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THE APPLICANT'S RESPONSES TO EXQ2 - APPENDICES
Appendix 2 – Carrying Capacity of the Development Site for Small Mammals

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ExQ2.1.15 Carrying Capacity of Small Mammals in Grassland Compared to Arable

The carrying capacity of a biological species is defined as "*the maximum population size of the species that the environment can sustain indefinitely*", it is also described as maximal load[1] and depends on the availability of resources such as food, suitable habitat for shelter, water and other variables which are required by a species.

The carrying capacity of species is predominantly related to the abundance of resources present. Small mammals present in the UK include rodents (mice, voles, squirrels and rats), shrews and hedgehogs. The requirements and habitat preferences for each species differs however a comparison can be made between the carrying capacity of rough grassland and arable land for small mammals, concentrating on mice, vole, and shrew species.

Some small mammals such as the shrews feed entirely on invertebrates, voles are herbivorous, and wood mice and harvest mice live on a mixed diet of plant material and insects. All small mammals require adequate supply of food, suitable nesting sites, cover in the form of hedgerows or tall grassland/scrub and refuge from farming operations[2].

Habitat Suitability for Small Mammals

Rough Grassland

Rough grassland is defined as permanent grassland which is mostly ungrazed, or lightly grazed. In the case of the Development, this is the area defined as 'Proposed Coastal and Floodplain Grazing Marsh Based on Priority Habitat Inventory' in the outline LBMP Figure A5.1.

Rough grassland is composed of a mixed sward of palatable grasses, and has a substantial "litter-layer" of dead grass at its base. In addition to grasses, there is usually a mix of flowering herbs, which provide food and shelter for insects, which can in turn be preyed on by small mammals[3]. Rough grassland is the preferred habitat of field voles and supports other species of small mammal (bank vole, harvest mouse and shrew species) due to the foraging and shelter opportunities provided. As well as supporting a higher abundance of invertebrate species, the cover provided by rough grassland during winter months serves to insulate small mammals from the effects of frost and snow.

Hedgerows and Linear Features

Botanically rich and structurally diverse hedgerows support a community of small mammals including dormice, bank voles and harvest mice. Recent work has shown that hedges with more trees support more wood mice, the thicker the hedge the more suitable it is for small mammals. These hedgerows also provide corridors for the small mammals to move between open space and farmland. Other linear features such as drystone walls and ditches also provide shelter and commuting routes within agricultural landscapes, and are of extreme importance in fragmented landscapes, connecting areas of valuable habitat.

Although not proposed in the northern part of the site, the approximately 3.6 km of hedgerow proposed as part of the outline LBMP will provide complementary habitat to support small mammal populations.

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[1] Hui, C (2006). "*Carrying capacity, population equilibrium, and environment's maximal load*". Ecological Modelling. 192 (1–2): 317–320. doi:10.1016/j.ecolmodel.2005.07.001.

[2] WildCRU (2019). [online] Agricology.co.uk. Available at: https://www.agricology.co.uk/sites/default/files/Mammals.pdf [Accessed 22/08/19].

[3] https://farmwildlife.info/how-to-do-it/existing-wildlife-habitats/rough-grassland/ https://theecologist.org/2019/may/01/agriculture-and-insects [Accessed 28/08/19]

Agricultural/Arable Land

Arable crops are sub-optimal for small mammals for a number of reasons. Intensively managed crops are usually subject to heavy insecticide spraying. This greatly reduces the number of insects present which reduces prey available to small mammals. Secondly, pesticide spraying impacts on the diversity of wild plants available to small mammals, and in extreme examples results in a field of sandy soil with crop. Increasingly, field margins have become smaller, while hedgerows are increasingly degraded. This all has the effect of reducing available food and shelter for small mammals. The harvesting period is also highly disturbing to small mammals and can result in mortality[4].

The methods of farming used will have a huge impact on biodiversity, intensively managed crop monocultures, with heavy use of pesticides and herbicides will support a greatly decreased abundance of small mammals in comparison to sympathetic farming practices. The retention of wide field margins, hedgerows and other linear features, coupled with decreased spraying and greater in-crop biodiversity will increase the habitat suitability for small mammals.

Grazed pasture and arable farmland is also typically sub-optimal for small mammals. In intensively grazed grassland, there is little cover for small mammals such as voles and mice, leaving them more susceptible to predation, and also creating a habitat which is less suitable for shelter. In addition, there are reduced food sources with a low sward height (reduced vegetation and insects) and increased competition with large herbivores such as sheep for the remaining food resources[Error! Bookmark not defined.]. The solar panels and associated infrastructure and the greater level of habitat variation they create within the area marked on Figure A5.1 of the outline LBMP as 'Proposed Coastal and Floodplain Grazing Marsh Based on Priority Habitat Inventory - under and around solar panels' may provide more small mammal habitat than open grazed grassland but it is considered appropriate to assume that it will not, and therefore this habitat will be broadly similar in its carrying capacity to the arable baseline.

Selected Small Mammals and their Habitat Preferences[5]

Harvest Mouse *Micromys minutus* – Harvest mice weave a distinctive nest usually from grass, and favour areas of tall dense grassy vegetation, for example rough grassland. Intensely grazed pasture is unsuitable for nest weaving, and therefore cannot support this species. Cereal crops are sub-optimal although can support smaller populations.

Wood Mouse *Apodemus sylvaticus* – The wood mouse is a highly adaptable generalist, which is found in a range of habitats including rough grassland and arable farmland, although their preferred habitat is deciduous woodland. Wood mice prefer grassland to crop, although can be found in less intensively managed arable farmland. Within crops, weedy areas are preferred due to their relative invertebrate richness, and abundance is positively impacted by sward height in cereals fields. Mice can persist on bare fields over winter, however the removal of cover greatly increases vulnerability to predation.

Field Vole *Microtus agrestis* – Field voles prefer rough, often damp, ungrazed grasslands. Sparse populations occur in marginal habitats such as woodland, hedgerows, bogs and dunes. Within rough grassland, field voles are the most abundant species.

Bank Vole *Myodes glareolus*– Bank voles are most populous in mixed and deciduous woodland, but also present in grassland. In all habitats thick ground cover is the key characteristic.

[4] https://cereals.ahdb.org.uk/media/185927/g35-saffie_enhancing_arable_biodiversity2.pdf [Accessed 28/08/19]
[5] Yalden, DW & Harris, S (ed.) 2008, *Mammals of the British Isles: Handbook, 4th edition*. The Mammal Society.

Common Shrew *Sorex araneus* – Abundant wherever there is some low vegetation cover, but are most abundant in thick grassland, scrub, hedgerows and deciduous woodland.

Density of Small Mammals in Different Habitats.

As discussed above, a structurally diverse habitat such as a rough grassland is likely to contain a greater variety of food sources and potential nesting sites. If mobility allows then mammals have been shown to distribute themselves between habitats according to habitat quality, with higher densities of mammals in higher quality habitats. The most important factors are believed to be being food availability and quality, predation risk and competition.

A study of barn owl feeding areas in Northumberland looked at the overall composition of small mammals within two corridors, with particular emphasis on field voles, wood mice and common shrew[6]. The study showed a statistically significant increase in field vole abundance within ungrazed habitats compared to the managed grassland. Other studies have shown that densities of field vole can range from 1-15/ha in mixed farmland up to 100-300/ha in rough grassland[7][8].

Densities of common shrew are very variable, but have been states as 10 per ha in lowland unimproved grasslands prior to the breeding season, compared to lower densities of 2.5 per ha in arable areas, where common shrews are only found within hedgerows[7].

Wood mouse densities are greatest in woodland and scrub, however there is an increased density of 2.5 per ha in unimproved grassland, compared to 1 per ha in arable land. In contrast to the generalist habits of wood mice, harvest mice are more specialized and dependent on a high sward height. Mean density estimates for a number of habitats are as follows; 0.05 per ha in barley; 0.4 per ha in wheat; 2.5-5.0 per ha in rough and damp meadows; 20 per ha in reedbeds[7].

These figures show that as expected, densities of the selected small mammals are all lower in arable habitats compared to rough grassland, however as mentioned previously, the type of management of arable fields will have a huge impact on the density of mammals present and overall biodiversity.

Conclusions

The habitat change from arable to grassland is expected to result in benefits for small mammals, with the Proposed Coastal and Floodplain Grazing Marsh Based on Priority Habitat Inventory grassland habitats created accommodating significantly greater carrying capacity for small mammals relative to the arable baseline. The grassland cover beneath the solar panels is expected to have a carrying capacity similar to the existing baseline arable land-use.

The overall carrying capacity of the Development site for small mammals is therefore expected to increase significantly as a result of the Development.

[6] Keene, A. (2009) *Study of small mammal populations within two Barn owl corridors at Folly Farm* Bioscience Horizons Vol 2
[7] Harris S, Morris P, Wray S et al. (1995) *A Review of British Mammals: Population Estimates and Conservation Status of British Mammals Other than Cetaceans*. Peterborough: JNCC.
[8] Lambin X, Petty SJ, Mackinnon JL (2000) *Cyclical dynamics in field vole populations and generalist predation.* J Anim Ecol 69: 106–118.