Managing brownfields for ground beetles

Ground beetles can thrive on brownfields due to the range of habitats which provide opportunities for a great number of both generalists and specialists. Ground beetles can be useful in assessing the biodiversity value of brownfields as many are voracious predators so good populations indicate a strong invertebrate assemblage. Others are seed feeders requiring a diverse range of flowering plants. They can also be found throughout the year and include some charismatic and easy to identify species.

The importance of brownfields for ground beetles

The mosaic of successional stages found on wildlife-rich brownfields can support a diverse assemblage of ground beetles. Brownfield mosaics can show varied soil characteristics, vegetation communities and vegetation structure across a site which is ideal for an abundance of generalists as well as specialists of open, dry habitats and wet features (Lott 2003; Small et al. 2003).

Ground beetles of open, dry habitats thrive on brownfileds which support a rich and varied ruderal wildflower resource linked to their history of disturbance and abandonment. Free-draining and low nutrient substrates prevent fast growing and more competitive species from dominating, allowing an abundance of wildflowers to grow. Ruderal plants produce vast quantities of food for seed-eating *Amara* and *Harpalus* beetles. The same species are among the many active ground beetles that will often use plant basal rosettes and larger leaves for shelter during daylight hours.

Key species of ground beetle on brownfields

Streaked bombardier (*Brachinus sclopeta*), Saltmarsh short spur (*Anisodactylus poeciloides*), Mellet's Downy-back (*Ophonus melletii*), Oolite downy-back (*Ophonus stictus*), *Ophonus puncticollis,* Green tiger (*Cicindela campestris*), Heath tiger (*Cicindela sylvatica*), Scarce Four-dot Pin-palp (*Bembidion quadripustulatum*) *Omophron limbatum*, *Dyschirius obscurus, Harpalus* spp. including Brush-thighed Seed-eater (*Harpalus froelichii*) and *Harpalus obscurus*, *Platyderus depressus*, Necklace ground beetle (*Carabus monilis*), Silt silver spot (*Bracteon argenteolum*), *Demetrias* spp. including *Demetrias imperialis.*

Mellet's downy-back beetle (*Ophonus melletii*) © Christoph Benisch

Green tiger beetles (*Cicindela campestris*) hunt on bare ground © Steven Falk

Bare ground within early successional mosaics is particularly valuable for the many active predatory ground beetles. Bare ground warms up more quickly than the surrounding environment, allowing them to be more active during cooler weather. Predatory species such as the tiger beetles (*Cicindela* spp.) will seek out patches of open bare ground to hunt for prey, while they also need bare sandy ground for their larval burrows. Diverse assemblages of predatory ground beetles can be found on the best brownfields, as the habitat diversity that a single site can support means that there is often a larger pool of potential prey than in the wider landscape.

A valuable feature for ground beetles on brownfields is introduced substrates and aggregates. Of particular value are bunds or mounds of rubble and site clearance debris, especially those with an open, south-facing aspect. Introduced and disturbed materials are useful on sites whether they are piled or strewn across the ground, offering a multitude of sheltering opportunities. Where sites have been subject to the repeated introduction of different aggregates over a long period of time, a complex mosaic of different substrates and local microclimates can develop, suiting many different species. Topographical variation resulting from a history of disturbance can also provide a range of microclimates, enabling both hygrophilous (damp loving) species such as many *Agonum* spp., and xerophilous (dry loving) species such as *Harpalus* spp., to be found on the same site.

An absence of management on brownfields is a further benefit for ground beetles. Free of grass cutting, wildflowers are able to set seed to provide food for both seed-eating beetles and the prey of predatory species. Tall herb-rich grasslands are able to develop, including tussocks with accumulated leaf litter which is a key habitat feature for overwintering ground beetles (Lott 2003).

Diverse brownfields are becoming increasingly important for ground beetle populations, as they can mimic the natural and semi-natural habitats that have declined in the modern countryside (Eversham et al. 1996). For example, calcareous brownfields can mimic the coastal chalk grasslands traditionally favoured by Mellet's downy-back (*Ophonus melletii*). This dependence on brownfields can be extremely acute, with the only surviving populations of species such as the Streaked bombardier (*Brachinus sclopeta*) and Silt silver spot (*Bracteon argenteolum)* restricted to brownfields.

Key brownfield habitat features for ground beetles

- Rubble and introduced substrates piles
- Sparsely vegetated early successional habitats
- Ephemeral and permanent wet features
- Rosettes of ruderal vegetation
- Topographical and microclimate variation
- Bare and friable ground

Novel opportunities on brownfields can enable ground beetles to occupy sites well outside of their normal range. Wetland brownfields, particularly flooded sand pits and former gravel workings support inland populations of normally coastal species such as *Omophron limbatum.* Species such as the Saltmarsh shortspur (*Anisodactylus poeciloides*) have not moved quite such distances, but use wet areas of Pulverised Fuel Ash (PFA) as a local surrogate for their traditional habitat of saline coastal habitats, which may become increasingly important as the UK's saltmarshes suffer from rising sea levels. These new habitats in unusual locations are likely to become increasingly important in allowing more mobile ground beetles to move across the landscape in response to climate change.

Threats to ground beetles on brownfields

The ongoing loss of brownfields to redevelopment is having a significant impact on ground beetle populations. Less mobile ground beetles can find it difficult to persist in fragmented habitat networks, as they do not readily colonise new sites, making them progressively more isolated (Small et al. 2006).

Streaked bombardier beetle (*Brachinus sclopeta*) © Craig Slawson

Vegetated rubble providing good ground beetle habitat © Jamie Robins

Some species, such as the Streaked bombardier are only known from a small number of sites and are highly dependent on brownfields. However, urban regeneration continues to reduce the amount of suitable habitat available to them as more and more brownfields are re-developed. This unsustainable rate of site loss runs the risk of the species being lost from the UK fauna completely.

Inappropriate management of brownfields such as tidying up for public access can result in tidying up and the loss of key features such as rubble, mounds and topographical variation. Conversely, a long-term absence of management on a brownfield can lead to scrub encroachment and the eventual loss of open habitat.

Creating & managing habitat for ground beetles

Although an absence of management is often a key factor in the high biodiversity of brownfields, management will eventually be necessary to retain that wildlife value. Without management, brownfield sites will eventually revert to dense scrub and secondary woodland.

Diversifying habitat types is key to encouraging a rich ground beetle assemblage. Brownfield management should always be rotational, with only parts of a site managed in a single year to maintain a mosaic, avoiding using a single technique site-wide in a single year. This is essential to retain a habitat mosaic and prevent homogenisation of a site.

- Creating areas of early successional habitat using varied cycles of disturbance and different types of disturbance activity will increase the range of conditions for the many ground beetles associated with bare ground. Disturbance in low nutrient areas will produce a better response than in higher nutrient soils. Disturbance regimes should operate rotationally to ensure a steady supply of newly disturbed areas for early successional habitats to develop. Over time this will ensure a mosaic of successional stages develop, providing diverse vegetation types and structures. Disturbance can be small scale and undertaken manually with hand tools or with machinery such as an excavator to scrape off larger areas of material and vegetation, overturn soil or simply be driven around to churn up soils. Newly created disturbed and bare ground can be valuable for active predators such as tiger beetles, as well as seed-eating *Ophonus* and *Harpalus* species which thrive in disturbed, ruderal environments.
- Topographical variation can create a range of microclimates, differing soil conditions, wet and dry areas and diverse vegetation communities which can support more species. Machinery such as an excavator can be used to create hollows and the removed material used to create adjacent banks. Hollows may develop the damp conditions favoured by some species, while drier bank slopes may provide sparsely vegetated habitat with ruderal plants, ideal for seed-eating species. Topography can be managed in a piecemeal manner by creating new humps and hollows on a cycle of 10-20 years. This can be linked to the maintenance of early successional stages and stripping of any over-fertile soils.
- Where a brownfield shows a natural tendency to become waterlogged, large scrapes and hollows can be created using machinery or hand tools to encourage ephemeral or permanent pools to develop. Shallow-profiled pool margins and summer draw-down will offer a range of depths for different vegetation to develop and encourage wet mud margins for species such as the Scarce four-dot pin-palp (*Bembidion quadripustulatum)*. Wetland features should ideally be managed in a piecemeal manner to ensure a diversity of types and degree of vegetation cover. Effective wetland mosaics are likely to benefit a host of damp-loving ground beetles such as many *Agonum, Bembidion* and *Demetrias* species. Where possible, it is worth creating scrapes on different introduced substrates, with a number of scarce ground beetles associated with damps sands, while Pulverised Fuel Ash (PFA) has been known to support the Saltmarsh shortspur in the south-east of England. Willow

Mosaic with mound, bare areas and ruderal resource © Jamie Robins

Topographical mosaic of wet and dry habitats © Steven Falk

encroachment can be persistent, and is best controlled on a 5-10 years cycle to diversify carr conditions whilst maintaining some open wetland.

- Clearing encroaching scrub, carr and trees will help maintain open habitat, but some areas should be retained as they are valuable habitats in their own right. Scrub and carr should be cleared in a rotational manner and the stumps treated to prevent regrowth. Leaf litter should then be scraped off to create bare ground for ruderal plants to colonise. Secondary woodland on brownfields can also be coppiced to diversify conditions. Arising can be piled up in a specific part of the site in log or brash piles as an additional habitat feature which provides shelter and overwintering areas. Previously scrub cleared areas are best managed by regularly pulling young saplings to slow succession.
- Many brownfield sites can be enhanced by bringing in new substrates from external locations. This can help diversify ground conditions as different substrates may develop distinct vegetation, soil and drainage characteristics. Beetle bunds can be created using large sized rubble and low nutrient soil or scraped off material, preferably in open areas with a south-facing aspect. Soil and rubble should be alternately laid and topped with areas of both bare soil and rubble to encourage a vegetation mosaic. Aggregates to consider include rubble, hardcore, sands, chalk, industrial materials such as blast furnace slag, dredgings, gravels or PFA. If particular scarce species are known in the local area, substrates could be targeted. For example, sands or calcareous substrates may be useful in areas with records of Mellet's downy-back beetle. It may also be useful to consider the surrounding landscape when choosing aggregates, such as importing sandy materials where their have been local losses of acid grassland or heathland habitats to help contribute to local biodiversity targets.
- Grassland management should aim to retain a varied grassland and tall herb stands with plentiful ruderal species for flower-rich grassland loving ground beetles. If cutting is required for site management, long rotational cutting of grasslands should ensure that longer grassland, including tussocks with accumulated leaf litter, are retained to provide structural diversity and overwintering sites. Any cutting should be undertaken in autumn after flowering plants have set seed, with arisings removed to lower site nutrients.
- Some scarce ground beetles are specifically associated with former sand pits and gravel workings for example the Scarce four-dot pin palp. To best encourage and support these species, consider a diversity of habitats on the shoreline of waterboides. Try to ensure that bare, damp sands and gravels are retained alongside marginal vegetation and a combination of both open and shaded environments.

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Chalk bund with a sparsely vegetated mosaic © Jamie Robins

Wetland mosaic in shallow sand workings © Jamie Robins

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