**Title:** Comparing Field-Based Management Approaches for Invasive Winter Heliotrope (*Petasites pyrenaicus*: Asteraceae)

**Journal:** NeoBiota

**Authors:** Daniel Jones1,2, Mike S. Fowler1, Sophie Hocking1 and Daniel Eastwood1

1Department of Biosciences, Swansea University, UK

2Advanced Invasives Ltd, Cardiff, UK

**Corresponding author email address:** daniel.ll.jones@gmail.com

**Supplementary resource 1:** Desk-based site geological, hydrological and historical surveys.

GroundSure® geographical, geological, hydrological, current and historic landuse data layers (MapInsight®, GeoInsight® and EnviroInsight®) were obtained for the Invasives Research Centre (IRC), Taffs Well. These data were interpreted in conjunction with author pre-trial onsite investigations to ensure appropriate siting of *Petasites pyrenaicus* field trial plots and treatment groups, i.e. only biactive formulations of glyphosate may be used near water and excavation should not be undertaken near watercourses due to the potential for dispersal of vegetative propagules.

**Field Trial Site:** Invasives Research Centre (IRC), Taffs Well

**Location:** WGS 84: 51.534124, -3.259120

**Ordnance Survey (OS) Grid Reference:** ST 127 824

No artificial ground, landslips, ground workings or natural ground subsidence was reported at the field trial site (Table S2.1). Measures of natural ground subsidence are rated very low to moderate at the site. Substratum at the site consists of alluvium, river terrace and glaciofluvial deposits with high permeability, overlying permeable limestone. Estimated soil chemistry reported: arsenic (25 to 45 mg kg-1), cadmium (<1.8 mg kg-1), chromium (60 to 90 mg kg-1), nickel (15 to 45 mg kg-1) and lead (<150 mg kg-1).

**Supplementary Table S1.1** Summary of IRC GroundSure GeoInsight® report.

|  |  |  |
| --- | --- | --- |
| **Report Section** |  | **Description** |
| **Artificial Ground** | Is there any Artificial Ground /Made Ground present beneath the study site? | No |
| Are there any records relating to permeability of artificial ground within the study site boundary? | No |
| **Superficial Geology & Landslips** | Is there any Superficial Ground/Drift Geology present beneath the study site? | Yes |
| Are there any records relating to permeability of superficial geology within the study site boundary? | Yes |
| Are there any records of landslip within 500m of the study site boundary? | No |
| Are there any records relating to permeability of landslips within the study site boundary? | No |
| **Ground Workings** | Historical Surface Ground Working Features from Small Scale Mapping | 0 |
| Historical Underground Workings Features from Small Scale Mapping | 0 |
| Current Ground Workings | 0 |
| **Natural Ground Subsidence** | Shrink-Swell Clay | Very Low |
| Landslides | Moderate |
| Ground Dissolution of Soluble Rocks | Low |
| Compressible Deposits | Moderate |
| Collapsible Deposits | Very Low |
| Running Sand | Low |
| **Records of Superficial Deposits/Drift Geology** | Lex Code | GFSDD-SAGR; RTDU-SAGR; ALV-CSSG |
| Description | GLACIOFLUVIAL SHEET DEPOSITS, DEVENSIAN; RIVER TERRACE DEPOSITS (UNDIFFERENTIATED); ALLUVIUM |
| Rock Description | SAND AND GRAVEL; SAND AND GRAVEL; CLAY, SILT, SAND AND GRAVEL |
| **Records of Permeability of Superficial Ground** | Flow type | Intergranular |
| Maximum Permeability | High—Very High |
| Minimum Permeability | Very Low—High |
| **Records of Bedrock & Solid Geology** | Lex Code | CCL-LMST; PEMB-DOLM |
| Rock Description | Castell Coch Limestone Formation - Limestone; Pembroke Limestone Group - Dolomitic Limestone |
| Rock Age | Courceyan; Brigantian / Courceyan |
| **Records of Permeability of Bedrock Ground** | Flow type | Fracture |
| Maximum Permeability | Very High |
| Minimum Permeability | High |
| **Faults** | Category description | FAULT |
| Feature description | Normal fault, inferred |
| **Estimated Background Soil Chemistry** | Sample Type | Sediment |
| Arsenic (As) soil concentration range | 25-35 mg/kg |
| Cadmium (Cd) | <1.8-2.2 mg/kg |
| Chromium (Cr) | 60-90 mg/kg |
| Nickel (Ni) | 15-45 mg/kg |
| Lead (Pb) | <150 mg/kg |

One environmental permit, incident or register was reported at the field trial site, though it was not stated what the report related to (Table S2.2). There are no abstraction licenses within 2,000 m of the site and there are no Source Protection Zones (SPZs) within 500 m of the site, although there are aquifers present within superficial and bedrock deposits at the site. One river (River Taff) is present at the site and field trial plots are located within Environment Agency indicative zone 2 and 3 floodplains. BGS ground water flooding susceptibility is very high for the site. There are no environmentally sensitive site designations for site 1. Ground subsidence risk is moderate.

**Supplementary Table S1.2** Summary of IRC GroundSure EnviroInsight® report.

|  |  |  |
| --- | --- | --- |
| **Report Section** |  | **Description** |
| **Environmental Permits, Incidents and Registers** | Environmental Permits, Incidents and Registers at study site | 1 |
| **Hydrogeology and Hydrology** | Aquifer present within Superficial Deposits | Secondary A |
| Aquifer present within Bedrock Deposits | Principal Aquifer |
| Groundwater Abstraction Licences (within 2000m of the study site) | 0 |
| Surface Water Abstraction Licences (within 2000m of the study site) | 0 |
| Potable Water Abstraction Licences (within 2000m of the study site) | 0 |
| Are there any Source Protection Zones within 500m of the study site? | No |
| **Hydrology – Detailed River Network and River Quality** | Rivers present at study site? | 1 |
| **Flooding** | Are there any Environment Agency indicative Zone 2 floodplains within 250m of the study site? | Yes |
| Are there any Environment Agency indicative Zone 3 floodplains within 250m of the study site? | Yes |
| Are there any Flood Defences within 250m of the study site? | No |
| Are there any areas benefiting from Flood Defences within 250m of the study site? | No |
| Are there any areas used for Flood Storage within 250m of the study site? | No |
| What is the maximum BGS Groundwater Flooding susceptibility within 50m of the study site? | Very high |
| What is the BGS confidence rating for the Groundwater Flooding susceptibility areas? | High |
| **Designated Environmentally Sensitive Sites** | Records of Sites of Special Scientific Interest (SSSI) | 0 |
| Records of National Nature Reserves (NNR) | 0 |
| Records of Sites of Special Scientific Interest (SSSI) | 0 |
| Records of Local Nature Reserves (LNR) | 0 |
| Records of Special Areas of Conservation (SAC) | 0 |
| Records of Special Protection Areas (SPA) | 0 |
| Records of Ramsar sites | 0 |
| Records of World Heritage Sites | 0 |
| Records of Environmentally Sensitive Areas | 0 |
| Records of Areas of Outstanding Natural Beauty (AONB) | 0 |
| Records of National Parks | 0 |
| Records of Nitrate Sensitive Areas | 0 |
| Records of Nitrate Vulnerable Zones | 0 |
| **Natural Hazards** | What is the maximum risk of natural ground subsidence? | Moderate |

National Flood Risk Assessment Flood Rating (NaFRA) was reported as moderate for the field trial site (Table S2.3). Further, the Environment Agency and BGS have recorded historic pluvial and ground water flooding at the site.

**Supplementary Table S1.3** Summary of IRC GroundSure FloodInsight® report.

|  |  |  |
| --- | --- | --- |
| **Report Section** |  | **Description** |
| **National Flood Risk Assessment (NaFRA)** | What is the National Flood Risk Assessment (NaFRA) Flood Rating for the study site? | Moderate |
| **Historic Flood Events** | Has the site been subject to past flooding as recorded by the Environment Agency? | Yes |
| **Surface Water Floods** | Is the site or any area within 50m at risk of Surface Water (Pluvial) Flooding? | Yes |
| **Groundwater Flooding** | What is the maximum BGS Groundwater Flooding susceptibility within 50m of the study site? | Very High |
| What is the BGS confidence rating for the Groundwater Flooding susceptibility areas? | High |
| **BGS Geological Indicators of historic flooding** | Are there any geological indicators of historic flooding within 250m of the study site? | Yes |

**Demarcating field trial plots and treatment group assignment**

Following desk-based assessment and pre-experiment onsite investigations, field trial plots were delineated, and treatment groups assigned based upon proximity to water, conservation designations and accessibility.