Amphibian and Reptile Conservation

RESEARCH REPORT 18/01

Jersey multi-species distribution, habitat suitability & connectivity modelling

Appendix B

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States of Jersey

amphibian and reptile conservation

Appendix B - Species ecology and conservation status review

In this section we briefly review the ecology and conservation status for each of the 17 focal species, and summarise home range requirements and dispersal capabilities for a broader range of Jersey's protected species[1] (Table B1).

Focal species

Western toad (*Bufo spinosus*): The Western toad, known locally as the Crapaud, is the only toad species found within Jersey, and is one of three native amphibians. Its distribution is well recorded due to a PhD study (Wilkinson 2007) and further efforts to map its distribution subsequently via Toadwatch (Wilkinson and Starnes 2016) and the Jersey National Amphibian and Reptile Recording Scheme (NARRS; Wilkinson et al. 2014). These have indicated the population in Jersey to be primarily associated with garden ponds, but for subpopulations to be isolated from one another due to poor connectivity. They can disperse up to 1000 m or more, though may not stray far from their breeding grounds (Table B1) and often undertake their migratory movements to and from ponds at night. The species is the subject of a Biodiversity Action Plan (BAP) in Jersey.

Grass snake (*Natrix helvetica*): The grass snake is elusive in Jersey; however recent records stem from radio-tracking, site surveys and public records collected during a PhD study (Ward 2017). Habitat associations appear to be scrub/bush and rough grassland (Ward 2017) and the primary prey of grass snakes is amphibians (Gregory and Isaac 2004). Despite their ability to travel reasonably large distances (Table B1), grass snakes in Jersey may avoid crossing roads (R. Ward pers. obs.) due to the risk of mortality and there appears to be poor connectivity between populations in the west and southwest (Ward 2017). It is a BAP species in both Jersey and the UK. We note that many records are currently stored under its former taxonomic name of *Natrix natrix*.

Jersey bank vole (*Myodes glareolus* ssp*. caesarius*): Jersey's bank vole is considered an endemic subspecies (Crowcroft and Godfrey 1959) and is primarily herbivorous; feeding on fruits, seeds and leaves in addition to other plant matter and invertebrates. Typical habitats consist of areas providing good vegetative cover to protect them from predators. These

[1] A consultation on a new draft wildlife law was being undertaken during the writing of this report. Therefore, references to wildlife conservation laws and protected species schedules reflect those available at the time of writing (true as of July 2018), and may differ from those in place at the time of reading.

include deciduous woodland with thick understorey cover, dense shrubs, hedgerows, banks and rough grassland (Mcgowan and Gurnell 2014). They are a BAP species in Jersey, and are considered an important prey species for a number of predators including barn owls (*Tyto alba*). The majority of occurrence records originate from small mammal trapping studies (Magris and Gurnell 2000; Mcgowan and Gurnell 2014); however, a number of records also exist due to incidental observations during a recent PhD on the island's grass snake population (Ward 2017).

Common pipistrelle (*Pipistrellus pipistrellus*): This is the most well-recorded bat in the island, and is likely to be more accurately recorded using automated acoustic identification than other species present in Jersey (Walters et al. 2012). Bats in Jersey fall under a single BAP, and all species in Jersey are protected by the Conservation of Wildlife Law (Jersey) 2000 (CWL2000). They also receive some consideration under the Planning and Building Law. Local threats can influence populations in three ways; (i) those affecting foraging areas, with sheltered commuting routes being particularly important, (ii) those affecting roosts and (iii) direct losses to populations. Important features in the landscape consist of linear (Verboom and Huitema 1997; Boughey et al. 2011a) and structurally diverse features such as woodland edges, trees and hedgerows, undeveloped land that does not meet SSI standards which may be foraging areas (e.g. large gardens), hibernation areas and summer roosting structures. Roosts can include buildings or trees; though there is limited data and a lack of 'veteran' trees in Jersey. Historic buildings and suburban areas can therefore be important sources of roosts for bats. The proximity to and extent of broadleaved woodland is also likely to be important in roost location (Boughey et al. 2011b). The dataset used in this analyses consist of Jersey Bat Group roost survey data, with many occurrences recorded during emergence surveys.

Long-eared bats (*Plecotus* spp.): The long-eared bats in Jersey consist of two known species; the brown long-eared (*Plecotus auritus*) and the grey long-eared bat (*Plecotus austriacus*). For the purposes of this study, we pool records from both species and assume similar habitat preferences. They are poorly recorded in Jersey when compared to common pipistrelles, and are likely to be more selective in their roosts. Most roost records in Jersey are from old building structures. The dataset used in this analyses consist of Jersey Bat Group roost survey data, with many occurrences recorded during emergence surveys.

Red squirrel (*Sciurus vulgaris*): The red squirrel is relatively widespread throughout the island, with four main population centres (Gurnell et al. 2002) and associations to woodland and hedgerows. These habitats are important corridors for the species, but have declined and occur in small fragments (Magris and Gurnell 2002). Such corridors are vital for

population survival and dispersal (Verboom and Van Apeldoorn 1990; Gurnell et al. 2002). Supplementary feeding, often in gardens, is also likely to play a role in the survival and distribution of the population (Magris 1998; Jokimäki et al. 2017). Natural food sources include oak and sweet chestnut trees (Magris and Gurnell 2002). In addition to habitat availability, threats include predation from cats and road collisions (Magris 1998; Magris and Gurnell 2002).

Field cricket (*Gryllus campestris*): The field cricket is the subject of a Biodiversity Action Plan in Jersey, and is also part of a BAP in the UK due to its threatened status (Pearce-Kelly et al., 1998). This large cricket is considered locally rare in Jersey and is primarily restricted to sandy coastal habitats in the west and south-west of the island. Here it relies on areas with short turf or bare ground to provide the warmth it prefers and so that it can effectively burrow in the sand. Therefore, the level of disturbance may be key to avoid succession but for sites not to be so disturbed that the species cannot thrive. Declines may occur due to loss and fragmentation of habitat due to agricultural intensification (Gawałek et al. 2014). This species has been proposed for protection under the CWL2000 to protect the species, its habitats and to provide potential source stock for reintroductions in England.

Waxcap fungi (*Hygrocybe* spp.): Data from 23 waxcap fungi within the *Hygrocybe* genus (Table 8, main report) were pooled in to a single dataset and assumed to have similar habitat preferences consisting of oligotrophic (nutrient-poor) unimproved grasslands (Schweers 1949) with possible associations to moss (Arnolds 1981, 1982). The species are not currently protected in Jersey, however the oligotrophic grassland habitats they represent are an important habitat for multiple protected species such as the field cricket (*G. campestris*). Furthermore, the species has been used previously in assessing the conservation value of grasslands based on the number of species found (Rald 1985; Boertmann 2010). The grazing of their favoured grasslands is likely to be an important factor in their maintenance.

Scaly stalkball (*Tulostoma melanocyclum*): The scaly stalkball has a restricted distribution in Jersey, is rare in Britain and Ireland and is subsequently a UK BAP species. It is a xerothermic species, meaning it prefers warm dry habitats. It typically occurs on sand or sandy soil and is also known from forest clearings elsewhere in its range (Karadelev and Rusevska 2006; Kaya 2015; Kholfy et al. 2017).

Green-winged orchid (*Anacamptis morio*):

The green-winged orchid occurs in the west and southwest of the island, particularly at Les Blanches Banques and surrounding localities with a preference for undisturbed grassland

with a short sward height. Historically it has also been recorded at La Lande de l'Ouest and on the east coast in Grouville common but is thought to be undergoing declines due to human disturbance, illegal harvesting, inappropriate habitat management and scrub encroachment (T. Wright, pers. comm.). It is locally protected under the Conservation of Wildlife (Protected Plants) (Jersey) Order 2009 (CWL2009).

Pryamidal orchid (*Anacamptis pyramidalis*): The pyramidal orchid is primarily found along the west coast of Jersey and inland within sand dune, dune grassland or grazed turf habitats. Small populations are also known from coastal areas in the east and southeast with occasional records from inland locations. Its presence is seasonal, with the species appearing to lie dormant in some years dependent on weather. It is locally protected under the CWL2009. Though of less conservation concern perhaps than some other orchid species, it faces similar threats including human disturbance, illegal harvesting, inappropriate habitat management and scrub encroachment (T. Wright, pers. comm.).

Southern marsh-orchid (*Dactylorhiza praetermissa*): The southern marsh-orchid is protected under the CWL2009 and known from seven localities including along the west coast, the southwest and at Rue des Pres SSI in the southeast of the island. Two sites are likely to be due to translocations. The species inhabits damp habitats including wet meadows and damp woods. It faces similar threats as posed to Jersey's other orchid species including human disturbance, illegal harvesting, inappropriate habitat management and encroachment from other plant species (T. Wright, pers. comm.). Management of water may also play a key role in the survival of the species due to their requirement for damp habitats.

Lizard orchid (*Himantoglossum hircinum*): The lizard orchid is protected under the CWL2009 and is also a BAP species in Jersey. Its current distribution is extremely restricted in Jersey on the Les Blanches Banques dune system. The species is highly sensitive to grazing effects, including from rabbits. It requires open habitats on dunes or with short grassland, and is therefore at risk from encroachment of dominating plant species. As with other orchid species, human disturbance and illegal harvesting are threats, though the population is fenced hopefully reducing these risks.

Early-purple orchid (*Orchis mascula*): The early-purple orchid is another orchid protected under the CWL2009, and can be found at roadsides, hedgerows and elsewhere often on sandy soils. Though it is known from woodland elsewhere, it is not currently recorded in this habitat type in Jersey. In Jersey it is primarily restricted to the west coast, though records exist from further inland.

Jersey buttercup (*Ranunculus paludosus*): The Jersey buttercup prefers grassland and heath which is seasonally damp in winter and dry in summer. Within Jersey it is found in the southwest. The species is protected under the CWL2009.

Ragged robin (*Silene flos-cuculi*): Ragged robin is not a protected species in Jersey, but is considered to be a good representative of marshy/boggy habitats that remain wet throughout the year. Within Jersey it is recorded from around St Ouen's pond and in damp wooded valleys.

Autumn lady's-tresses (*Spiranthes spiralis*): Autumn lady's-tresses is protected under the CWL2009 and is found in several locations in Jersey including coastal areas in the west, southwest and east, plus a few inland locations including at Jersey Zoo. It occurs on dry calcareous soil including sand dunes where there is a short sward height and is known from ancient grassland and cemeteries (A. Haden pers. comm.).

Movement and dispersal

The varied behaviour and movement of species greatly influences the way in which they interact with, and perceive the landscape. Animals rarely travel in straight lines, instead following the route of favoured habitats such as pasture, hedgerows and trees for bats (Robinson and Stebbings 1997). Not only will different species have different range sizes and dispersal capabilities, these behavioural aspects will be governed by and differ among habitat types, location (including latitude as an effect of productivity due to the shortened season; Rautio et al. 2013) seasonality, lifestage, individual, body mass and sex (Turner et al. 1969; Rautio et al. 2013). Furthermore, species with small population sizes or limited dispersal capabilities can demonstrate high sensitivity to the effects of habitat loss and fragmentation (Hand et al. 2014). Therefore, selecting an appropriate scale at which to model wildlife corridors is a complex task. In consideration of this, we first review the dispersal capabilities and range sizes for a number of study species.

We consider ranges to consist of the area an individual of a species needs in order to meet resource requirements and other ecological functions, including where appropriate, migration events (e.g. amphibians moving to and from breeding ponds). Comparatively, dispersal is considered as movement that facilitates gene flow between populations/sub-populations, often occurring during the juvenile lifestage or as the result of territorial disputes. Where data for species were lacking in the literature, data were collated from closely related species assumed to be similar in behaviour. These data were typically radio-tracking or recapture data. However, the methods used to make estimations varied between studies and so must be interpreted with caution.

Amphibians: Jersey's amphibian species migrate to ponds to breed, and spend the rest of the year in terrestrial habitats. The largest movements usually occur during these migration periods, whereas they may travel fairly little outside of migration. Roads are common sources of mortality during these migrations, though movements at night when traffic is reduced may mean that roads are less of a barrier during this time of the day. Studies of the toad (*Bufo bufo* and *B. spinosus*) indicate that they are capable of moving up to 4 km during migration events (Trochet et al. 2014), but are otherwise fairly limited in their movements and with shorter distances recorded in Jersey (Wilkinson 2007). Their home range can be up to 2.5 ha, though is normally nearer 0.1–0.2 ha or less. The agile frog (*Rana dalmatina*) has been recorded covering distances over 6 km (Bonk et al. 2012). However, more typical are distances of up to 1 or 2 km from breeding ponds and much less outside of the migration period. The limited data available on its range suggests it is very small, but further research is needed. The palmate newt (*Lissotriton helveticus*) and its close relative the smooth newt (*Lissotriton vulgaris*) have been shown to cover very little distance (< 1 km) (Kovar et al. 2009; Trochet et al. 2014), though there appears to be little literature on the subject. Their range can be between 0.1 and 0.5 hectares if similar to that of great crested newts (*Triturus helveticus*) (Langton and Beckett 1995).

Reptiles: Reptiles vary in their requirements for dispersal. The slow-worm (*Anguis fragilis*) is the least mobile of Jersey's reptile species, with few records of the species exceeding distances of 100 metres or ranges over 0.1 ha (Smith 1990). The green lizard (*Lacerta bilineata*) and its close relative *L. viridis* have been poorly studied in this respect, with data suggesting they can cover anywhere between 200 and 5000 metres (Sound and Veith 2000; Schneeweiss 2001). The larger of these distances is likely to be associated to dispersal rather than regular activity. By comparison, another related species - the sand lizard (*Lacerta agilis*), has a small home range < 0.4 ha (Nicholson and Spellerberg 1989). The grass snake (*Natrix helvetica* / *Natrix natrix*) is the most mobile of Jersey's reptiles; capable of covering several kilometres during its annual activity (e.g. Pittoors 2009; Ward 2017). However, regular movements are often closer to 100 metres or less. Home range measurements have been variable in this species, but they are often between 10 and 30 ha, with an extreme record of ~120 ha (Wisler et al. 2008). Little information is available on wall lizard (*Podarcis muralis*) dispersal capabilities; however, their extremely small range (<0.006 ha) (e.g. Brown et al. 1995) suggests they could be limited in their ability to traverse large distances.

Mammals: Mammal species are varied in their movements, with some being territorial. Studies of lesser-white toothed (*Crocidura suaveolens*), greater-white toothed (*Crocidura russula*), common (*Sorex araneus*) and Eurasian pygmy shrews (*Sorex minutus*) suggests

that shrews travel less than 150 metres, with small ranges often much less than 0.2 ha (Pernetta 1977; Sibbald et al. 2006). The bank vole (*Myodes glareolus*) is likely to be able to travel several hundred metres further than the shrew species, with larger home ranges which rarely exceed 6 ha, and that are often closer to 1 ha (e.g. Andrzejewski and Babińska-werka 1986). Female bank voles have their own territories whereas males can be territorial with large ranges encompassing several female ranges. They disperse when they reach sexual maturity, can be active at all times of day and night, and are usually less active in the winter. The hedgehog (*Erinaceus europaeus*) can travel over 1.5 km (Reeve 1982), though most data relates to its home range rather than dispersal capabilities. It is likely that it can disperse widely, particularly as it occupies a variety of habitats and has recorded home ranges upwards of 100 ha (e.g. Rautio et al. 2013). The most mobile of Jersey's non-flying mammals is the red squirrel (*Sciurus vulgaris*), which can cover up to 3 km in a day, and is capable of dispersing up to 20 km (Magris and Gurnell 2002; Selonen and Hanski 2015). Their home ranges are normally < 25 ha, but have been recorded at over 120 ha (Andrén and Delin 1994).

Being winged, bats are capable of covering large distances, though often prefer to commute over specific habitat features such as tree lines or hedgerows. During foraging, the various species can reach several kilometres away from their roosts; though brown long-eared bats (*Plecotus auritus*) appear to only travel up to 3 km from their roosts (Entwistle et al. 1996). The serotine bat (*Eptesicus serotinus*) appears to be able to cover much larger distances (40 km +) (Robinson and Stebbings 1997). During other movements (e.g. roost switching), common pipistrelles (*Pipistrellus pipistrellus*) have been recorded covering distances up to 15 km (Feyerabend and Simon 2000). Their ranges vary between species, with pipistrelles having ranges of up to 220 ha, and serotine bats over 4000 ha (Robinson and Stebbings 1997; Davidson-Watts et al. 2006; Nicholls and Racey 2006). Home-range data on long-eared bat was not available.

Birds: Birds are typically capable of covering extremely large distances (Enderson and Craig 1997) so we therefore assume that they would be able to access any suitable habitat in the island with relative ease. Smaller species such as warblers and tits may only cover small distances during foraging trips, but are still capable of long-distance migrations. The home ranges of birds reviewed were highly variable, from linear territories spanning up to 3 km in kingfishers (*Alcedo* atthis) (Cramp 1985), a range of a couple of hectares in Dartford warblers (*Sylvia undata*) (Pons et al. 2008) to millions for peregrines (*Falco peregrinus*) (Enderson and Craig 1997).

Insects: Of all of Jersey's animals, insects are generally the most limited in their dispersal ability. Many species are understudied in their ranging and dispersal capabilities. Higher dispersal is expected from those that are winged or can be air- or vector-borne to new locations. Data was limited on their home ranges, but are assumed to be small. Studies of grasshoppers (*Chorthippus montanus*, *C. parallelus* and *C. vagans*) suggests they are capable of dispersing a maximum of 100–200 metres (e.g. Hochkirch et al. 2008). Field crickets (*Gryllus campestris* and its relative *G. integer*) have been recorded moving up to 250 metres, but their daily movements are likely closer to 10–20 metres with males being territorial compared to vagrant females (Beugnon and Campan 1989; Hochkirch et al. 2007). The vernal Colletes bee (*Colletes cunicularius*) has been recorded covering up to 50 metres (Peakall and Schiestl 2004), hoverflies (*Syrphidae* family) between 200 and 2000 metres (Moquet et al. 2018) and the southern emerald damselfly (*Lestes barbarus*) up to 2000 metres (Utzeri et al. 1984). Further still, the swallowtail butterfly (*Papilio machaon*) has been recorded travelling over 4 km (Shield 1967). However, the white-letter hairstreak butterfly (*Satyrium w-album*) may only travel very short distances (Heikkinen et al. 2010).

Plants and fungi: We considered plants and fungi to have passive dispersal; either wind-, water- or vector-borne (e.g. animal). Plant seeds, spores or fragments (e.g. roots) are often only carried relatively small distances, with larger distances more likely to occur when carried by a vector (Pearson and Dawson 2005; Bullock et al. 2006). Therefore, improving the dispersal capability of animals can serve to also improve dispersal of plants. Fungi can either eject their spores forcibly or rely on external forces (e.g. in puffballs), from where they can subsequently disperse over tremendous distances on the wind. Fungi can also disperse their spores over water, or via animal vectors (e.g. flies).

Table B1 A review of dispersal and home range behaviour in animal species listed as protected or proposed for protection in Jersey. Data on congeners is presented where limited data is available for the species of interest. Where known, the number of days over which measurements were calculated/recorded is shown in brackets. Several species protected or proposed for protection are absent due to a lack of available data. These include multiple protected bat species, the European wood ant (*Formica pratensis*), Serin (*Serinus serinus*) and Cirl bunting (*Emberiza cirlus*).

Target species	Home range (m^2)	Distance (m)	Study
Amphibians			
Common toad *Bufo spinosus**			
B. spinosus	–	130	(Wilkinson 2007)
B. spinosus	245–25000	–	(Daversa et al. 2012)
B. bufo†	–	250	(Gittins et al. 1980)
B. bufo†	2000	1000–3000	(Heusser 1968)
B. bufo†	490–2671	–	(Sinsch 1987)
B. bufo†	707–3420	70–1230	(Sinsch 1988)
B. bufo†	–	4–440	(Van Gelder et al. 1986)
B. bufo†	–	500	(Denton and Beebee 1993)
B. bufo†	–	254–1835	(Kovar et al. 2009)
B. bufo†	50	15–4000	(Trochet et al. 2014)
Palmate newt *Lissotriton helveticus*			
L. helveticus	1000–5000	–	(Langton and Beckett 1995)
L. helveticus	–	400	(Trochet et al. 2014) and references therein
L. vulgaris†	–	161–866	(Kovar et al. 2009)
Agile frog *Rana dalmatina*			
R. dalmatina	90	26–1700	(Trochet et al. 2014) and references therein
R. dalmatina	–	300–500	(Ponsero and Joly 1998; Stümpel and Grosse 2005) in (Bonk et al. 2012)
R. dalmatina	–	4000–7000	(Lác 1959; Ahlén 1997; Riis 1997) in (Bonk et al. 2012)
R. dalmatina	–	0–700	(Lemckert 2004)
Birds			
Sparrowhawk *Accipiter nisus*			
A. nisus	–	0–178000	(Newton 2001)

Table B1 continued

Target species	Home range (m^2)	Distance (m)	Study
A. nisus	–	4000–22000	(Wyllie 1985)
A. nisus	30000–35280000	–	(Marquiss and Newton 1982)
A. nisus	–	5000–52500	(Newton and Rothery 2000)
Kingfisher *Alcedo atthis*			
A. atthis	600–1380 (15–70)	–	(Libois 1997)
A. atthis	3000	–	(Cramp 1985) in (Vilches et al. 2012)
Cetti's warbler *Cettia cetti*			
C. cetti	–	0–649000	(Robinson et al. 2007)
Kentish plover *Charadrius alexandrinus*			
C. alexandrinus	1900–82900	–	(Kosztolányi et al. 2009)
C. alexandrinus	855–1027 (30)	0–2723	(Wilson and Colwell 2010)
C. alexandrinus	–	50–101400	(Paton and Edwards Jr 1996)
Peregrine *Falco peregrinus*			
F. peregrinus	358000000–1508000000000	13000–32000	(Enderson and Craig 1997)
F. peregrinus	104000000–1556000000	44000–204000	(Ganusevich et al. 2004)
F. peregrinus	–	4262000	(Ganusevich et al. 2004)
F. peregrinus	–	10000–185000	(Mearns and Newton 1984)
Bearded tit *Panurus biarmicus*			
P. biarmicus	–	6000–962000	(Malzer 2017)
P. biarmicus	39000–586000	97–134.2	(Malzer 2017)
P. biarmicus	–	6000–283000 (1–2270)	(Peiró 2013)
Dartford warbler *Sylvia undata*			
S. undata	–	750000	(Berthold 1973)
S. undata	–	200–9100	(Bibby 1979b)
S. undata	1400	–	(Cody and Walter 1976) in (Pons et al. 2008)
S. undata	25000	–	(Bibby 1979a) in (Pons et al. 2008)

Table B1 continued

Target species	Home range (m^2)	Distance (m)	Study
S. undata	547–17121	–	(Pons et al. 2008)
Barn owl *Tyto alba*			
T. alba	3170000	–	(Taylor 2004) in (Martínez and Zuberogoitia 2004)
T. alba	28260000	2000–5000	(Taylor 2004) in (Martínez and Zuberogoitia 2004)
T. alba	–	0–758000	(Altwegg et al. 2003)
T. alba	5000–10000	0–925000	(Debruijn 1994)
T. alba	–	0–442000	(Fajardo et al. 2000)
Insects			
Heath grasshopper *Chorthippus vagans* & Jersey grasshopper *Euchorthippus elegantulus*			
C. vagans	–	0–180	(Hochkirch et al. 2008)
C. montanus†	–	10–104 (66)	(Weyer et al. 2012)
C. parallelus†	–	10–130	(Wiesner et al. 2011) and references therein
Hoverfly *Chrysotoxum vernale*			
Syrphidae family†	–	200–400	(Rader et al. 2011)
Syrphidae family†	–	200–2000	(Moquet et al. 2018) and references therein (Lövei et al. 1998; Wratten et al. 2003; Westphal et al. 2006; Schönrogge et al. 2006; Schweiger et al. 2007)
Vernal colletes bee *Colletes cunicularius*			
C. cunicularius	–	0–50 (11)	(Peakall and Schiestl 2004)
Field cricket *Gryllus campestris**			
G. campestris	–	20	(Beugnon and Campan 1989)

Table B1 continued

Target species	Home range (m^2)	Distance (m)	Study
G. campestris	–	250 (1095)	(Hochkirch et al. 2007)
G. integer†	–	12.2–18.1	(Cade and Cade 1992)
Southern emerald damselfly *Lestes barbarus*			
L. barbarus	–	2000	(Aguesse 1960) in (Utzeri et al. 1984)
L. barbarus	–	200–1000	(Utzeri et al. 1984)
Swallowtail *Papilio machaon*			
P. machaon	–	4300	(Shield 1967) in (Sperling and Harrison 1994)
White-letter hairstreak *Satyrium w-album*			
S. w-album	–	'Sedentary'	(Heikkinen et al. 2010)
Mammals			
Lesser white-toothed shrew *Crocidura suaveolens*			
C. suaveolens	–	23.3–80	(Rood 1965)
C. suaveolens	–	8.2–54.3	(Spencer-Booth 1963)
C. russula†	75–395	–	(Macdonald and Tattersall 2001) in (Sibbald et al. 2006)
Hedgehog *Erinaceus europaeus*			
E. europaeus	236000–1112000	–	(Rautio et al. 2013)
E. europaeus	55000–415000	1006–1690	(Reeve 1982)
E. europaeus	81000–677000	–	(Kristiansson 1984)
E. europaeus	55000–1025000	–	(Boitani and Reggiani 1984)
E. europaeus	260000–960000	–	(Riber 2006)
E. europaeus	165000–560000	–	(Haigh 2011)
Jersey bank vole *Myodes glareolus**			
M. glareolus	1000–7000	–	(Bashenina 1981; Mazurkiewicz 1983) (and references therein) in (Andrzejewski and Babińska-werka 1986)

Table B1 continued

Target species	Home range (m^2)	Distance (m)	Study
M. glareolus	150–11000	–	(Korn 1986)
M. glareolus	35000–70000	–	(Andrzejewski and Babińska-werka 1986)
M. glareolus	700–900	–	(Koskela et al. 1997)
M. glareolus	500–7300	–	(Macdonald and Tattersall 2001) in (Sibbald et al. 2006)
Red squirrel *Sciurus vulgaris**			
S. vulgaris	230000–1216000 (120)	180–2800 (0.48)	(Andrén and Delin 1994)
S. vulgaris	134000	–	(Corbet and Southern 1977)
S. vulgaris	–	61–107	Lemnel, 1967 in (Corbet and Southern 1977)
S. vulgaris	–	3200–3500	(Magris and Gurnell 2002)
S. vulgaris	–	1000–20000	(Selonen and Hanski 2015) in (Jokimäki et al. 2017)
S. vulgaris	15000	–	(Wauters and Dhondt 1986)
S. vulgaris	25000–31000	–	(Wauters and Dhondt 1992)
S. vulgaris	–	51–4118	(Wauters et al. 2010)
Common or French shrew *Sorex coronatus*			
S. coronatus	370–630	–	(Sibbald et al. 2006)
S. araneus†	832.4–1074	–	(Pernetta 1977)
S. araneus†	370–630	–	(Michielsen 1966) in (Sibbald et al. 2006)
S. araneus†	–	8–144	(Shillito 1963)
S. minutus†	1475–1718	–	(Pernetta 1977)
Serotine bat *Eptesicus serotinus*			
E. serotinus	100000–47580000 (2–24)	340–40800	(Robinson and Stebbings 1997)
Common pipistrelle bat *Pipistrellus pipistrellus**			
P. pipistrellus	2020000	1163–3732 (3–6)	(Nicholls and Racey 2006)

Table B1 continued

Target species	Home range (m^2)	Distance (m)	Study
P. pipistrellus	1704000–2184000 (2.91)	1222–1916 (2.91)	(Davidson-Watts and Jones 2006)
P. pipistrellus	–	470–15000 (21)	(Feyerabend and Simon 2000)
P. pipistrellus	–	1000–5100	(Racey and Swift 1985)
Soprano pipistrelle bat *Pipistrellus pygmaeus*			
P. pygmaeus	550000	698–2332 (3–6)	(Nicholls and Racey 2006)
P. pygmaeus	1636000–1723000 (2.26)	1715.4–1940.2 (2.26)	(Davidson-Watts and Jones 2006)
Brown long-eared bat *Plecotus auritus**			
P. auritus	–	500–2800	(Entwistle et al. 1996)
P. auritus	–	1500	(Fuhrmann and Seitz 1992)
P. auritus	–	1100	(Swift and Racey 1983)
Reptiles			
Slow worm *Anguis fragilis*			
A. fragilis	–	40 / 267 (42 / 365)	(Fuke 2011)
A. fragilis	62–1143 (417)	9–96 (2–6)	(Platenberg 1999)
A. fragilis	20–312 (214)	3.9–34	(Platenberg 1999)
A. fragilis	23–910 (203)	12.2–16.2 (42.4–189.3)	(Platenberg 1999)
A. fragilis	192.2–587.5	–	(Riddell 2000)
A. fragilis	–	0.21–17.39	(Ryan 2008)
A. fragilis	49.36–1075.65 (134)	8.9–161.61 (134)	(Ryan 2008)

Table B1 continued

Target species	Home range (m^2)	Distance (m)	Study
A. fragilis	–	12.18–68.81 (99)	(Schmidt et al. 2017)
A. fragilis	48.4–798 (365–2190)	10.3–115.2 (365–2190)	(Smith 1990)
A. fragilis	–	130 (672)	(Stumpel 1985)
A. fragilis	–	80	(Stumpel 1985)
Green lizard *Lacerta bilineata*			
L. bilineata	–	0–205	(Sound and Veith 2000)
L. agilis†	182–3890	–	(Nicholson and Spellerberg 1989)
L. agilis†	100	–	(Olsson 1984) *in* (Olsson 1993)
L. agilis†	156–1100	–	(Olsson 1986)
L. viridis†	–	5000	(Schneeweiss 2001) *in* (Böhme and Moravec 2011)
Grass snake *Natrix helvetica**			
N. helvetica	81000 (82.2)	–	(Brown 1991)
N. helvetica	12029–142799.5 (55–87)	1306.39–3105.38 (55)	(Pittoors 2009)
N. helvetica	–	15.21–36.6	(Pittoors 2009)
N. helvetica	1300–109000 (90–720)	–	(Reading and Jofré 2009)
N. helvetica	–	10.71–107.71	(Ward 2017)
N. helvetica	400–133800 (4–75)	86.96–4411.9 (4–75)	(Ward 2017)
N. helvetica	151000–1205400 (81–109)	–	(Wisler et al. 2008)
N. natrix†	99000–249000	1.1–114.4	(Madsen 1984)
N. natrix†	–	19.11–71.93	(Pettersson 2014)

Table B1 continued

Target species	Home range (m^2)	Distance (m)	Study
N. natrix†	2775.2–49880.15 (25)	477–1798 (25)	(Pettersson 2014)
N. natrix†	80000–300000	–	(Günther and Völkl 1996)
N. natrix†	149000–348000 (21–400)	–	(Hofer and Wisler 2011)
N. natrix†	83000–289000 (43–200)	0–460	(Mertens 1994, 2008)
Wall lizard *Podarcis muralis*			
P. muralis	5–15	–	(Brown et al. 1995)
P. muralis	15	–	(Weber 1957)
P. muralis	6–52	–	(Boag 1973)
P. muralis	15–25	–	(Strijbosch et al. 1980) *in* (Brown et al. 1995)

* Species modelled during the distribution modelling phase.

† Data from proxy species / congeners has been used.

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