased landscape-scale connectivity of habitats within and outside of N2K sites; improved water quality or flood mitigation within a catchment.

*Local economy*
Economic benefits to those individuals, businesses, land managers and contractors within or close to the application area.

*Community engagement*
Increased public participation, awareness and enjoyment of environmental, historic or cultural features in the application area. Includes actions likely to contribute towards well-being goals including promoting health and equality of access.

*Knowledge enhancement*
Investment in expertise, training and knowledge about biodiversity and ecosystem services relating to the targeted Natura site or the wider landscape. Includes planning, data collection and disseminating information. May involve collaboration across academia and/or industry.

N2K = Natura 2000

| Type of action | Action detail | Project no. (action no.) | Strength of evidence for potential impact on features of relevant N2K site | Additional biodiversity in the application area | Landscape scale | Local economy | Community engage-ment | Knowledge enhance-ment |
|---|---|---|---|---|---|---|---|---|
| Boundaries | • Installation of outer and inner stock-proof fencing | 1 (1) | | + | + | + | | |

| Type of action | Action detail | Project no. (action no.) | Strength of evidence for potential impact on features of relevant N2K site | Additional biodiversity in the application area | Landscape scale | Local economy | Community engage-ment | Knowledge enhance-ment |
|---|---|---|---|---|---|---|---|---|
| Boundaries | • Riparian fencing to exclude livestock | 12 (2) | | | P | P | | |
| Boundaries | • Cloddiau: Repair boundaries and stock-proof heathland habitats. Stone walling<br>• Fencing repair around traditional 'quillets'.<br>• Fencing and wall maintenance of Chough feeding pastures at Cors Goch | 13c (1) | | + | + | + | | |
| Boundaries | • Fence replacement around woodland<br>• Fence replacement around woodland pasture | 15 (4) | | | | | | |
| Boundaries | • Dry stone walling<br>• Slate-pillar fencing<br>• Hedgerow works | 4a (1) | U | | + | + | | |
| Building repair | • Repointing, rebuilding walls and/or concrete repairs, largely targeted at preventing structural failure | 4c (1) | | | | + | + | |
| Building repair | • Timber repairs, roof repairs, access & utility improvements; targeted at structural improvements, but in some cases improved access and use of buildings | 4c (2) | | | | + | + | |
| Habitat restoration or management | • Cut and collect prior to reintroduction of grazers, taking care to avoid larval webs and non-rank vegetation. | 1 (2) | | + | + | + | | |
| Habitat restoration or management | • Removal of scrub, bracken, bramble, willow and encroaching woodland. | 1 (3) | | | + | | | |
| Habitat restoration or management | • Planting of *Succisa pratensis* seed/plants of local provenance, or scattering of seed (preferably collected from the site) | 1 (4) | | + | | | | |
| Habitat restoration or management | • Remove concrete and reprofile shoreline of freshwater lagoon | 3 (5) | | | + | + | | |
| Habitat restoration or management | • Remove silt from freshwater lagoon | 3 (6) | | | + | + | | |
| Habitat restoration or management | • coppicing, laying hedgerows and removing tress | 3 (8) | | | | | + | |

| Type of action | Action detail | Project no. (action no.) | Strength of evidence for potential impact on features of relevant N2K site | Additional biodiversity in the application area | Landscape scale | Local economy | Community engage-ment | Knowledge enhance-ment |
|---|---|---|---|---|---|---|---|---|
| Habitat restoration or management | • create new wetland treatment system reedbed | 3 (9) | | | | + | | |
| Habitat restoration or management | • Cutting up dense tussocks of *Molinia caerulea* | 6 (1) | | + | | | | |
| Habitat restoration or management | • Maintain a short sward in waxcap grasslands | 6 (4) | | + | | | | |
| Habitat restoration or management | • Cut areas of encroaching gorse | 6 (6) | | + | + | | | |
| Habitat restoration or management | • Creation of 1 pond<br>• Restoration of 4 ponds | 7 (1) | | + | + | + | P | |
| Habitat restoration or management | • Annual heather cutting, removal and disposal to improve heathland condition in “no burn zone”. | 13c (4) | | | + | + | | |
| Habitat restoration or management | • Hire of excavator for bed-lowering in wetlands and reedbeds | 13g (1) | | + | + | + | | |
| Habitat restoration or management | • Hire of excavator to create additional ponds, open waters and back-waters | 13g (2) | | + | + | + | | |
| Habitat restoration or management | • Hire of excavator to remove willow scrub and maintain fringing reed-bed habitat and fen margins | 13g (3) | | + | + | + | | |
| Habitat restoration or management | • Clearing firebreaks through gorse, heather, bracken and grass | 6 (2) | | + | | | | |
| Habitat restoration or management | • Pond restoration | 10f (3) | | + | + | + | | |
| Habitat restoration or management | • Seagrass planting | 11 (7) | | + | + | | | + |
| Habitat restoration or management | • Mow/clear soft rush/scrub and introduce appropriate grazing | 2 (2) | U | + | + | + | + | |
| Habitat restoration or management | • Re-introducing and managing conservation grazing sites<br>• More connectivity features and minimizing habitat fragmentation | 4a (2) | U | | | | | |
| Habitat restoration or management | • Top leys to build organic matter and increase soil fertility | 6 (5) | | + | + | | | |
| Habitat restoration or management | • Clear vegetation from footpaths and woodland rides | 6 (3) | | | | | + | |

| Type of action | Action detail | Project no. (action no.) | Strength of evidence for potential impact on features of relevant N2K site | Additional biodiversity in the application area | Landscape scale | Local economy | Community engage-ment | Knowledge enhance-ment |
|---|---|---|---|---|---|---|---|---|
| Habitat restoration or management | • Planting wildflower plugs<br>• Public engagement | 7 (2) | | + | + | | + | |
| Habitat restoration or management | • Create scrape in drainage channel to re-wet a field and allow sowing with *Succisa pratensis* and a mix of damp meadow species | 2 (3) | | + | + | | | |
| Habitat restoration or management | • Collect seed and propagate Succisa plugs – to be planted during, and post, project completion – and plant honeysuckle | 2 (4) | | + | + | + | + | |
| Habitat restoration or management | • Modify and create new islands in freshwater lagoon | 3 (3) | | | + | + | | |
| Habitat restoration or management | • Fencing wet meadows to allow conservation grazing (supporting habitat)<br>• Cut and collect on dry meadow | 10f (2) | | + | + | + | | |
| Habitat restoration or management | • Pond building and restoration | 15 (6) | | | + | | P | |
| Information and engagement | • Signage for visitors explaining the importance of preventing entry of non-native species, particularly mammals, to Skomer | 10a (2) | | | | | + | |
| Information and engagement | • Stakeholder workshop | 11 (2) | | | | | | + |
| Information and engagement | • Develop comms material | 11 (6) | | | | | + | |
| Information and engagement | • Deployment and maintenance of live cameras to show wildlife to potential visitors | 10a (3) | | | + | + | + | |
| Information and engagement | • Replacement of degraded interpretative signage<br>• | 10a (4) | | | | + | + | |
| Information and engagement | • Install project outreach hub with 10 bilingual interpretation boards | 2 (6) | | | | + | + | |
| Information and engagement | • Education materials (presentation and leaflets) distributed to schools explaining how to behave ()responsibly around grazing livestock | 2 (7) | | | | | + | |

| Type of action | Action detail | Project no. (action no.) | Strength of evidence for potential impact on features of relevant N2K site | Additional biodiversity in the application area | Landscape scale | Local economy | Community engage-ment | Knowledge enhance-ment |
|---|---|---|---|---|---|---|---|---|
| Information and engagement | • Citizen science macroinvertebrate monitoring<br>• Public talks | 12 (4) | | | | | + | + |
| Information and engagement | • install new interpretation boards | 3 (4) | TBC | | | | + | |
| Invasive species management | • Consultant ecologist hired to carry out rare plants survey and guide INNS treatment plan<br>• Purchase of equipment | 10h (1) | | + | + | | | + |
| Invasive species management | • Invasive species removal via herbicide | 15 (5) | | | | | + | |
| Invasive species management | • Bracken roller purchase to replace herbicide use | 10f (4) | | | + | | | |
| Livestock infrastructure | • Complete access road surfacing, erect livestock fencing and gates on habitat land; create run-back; install livestock handling equipment and water troughs | 2 (5) | U | | | + | | |
| Livestock infrastructure | • Construct a shed to hold livestock (in case unwell) and equipment | 13c (2) | P | | | + | | |
| Machinery and/or equipment | • Vehicle to transport kit to lowland heath for management works | 13c (3) | | | + | | + | |
| Machinery and/or equipment | • Purchase of ATV to transport equipment around site<br>• Purchase of ATV ramps<br>• Purchase of electric chainsaws | 10c (1) | P | | | | | |
| Machinery and/or equipment | • Purchase of equipment for volunteers for vegetation management | 10c (2) | P | P | P | | + | |
| Natura 2000 biosecurity | • Purchase and deployment of small mammal traps on boats and boat landing area of Skomer | 10a (1) | | | | | | |
| Other | • Legal management and governance framework | 11 (3) | | | | | | + |
| Other | • create underwater causeways to islands in FW lagoon | 3 (7) | | | | | | |
| Other | • The purchase of Digital Animal GPS Collars to track cattle grazing. | 1 (5) | | | | | + | + |
| Study or data collection | • Stakeholder mapping | 11 (1) | | | | | | + |

| Type of action | Action detail | Project no. (action no.) | Strength of evidence for potential impact on features of relevant N2K site | Additional biodiversity in the application area | Landscape scale | Local economy | Community engage-ment | Knowledge enhance-ment |
|---|---|---|---|---|---|---|---|---|
| Study or data collection | • Benthic site assessments | 11 (5) | | | | | | + |
| Study or data collection | • Acoustic fish tracking | 11 (8) | | | | | | + |
| Study or data collection | • Deer impact survey<br>• Bast bark beetle survey<br>• Invertebrate trapping | 15 (9) | P | | | | | + |
| Study or data collection | • Habitat suitability model | 11 (4) | | | | | | + |
| Study or data collection | • Fish pass feasibility study around dam for salmonids and eel | 12 (1) | P | | P | + | | + |
| Study or data collection | • Set up weather stations (rainfall, soil moisture, soil temperature, air temperature and wind speed).<br>• Fencing around weather stations<br>• Web platform design | 14 (1) | *P* | | P | P | + | + |
| Study or data collection | • Survey and map habitat suitability for *E. aurinia* across the project land | 2 (1) | | | + | + | + | + |
| Training and engagement | • One training day on habitat suitability surveying and marsh fritillary surveying | 2 (8) | | | | + | + | + |
| Visitor infrastructure | • Provision of board walk and interpretation panel<br>• Felling hazardous trees<br>• Picnic bench | 10f (1) | | | | + | + | |
| Visitor infrastructure | • Installation of Kissing gate to encourage appropriate public access but remain stock proof. | 1 (6) | | | | | + | |
| Visitor infrastructure | • Purchase of shelter and management base for visitors | 10c (3) | | | | | + | |
| Visitor infrastructure | • Path clearing<br>• Entrance restoration<br>• Information boards | 15 (8) | | | | | + | |
| Water management infrastructure | • Sluice installation in saline lagoons | 3 (1) | | | + | + | | |

| Type of action | Action detail | Project no. (action no.) | Strength of evidence for potential impact on features of relevant N2K site | Additional biodiversity in the application area | Landscape scale | Local economy | Community engage-ment | Knowledge enhance-ment |
|---|---|---|---|---|---|---|---|---|
| Water management infrastructure | • Repair banks for saline lagoons | 3 (2) | | + | + | + | | |
| Water management infrastructure | • New sluices to control water levels | 10f (5) | | | + | | | |
| Water management infrastructure | • Leaky dam building | 15 (7) | | | + | | P | |
| Woodland (and tree) restoration or management | • Tree planting | 15 (3) | | | + | | | |
| Woodland (and tree) restoration or management | • Tree felling<br>• Coppicing | 15 (1) | | + | + | | | |
| Woodland (and tree) restoration or management | • Pollarding<br>• Halo-thinning | 15 (2) | | | | P | | |
| Woodland (and tree) restoration or management | • Riparian tree planting | 12 (3) | | + | + | | | |

# TECHNICAL ANNEX-3: ANALYSIS OF EVIDENCE FOR POTENTIAL BENEFITS OF 17 PROJECTS, BY PROJECT AND ACTION

### Key: Evidence for potential impact of action on features of Natura 2000 site

| | |
|---|---|
| | Blue: Well tested at multiple sites with outcomes consistent with accepted logic chain etc. |
| | Amber: Agreement in the expert community that there is an intervention logic chain, but evidence is limited/trade-offs exist |
| | Pink: Logic chain not supported/impractical/significant trade-offs/negligible positive impact |
| | Light grey: No link |
| | Dark grey: Action not at relevant Natura 2000 site |
| P | Preliminary step towards impact, which would be dependent on additional actions being taken |

### Key: Definitions of potential additional benefits

| | |
|---|---|
| *Additional biodiversity in the application area* | Benefits to species, habitats or biodiversity features at the site of the action, which are not listed in the Prioritised Improvement Plan matrix for relevant N2K sites. |
| *Landscape scale* | Benefits to biodiversity or ecosystem services occurring at scales larger than the application area. Includes improvements to the diversity, extent, connectivity, condition and adaptability of ecosystems (DECCA ecosystem resilience framework). E.g. increased landscape-scale connectivity of habitats within and outside of N2K sites; improved water quality or flood mitigation within a catchment. |
| *Local economy* | Economic benefits to those individuals, businesses, land managers and contractors within or close to the application area. |
| *Community engagement* | Increased public participation, awareness and enjoyment of environmental, historic or cultural features in the application area. Includes actions likely to contribute towards well-being goals including promoting health and equality of access. |
| *Knowledge enhancement* | Investment in expertise, training and knowledge about biodiversity and ecosystem services relating to the targeted Natura site or the wider landscape. Includes planning, data collection and disseminating information. May involve collaboration across academia and/or industry. |

| **Project 1: Aberbargoed Grasslands** | | **Evidence for impact** | | **Additional benefits** | | | | |
|---|---|---|---|---|---|---|---|---|
| Natura Site: | | Aberbargoed Grasslands SAC | | | | | | |
| Actions | | Purple moor-grass meadows | Marsh Fritillary - Euphydryas (*Eurodryas, Hypodryas aurinia*) | Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 | Stock-proof fencing | Assume appropriate grazing | Assume appropriate grazing | x | x | x | | |
| 2 | Cut & collect | Assume appropriate grazing | Assume appropriate grazing | x | x | x | | |
| 3 | Scrub removal | | | | x | | | |
| 4 | Succisa pratensis planting | | | x | | | | |
| 5 | GPS tracking of herd | | | | | | x | x |
| 6 | Install kissing gate | | | | | | x | |

| **Project 2:Creating a 100-acre habitat corridor** | | **Evidence for impact** | | | | | **Additional benefits** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Natura Site: | | North West Pembrokeshire Commons | | | | | | | | | |
| Actions | | Dry heaths | Floating Water-plantain - *Luronium natans* | Purple moor-grass meadows | Very wet mires often identified by an unstable 'quaking' surface | Wet heathland with cross-leaved heath | Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 | Survey land for habitat suitability for *E. aurinia* | | | | | | | x | x | x | x |
| 2 | Mow/clear and introduce appropriate grazing | Unclear to which, if any, SAC features grazing might apply | | | | | x | x | x | x | |
| 3 | Create scrape in drainage channel | | | | | | x | x | | | |
| 4 | Succisa pratensis and honeysuckle planting | | | | | | x | x | x | x | |
| 5 | Construct infrastructure for vehicle access and grazing | Unclear to which, if any, SAC features grazing might apply | | | | | | | x | | |
| 6 | Develop and translate project hub interpretation | | | | | | | | x | x | |
| 7 | Create education materials for schoolchildren and distribute | | | | | | | | | x | |
| 8 | Public training on habitat suitability surveying and marsh fritillary surveying | | | | | | | | x | x | x |

| **Project 3: Enhancing SPA Wetlands** | | **Evidence for impact** | | | | | | | | | | | | | | | | | | | | | | | **Additionalbenefits** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natura Site: | | Carmarthen Bay & Estuaries EMS (Inc. Burry Inlet & Carmarthen Bay SPA) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Actions | | Estuaries | Mudflats & Sandflats not covered by seawater at low tide | Sandbanks which are lightly covered by seawater all the time | Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) | *Salicornia* and other annuals colonising mud and sand | Large shallow inlets and bays | *Alosa alosa* | *Alosa fallax* | *Lampetra fluviatilis* | *Petromyzon marinus* | *Lutra lutra* | Black (common) scoter | Common redshank | Common shelduck | Dunlin | Eurasian oystercatcher | Eurasian curlew | Eurasian teal | Eurasian widgeon | Grey plover | Northern pintail | Northern shoveler | Red knot | Turnstone | Waterfowl assemblage | Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 | Sluice installation in saline lagoons | | | | | | | | | | | | | | | | | | | | | | | | | + | + | | |
| 2 | Repair banks for saline lagoons | | | | | | | | | | | | | | | | | | | | | | | | + | + | + | | |
| 3 | Modify and create new islands in freshwater lagoon | | | | | | | | | | | | | | | | | | | | | | | | | + | | | |
| 4 | install new interpretation boards | | | | | | | | | | | | | | | | | | | | | | | | | | | + | |
| 5 | Remove concrete and reprofile shoreline of freshwater lagoon | | | | | | | | | | | | | | | | | | | | | | | | | + | + | | |
| 6 | Remove silt from freshwater lagoon | | | | | | | | | | | | | | | | | | | | | | | | | + | + | | |
| 7 | Create underwater causeways to islands in FW lagoon | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | Coppicing, laying hedgerows and removing trees | | | | | | | | | | | | | | | | | | | | | | | | | | | + | |
| 9 | Create new wetland treatment system reedbed | | | | | | | | | | | | | | | | | | | | | | | | | | + | | |

| **Project 4a:Traditional boundaries and stock- proofing** | | **Evidence for Impact** | | | | | | | | | | | | | | | | | | | | | | **Additional benefits** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natura Site: | | Eryri/Snowdonia SAC | | | | | | | | | | | | | | Meirionnydd Oakwoods and Bat Sites SAC | | | | | | | | | | | | |
| Actions | | Clear-water lakes or lochs with aquatic vegetation and poorto moderate nutrient levels | Species-rich grassland with mat-grass in upland areas | Tall herb communities | Acidic Scree | Plants in crevices in base-rich rocks | Wet heathland with cross-leaved heath | Alpine and subalpine calcareous grasslands | Montane acid grasslands | Blanket bog | Depressions on peat substrates | Hard-water springs depositing lime | Calcium-rich springwater-fed fens | High-altitude plant communities associated with areas of water seepage | Western acidic oak woodland | Slender Green Feather Moss - *Hamatocaulis vernicosus* | Floating Water-plantain - *Luronium natans* | Purple moor-grass meadows | Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* - *Alno-Padion, Alnion incanae, Salicion albae* | Bog Woodland | Rivers with floating vegetation often dominated by water-crowfoot | Lesser horseshoe bat - *Rhinolophus hipposideros* | Dry heaths | Wet heathland with cross-leaved heath | Western acidic oak woodland | Mixed woodland on base-rich soils associated with rocky slopes | Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 & 2 | Boundary repair and stock-proofing; dry stone walling, slate-pillar fencing, hedgerow works, conservation grazing | | Unclear to which, if any, SAC features grazing might apply | | | | | | Unclear to which, if any, SAC features grazing might apply | | | | | | | | | Unclear to which, if any, SAC features grazing might apply | | | | | Unclear to which, if any, SAC features grazing might apply | | | | x | x | x | | |

| **Project: 4c Gwaith Powdwr** | | **Evidence for Impact** | | | | | | | | | **Additional benefits** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natura Site: | | Coedydd Derw a Safleoedd Ystlumod Meirion/ Meirionnydd Oakwoods and Bat Sites | | | | | | | | | | | | | |
| Actions | | Purple moor-grass meadows | Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* - *Alno- Padion, Alnion incanae, Salicion albae* | Bog Woodland | Rivers with floating vegetation often dominated by water-crowfoot | Lesser horseshoe bat - *Rhinolophus hipposideros* | Dry heaths | Wet heathland with cross-leaved heath | Western acidic oak woodland | Mixed woodland on base-rich soils associated with rocky slopes | Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 | Repointing, rebuilding walls and/or concrete repairs Acid plant, J2, K1, P11, P15 | | | | | | | | | | | | x | x | |
| 2 | Timber repairs, roof repairs, access & utilityimprovements, Pendulum shed, settling shed, T1, T2,T4, T7 | | | | | | | | | | | | x | x | |

| **Project 6: Gilfach** | | **Evidence for impact** | | | | | | | | **Additional benefits** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natura Site: | | Elenydd SAC | | | | | Elenydd Mallaen SPA | | | | | | | |
| Actions | | Blanket Bog | Floating water-plantain (*Nuronium natans* ) | Clear-water lakes or lochs with aquatic vegetation and poor to moderate nutrient levels | Grasslands on soils rich in heavy metals | Dry heaths | Merlin (Breeding) | Peregrine (Breeding) | Red Kite (Breeding) | Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 | Cutting back Purple moor-grass (*Molinia caerula* ) | | | | | | | | | X | | | | |
| 2 | Clear vegetation to create firebreaks | | | | not clear where this action will be undertaken | | | | | X | | | | |
| 3 | Clear footpaths and woodland rides | not clear where this will be carried out | | | | not clear where this will be carried out | | | | | | | X | |
| 4 | Mowing to maintain waxcap grasslands | | | | | | | | | X | | | | |
| 5 | Top leys to increase soil fertility & wildlife crops | | | | | | assuming increase in avian and other prey | | | X | X | | | |
| 6 | Cut back encroaching gorse | | | | | | assuming due to improved conditions for passerine species | | | X | X | | | |

| **Project 7: Globe Way** | | **Evidence for impact** | | **Additional benefits** | | | | |
|---|---|---|---|---|---|---|---|---|
| Natura Site: | | Deeside and Buckley Newt site SAC | | | | | | |
| Actions | | Great Crested Newt - *Triturus cristatus* | Western acidic oak woodland | Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 | Pond restoration and creation | | | + | + | P | | + |
| 2 | Wildflower meadow management | | | + | | + | | + |

| **Project 10a: Skomer Island** | | **Evidence for impact** | | | | | | | | | | | | | | | | | | | | | | | | | | **Additional benefits** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natura Site: | | Skomer, Skokholm and the seas off Pembrokeshire SPA | | | | | | | Pembrokeshire Marine SAC | | | | | | | | | | | | | | | | | | | | | | | |
| Actions | | Manx Shearwaters | Atlantic Puffin | European Storm-petrel | Lesser Black-backed-gull | Seabird assemblage | Short-eared owl | Chough | Large shallow inlets & bays | Estuaries | Intertidal mudflats & sandflats | Reefs | Atlantic salt meadows | Coastal Lagoons | Grey Seal | Allis Shad | Twaite Shad | River Lamprey | Otter | Sea Lamprey | Subtidal sandbanks | Submerged or partly-submerged sea caves | Sea caves not open to the public | European dry heath | *Luronium natans* | Greater horseshoe bat | *Rumex rupestris* | Dry grasslands & scrub-lands or chalk or limestone | Vegetated sea cliffs | Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 | Small mammal trapping onboats and landing area | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Biosecurity signage on boatsand landing area | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | |
| 3 | Live camera streaming andequipment maintenance | Species to be filmed not specified so inferred | | | | | | | | | | | | | *see below | | | | | | | | | | | | | | | | X | X | X | |
| 4 | Improved interpretative signage | Not specified, assumed to be aimed at all features | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | |

*Species to be filmed not specified so inferred

| **Project 10c: Pengelli Forest** | | **Evidence for impact** | | | **Additional benefits** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Natura Site: | | North Pembrokeshire Woodlands SAC | | | | | | | |
| Actions | | Alder woodland on floodplains | Barbastelle bat | Western acidic oak woodland | Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 | Machinery Purchase | | P | P | | | | | |
| 2 | Volunteer equipment purchase | | | P | P | P | | + | |
| 3 | Visitor facilities purchase | | | | | | | + | |

| **Project 10f: Teifi Marshes** | | **Evidence for impact** | | | | | | | | | **Additional benefits** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natura Site: | | Afon Teifi SAC | | | | | | | | | | | | | |
| Actions | | *Cottus gobio* / Bullhead | *Lampetra fluviatilis* / River Lamprey | *Lampetra planeri* / Brook Lamprey | *Luronium natans* / Floating Water - Plantain | *Lutra lutra* / Otter | Clear-water lakes or lochs with aquatic vegetation and poor to moderate nutrient levels | *Petromyzon marinus* / Sea Lamprey | *Salmo salar* / Atlantic Salmon | Rivers with floating vegetation often dominated by water-crowfoot | Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 | Visitor access and information | | | | | | | | | | | | + | + | |
| 2 | Meadow management | | | | | | | | | | + | + | + | | |
| 3 | Pond habitat restoration | | | | | | | | | | + | + | + | | |
| 4 | Invasive species management change | | | | | | | | | | | + | | | |
| 5 | Water level management | | | | | | | | | | | + | | | |

| **Project 10h: South Gower Coast** | | **Evidence for impact** | | | | | | | | | **Additional benefits** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natura Site: | | Limestone coast of South West Wales | | | | | | | | | | | | | |
| Actions | | Vegetated seacliffs of Atlantic and Baltic coasts | Fixed coastal dunes with herbaceous vegetation ("grey dunes") | European dry heaths | Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (Important orchid sites) | Caves not open to the public | Submerged or partially submerged caves | Greater horseshoe bat (*Rinolophus ferrumequinum*) | Early gentian (*Gentianella anglica*) | Petalwort (*Petalophyllum ralfsii*) | Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 | Invasive species management and survey | P | | P | P | | | | | | + | + | | | + |

| Project 11: RESOW | Evidence for impact | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Additional benefits | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natura Site: | Seacliffs of Lleyn SAC & Glannau Aberdaron SPA | | | | Lleyn Peninsula and the Sarnau Special Area of Conservation | | | | | | | | | | | Pembrokeshire Marine | | | | | | | | | | | | | | | | | | | | |
| Actions | Chough (Breeding) | Chough (Wintering) | Vegetated sea cliffs of the Atlantic & Baltic coasts | Manx Shearwater | Reefs | Large shallow inlets | Sandbanks | Estuaries | Coastal lagoons | Mudflats and sandflats | Atlantic salt meadows | *Salicornia* and other annuals | Submerged/partially submerged sea caves | *Tursiops turncates* | *Lutra lutra* | *Halichoerus grypus* | Estuaries | Large shallow inlets and bays | Reefs | Sandbanks which are slightly covered by sea water all the time | Mudflats and sandflats not covered by seawater at low tide | Coastal lagoons | Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) | Submerged or partially submerged sea caves | *Halichoerus grypus* | *Rumex rupestris* | *Petromyzon marinus* | *Lampetra fluviatilis* | *Alosa* | *Alosa fallax* | *Lutra lutra* | Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 Stakeholder mapping | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + |
| 2 Stakeholder workshop | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + |
| 3 Legal management and governance framework | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + |
| 4 Habitat suitability model | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + |
| 5 Benthic site assessments | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + |
| 6 Develop comms material | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | |
| 7 Seagrass planting | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | + | | | + |
| 8 Acoustic fish tracking | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | | | + |

| Project 12: Rivers of Pembrokeshire | | Evidence for impact | | | | | | | | | | | | | | | | | | | | | | Additionalbenefits | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natura Site: | | Afonydd Cleddau SAC | | | | | | | | Sir Benfro Forol / Pembrokeshire Marine | | | | | | | | | | | | | | | | | | |
| Actions | | Active raised bogs | Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior - Alno- Padion, Alnion incanae, Salicion albae* | Bullhead - *Cottus gobio* | River Lamprey - *Lampetra fluviatilis* | Brook Lamprey - *Lampetra planeri* | Otter - *Lutra lutra* | Sea Lamprey - *Petromyzon marinus* | Rivers with floating vegetation often dominated by water-crowfoot | Estuaries | Large shallow inlets and *Halichoerus grypus Rumex rupestris Petromyzon marinus Lampetra fluviatilis Alosa* | Reefs | Sandbanks which are slightly covered by sea water all the time | Mudflats and sandflats not covered by seawater at low tide | Coastal lagoons | Atlantic salt meadows *(Glauco-Puccinellietalia maritimae)* | Submerged or partially submerged sea caves | *Halichoerus grypus* | Shore Dock - *Rumex rupestris* | *Petromyzon marinus* | *Lampetra fluviatilis* | *Alosa alosa* | *Alosa fallax* | Otter - Lutra lutra | Additional biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 | Fish pass feasibility investigation | | | | | | | | | | | | | | P | | | | | | | P | P | | | P | + | | + |
| 2 | Livestock exclusion fencing | | | | | | | | | | | | | | | | | | | | | | | | | P | P | | |
| 3 | Riparian restoration - tree planting | | | | | | | | | | | | | | | | | | | | | | | | + | + | | | |
| 4 | Community engagement | | | | | | | | | | | | | | | | | | | | | | | | | | | + | + |

| **Project 13c: South Stack** | | **Evidence for impact** | | | | **Additional benefits** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Natura Site: | | Glannau Ynys Gybi/ HolyIsland Coast SAC and SPA | | | | | | | | |
| Actions | | Dry heaths | Vegetated sea cliffs | Wet heathland with cross-leaved heath | Chough - *Pyrrhocorax pyrrhocorax* - Breeding | Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 | Boundary repair for grazing | | | | | x | x | x | | |
| 2 | Construct shed to house sick livestock and equipment | | | | P | | | x | | |
| 3 | Purchase Gator vehicle to aid management of heathland | | | | | | x | | x | |
| 4 | Annual heather cutting, removal and disposal | | | | | | x | x | | |

| **Project 13g: Llyn Dinam/Valley Wetlands** | | **Evidence for impact** | **Additional benefits** | | | | |
|---|---|---|---|---|---|---|---|
| Natura Site: | | Llyn Dinam SAC | | | | | |
| Actions | | Naturally nutrient-rich lakes which are often dominated by pondweed | Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 | Bed-lowering to manage water levels and succession | | X | X | X | | |
| 2 | Creation of ponds, open water and back-waters | | X | X | X | | |
| 3 | Willow removal in reed beds | | X | X | X | | |

| **Project 14: Tywydd Tywi Weather** | | **Evidence for impact** | | | | | | | **Additional benefits** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natura Site: | | Afon Tywi / River Tywi | | | | | | | | | | | |
| Actions | | Allis Shad - *Alosa alosa* | Twaite Shad - *Alosa fallax* | Bullhead - *Cottus gobio* | River Lamprey - *Lampetra fluviatilis* | Brook Lamprey - *Lampetra planeri* | Otter – *Lutra lutra* | Sea Lamprey - *Petromyzon marinus* | Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 | Research Infrastructure | P | P | P | P | P | P | P | | P | P | + | + |

| **Project 15: Wye Valley Woodland** | | **Evidence for impact** | | | | | | | | | | | | | | | **Additional benefits** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natura Site: | | Wye Valley Woodland SAC | | | | River Wye SAC | | | | | | | | | | | | | | | |
| Actions | | Beech forests on neutral to rich soils | Lesser horseshoe bat (Hibernacula | Mixed woodland on base rich soils associated with rocky slopes | Yew-dominated woodland | *Alosa alosa* / allis shad | *Alosa fallax* / twait shad | *Austropotamobius pallipes*/ White-clawed (or Atlantic stream) Crayfish | *Cottus gobio* / bullhead | Lampetra fluviatilis /River lamprey | *Lampetra planeri* / Brook lamprey | *Lutra lutra* / Otter | *Petromyzon marinus* Sea lamprey | *Salmo salar* / Atlantic salmon | Very wet mires often identified by an unstable 'quaking' surface | Rivers with floating vegetation often dominated by water-crowfoot | Additional Biodiversity | Landscape scale | Local economy | Community engagement | Knowledge enhancement |
| 1 | Woodland restoration (felling and coppicing) | | | | | | | | | | | | | | | | + | + | | | |
| 2 | Veteran tree management | | | | | | | | | | | | | | | | | | P | | |
| 3 | Veteran tree planting | | | | | | | | | | | | | | | | | + | | | |
| 4 | Livestock fencing replacement | | | | | | | | | | | | | | | | | | | | |
| 5 | Invasive species management | | | | | | | | | | | | | | | | | | | + | |
| 6 | Pond restoration and creation (natural flood management) | | | | | | | | | | | | | | | | | s | | P | |
| 7 | Leaky dam creation (natural flood management) | | | | | | | | | | | | | | | | | + | | P | |
| 8 | Visitor access and information | | | | | | | | | | | | | | | | | | | + | |
| 9 | Investigation of deer browsing and invertebrate biodiversity | | | P | P | | | | | | | | | | | | | | | | + |

# TECHNICAL ANNEX-4: POTENTIAL FOR USING OPEN-SOURCE MODELS TO AID EVALUATION, BY PROJECT

| Project title and code | Habitat/species/ feature of the Natura 2000 site targeted by this action | Modelling options | Requirements for data and scenarios | Model focus |
|---|---|---|---|---|
| 1 Aberbargoed Grasslands (fencing, scrub removal, plug-planting) | Marsh Fritillary - *Euphydryas* (*Eurodryas, Hypodryas*) *aurinia* | Modelling of the butterfly has been carried out elsewhere but depends on the availability of high resolution distribution data and the covariates that convey change in influential habitat conditions (Brunbjerg et al. 2017). No model appears to exist specifically for Wales although a metapopulation analysis of UK populations provides results that can support a narrative assessment of risk to existing populations (Bulman et al. 2007).<br><br>The MultiMOVE R package has an existing niche model for *Succisa pratensis* in Britain. This could be used to test the impact on habitat suitability resulting from changing livestock type and scrub removal. | Application of MultiMOVE would be restricted to applying a business as usual scenario based on existing conditions and then comparing the habitat suitability under these conditions with a scenario of more variability but overall reduction in canopy height associated with cattle grazing and scrub removal. If changes in substrate wetness were envisaged these could also be introduced into the scenario of changing conditions.<br><br>Data requirements: In order of decreasing cost and local realism; 1) soil samples + co-located vegetation quadrats, 2) vegetation quadrats only, 3) analogue soil + vegetation samples representing the habitat type and extracted from existing databases e.g. GMEP baseline or NRW phase II survey data. | Biodiversity (plants) |
| 2 Bug Farm (creating a 100-acre habitat corridor for a marsh fritillary metapopulation) | Marsh Fritillary - *Euphydryas* (E*urodryas, Hypodryas*) *aurinia,* although not a priority feature of NW Pembrokeshire Commons SAC | As above. | As above. Here intended changes in vegetation structure and wetness as a result of scrub and rush clearance and scrape creation could be turned into scenarios of increased wetness and reduced canopy height that could be explored using MultiMOVE.<br><br>Data requirements: In decreasing order of cost and local realism; 1) soil samples + co-located vegetation quadrats, 2) vegetation quadrats only, 3) analogue soil + vegetation samples representing the habitat type and extracted from existing databases e.g. GMEP baseline or NRW phase II survey data. | Biodiversity (plants) |
| 3 Llanelli wetland centre | Carmarthen Bay & Estuaries EMS | The suite of proposed management actions are expected to improve conditions for waterfowl assemblages. | It is possible that a habitat map depicting changes associated with the proposed works could be used to | Biodiversity (plants & birds) |

| Project title and code | Habitat/species/ feature of the Natura 2000 site targeted by this action | Modelling options | Requirements for data and scenarios | Model focus |
|---|---|---|---|---|
| (water level management, coppicing and hedge management, lagoon repair, creation and reprofiling, outreach) | (Inc. Burry Inlet & Carmarthen Bay SPA). Waterfowl assemblage. | Depending upon the species concerned impacts could be modelled using the BTO/IMP-Birds model where land-cover and habitat features are used as predictors of bird presence and abundance (e.g. Plummer et al. 2020).<br><br>Habitat models for a number of waterfowl have been developed in the past for British populations (Milsom et al. 2001) but new development and application is likely to be necessary to ensure local realism and relevance. | generate baseline and post-impact extent of features that are predictors in the BTO/IMP-Birds model. These include saltmarsh, winter bare ground, shrub and woodland, rough grass and freshwater. Therefore two maps could be used as input to this model so as to estimate potential impact. However, the application of the model is likely to be restricted because water birds are poorly covered. | |
| 4A Eyri N2K (sub-project Boundary repair and stock-proofing) | Unclear | The assessment notes that the detail of the project is very vague, both with respect to management intervention and the identification of targeted features. Benefits ensuing from the proposed actions are however broad and are claimed to include landscape connectivity, increased water absorption, carbon sequestration and storage along with biodiversity gains. On this basis connectivity, carbon and biodiversity models from within the IMP framework could have a role to play in prospectively assessing future impacts. Economic impacts are also expected hence the valuation component of the IMP may also be relevant. | A key constraint is likely to be data availability to drive the suite of models. Coarsely resolved input data could be used but the outputs may then prove unrealistic and lacking in local sensitivity. Given that this project aspires to impact a whole range of public goods and the local economy it would be a good test case for how well the IMP platform can perform at the local scale. | Connectivity, Carbon, Biodiversity, Farm economics<br><br>(potential scope but limited by data availability) |
| 4C Eyri N2K (sub-project C Building restoration at Gwaith Powdwr) | Lesser horseshoe bat - *Rhinolophus hipposideros* | The specificity of the project in terms of works planned and the target species suggest modelling would not be necessary to explore the likely impact on the suitability of conditions for the bat species. A combination of existing ecological knowledge and local abundance data would probably be enough to derive a narrative-based expectation of impact to be compared with observations over time. | Not applicable given the actions envisaged. However, worth noting that a freely available species distribution model for Lesser Horseshoe Bat has been developed by Forest Research (see https://www.forestresearch.gov.uk/research/putting-uk-woodland-bats-on-the-map/ and Bellamy et al. 2020). | Not applicable |
| 6 Gilfach (managing vegetation and access) | Elenydd Mallaen SPA and Elenydd SAC. Features listed are Blanket Bog, Dry Heath, metal-rich | The BTO/IMP-Birds model includes Red Kite but not Merlin nor Peregrine. However the model could potentially be used for prey species for these raptors if the planned changes were translated into a map of change in habitat types and features that are inputs to the model. However, this would be a model application | Application of the BTO/IMP-Birds and MultiMOVE models to explore impacts on birds and plants would require locally specific information to maximise the relevance and accuracy of predictions. For the BTO/IMP-Birds model this would be a baseline and proposed map of change in habitat extent. For MultiMOVE in order of decreasing cost yet decreasing local realism this would require ; 1) soil | Biodiversity (plants, birds are possible but currently limited to raptor prey species and |

| Project title and code | Habitat/species/ feature of the Natura 2000 site targeted by this action | Modelling options | Requirements for data and scenarios | Model focus |
|---|---|---|---|---|
| | grasslands, the three SPA features are Merlin, Red Kite and Peregrine. Lichen-rich rocks are mentioned although not a designated feature. | rather removed from exploring direct impacts on the target raptors.<br><br>Exploration of the impact of proposed actions on plant biodiversity could be explored using MultiMOVE. These actions include clearing vegetation from footpaths and rides, reducing *Molinia* cover, clearing firebreaks through Gorse, heather, bracken and grass and cutting Gorse. | samples + co-located vegetation quadrats, 2) vegetation quadrats only, 3) analogue soil + vegetation samples representing the habitat type and extracted from existing databases e.g. GMEP baseline or NRW phase II survey data. | one target raptor species) |
| 7 Globe Way (pond creation and meadow restoration) | Deeside and Buckley SAC, Great Crested Newt (*Triturus cristatus*).<br><br>Wildflower meadows also targeted but not highlighted as a designated feature. | A Species Distribution Model for Wales for the Great Crested Newt (GCN) has been developed at 25m resolution within a GIS platform (Fletcher et al. 2014). Inputs are pond density from OS Mastermap digital elevation, land cover (LCM2007) and climate, all of which could probably be provided at the study site to represent baseline and a post-impact scenario.<br><br>The MultiMOVE model could be used to explore the likely successful establishment of wildflower meadow species if soil samples were available. | Data are likely to be available as input to the GCN model and a baseline could be run against a scenario of expected changes in habitat structure and condition. Presumably reliable local information is available on GCN abundance to be able to determine whether the availability of the target species is likely to be an obstacle.<br><br>A small number of soil samples would allow MultiMOVE to profile the suitability of the soil conditions at varying vegetation heights for suites of target meadow species. A less locally realistic yet low-cost option would be to seek analogue samples on the same soil type from the GMEP database. | Biodiversity (plants, Great Crested Newt using model developed for NRW) |
| 10 A Welsh Wildlife, Skomer (small mammal trapping, outreach) | Skomer, Skokholm and seas off Pembrokeshire SPA – Manx Shearwater, European Storm-petrel, Atlantic Puffin | Not applicable. | Not applicable. | Not applicable. |
| 10 C Welsh Wildlife C - Pengelli Forest (equipment and | Barbastelle bats Western acidic oak woodland | The actions are rather removed from the intent to drive ecological change. Equipment purchase has been funded to aid management but the applicants envisage that this will allow "*Improved access to areas of western acidic oak woodland for future management*" hence | Not applicable. | Not applicable. |

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| visitor facilities purchase) | | ecological change is speculative. Modelling therefore seems inappropriate although if specific impacts were described for the oak woodland then it is possible that BTO bird and UKCEH plant species models would be relevant.<br><br>A species distribution model exists for Lesser Horseshoe Bat in Britain (Bellamy et al. 2020) but not for the Barbastelle to our knowledge. | | |
| 10 F Welsh Wildlife. Teifi Marches (outreach, pond restoration, meadow and water level management) | Afon Teifi SAC. Otter and other targeted features were not clear from the application. | Management intervention on wet and dry meadows is expected to "support pollinator habitat and flowering plant diversity". These aren't especially aspirational objectives but baseline and expected positive change to plant communities could be modelled using MultiMOVE with subsetting of outputs by pollinator plant group.<br><br>Interventions to improve aquatic habitats suggest that model-based assessment using RIVPACS (Wright 2000) could be carried out (https://www.sepa.org.uk/environment/water/aquatic-classification/river-invertebrate-classification-tool/). This free tool could be used to explore potential impacts on trophic status and aquatic biodiversity.<br><br>Overall the difficulty of applying models relates to the low level of detail in the application. As the assessors point out "*The application rarely indicates which features would benefit from each action and justifications for actions are vague*." | For MultiMOVE in order of decreasing cost yet decreasing local realism this would require; 1) soil samples + co-located vegetation quadrats, 2) vegetation quadrats only, 3) analogue soil + vegetation samples representing the habitat type and extracted from existing databases e.g. GMEP baseline or NRW phase II survey data.<br><br>Applying the RIVPACS tool on a site requires macro-invertebrate sampling, water chemistry and other environmental data. | Biodiversity (plants), water quality. |
| 10 H South Gower Coast (habitat survey, equipment purchase) | Not specified (possibly subject to survey results) | Detail regarding the target habitat types and invasive species requiring control are lacking. If positive impacts of management on birds and plant species composition were specified then the BTO/IMP-Birds and MultiMOVE models could be relevant. | Further dialogue with site managers would be needed to define the baseline and location of interventions thus creating a map-based scenario of change in the input variables used for modelling. For BTO/IMP-Birds this would be land-use/habitat type and for MultiMOVE in order of decreasing cost yet decreasing local realism this would | Unclear but likely to be biodiversity (birds and plants) |

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| | | | require; 1) soil samples + co-located vegetation quadrats; 2) vegetation quadrats only; 3) analogue soil + vegetation samples representing the habitat type and extracted from existing databases e.g. GMEP baseline or NRW phase II survey data. | |
| 11 RESOW (baseline survey of habitat, connectivity and suitability modelling, outreach activities, seagrass planting) | Penllyn A'r Sarnau SAC/Large shallow inlets and bays/seagrass | This is a high value project and part of a larger and well-publicised restoration programme. Modelling is a specific action in the proposal and so we assume that model development and application is part of the funded activity.<br><br>Given the difficulty but wider need for such modelling it would be useful if the model framework and lessons learned were disseminated during and after the project. | Not applicable as modelling already part of proposal. | Not applicable. |
| 12 Rivers of Pembrokeshire (riparian conservation measures, outreach, fish pass feasibility study) | Pembrokeshire Marine SAC (fish species) | Interventions to improve aquatic habitats suggest that model-based assessment using RIVPACS (Wright 2000) could be carried out (https://www.sepa.org.uk/environment/water/aquatic-classification/river-invertebrate-classification-tool/). This free tool could be used to explore potential impacts on trophic status and aquatic biodiversity.<br><br>Interventions to improve condition of riparian habitats could be modelled using MultiMOVE. This would be restricted to exploring impacts on habitat suitability for plants (trees, shrubs, herbaceous species and lower plants in terrestrial habitats).<br><br>The FARMSCOPER model could be readily applied to explore proposed impacts of reduced diffuse pollution. This is a decision support tool that can be used to **assess diffuse agricultural pollutant loads** on a farm and **quantify the impacts of farm mitigation options** | Applying the RIVPACS tool on a site requires macro-invertebrate sampling, water chemistry and other environmental data.<br><br>Scenarios of the impact of reduced diffuse pollution, grazing, tree planting and fencing could be translated into changes in vegetation height and mineralisable N, which are inputs to MultiMOVE.<br><br>The FARMSCOPER model requires the following input data for the catchment:<br>• Farm type<br>• Information in mitigation measures already applied.<br>• Area of arable cropping by soil type / rainfall<br>• Area of grassland by soil type / rainfall<br>• Average N and P fertiliser rates to those areas<br>• Either: | Diffuse pollution, water quality, biodiversity (terrestrial plants, aquatic species) |

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| | | on these pollutants (https://www.adas.uk/Service/farmscoper). | o Total volume of excreta or manure on the farm by livestock type; or<br>o Total volume of manure applied to arable cropping and to grassland by soil type / rainfall by livestock type. | |
| 13C RSPB sub-project C south Stack (boundary repair, annual heather cutting, equipment purchase) | Glannau Ynys Gybi / Holy Island Coast SAC and SPA (Dry and wet heaths, boundaries, Chough habitat) | Chough is a rare species in Wales. Its ecological requirements and distribution are well known hence there is probably little need for modelling to support assessment.<br><br>The MultiMOVE model could be used to explore the possible impact of interventions on habitat suitability for plants in the wet and dry heath. This would involve simple scenarios of change in canopy height. | See above for input data required for MultiMOVE. | Biodiversity (plants) |
| 13G RSPB Llyn Dinam Valley Wetlands (habitat management of reedbed, open water and ponds) | Naturally nutrient-rich lakes which are often dominated by pondweed | There is a lack of operational habitat models for Waterfowl for Wales, although these have been produced in the past for GB showing that model development is possible where bird abundance can be linked to available land-use and habitat predictors (Milsom et al. 2001). Bittern is a target species in the proposal but is not included in the BTO platform. Similarly, assemblages of aquatic plants are not well covered by MultiMOVE.<br><br>The impact of changes in canopy height on plant species composition following Willow removal could be explored using MultiMOVE. | As above for MultiMOVE input data. | Biodiversity (plants) |
| 14 Tywydd Tywi Weather (installation of weather stations) | *Alosa alosa*/Allis Shad, *Alosa fallax*/Twait shad, *Cottus goblo*/Bullhead, | While the funding sought covered the installation of weather stations the assessment highlights wider aims in the project. These cover climate projections but no further information was provided in the application. Data gathering will also ostensibly support more efficient | Applying the RIVPACS tool on a site requires macro-invertebrate sampling, water chemistry and other environmental data.<br><br>The FARMSCOPER model requires the following input data for the catchment: | Water quality, diffuse pollution, farm profitability |

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| | *Lametra fluviatillis*/ River lamprey, *Lampetra planeri*/ Brook lamprey, *Lutra lutra*/ Otter *Petromyzon marinus*/ Sea Lamprey | nutrient management reducing diffuse pollution and costs to the 40 farmers involved.<br><br>The project is catchment-scale. Given the objectives above there would be a possible role for Sfarmod (Audsley et al. 2014) to model the economic impact of pollution mitigation that is expected to be more effective by incorporating new high resolution climate data. FARMSCOPER could also be used to explore the likely impact of mitigation on nutrient surpluses and RIVPACS used to estimate impacts on river quality. The scale of the project involving a large number of farmers constitutes an interesting case-study of how joined up action enhanced by better data availability can make a difference and how models could be used to forecast the size of expected effects. | • Farm type<br>• Information in mitigation measures already applied.<br>• Area of arable cropping by soil type / rainfall<br>• Area of grassland by soil type / rainfall<br>• Average N and P fertiliser rates to those areas<br>• Either:<br>o Total volume of excreta or manure on the farm by livestock type; or<br>o Total volume of manure applied to arable cropping and to grassland by soil type / rainfall by livestock type.<br><br>The Sfarmod platform for modelling impacts of interventions on farm profitability requires the following classes of information:<br>• Environmental data – particularly soil and climate (to determine yields, soil workability etc)<br>• Resources available to the farm e.g. machines, land, labour etc<br>• Input prices e.g. seeds, fuel, feed, labour, operations<br>• Output prices e.g. milk, meat, livestock, crop prices<br>• Restrictions/constraints e.g. NVZ etc<br><br>The process of devising scenarios of change in model input variables consistent with interventions could be complex given the scale of the project. This would require stakeholder engagement with modelling experts to discuss and agree a number of scenarios to apply. The cost of this exercise would be significant but it would be an extremely useful test of the models' capability to work together with a broad range of participants and perform credibly at a scale that is appropriate for guiding land management. | |

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| 15 Gwent woodland trust (woodland management including felling, coppicing, tree planting, fencing and invasive species management) | Wye Valley Woodlands SAC and Wye River SAC (Mixed woodland on base-rich soils associated with rocky slopes Beech forests on neutral rich soils Yew dominated woodland) | Woodland management interventions are expected to promote natural regeneration of woodland, improving light conditions for ground flora. The installation of 'leaky dams' is also expected to enhance wetland habitat. The impacts on plant species composition can be readily modelled using MultiMOVE.<br><br>Expectations of positive impact on Lesser Horseshoe Bat could potentially be modelled by an existing open-source Forest Research model (Bellamy et al. 2020). Impacts on landscape-scale connectivity bring in the capability of the existing IMP spatial analysis toolbox and would be reliant on local knowledge for parameter estimates. | See above for input data for MultiMOVE.<br><br>Habitat connectivity could be explored by re-parameterising the ERAMMP IMP model within ArcGIS toolbox. The model requires a baseline map of habitat patch structure, a map that has changed following expected intervention and estimates of dispersal distance and minimum patch size for the focal species. | Biodiversity (plants, Lesser Horseshoe Bat), habitat connectivity |

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