



Effects of hedgerows on bats and bush crickets at different spatial scales

Aurélie Lacoeylthe, Nathalie Machon, Jean-François Julien, Christian Kerbirou

► To cite this version:

Aurélie Lacoeylthe, Nathalie Machon, Jean-François Julien, Christian Kerbirou. Effects of hedgerows on bats and bush crickets at different spatial scales. *Acta Oecologica*, 2016, 71, pp.61 - 72. 10.1016/j.actao.2016.01.009 . hal-04008813

HAL Id: hal-04008813

<https://hal.science/hal-04008813>

Submitted on 1 Mar 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Effects of hedgerows on bats and bush crickets at different spatial scales

Aurélie Lacoëuilhe ^{1,2*}, Nathalie Machon ¹, Jean-François Julien ¹, Christian Kerbiriou ¹

¹ French National Museum of Natural History, Species Conservation, Restoration and Monitoring of Populations, - CERSP-UMR7204 MNHN-CNRS-UPMC, 55 rue Buffon, 75005 Paris, France.

²EDF R&D, EPI Department, Site des Renardières - Ecuelles 77818 Moret sur Loing cedex - France

* Corresponding author: lacoëuilhe@mnhn.fr

Abstract

Biodiversity is threatened by the loss and fragmentation of habitats. The role of hedgerows in maintaining biodiversity is well established, but few studies have addressed the importance for biodiversity of the intrinsic characteristics of hedgerows and the quality of hedgerow networks along a spatial scale. We examined three quality indices providing information at different territorial levels: density in the landscape, structural diversity and wood production. We performed an acoustic survey in a grassland to estimate the species abundance and community composition of bats (9 taxa) and bush crickets (11 species). Using an approach based on species and traits, we assessed how hedgerow quality influenced the activity of these taxa at different spatial scales (from 50 to 1000 meters) and focused on three types of traits: bush cricket mobility ability, bat foraging strategy and habitat specialization. In general, our results showed the importance of hedgerow quality for bats and bush crickets, but the strength of the association between taxa and hedgerows varied substantially among the species and the spatial scales. Although it depends on the taxa, the production, density and structural diversity of hedgerows each had an overall positive effect. Our results suggested that these effects were generally more important at large scales. The scale effect of the production index is the best predictor of activity for bat and bush cricket taxa and traits. Our results showed the importance of hedgerow quality for the ecology of bat and bush cricket communities and could be used to improve conservation management.

Keywords: hedgerows, scale effect, Chiroptera, Orthoptera, acoustic monitoring, conservation

32 **Introduction**

33 Over the last century, agricultural intensification, particularly the increase in agricultural
34 parcel sizes, has had severe consequences for biodiversity (Robinson and Sutherland 2002).
35 At the landscape scale, one consequence of such intensification is the widespread removal of
36 linear landscape elements in Europe (Robinson 1997; Sklenicka et al. 2009) and also of large
37 patches of semi-natural habitats, such as forests and grasslands, even though the ecological
38 importance of hedgerows and linear landscape elements has been known for decades (i.e.,
39 Burel 1992; Beier and Noss 1998; Bennett 2003). Hedgerows play a role in the control of
40 water flow, water level and water quality (Mérot 1999; Baudry et al. 2000). They provide
41 breeding habitat, food resources and dispersal pathways for many species of birds (Hinsley
42 and Bellamy 2000), amphibians (Scribner et al. 2001; Rosenberg et al. 1998; Brown et al.
43 2006), mammals (Henderson et al. 1985; Pardini et al. 2005) and invertebrates (Burel 1992;
44 Hannon 2009).

45 However, to our knowledge, the effects of the quality of linear elements, such as hedgerows
46 (e.g., their diversity of structure and wood production), at different scales, on biodiversity
47 have been poorly considered in previous studies, except in Pywell et al. (2004) and Dainese et
48 al. (2015). Nevertheless, these effects are of interest because many agri-environmental
49 schemes provide financial support for environmentally sensitive hedgerow management. The
50 effectiveness of such initiatives in terms of both financial costs and biodiversity gains can be
51 improved through a better understanding of the benefits provided by different types of
52 hedgerows in different landscape contexts (Boughey et al. 2011).

53 In this paper, we present a study of bats and bush crickets, both of which are known to take
54 advantage of the presence of hedgerows, and which have been detected and identified based
55 on their calls, recorded by detectors. Bats (Chiroptera) and bush crickets (Orthoptera)
56 represent complementary ecological indicators of biodiversity quality. Bazelet and Samways
57 (2011) identified bush crickets as good bioindicators for the assessment of the habitat quality

of ecological networks because they respond strongly to management practices, such as grazing intensity (Jauregui et al. 2008) and mowing regime (Gardiner and Hassall 2009). Bush crickets belong to an invertebrate group that is abundant in grasslands, have a short life cycle and are at a low level in the food chain (mainly herbivore species and some omnivores) compared to bats. Although the importance of linear landscape elements is poorly understood for bush crickets, they have nevertheless been described to be useful for their dispersal behavior (Berggren et al. 2002) and colonization success (Berggren et al. 2001). Thus, we hypothesized that bush crickets could be sensitive to hedgerows at small spatial scales in accordance with Reinhardt et al. (2005). Bat species have a long life cycle relative to bush crickets. In the study areas, bats are all nocturnal insectivores at the top of the food chain (Dietz et al. 2009). They are considered to be bioindicators (Jones et al. 2009) because they react to several stressors, including the loss of landscape elements, which impacts their abundance, distribution and activity (e.g., Boughey et al. 2011). Moreover, all bat species are protected in Europe (IUCN 2011). The primary predictor of bat abundance is the quality of the habitat, which is positively related to the availability of vegetation corridors (Walsh and Harris 1996; Hein et al. 2009) and to the density of linear elements (Verboom and Huitema 1997). Based on the size of the foraging home range of the bat (see Davidson-Watts and Jones 2005, Perez-Jorda and Ibañez 1991), we hypothesized that bats could be sensitive to hedgerows at large spatial scales, in accordance with Bellamy et al. (2013) and Frey-Ehrenbold et al. (2013).

Many studies have been performed on the effects of the density and connectivity of linear landscape elements on the movement and dispersal of species (Erickson et al. 2013; Berggren et al. 2001; Berggren et al. 2002; Diekötter et al. 2007; Boughey et al. 2011). However, little is known about how the quality of linear elements affects their use by bats because the only studies that show such effects are (Boughey et al. 2011) and (Verboom and Huitema 1997), and even less is known about bush crickets; thus, we need to better understand the

relationship between biodiversity and the quality of linear landscape elements (Hein et al. 2009).

To study linear element quality, we examined three hedgerow characteristics: (1) density within the landscape (density) (2) potential wood production (production) and (3) structural diversity (diversity). Indeed, each of these three indices provides information at different land levels and involves different stakeholders. Density reflects the history of successive agricultural policies (changing the division of lands) at the landscape scale, whereas production and structural diversity are more linked to local farming practices. Thus, these three indices provided information on the management of the land at different scales, which is important because spatial processes are known to influence the structure and dynamics of animal populations and communities (Cottenie 2005).

In this study, we used two approaches: 1) a species approach in which we tested the effects of the linear element quality on the activity of the species and 2) a trait based approach in which we tested the same effects on several traits (e.g., habitat specialization, bat foraging strategy and bush cricket mobility ability). The trait approach can provide information on the mechanisms involved in the use of different types of hedgerows by bat and bush cricket communities. Such information is essential for developing effective conservation plans and can be used to improve forest and agriculture management strategies.

1 Materials and methods

1.1 Study area

The study was conducted in western France, in the Loire delta, between the cities Nantes and Saint-Nazaire, in a European network of the protected area "Natura 2000" (Figure 1). The site is mainly composed of extensively managed grassland grazed by cattle and surrounded by a dense network of hedgerows. The grassland was identified as having a high nature conservation value by Veen et al. (2009).

1.2 *Sampling design and scale approach*

We employed a random stratified design in which 51 point counts were sampled in the grassland, the dominant habitat in the studied site. The point counts were positioned according to two criteria: 1) more than 50% of grassland in the 500 m buffer and 2) at three classes of distance from the hedgerow: 23 point counts at 0 meters (i.e., in the hedgerow), 17 at 25 and 11 at 50 meters from the hedgerow. These two criteria, “proportion of grassland in the buffer” and “distance to the hedgerow”, were not correlated ($\rho = 0.09$, p value = 0.378) and were therefore included as covariables. To measure the effects of the characteristics of the linear landscape elements at different scales, we used ArcGIS 9.3 and a local landuse database (Geffray 2010). Previous studies linked environmental variables at a few spatial scales with the abundance of bush crickets (Batáry et al. 2007; Braschler et al. 2009; Diekötter et al. 2007, Penone et al. 2013b) and bats (Bellamy et al. 2013; Lookingbill et al. 2010; Dixon 2012; Hale et al. 2012), and we defined 11 circular buffers (radii of 50 m and every 100 m until 1000 m) around each point count that defined our sampling plots (a correspondence scale of areas depending on the buffer size used in this study and areas obtained with a doubling of surfaces is provided in Appendix C). Within these circular buffers, we extracted landscape characteristics: the proportion of semi-natural habitat area (grasslands) in each plot (for 500 m buffers around the 51 point counts, mean = 73.6% \pm 1.6% SE) and the 3 indices of the quality of linear landscape elements in each plot: 1) the density, i.e., length per unit of studied area, 2) the structural diversity and 3) the wood production.

1.3 *Linear landscape element and hedgerow indices*

We calculated the three indices for each study plot. To describe the density of linear elements, we calculated the sum of their lengths in meters within the buffer zones. To describe the structural diversity, we used Shannon’s diversity index (Shannon and Weaver 1949) and a database (Geffray 2010) that described the linear landscape elements in six categories: (1)

alignment of trees, (2) riparian vegetation, (3) shrub hedgerows with only shrubs, (4) wooded hedgerows without the presence of shrubs, (5) three-strata hedgerows (tree, shrub and herb). The production index is a measure of the wood volume contained by the linear element (in m^3). Hereafter in this study, linear landscape elements will be termed hedgerows in accordance with Baudry and Jouin (2003), who defined a hedgerow as a line of trees and / or shrubs. The production index is calculated from the length of the hedgerow and a coefficient of density for the woody elements given by the database (Geffray 2010) (see Appendix A). The diversity is not correlated with the production (for 500 m buffer: $\rho = 0.124$, p value = 0.215) or the density (for 500 m buffer: $\rho = 0.117$, p value = 0.241), whereas there is a correlation between density and production (for 500 m buffer: $\rho = 0.961$, p value < 0.001), which makes sense because the more trees present in an area, the greater the timber production. The high value of the last correlation implies the necessity of performing separate analyses of hedgerow indices.

1.4 Bat sampling

Bat activity was assessed by recording bat calls using a Tranquility Transect Bat detector (Courtpan Design Ltd., Cheltenham, UK) with direct and continuous recording on a Zoom H2 digital recorder (Zoom Corporation, Tokyo, Japan) at a sampling rate of 96 ks/s in .wav format. From the two possible outputs of the detector, time expansion and high frequency, we only used the second output, which did not include a trigger on sound volume. We placed one detector at each station at a height of 1.50 meters above the ground and facing away from the hedgerow. Each station was monitored twice in 2011. The first monitoring session was from June 15th to July 31st, during which female bats are known to give birth and to feed their offspring. The second monitoring session was performed from August 15th to September 30th, during which the young are flying and individuals are suspected to be less dependent on their reproductive roost. For each station, we recorded two 30-minute sound samples (one per

session) . This sampling occurred during the bat activity peak, which begins 30 minutes after sunset and spans 4 hours (Roche et al. 2005). Correlation between sampling point characteristics (density/diversity/ production) and covariables are presented in Appendix D. The sampling was only performed when weather conditions were favorable, i.e., no rain, low wind speed and temperature higher than 12°C. Hourly cloud cover, temperature and wind speed data were retrieved from a local weather station (Météo France 2012). We studied bat calls within bat passes (Thomas and West 1989). Species calls were identified at the species level by the authors using Scan'R (Binary Acoustic Technology, 2010) to isolate each bat vocalization and automate the measurement of relevant parameters and Syrinx software version 2.6 (Burt 2006) for spectrogram analyses (for more details see Appendix E and Lacoëuilhe et al. 2014); exceptions included vocalizations of *Plecotus austriacus* and *Plecotus auritus*, which were pooled as *Plecotus* spp., and those of *Myotis myotis*, *Myotis daubentonii*, *Myotis mystacinus*, *Myotis nattereri* and *Myotis bechsteinii*, which were pooled as *Myotis* spp., due to their very low occurrence and some uncertainties in identification. We used the number of calls per 30 minutes as a proxy for the measure of bat activity. We distinguished two guilds according to their foraging traits: “gleaning bats” which include *Myotis* and *Plecotus* species that mainly eat diurnal brachyceran Diptera and non-volant arthropods, such as weevils, lepidopteran larvae, harvestmen and spiders (Audet 1990; Swift & Racey 2002, Dietz et al. 2009), and “aerial hawking bats” which include *Pipistrellus* species, *Eptesicus serotinus* and *Nyctalus* species that mainly search the sky for prey (Schnitzler et al. 2003 Holderied, & von Helversen, 2003) (Appendix B1).

1.5 Bush cricket sampling

Because bush crickets produce mating calls (Ragge & Reynolds 1998), it is possible to collect large standardized data sets using recording devices (Penone et al. 2013a). Bush cricket calling songs have a role in pre-mating isolation, and their structure is an important

component of their mate recognition system (Paterson 1985). Therefore, the analysis of calling songs may allow identification to the species level (Ragge & Reynolds 1998) and even provide reliable information on species abundances (Fischer et al. 1997). Nevertheless, it does not give an exact estimation of species abundances mainly because only adult males stridulate. However, this method can provide relative measures of abundance (rather than absolute abundance), which is adequate for detecting spatial changes in species abundances and for detecting anthropogenic pressures on bush cricket communities (Penone et al. 2013b). For species with uninterrupted calls such as *Tettigonia viridissima*, *Ruspolia nitidula*, *Metrioptera roeselii* and *Phaneroptera falcata*, it was not possible to determine a value of abundance because their syllables are emitted at a continuous and quick rate (10-100 per second), which does not allow the easy distinguishing of several individuals singing simultaneously. Thus, we only noted their presence/absence, while for other species, with interrupted calls, we counted the number of calls of each species in each sample point as a proxy for relative measures of their activities.

We detected 11 species from the Tettigoniidae community and distinguished two mobility traits according to Reinhardt et al. (2005) and Marini et al. (2010): mobile (mostly with wings) and sedentary (Appendix B2).

1.6 Mean trait community index

1.6.1 Habitat specialization index

Each species was characterized for habitat specialization through the calculation of a Species Specialization Index (SSI) following the Julliard approach (Julliard et al. 2006). To define habitat specialization for bush crickets, we used the SSI indices assessed by Penone et al. (2013a). For bat SSI calculation, we used an independent data set provided by the national biodiversity monitoring scheme coordinated by the French National Museum of Natural History (<http://vigienature.mnhn.fr/>; for more details on the data set used, see Appendix F).

209 The SSI was calculated for each species using the coefficient of variation of the species'
210 abundance across habitats (Appendix B1, B2 and F). We calculated the Community
211 Specialization Index (CSI) as the arithmetic mean of the SSI of the detected species weighted
212 by the abundances (Julliard et al. 2006) (see Appendix F). Because of the lack of SSI for some
213 species, CSI values were calculated on 85% of the total of bush cricket calls, whereas for the
214 bats, all calls contribute to the assessment of CSI.

215 1.6.2 *Mobility trait*

216 For dispersal ability of bush crickets, according to Reinhardt et al. (2005) and Marini et al.
217 (2010) we conducted analyses by summing, on the one hand, the abundances of mobile
218 species, and on the other hand, the abundances of sedentary species. Two species (*P.*
219 *albopunctata* and *M. roeselii*) had intermediate dispersal ability; thus, they were removed
220 from the analyses on this trait, but they represented only 14.4% of the total calls.

221 1.6.3 *Foraging strategy trait*

222 Based on Dietz et al. (2009), we conducted analyses by summing, on the one hand, the
223 abundances of aerial hawking species, and on the other hand, the abundances of gleaner
224 species. As *B. barbastellus* (only 0.9% of total calls) had a mixed foraging type, this species
225 was removed from the analyses of this trait.

226 For the bat community approach (foraging strategy trait and CSI), we corrected the bat
227 activity by their distance of detection (see coefficients of detection in Barataud 2012) before
228 calculating the community indices.

229 1.7 *Statistical analysis*

230 1.7.1 *The influence of hedgerow characteristics on bat and bush cricket species.*

231 We assessed the influence of the three indices of hedgerows (density, diversity and
232 production) on bat and bush cricket species using a generalized linear model (GLM).

233 The response variables were (i) abundance of bush crickets' stridulations (n = 11 species) or
 234 bat foraging calls (n = 9 taxa) and (ii) community traits (for bush crickets: species dispersal
 235 abilities and CSI and for bats: foraging type and CSI) per site (n = 51).
 236 In our model, the explanatory variables were density, structural diversity and potential of
 237 wood production. Using some of the some correlations (between production and density, see
 238 2.3), we constructed a model of each explanatory variable.
 239 We considered a set of covariables, date, temperature, wind speed, and time after sunset (in
 240 minutes), because they could also influence bush cricket or bat activities. To test the effect of
 241 hedgerow characteristics in taking into account the landscape structure, we also included in
 242 the model the distance of each station to the nearest hedgerow and the proportion of semi-
 243 natural habitat within the 11 buffer zones described above. We took into account the influence
 244 of covariables to study the hedgerows' characteristic variables. First, we systematically
 245 evaluated the correlations among explanatory variables using Spearman's rho for quantitative
 246 variables (Crawley 2009) (see Appendix D) to detect obvious correlation. Secondly, we
 247 performed variance-inflation factor (VIF) on the full models (Fox & Monette 1992); all
 248 variables had $VIF < 5$, indicating no problem of multicollinearity in the explanatory variables
 249 of our models. To account for spatial autocorrelation, we added an autocovariate (i.e., a
 250 distance-weighted function of neighboring response values; Dormann et al. 2007) with the
 251 autocov_dist function in R (package spdep, Bivand et al. 2011).
 252 Thus, for each species of bat and bush cricket and for each of the 11 buffer zones, our full
 253 statistical models were structured as follow:
 254 $[species\ activity]_i \sim date + time\ after\ sunset + temperature + wind\ speed + distance\ to\ the$
 255 $nearest\ hedgerow + proportion\ of\ grassland_i + hedgerow\ characteristic_i + autocovariate_i$
 256 where i is the buffer size considered (from 50 m to 1000 m radii) and *hedgerow characteristic*
 257 is the characteristic considered (density, structural diversity or potential of wood production).

258 Because of the expected non-normal distribution of bat and bush cricket species calls, and the
259 possible high frequency of zero, we followed Potts and Elith (2006) and Vanderveelde et al. (2014)
260 performing four GLMs according to the nature of the response variable (count of bat
261 and bush cricket calls) for each tested species: one with a Poisson error distribution (GLM-P),
262 one with a negative binomial distribution (GLM-NB) and two with a zero-inflated GLMs
263 (Zuur et al. 2010): one with a Poisson error distribution [ZAP] and one with a negative
264 binomial [ZANB]; R package pscl, Jackman 2012). The zero inflated models were hurdle
265 models (ZAP and ZANB) that consider presence and absence data (with a binomial function)
266 and analyze the presence data in a second step with a count model (Poisson or a negative
267 binomial) (Zuur et al. 2009). Finally, based on the patterns of residuals (as recommended by
268 Zuur et al. (2009) to choose the appropriate modeling), we selected ZANB for all species,
269 except for *Plecotus* spp., the gleaner group and community specialization indices, for which
270 we used GLM-NB (see Appendix G). For all species, we used the count model (Zuur et al.
271 2009) of the ZANB to account for their activity; for species with uninterrupted calls
272 (Appendix B2) and species with a very low occurrence (*B. barbastellus*), we focused on the
273 presence/absence and used the binomial model of the ZANB (Zuur et al. 2009). From the full
274 model, using a buffer size of 500 meters, we performed a backward selection based on
275 Akaike's information criterion (AIC). The final models for each species and community are
276 presented in Appendix G; note that, exploratory treatment indicate that the procedure of
277 covariable selection is not sensitive to buffer size. Finally, based on the foraging or mobility
278 traits for each bat and bush cricket species and community, we tested the same model taking
279 into account the covariables and measures of hedgerow quality in the landscape (density,
280 diversity and productivity). We can compare the different explanatory variables (indices)
281 using AIC comparisons.

282 1.7.2 *Effect of hedgerow characteristics at different landscape scales*

283 1.7.2.1 *Step 1: calculation at a given scale*

284 For a given species and for each of the eleven buffer sizes, from 50 meters to 1000 meters, we
285 used the same final model to test the effect of each hedgerow index (density, diversity or
286 production) on the activity of each species or the community index (forage, mobility and
287 CSI), taking into account significant co-variables. Because we used the same model to test
288 the effect of each index at all scales, we were able to directly compare the value of the
289 estimate of the effect or goodness of fit of model (AIC) of indices for one species or
290 community between different spatial scales. However, we could not perform direct
291 comparisons between species or communities (see Appendix G).

292 1.7.2.2 *Step 2: calculation across scales*

293 Next, we tested whether the slope of the relationship between the dependent variable (species
294 activities and community traits) and the hedgerow indices changed with the scale. Thus, we
295 tested the effect of the buffer sizes on estimates from previous models using a GLM with a
296 normal error structure because the response variable was normally distributed (hereafter
297 referred to as ‘scale analysis’) (see Appendix G3). Following the approach of Penone et al.
298 (2013a), we assigned the response variable (i.e., estimate of slope) different weights
299 according to the associated standard error (1 per SE^2) obtained from the previous analysis.
300 Buffer size effects were adjusted to variables using a type II ANOVA. When we did not detect
301 a linear effect across the buffer size range (from 50 to 1000), we used the exploratory
302 approach of broken-line models. Broken-line models are regression models in which the
303 relationships between the response and explanatory variables are piecewise linear, represented
304 here by two straight lines connected at unknown values: these values are usually called
305 breakpoints (Package segmented, Muggeo 2008) (see Appendix H). All p values were

306 corrected for potential over-dispersion according to the Faraway (2006) approach. All
307 analyses were performed with R software (R Development Core Team 2011).

308 **2 Results**

309 A total of 35 263 bat calls belonging to 14 species were recorded at the 51 point counts during
310 the two periods. The majority of echolocation calls from the 14 bat species came from three
311 *Pipistrellus* bats (*Pipistrellus pipistrellus* (48.5%), *Pipistrellus kuhli* (24.4%) and *Pipistrellus*
312 *nathusii* (21.2%)). For bush crickets, we detected 101 419 calling songs belonging to 11
313 species from the Tettigoniidae family (Appendix B2). For more details on average activities of
314 bats and bush crickets, see Appendix I.

315 *2.1 Effect of the wood production of hedgerows*

316 *2.1.1 The effect of the wood production of hedgerows on bats*

317 We obtained 104 positive estimates of which 44 were significant and 28 negative estimates of
318 which 3 were significant (see Appendix J3). The activity of bat species was generally
319 positively correlated with the wood production of hedgerows, as shown in Figure 2, and the
320 effect was stronger at larger spatial scales (see Appendix J3). In the graph e (Figure 2), we
321 present the effect of the density of hedgerows on the aerial bat species. We showed that 1) for
322 example, with the 1000 m buffer, the activity of aerial species is positively correlated with the
323 density of the hedgerow (the estimate reported from the modeling at 1000 meters - with its
324 standard error) is positive, i.e., above zero, and this effect is significant, as indicated by the
325 asterisk; and 2) the scale effect, obtained from the linear regression, from 50 meters to 1000
326 meters was significant and is shown by the dotted line. The activity of aerial bat species was
327 significantly and positively correlated with the hedgerow density in a 1000 m buffer. The
328 scale effect obtained from linear regressions was significant and there is a positive scale effect

for these communities (above zero). When we did not detect a linear scale effect, we assessed a potential breakpoint value (see also Appendix H).

2.1.2 The effect of the wood production of hedgerows on bush crickets

We obtained 108 positive estimates, of which 16 were significant and 56 negative estimates of which 15 were significant (see Appendix J3). The wood production of hedgerows had a positive influence on the activity of all bush cricket species, (see Figure 3) and the influence was greater when the spatial scale was large, except for the sedentary species and *Uromenus rugosicollis*, for which results were the inverse of the other species: wood production was negatively correlated with their activities and this effect was stronger when the spatial scale was large (see Appendix J3).

2.2 Effect of the density of hedgerows

2.2.1 The effect of the density of hedgerows on bats

The density of hedgerows had a generally positive effect on the foraging activity of the studied bat species and communities based on the studied traits. Among the 132 estimates ((9 taxa + 3 community indices) x 11 buffer sizes) we generated for bats, we obtained 106 positive estimates, of which 33 were significant, and 26 negative estimates, of which only 4 were significant (see Appendix J1). The greater the hedgerow density around the point count, the more numerous were the bat calls. We observed this effect at almost all the spatial scales we studied. Moreover, we found that the larger the scale, the stronger the effect (observed in 9 out of 12 cases, see Table 1 and Appendix J1); therefore, we suggest that the density of hedgerows significantly and positively influenced the activity of the bat species and the two guilds at increasingly large spatial scales (see Appendix K1).

2.2.2 The effect of the density of hedgerows on bush crickets

The effect of density on bush crickets' activity was less marked than for bats and depended on the species studied and on their mobility. Among our 154 estimates (((11 taxa + 4 community indices)-(1 non-convergent model)) x 11 buffer sizes), we obtained 96 positive estimates, of which 15 were significant and 68 negative estimates, of which 11 were significant (see Appendix J1).

Moreover, the obtained positive effect increased at a large scale (> 500 m) for *Tettigonia viridissima*, *Ruspolia nitidula* and *Pholidoptera griseoptera*, whereas the effect was negative and became stronger at a large scale for *Uromenus rugosicollis*. Two contrasting patterns were observed for the two communities based on their mobility traits. The activity of mobile species of bush crickets appeared to increase with the density of the hedgerows and to increase more strongly at large scales, whereas the opposite effect was observed for sedentary species whose activity decreased in the presence of high-density hedgerows, especially at large scale (see Appendix K2).

2.3 Effect of the diversity of hedgerows

2.3.1 The effect of the diversity of hedgerows on bats

We obtained 91 positive estimates, of which 30 were significant and 41 negative estimates, of which 12 were significant (see Appendix J2). This effect was weaker at larger scales and had a break point at approximately 500 m (see Appendix L1 and J2). Moreover, we obtained contrasting and opposing patterns for aerial and gleaner species. The latter showed decreased activity with increasing hedgerow diversity at all scales, whereas the activity of the aerial species increased until 500 m and then decreased at larger spatial scales. Unlike other gleaner species, the activity of *Myotis* spp. increased with hedgerow diversity, especially at large spatial scales (see Appendix J2 and L1).

2.3.2 *The effect of the diversity of hedgerows on bush crickets*

Among the 110 estimates (((11 taxa + 4 community indices)-(5 non convergent models)) x 11 buffer sizes), we obtained 88 positive estimates, of which 12 were significant, and 72 negative estimates, of which 24 were significant (see Appendix J2). *Tettigonia viridissima* and *Uromenus rugosicollis* activities increased with diversity at scales larger than 500 m (see Appendix L2). However, the activities of *Ruspolia nitidula* and *Pholidoptera griseoptera* decreased with hedgerow diversity at all spatial scales, and the effect was stronger at large spatial scales (see Appendix L2). Hedgerow diversity had a positive effect on the activity of the mobile species, but the effect decreased and became negative for buffers of 800 m and larger, whereas the activity of sedentary species increased with the diversity of hedgerows, and this effect was stronger at larger spatial scales (see Appendix L2).

2.4 *Comparison between the indices*

According to the AIC value (Table 1), the best model, for each bat and bush cricket species and for communities based on foraging, mobility and habitat specialization, was the model with the productivity index.

3 Discussion

To our knowledge, our study is the first to assess the influence of hedgerow quality using three characteristics (density, structural diversity and potential of wood production) on the activity of bats and bush crickets, as well as on communities, based on foraging, mobility and habitat specialization. The results of the present study demonstrate the importance of hedgerow quality for bats and bush crickets, but the strength of the association between taxa and hedgerows varied greatly among species and spatial scales. From management and conservation perspectives, we need to understand the characteristics of hedgerows and spatial scales that must be considered to assess the hedgerows' quality for conservation of the

different taxa. Indeed, many European bat species use linear features of the landscape for commuting and foraging (Downs and Racey 2006; Entwistle et al. 1996; Limpens and Kapteyn 1991, Glendell and Vaughan 2002), and thus the density of hedgerows was particularly correlated with the activity of bats such as *Pipistrellus* spp. (Verboom and Huitema 1997; Boughey et al. 2011). Some studies have shown that occupancy of bat species was positively associated with corridor overstory height (Hein et al. 2009). Merckx et al. (2012) showed that in agricultural landscapes, trees in hedgerows increase the diversity of nocturnal Lepidoptera — which are some of the prey of certain European bats — and can also provide microhabitats, such as dead wood, that also increase invertebrate abundance and diversity (DEFRA 2010; Winter and Möller 2008). Moreover, production reflected richly structured habitats with microhabitats (Regnery et al. 2013), that are preferred by many bat species such as *P. pipistrellus* (Davidson-Watts et al. 2006) and especially by highly specialized and threatened species such as *B. barbastellus* (Kusch et al. 2004). Moreover, to reach hunting grounds, species such as *Myotis daubentonii* forage and commute along wood edges and hedgerows and avoid crossing open areas (Limpens and Kapteyn 1991). Our results were congruent with the literature but showed this relationship at different spatial scales for 9 bat taxa. We also identified a positive effect on groups based on foraging traits, mobility and habitat specialization. However, concerning bush cricket activity, few studies have documented hedgerow effects (Berggren et al. 2002). For this group, there were nearly as many significantly negative indices as significantly positive indices. The species we studied included species predicted to prefer grasslands and others predicted to prefer forest, which may explain this result.

However, our study has several potential limitations. The ultrasound recording time per site may be relatively short for identifying accurate absolute animal activity or abundance. Sampling using recording throughout the entire night would be more appropriate but also more time-consuming. Still, our design focus on the beginning of the night occurred during

the bat and bush cricket activity peak. Moreover, our sampling design allows unbiased measurement of animal activity among the hedgerow characteristics tested.

3.1 Scale effect

Based on the intensities of bat calls and bush cricket stridulations and on the technical characteristics of the microphones, we did not expect to detect individuals at a distance greater than 100 meters from the recording point. However, in our study, the strengths of the correlations tended to be strongest at large scales, suggesting that hedgerows could exert an influence at the scale of the landscape. However, it is worth noting that the influence of hedgerows on activity seems to vary depending the index characterizing the hedgerows and the species, most likely because several processes may be involved at different spatial scales (Bellamy et al. 2013). In fact, as already shown by Hale et al. (2012) for bats, the organisms are sensitive to landscape composition and structural connectivity at multiple spatial scales, and the impact of forest harvesting on habitat use by foraging bats varies with spatial scale (Grindal and Brigham 1999).

Based on homerange studies of bats using radio-tracking methods (see ref. Drescher 2004), we expected to detect an effect of hedgerow quality at large spatial scales, and this is what we found. For instance, the positive effect of a hedgerow network was detected in buffers whose radii ranged from 400 m to 1000 m, a range that is comparable to the home range of some individuals of *Pipistrellus pipistrellus* (Davidson-Watts and Jones 2005) and, *Eptesicus serotinus* (Perez and Ibañez 1991) or to the mean distance between roost and feeding sites for species such as *Pipistrellus nathusii* (Flaquer et al. 2009) and *Eptesicus serotinus* (Robinson and Stebbings 1997).

In addition, our results showed that gleaner species were significantly influenced by the potential production of hedgerow at small scales (see Figure 2 and Appendix J3), whereas the

effect for aerial species was significant only at large scales (Figure 2 and Appendix J3).
Boughey et al. (2011) showed that hedgerows of all types were associated with a similar
increase in *P. Pipistrellus* incidence; it is interesting to note that in our study, density and
production indices had a positive increasing influence with spatial scales on the activity of the
aerial hawking guild and the gleaning guild except for the diversity index for this last group
(Table 1).

Based on habitat area requirements and the individual bush crickets' perception of the
landscape, we hypothesized that the bush crickets were more sensitive to small-scale changes.
Arak and Eiriksson (1992) found that males of *T. viridissima* were regularly spaced with a
mean distance of 6 m between nearest-neighbors. However, our results showed that the bush
cricket species (i.e., abundances) and community indices were also influenced by landscape
structures at large scales (Figure 3 and Table 1).

In addition, we did not identify thresholds beyond which the scale effect no longer
increased. This result was congruent with Penone et al. (2013a) and With and Crist (1995)
who showed that some bush cricket species were sensitive to large-scale effects. We obtained
a contrasting effect for the two bush cricket communities based on mobility: a significant
positive scale effect of the production index on the activity of mobile species and a significant
negative effect on the activity of sedentary species (See Appendix J and Figure 3 e and . and
Table 1).

The habitat of specialized species appeared to benefit from the density of hedgerows
composed of old and large trees. For bush crickets and bats, we detected a positive scale effect
of the density and production indices on the two communities based on indices of habitat
specialization (CSI), whereas the effect of the structural diversity index was not significant
(Table 1). The comparison of the AIC of the models, for each quality index and for each
species or community, showed that the scale effect of the potential wood production best
explained the activity of the bats and bush crickets we studied.

For some taxa (i.e., *N. noctula*, Fig. 2) and communities (i.e., gleaners, Fig. 2), we detected a slope change of approximately 600 m with the scale analysis. This change may be specific to our study site and could be linked to the landscape structuring at the regional scale linked to the Loire River. A non-exclusive hypothesis could be linked to specific biological features of the taxa studied, indicating scale variations of landscape perception, which emphasizes the need to confirm this observed trend with future studies.

3.2 Comparison among the 3 indices: density, structural diversity and wood production

There was no correlation between diversity and wood production or between diversity and density, whereas a correlation between the density and wood production was detected. This relationship was logical according to the construction of the production index (see section 2.3) which includes hedgerow density. However, this index includes the information contained in the density index. Even if the wood production index appears globally to be a better predictor of bat and bush cricket activities (according to AIC value, see Table 1), the strong correlation between these two indices prevents identifying, with certainty, the best predictor.

We showed that from the landscape perspective, the quality of the hedgerow network was better represented by the potential wood production that generally positively influenced the activity of bush crickets and bats. Concerning bats, the production index showed a frequent significant positive effect on bat activity. Concerning bush crickets, the production index showed a more frequent significant positive effect (see Appendix J) than the density or diversity indices. We assumed two non-exclusive hypotheses to explain the differences in the patterns observed in Figure 3 between the mobile and sedentary species (Figures 3.e and 2.f.). First, the community of a mobile species would be more related to forest edges (i.e., *T. viridissima*), whereas the community of a sedentary species (*C. dorsalis*, *U. rugosicollis*) would be more related to the open areas such as grasslands (Voisin 2003). Thus, we would

have congruence between the traits mobility and habitat selection. Second, the hedgerows may contribute to colonization success in the grasslands, and therefore play a functional role, as Berggren et al. (2001) showed in the case of *Metrioptera roeselii*, which showed higher activity in landscapes with more hedgerows. This result was congruent with our results showing that the activity of this species was influenced positively by the density, diversity, and productivity indices and increased with spatial scale.

Through the diversity index, our study provided new evidence regarding the importance of hedgerows. The diversity of the structure of the hedgerows reflected from an ecological perspective, the heterogeneity of habitats in the hedgerows and thus the heterogeneity of ecological niches. Although this index shows a generally positive effect on the activity of bats and bush crickets compared to the two other indices (see Appendix J), its influence appeared to be less linear: few linear scale effects were detected (see Appendix L) and broken line analysis indicated a change at approximately 400-600 m. These patterns may be linked to the nature of this variable: the diversity index is calculated using a Shannon index (see 2.3). Indeed, the effects of the diversity index can be reversed according to the scales considered. At a small scale, a high structural diversity indicates a strong heterogeneity of the hedgerow types at a given location, whereas at larger scales, high structural diversity implied a good spread of different hedgerows types and a large quantity of each type.

3.3 Conclusion and implications for conservation

If habitat is the primary predictor of bat abundance (Müller et al. 2012; Walsh and Harris 1996), hedgerows may play a role in optimal foraging by promoting the dispersal of individuals because, they improved the general quality of habitats by improving the access to resource areas and the dispersion between roosts (particularly maternities) and foraging sites. To manage protected areas and to maximize management efforts (the latter point often focuses on the preservation of habitat patches), efforts should focusing more on the preservation of

connected habitats (Lookingbill et al. 2010). Mimet et al. (2013) and Pellissier et al. (2012) suggested that, for land use management, both the composition and the configuration of habitats must be taken into account to maintain suitable conditions for biodiversity and Zeale et al. (2012) underline the need to improve the quality and the numbers of ecological corridors. Optimizing the biodiversity gain provided by linear features will maximize the effectiveness of these schemes (Boughey et al. 2011). We showed that the wood production index positively influences the variation in the activities of bats and bush crickets. According to Geffray (2010), the wood production index is potentially correlated to tall and old trees and also to a potential ecosystem service of high timber production for land managers and farmers. Moreover, hedgerows provide habitats for auxiliary crops (Van Emden & Dabrowski Z.T. 1994), shelter against the wind and cold for crops, and wood production for firewood (linked to the European and French energy transition) (Château & Rossetti di Valdalbero, 2011). Thus, hedgerows play important roles in the ecosystem and provide many ecosystem services (Altieri 1999). They reconcile agricultural practices and biodiversity. Moreover, tree-filled hedgerows could provide substitute environments for forest species; thus, in grassland habitats, such as our study site, we need to encourage hedgerows with large and old trees.

Usually, it is recognized that hedgerow density is a heritage of old historical agricultural practices that shaped this landscape structure. Although agricultural practices have been largely modified, this network of hedgerows persists today. Currently, this network is influenced by regional, national and even European (common agricultural policy (CAP) agricultural policy. The wood production of hedgerows, however, is linked to management by local farmers. Thus, territorial policy decisions or local practices could influence the quality of the biodiversity. The present study examined different scales and different hedgerow indices and its results suggest that landscape planning should be considered both :1) at large scales because they are the ones that are guided by agricultural policies that can increase the density of hedges and 2) at small scales, such as the agricultural parcel level, because it is at

this scale that agro-ecosystem schemes offer subsidies or/and financial tax shelters that could be distributed to farmers and landowners to create, conserve and manage hedgerows to promote longer cutting cycles for old trees with high production. The distribution of agri-environmental measures (AEM) may be conditional on the hedgerow quality, rather than simply their presence.

However, the current European context, with its political pressure regarding wood energy, may not be favorable to shortening cutting cycles for large timber. Because hedgerows provide valuable habitat for many species (Boughey et al. 2011), the diversity index reflected the different types of hedgerows and therefore must be linked with AEM for management. The reintroduction of structural elements to increase habitat heterogeneity should become part of agro-ecosystem schemes (Frey-Ehrenbold et al. 2013). Our study site, as with many other sites, was in spaces with multiple proposed including agriculture, hunting, and even wood production through which hedgerows contribute to ecosystem services (Baudry et al. 2000).

566 4 Acknowledgments

567 This study was supported by the company EDF. We certify that the funding sources had no
568 influence on the collection, analysis or interpretation of the data. We gratefully acknowledge
569 CORELA (Conservatoire Régional des Rives de la Loire et de ses Affluents:
570 <http://www.corela.org/>) for the land use database and the hedgerow database. We thank
571 Lucille Brianceau for her assistance with fieldwork and to Maud Deniau and Léa Noël for
572 their help with the sonogram analyses. We thank deeply the Vigie-Nature volunteers for data
573 collection allowing the calculation of a Species Specialization Index for bats. We thank
574 Agathe Le Bocq and Violaine Brochier for their comments on an earlier version of the
575 manuscript.

5 References

- Altieri, M.A., 1999. The ecological role of biodiversity in agroecosystems. *Agric. Ecosyst. Environ.* 74, 19–31
- Audet, D., 1990. Foraging behavior and habitat use by a gleaning bat, *Myotis myotis* (Chiroptera : Vespertilionidae). *J. Mammal.* 71: 420–427.
- Arak A & T Eiriksson 1992. Choice of singing sites by male bushcrickets (*Tettigonia viridissima*) in relation to signal propagation. *Behavioral Ecology and Sociobiology*, 30: 365–372.
- Barataud, M., 2012. *Ecologie acoustique des chiroptères d'Europe. Identification des espèces, études de leurs habitats et comportements de chasse.* Biotopé, Mèze ; Muséum national d'histoire naturelle, Paris (collection Inventaires et biodiversité), 344 p.
- Batáry, P., Orci, K.M., Báldi, A., Kleijn, D., Kisbenedek, T., Erdős, S., 2007. Effects of local and landscape scale and cattle grazing intensity on Orthoptera assemblages of the Hungarian Great Plain. *Basic Appl. Ecol.* 8 (3), 280–290.
- Baudry, J., Bunce, R.G.H., Burel, F., 2000. Hedgerows: An international perspective on their origin, function and management. *J. Environ. Manage.* 60 (1), 7–22.
- Baudry, J., Jouin, A., 2003. *De la haie aux bocages. Organisation, dynamique et gestion.* INRA Editions, France. 435 p.
- Bazelet, C.S., Samways, M.J., 2011. Identifying grasshopper bioindicators for habitat quality assessment of ecological networks. *Ecol. Indic.* 11 (5), 1259–1269.
- Beier, P., Noss, R.F., 1998. Do habitat corridors provide connectivity? *Cons. Biol.* 12 (6), 1241–1252.
- Bellamy, C., Scott, C., Altringham, J., 2013. Multiscale, presence-only habitat suitability models: fine-resolution maps for eight bat species. *J. App. Ecol.* 50 (4), 892–901.
- Bennett, A.F., 2003. *Linkages in the landscape: The role of corridors and connectivity in wildlife conservation.* IUCN, Gland, Switerland, & Cambridge, UK. 254 p.
- Berggren, Å., Carlson, A., Kindvall, O., 2001. The effect of landscape composition on colonization success, growth rate and dispersal in introduced bush-crickets *Metrioptera roeseli*. *J. Anim. Ecol.* 70 (4), 663–670.
- Berggren, Å., Birath, B., Kindvall, O., 2002. Effect of corridors and habitat edges on dispersal behavior, movement rates, and movement angles in Roesel's bush-cricket (*Metrioptera roeseli*). *Cons. Biol.* 16 (6), 1562–1569.

608 Bivand, R., and contributors. 2011. spdep: Spatial dependence: weighting schemes, statistics
 609 and models. R package version 0.5-40. <http://CRAN.R-project.org/package=spdep>
 610 Boughey, K.L., Lake, I.R., Haysom, K.A., Dolman, P.M., 2011. Improving the biodiversity
 611 benefits of hedgerows: How physical characteristics and the proximity of foraging
 612 habitat affect the use of linear features by bats. Biol. Cons. 144 (6), 1790–1798.
 613 Braschler, B., Marini, L., Thommen, G.H., Baur, B., 2009. Effects of small-scale grassland
 614 fragmentation and frequent mowing on population density and species diversity of
 615 orthopterans: a long-term study. Ecol. Entomol. 34 (3), 321–239.
 616 Brown, G.P., Phillips, B.L., Webb, J.K., Shine, R., 2006. Toad on the road: Use of roads as
 617 dispersal corridors by cane toads (*Bufo marinus*) at an invasion front in tropical
 618 Australia. Biol. Cons. 133 (1), 88–94.
 619 Burel, F. 1992. Effect of landscape structure and dynamics on species diversity in hedgerow
 620 networks. Land. Ecol. 6 (3), 161–174.
 621 Burt, 2006. Syrinx a software for real time spectrographic recording, analysis and playback of
 622 sound. [<http://www.syrinxpc.com>].
 623 Cottenie, K. 2005. Integrating environmental and spatial processes in ecological community
 624 dynamics. Ecol. Lett. 8 (11), 1175–1182.
 625 Château B., Rossetti di Valdalbero D., 2011. (Eds.) World and European Energy and
 626 Environment Transition Outlook WETO-T European Commission Report EUR 24805.
 627 [http://ec.europa.eu/research/social-sciences/pdf/policy_reviews/publication-weto-](http://ec.europa.eu/research/social-sciences/pdf/policy_reviews/publication-weto-t_en.pdf)
 628 [t_en.pdf](http://ec.europa.eu/research/social-sciences/pdf/policy_reviews/publication-weto-t_en.pdf)
 629 Crawley, M.J., 2009. The R book. John Wiley & Sonc, Chicago, USA. Dainese, M., Inclán, D.
 630 J., Sitzia, T., & Marini, L. (2015). Testing scale-dependent effects of semi-natural
 631 habitats on farmland biodiversity. Ecological Applications, [http://dx.doi.](http://dx.doi.org/10.1890/14-1321.1)
 632 [org/10.1890/14-1321.1](http://dx.doi.org/10.1890/14-1321.1) (in press)
 633 Davidson-Watts, I., Jones, G., 2005. Differences in foraging behaviour between *Pipistrellus*
 634 *pipistrellus* (Schreber, 1774) and *Pipistrellus pygmaeus* (Leach, 1825): Foraging
 635 behaviour in cryptic bat species. J. Zool 268 (1), 55–62.
 636 Davidson-Watts I., Walls, S. & Jones, G. 2006. Differential habitat selection by *Pipistrellus*
 637 *pipistrellus* and *Pipistrellus pygmaeus* identifies distinct conservation needs for cryptic
 638 species of echolocating bats. Biol. Cons. 133, 118-127.
 639 DEFRA. 2010. *Trends, long term survival and ecological values of hedgerow trees:*
 640 *Development of populations models to inform strategy*. Forest Research, Forestry
 641 Commission. Report to the UK Government Department for the Environment, Food
 642 and Rural Affairs, London.

643 Diekötter, T., Speelmans, M., Dusoulrier, F., Van Wingerden, W.K.R.E., Malfait, J.P., Crist,
 644 T.O., Edwards, P.J., Dietz, H., 2007. Effects of landscape structure on movement
 645 patterns of the flightless bush cricket *Pholidoptera griseoaptera*. Environ. Entomol.
 646 36 (1), 90–98.

647 Dietz, C., von Helversen, O., Nill, D., 2009. *L'encyclopédie des chauves-souris d'Europe et*
 648 *d'Afrique du Nord : Biologie, caractéristiques, protection*. Delachaux et Niestlé, Paris,
 649 France. 400 p.

650 Dixon, M.D., 2012. Relationship between land cover and insectivorous bat activity in an
 651 urban landscape. Urban. Ecosyst. 15, 683–695.

652 Dormann, C.F., McPherson, J.M., Araújo, M.B., Bivand, R., Bolliger, J., Carl, G., Davies,
 653 R.D., Hirzel, A., Jetz, W., Daniel Kissling, W., Kühn, I., Ohlemüller, R., Peres-Neto,
 654 P.R., Reineking, B., Schröder, B., Schurr, F.M., Wilson, R. 2007. Methods to account
 655 for spatial autocorrelation in the analysis of species distributional data: a review.
 656 Ecography, 30, 609–628.

657 Downs, N.C., Racey, P.A., 2006. The use by bats of habitat features in mixed farmland in
 658 Scotland. Acta Chiropterol. 8, 169–185.

659 Drescher, C., 2004. Radiotracking of *Myotis myotis* (Chiroptera, Vespertilionidae) in south
 660 Tyrol and implications for its conservation Mammalia 68, 387–395.

661 Entwistle, A.C., Racey, P.A., & Speakman, J.R., 1996. Habitat exploitation by a gleaning bat,
 662 *Plecotus auritus*. *Philosophical Transactions of the Royal Society of London. Series B:*
 663 *Biological Sciences*, 351: 921–931.

664 Erickson, A., Low, M., Berggren, Å., 2013. Influence of linear versus network corridors on
 665 the movement and dispersal of the bush-cricket *Metrioptera roeseli* (Orthoptera:
 666 Tettigoniidae) in an experimental landscape. Eur. J. Entomol. 110, 81–86.

667 Faraway, J.J., 2006. Extending the linear model with R, Generalized linear, mixed effects and
 668 nonparametric regression models Chapman & Hall/CRC, USA.

669 Fischer, F.P., Schulz, U., Schubert, H., Knapp, P., Schmoger, M. 1997. Quantitative
 670 assessment of grassland quality: acoustic determination of population sizes of
 671 orthopteran indicator species. Ecol. Appl. 7, 909–920.

672 Flaquer, C., Puig-Montserrat, X., Goiti, U., Vidal, F., Curco, A., Russo, D., 2009. Habitat
 673 selection in Nathusius' pipistrelle (*Pipistrellus nathusii*): the importance of wetland.
 674 Acta Chiropterol. 11, 149–155.

675 Fox, J., Monette, G., 1992. Generalized collinearity diagnostics. J. Am. Statist. Assoc. 87,
 676 178–183.

677 Freckleton, R.P. 2002. On the misuse of residuals in ecology: regression of residuals vs.
678 multiple regression. *Journal of Animal Ecology* 71: 542–545.

679 Frey-Ehrenbold, A., Bontadina, F., Arlettaz, R., Obrist, M.K., 2013. Landscape connectivity,
680 habitat structure and activity of bat guilds in farmland-dominated matrices. *J. Appl.*
681 *Ecol.* 50, 252–261.

682 Gardiner, T., Hassall, M., 2009. Does microclimate affect grasshopper populations after
683 cutting of hay in improved grassland? *Journal of Insect Conservation* 13: 97–102.

684 Geffray, O., 2010. Le bocage en vallée de la Loire: mise à jour cartographique et estimation
685 des capacités en bois-énergie. Conservatoire Régional des Rives de la Loire et de ses
686 Affluents (CORELA), Rapport d'étude. 63 p. Data available at
687 <http://www.geopal.org/accueil/geoservice>.

688 Glendell, M., Vaughan, N., 2002. Foraging activity of bats in historic landscape parks in
689 relation to habitat composition and park management. *Anim. Conserv.* 5: 309–316.

690 Grindal, S.D., Brigham, R.M., 1999. Impact of forest harvesting on habitat use by foraging
691 insectivorous bats at different spatial scales. *Ecoscience* 6, 24–34.

692 Hale, J.D., Fairbrass, A.J., Matthews, T.J., Sadler, J.P., 2012. Habitat composition and
693 connectivity predicts bat presence and activity at foraging sites in a large UK
694 conurbation. *PLoS ONE* 7 (3), e33300.

695 Hannon, L.E. 2009. Hedgerows in an agri-natural landscape: potential habitat value for native
696 bees. *Biol. Cons.* 142, 2140–2154.

697 Hein, C.D., Castleberry, S.B., & Miller, K.V. 2009. Site-occupancy of bats in relation to
698 forested corridors. *Forest Ecology and Management* 257: 1200–1207.

699 Henderson, M.T., Merriam, G., Wegner, J., 1985. Patchy environments and species survival:
700 chipmunks in an agricultural mosaic. *Biol. Cons.* 31, 95–105.

701 Hinsley, S.A., Bellamy, P.E., 2000. The influence of hedge structure, management and
702 landscape context on the value of hedgerows to birds: A review. *J. Environ. Manage.*
703 60, 33–49.

704 Holderied, M.W., von Helversen, O., 2003. Echolocation range and wingbeat period match in
705 aerial-hawking bats. *Proc. R. Soc. Lond. [Biol.]* 270, 2293 – 2299

706 IUCN. 2011. *IUCN Red List of Threatened Species*. Version 2011.2. IUCN, Cambridge, UK.

707 Jackman, S., Zeileis, C. M., Fearon, J., Jackman, M. S., MCMCpack, S., 2012. Package
708 'pscl'. *Political Science Computational Laboratory, Stanford University*.

709 Jauregui, B.M., Rosa-Garcia, R., Gracia, U., WallisDeVries, M.F., Osoro, K., Celaya, R.,
710 2008. Effects of stocking density and breed of goats on vegetation and grasshopper
711 occurrence in heathland. *Agric. Ecosyst. Environ.* 123, 219–224.

712 Jones, G., Jacobs, D.S., Kunz, T.H., Willig, M.R., Racey, P.A., 2009. Carpe noctem: the
713 importance of bats as bioindicators. *Endanger. Species Res.* 8, 93–115.

714 Julliard, R., Clavel, J., Devictor, V., Jiguet, F., Couvet D., 2006. Spatial segregation of
715 specialists and generalists in bird communities. *Ecol. Lett.* 9, 1237–1244.

716 Kruess, A., Tschardtke, T., 1994. Habitat fragmentation, species loss, and biological control.
717 *Science* 264, 1581–1584.

718 Kusch, J., Weber, C., Idelberger, S., Koob, T., 2004. Foraging habitat preferences of bats in
719 relation to food supply and spatial vegetation structures in a western European low
720 mountain range forest. *Folia. Zool.* 53, 113–128.

721 Lacoëuilhe, A., Machon, N., Le Bocq, A., Julien, J.F., Kerbiriou, K. 2014. The influence of
722 low intensities of light pollution on bat communities in a semi-natural context.
723 *PlosOne* 9 (10): e103042.

724 Limpens, H.J.G.A., Kapteyn, K., 1991. Bats, their behaviour and linear landscape elements.
725 *Myotis* 29, 63–71.

726 Lookingbill, T.R., Elmore, A.J., Engelhardt, K.A.M., Churchill, J.B., Gates, J.E., Johnson,
727 J.B., 2010. Influence of wetland networks on bat activity in mixed-use landscapes.
728 *Biol. Cons.* 143, 974–983.

729 Marini, L., Bommarco, R., Fontana, P., Battisti, A., 2010. Disentangling effects of habitat
730 diversity and area on orthopteran species with contrasting mobility. *Biol. Cons.* 143,
731 2164–2171.

732 Merckx, T., Marini, L., Feber, R.E., Macdonald, D.W., 2012. Hedgerow trees and extended-
733 width field margins enhance macro-moth diversity: implications for management. *J.*
734 *Appl. Ecol.* 49, 1396–1404.

735 Mérot, P., 1999. The influence of hedgerow systems on the hydrology of agricultural
736 catchments in a temperate climate. *Agronomie* 19, 655–669.

737 Météo France, 2012. French national meteorological service. Data available
738 www.meteofrance.com (accessed Août 2012).

739 Mimet, A., Houet, T., Julliard, R., Simon, L., 2013. Assessing functional connectivity: a
740 landscape approach for handling multiple ecological requirements. *Methods Ecol.*
741 *Evol.* 4, 453–463.

742 Muggeo, V.M.R., 2008. Segmented: an R package to fit regression models with broken-line
743 relationships. *R News* 8(1), 20–25.

744 Müller, J., Mehr, M., Bässler, C., Fenton, M.B., Hothorn, T., Pretzsch, H., Klemmt,
745 H.J., Brandl, R., 2012. Aggregative response in bats: prey abundance versus habitat.
746 *Oecologia* 169: 673–684.

747 Pardini, R., de Souza, S.M., Braga-Neto, R., Metzger, J.P., 2005. The role of forest structure,
748 fragment size and corridors in maintaining small mammal abundance and diversity in
749 an Atlantic forest landscape. *Biol. Cons.* 124, 253–266.

750 Paterson, H.E.H., 1985. The recognition concept of species. In: *Species and Speciation* (ed. by
751 E.S. Vrba), pp. 21–29. Transvaal Museum Monograph No. 4, Transvaal Museum,
752 Pretoria, South Africa.

753 Pellissier, V., Cohen, M., Boulay, A., Clergeau, P., 2012. Birds are also sensitive to landscape
754 composition and configuration within the city centre. *Landsc. Urban Plan.* 104, 181–
755 188.

756 Penone, C., Kerbiriou, C., Julien, J.F., Julliard, R., Machon, N., Le Viol, I., 2013a.
757 Urbanisation effect on Orthoptera: which scale matters? *Insect Conserv. Divers.* 6,
758 319–32.

759 Penone, C., Le Viol, I., Pellissier, V., Julien, J.F., Bas, Y., Kerbiriou, C., 2013b. Use of large-
760 scale acoustic monitoring to assess anthropogenic pressures on Orthoptera
761 communities monitoring. *Cons. Biol.* 27, 979–987.

762 Perez-Jorda, J.L., Ibañez, C., 1991. Preliminary results on activity rhythms and space use
763 obtained by radio-tracking a colony of *Eptesicus serotinus*. *Myotis* 29:61–66.

764 Potts, J.M., Elith, J., 2006. Comparing species abundance models. *Ecol. model.* 199, 153–
765 163. Pywell, R., E. Warman, T. Sparks, J. Greatorex-Davies, K. Walker, W. Meek, C.
766 Carvell, S. Petit, and L. Firbank. 2004. Assessing habitat quality for butterflies on
767 intensively managed arable farmland. *Biological Conservation* 118:313-325.

768 Ragge, D.R., Reynolds, W.J. 1998. The Songs of the Grasshoppers and Crickets of Western
769 Europe. Harley Books, Colchester, UK. 600 p.

770 R Development Core Team, 2011. R: A language and environment for statistical computing. R
771 Foundation for Statistical Computing, Vienna, Austria. [<http://www.R-project.org/>]

772 Reinhardt, K., Köhler, G., Maas, S., Detzel, P., 2005. Low dispersal ability and habitat
773 specificity promote extinctions in rare but not in widespread species: the Orthoptera of
774 Germany. *Ecography* 28, 593–602.

775 Regnery, B., Couvet, D., Kubarek, L., Julien, J.F., Kerbiriou, C., 2013. Tree microhabitats as
776 indicators of bird and bat communities in Mediterranean forests. *Ecol. Indic.* 34, 221-
777 230.

778 Robinson, M.F., Stebbings, R.E., 1997. Home range and habitat use by the serotine bat,
779 *Eptesicus serotinus*, in England. *J. Zool.* 243, 117–136.

780 Robinson, R.A., 1997. The ecology and conservation of seed-eating birds on farmland. PhD
781 Thesis, University of East Anglia, Norwich, UK.

- 782 Robinson, R.A., Sutherland, W.J., 2002. Post-war changes in arable farming and biodiversity
783 in Great Britain. *J. App. Ecol.* 39, 157–176.
- 784 Roche, N., Catto, C., Langton, S., Aughney, T., Russ, J., 2005. Development of a Car-Based
785 Bat Monitoring Protocol for the Republic of Ireland. *Irish Wildlife Manuals*, No. 19.
786 National Parks and Wildlife Service, Department of Environment, Heritage and Local
787 Government, Dublin, Ireland.
- 788 Rosenberg, D.K., Noon, B.R., Megahan, J.W., Meslow, E.C., 1998. Compensatory behaviour
789 of *Ensatina eschscholtzii* in biological corridors: a field experiment. *Can. J. Zool.* 76,
790 117–133.
- 791 Shannon, C. E., Weaver, W., 1949. The mathematical theory of communication (Urbana, IL.
792 *University of Illinois Press*, 19, 1.
- 793 Schnitzler, H.U., Moss, C.F., Denzinger, A., 2003. From spatial orientation to food acquisition
794 in echolocating bats. *Trends Ecol. Evol.* 18, 386–394.
- 795 Scribner, K.T., Arntzen, J.W., Cruddace, N., Oldham, R.S., Burke, T., 2001. Environmental
796 correlates of toad abundance and population genetic diversity. *Biol.Cons.* 98, 201–210.
- 797 Sklenicka, P., Molnarova, K., Brabec, E., Kumble, P., Pittnerova, B., Pixova, K., Salek, M.,
798 2009. Remnants of medieval field patterns in the Czech Republic: Analysis of driving
799 forces behind their disappearance with special attention to the role of hedgerows.
800 *Agric. Ecosyst. Environ.* 129, 465–473.
- 801 Swift, S., Racey, P., 2002. Gleaning as a foraging strategy in Natterer's bat *Myotis nattereri*
802 *Behav. Ecol. Sociobiol.* 52(5), 408–416
- 803 Thomas, D.W., West, S.D., Portland, O., 1989. Sampling methods for bats. Portland, Or.: US
804 Dept of Agriculture, Forest Service.
- 805 Van Emden H.F., Dabrowski Z.T., 1994. Biodiversity and habitat modification in pest
806 management. *Int. J. Trop. Insect Sc.* 15, 605–620
- 807 Vandevelde, J.C., Bouhours, A., Julien, J.F., Couvet, D., Kerbiriou, C., 2014. Activity of
808 European common bats along railway verges. *Ecol. Eng.*, 64: 49–56.
- 809 Veen, P., Jefferson, R., de Smidt, J., van der Straaten, J., (eds.) 2009. *Grasslands in Europe of*
810 *high nature value*. KNNV Publishing, Zeist, The Netherlands. 320p.
- 811 Verboom, B., Huitema, H., 1997. The importance of linear landscape elements for the
812 pipistrelle *Pipistrellus pipistrellus* and the serotine bat *Eptesicus serotinus*. *Land. Ecol.*
813 12, 117–125.
- 814 Voisin J.F., (coord.) 2003. Atlas des Orthoptères et des Mantides de France. Patrimoines
815 Naturels, 60, Paris, MNHN. 104p.

816 Walsh, A.L., Harris, S., 1996b. Factors determining the abundance of vespertilionid bats in
817 Britain: Geographical, land class and local habitat relationships. *J. App. Ecol.* 33, 519-
818 529.

819 Winter, S., Möller, G.C., 2008. Microhabitats in lowland beech forests as monitoring tool for
820 nature conservation. *For. Ecol. Manage.* 255, 1251–1261.

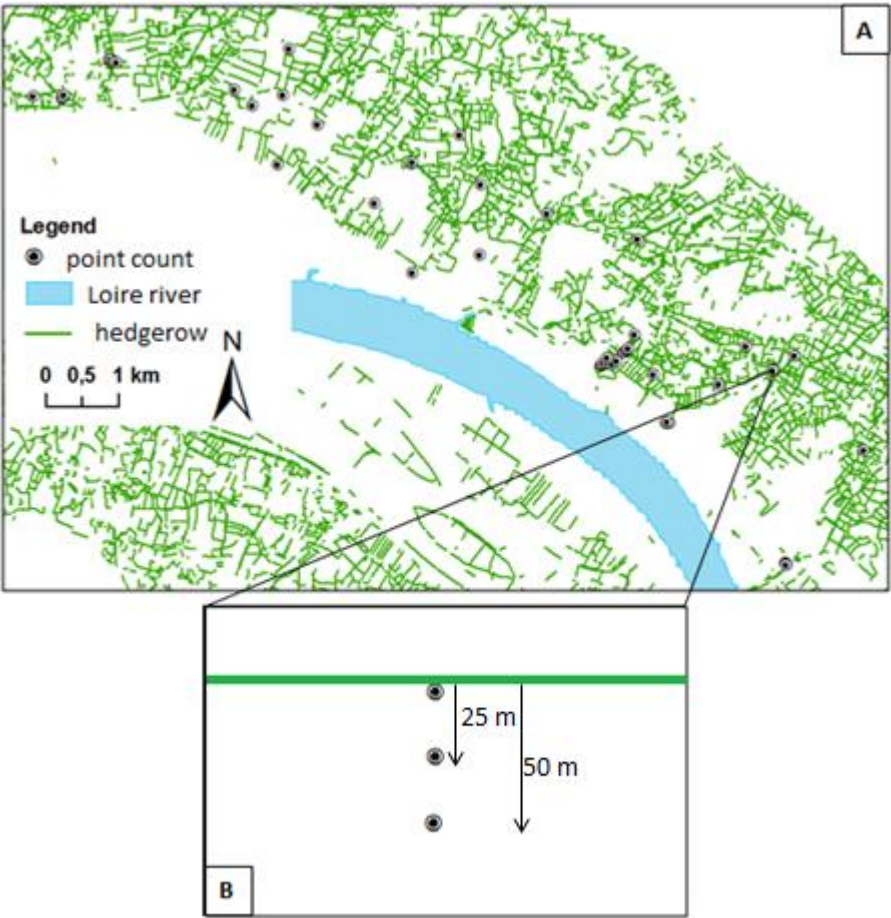
821 With, K.A., Crist, T.O., 1995. Critical thresholds in species responses to landscape structure.
822 *Ecology* 76, 2446–2459.

823 Zeale, M.R.K., Davidson-Watts, I., Jones, G., 2012. Home range use and habitat selection by
824 barbastelle bats (*Barbastella barbastellus*): implications for conservation. *J. Mammal.*
825 93, 1110–1118.

826 Zuur, A.F., Ieno, E.N., Walker, N., Saveliev, A.A., Smith, G.M., 2009. *Mixed Effects Models*
827 *and Extensions in Ecology with R*. Statistics for Biology and Health, Springer, New
828 York, USA. 574p.

829 Zuur A.F., Ieno, E.N., Elphick, C.S., 2010. A protocol for data exploration to avoid common
830 statistical problems. *Methods Ecol. Evol.* 1, 3–14.

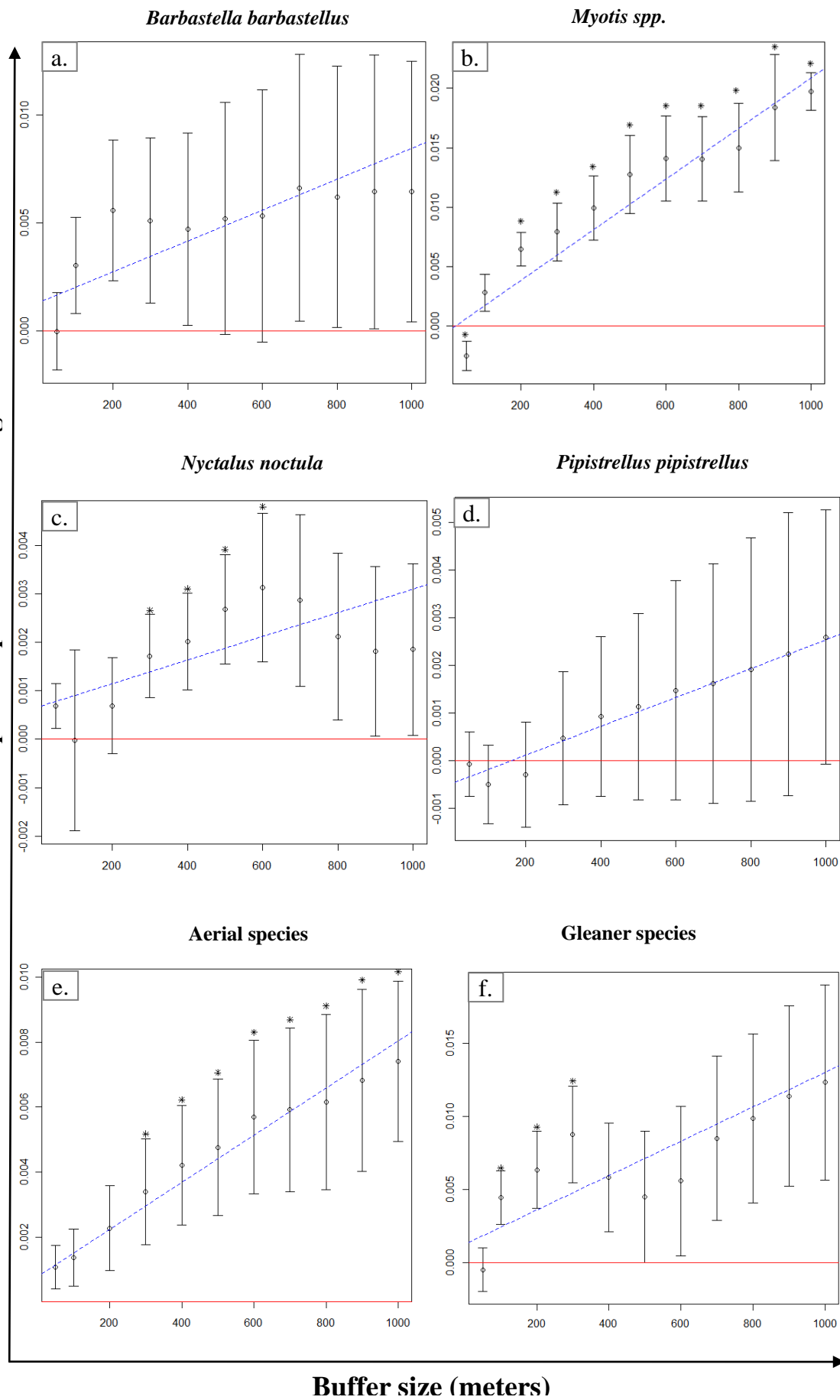
Figure 1: Positions of point counts in the study site (A) and an enlargement showing the 3 distances from the hedgerow (0 m, 25 m and 50 m) (B)



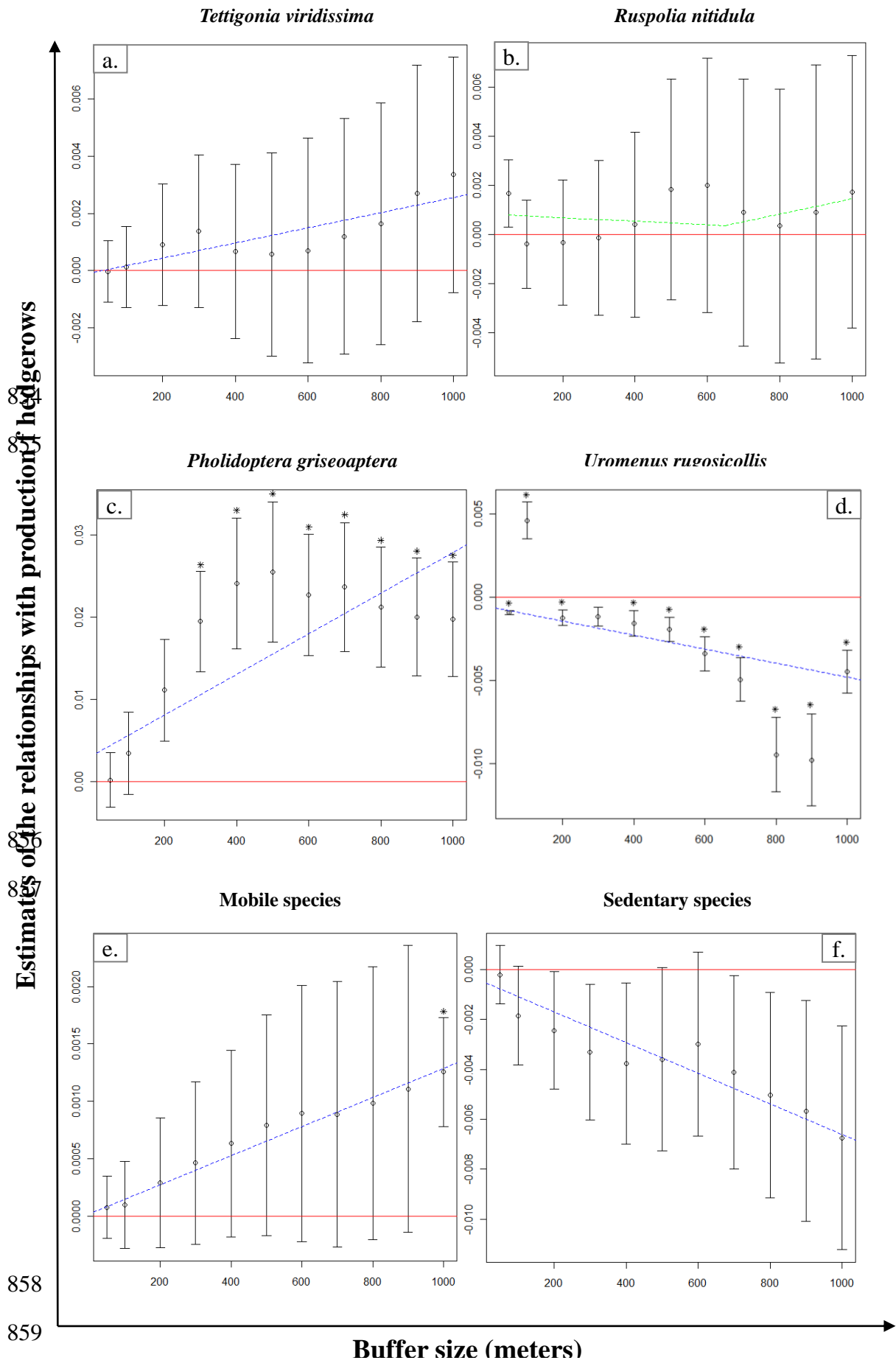
835 *Figure 2: Effect on bats of the production of hedgerows at different spatial scales. On the Y-*
836 *axis: estimates of the relationships between production and activity of 4 different species and*
837 *activity of aerial and gleaner species. 6 graphs are presented: 4 species (a, b, c, d) with*
838 *various ecologies and 2 traits (e, f). Asterisks indicate significance. The dotted line shows the*
839 *scale effect obtained from linear regressions.*

840

841
842
843
844
845
846
847



848
849 *Figure 3: Effect on the bush crickets of the hedgerow production at different spatial scales.*
850 *On the Y-axis: estimates of the relationships between production and activity of 4 different*
851 *species, community specialization and activity of mobile and sedentary species (see also*
852 *Appendix H)*
853



861 *Table 1: Spatial scale effect of density, diversity and productivity (estimate of GLM) and the*
862 *significance of the GLM (anova, F test) at each spatial scale from 50 to 1000 m.*

			<i>Hedgerow density</i>					<i>Hedgerow diversity</i>					<i>Hedgerow production</i>				
		Species	Estimated GLM	SE GLM	P value ANOVA	F ANOVA	AIC GLM	Estimate GLM	SE GLM	P value ANOVA	F ANOVA	AIC GLM	Estimate GLM	SE GLM	P value ANOVA	F ANOVA	AIC GLM
Bush crickets	Continuous calls	<i>T. viridissima</i>	0.028	0.015	0.093	3.52	96.10	0.001	0.001	0.492	0.51	34.70	2.65E-06	4.63E-07	<0.001	32.80	-132.00
		<i>R. nitidula</i>	-0.005	0.034	0.884	2.25E-02	114.00	-0.004	0.001	0.012	9.82	38.20	8.49E-08	1.30E-06	0.950	0.00	-110.00
		<i>M. roeselii</i>	0.082	0.026	0.013	9.64	109.00	0.004	0.002	0.069	4.27	49.00	2.75E-06	1.34E-06	0.071	4.20	-109.00
		<i>P. falcata</i>	0.003	0.043	0.947	4.62E-03	120.00	0.007	0.002	0.010	10.40	48.80	-1.92E-06	1.96E-06	0.352	0.97	-99.30
	Non-continuous calls	<i>P. griseoaptera</i>	0.394	0.072	<0.001	30.10	133.00	-0.012	0.004	0.009	10.80	68.40	2.47E-05	5.80E-06	0.002	18.20	-74.60
		<i>U. rugosicollis</i>	-0.662	0.050	<0.001	175.00	114.00	0.005	0.002	0.070	4.24	56.80	-4.21E-06	1.59E-06	0.026	7.04	-103.00
		<i>P. nana</i>	0.052	0.097	0.610	0.282	127.60	-0.050	0.014	0.005	13.61	90.79	8.93E-06	7.43E-06	0.260	1.44	-72.85
		<i>L. punctatissima</i>	0.094	0.022	0.002	18.50	108.00	-0.009	0.001	<0.001	48.70	41.00	4.54E-06	7.57E-07	<0.001	35.90	-118.00
		<i>P. albopunctata</i>	1.076	0.487	0.069	4.87	131.14	-0.074	0.010	0.020	49.50	19.00	6.02E-05	4.18E-05	0.188	2.07	-30.05
		<i>C. dorsalis</i>	-0.032	0.039	0.428	0.69	115.00	-0.002	0.002	0.416	0.73	48.40	-7.70E-07	1.29E-06	0.565	0.36	-112.00
		<i>P. tessellata</i>	-0.070	0.017	0.003	16.10	96.90	0.015	0.004	0.007	12.70	60.40	-6.15E-06	1.27E-06	0.001	23.30	-105.00
		Mobility	0.022	0.001	<0.001	1610.00	31.00	-2.64E-04	1.71E-04	0.158	2.37	-0.25	1.27E-06	4.81E-08	<0.001	700.00	-176.00
	Orthoptera mobility trait	Sedentary	-0.066	0.020	0.008	11.40	103.00	0.001	0.001	0.021	7.74	19.20	-6.15E-06	8.36E-07	<0.001	54.10	-119.00
		Intermediate	-0.036	0.027	0.208	1.84	108.57	-0.001	0.001	0.38	0.86	40.54	-2.05E-06	1.12E-06	0.100	3.35	-112.95
		CSI	0.018	0.009	0.088	3.65	85.33	4.51E-04	3.51E-04	0.23	1.65	9.59	6.10E-07	4.98E-07	0.251	1.50	-131.38
Bats		<i>B. barbastellus</i>	0.158	0.044	0.006	12.90	120.00	0.001	0.001	0.188	2.03	35.23	7.13E-06	1.96E-06	0.005	13.18	-100.17
		<i>Myotis spp.</i>	0.450	0.052	<0.001	73.60	113.00	0.017	0.003	<0.001	23.20	64.62	2.13E-05	2.16E-06	<0.001	97.83	-93.06
		<i>N. noctula</i>	0.064	0.018	0.006	12.50	99.50	-0.001	0.002	0.411	0.74	50.37	2.45E-06	6.14E-07	0.003	15.91	-125.13
		<i>P. pipistrellus</i>	0.051	0.007	<0.001	52.80	78.30	0.003	0.001	0.060	4.64	39.20	3.03E-06	3.75E-07	<0.001	65.20	-138.00
		<i>P. kuhlii</i>	0.134	0.030	0.002	20.10	111.00	0.003	0.001	0.043	5.55	35.20	9.69E-06	6.02E-07	<0.001	258.00	-126.00
		<i>P. nathusii</i>	0.154	0.008	<0.001	411.00	81.60	-0.005	0.002	0.047	0.05	50.90	8.11E-06	2.64E-07	<0.001	946.00	-144.00
		<i>Plecotus spp.</i>	-0.003	0.031	0.920	1.07E-02	113.48	-0.004	0.002	0.057	4.74	48.16	-2.85E-06	3.31E-06	0.412	0.74	-88.43
		<i>E. serotinus</i>	-0.056	0.026	0.060	4.63	113.00	0.006	0.001	<0.001	93.70	30.60	-8.08E-07	1.47E-06	0.596	0.30	-103.00
		<i>N. leisleri</i>	-0.121	0.034	0.006	12.60	114.00	0.008	0.001	<0.001	46.40	41.20	-4.28E-06	1.46E-06	0.017	8.57	-108.00
	Bat foraging trait	Aerial	0.218	0.015	<0.001	220.30	95.75	0.003	0.002	0.161	2.33	46.28	1.11E-05	2.88E-07	<0.001	1495.18	-142.59
		Gleaner	0.273	0.084	0.010	10.60	133.69	-0.007	0.002	0.019	8.15	53.11	1.17E-05	3.23E-06	0.005	13.22	-90.37
		CSI	0.015	0.001	<0.001	124.83	48.25	-2.17E-04	3.69E-04	0.57	0.34	10.90	6.20E-07	8.98E-08	<0.001	47.76	-168.98

863 6 Appendix list

864	Appendix A: Proposition of potential production of hedgerows in Loire Valley between
865	Saint-Nazaire and Montsoreau in 2010.
866	Appendix B1 Index uses for bat community assessment
867	Appendix B2: Bush cricket species specialization and traits
868	Appendix C: Correspondence scale of areas depending on the buffer size
869	Appendix D: Correlations between variables
870	Table D1: Correlations between characteristics of hedgerows (density, structural diversity and:
871	potential wood production) and covariables at each spatial scale
872	Table D2: Spearman correlations between characteristics of hedgerows (density, structural
873	diversity and potential wood production) for a 500 m buffer
874	Appendix E: Sonograms and information on sound files
875	Appendix F: Assessment of Habitat Specialization species index and community specialization
876	indices
877	Table F1: Habitat Specialization Index
878	Appendix G: Details on statistical analysis
879	Appendix G1: Graphical abstract of the calculation at a given scale
880	Appendix G2: Models used (= final models) for each species and community to assess the influence
881	of the variables density, structural diversity and potential wood production
882	Appendix G3: Graphical abstract of the calculation across scales
883	Appendix H: Average activities of bats and bush-crickets
884	Figure H1: Bat activities
885	Figure H2: Bush cricket activities
886	Appendix I: Inflection points and slopes for species and groups with segmented method for linear
887	landscape element density, diversity and production
888	Appendix J1: Effect of Density (estimate (Est.), SE and p value)
889	Appendix J2: Effect of Diversity (estimate (Est.), SE and p value)
890	Appendix J3: Effect of Production (estimate (Est.), SE and p value)
891	Appendix K: Density figures for bats and bush crickets
892	Figure K1: Effect of the density of linear landscape elements on bats at different spatial scales
893	Figure K2: Effect of the density of linear landscape elements on bush crickets at different
894	spatial scales
895	Appendix L: Diversity figures for bats and bush crickets
896	Figure L1: Effect of the diversity of linear landscape elements on bats at different spatial scales
897	Figure L2: Effect of the diversity of linear landscape elements on bush crickets at different
898	spatial scales
899	
900	

7 Appendix A: Potential production of hedgerows in Loire Valley between Saint-Nazaire and Montsoreau in 2010.

The database (Geffray 2010) described the linear landscape elements in five categories:

- (1) Alignment of trees,
- (2) Riparian vegetation,
- (3) Shrub hedgerow (which only correspond to weak productivity)
- (4) Wooded hedgerow without the presence of shrubs
- (5) Three strata hedgerow (tree, shrub and herb)

<i>Typology (CORELA 2010)</i>	<i>Productivity in m³/1 hm /year (CORELA prediction)</i>
<i>Shrub hedgerow and alignment of trees with weak productivity</i>	<i>0.22</i>
<i>Hedgerow with trees and riparian vegetation adjacent to rivers with weak productivity</i>	<i>0.74</i>
<i>Wooded hedgerow and alignment of trees with high productivity</i>	<i>1.11</i>
<i>Wooded hedgerow and alignment of trees with medium productivity</i>	<i>0.93</i>
<i>Riparian vegetation adjacent to rivers with high productivity</i>	<i>1.67</i>
<i>Riparian vegetation adjacent to rivers with medium productivity</i>	<i>1.11</i>
<i>Three strata hedgerow with high productivity</i>	<i>1.11</i>
<i>Three strata hedgerow with medium productivity</i>	<i>0.74</i>

Note: 1 hm=100 linear meters; MAP = meter apparent of wood planking ($2.7 \text{ MAP sec/m}^3 = 1 \text{ m}^3$ of wood).

Reference

Geffray, Olivier, 2010. *Le bocage en vallée de la Loire: mise à jour cartographique et estimation des capacités en bois énergie. Conservatoire Régional des Rives de la Loire et de ses Affluents (CORELA), Rapport d'étude, 63 p.*

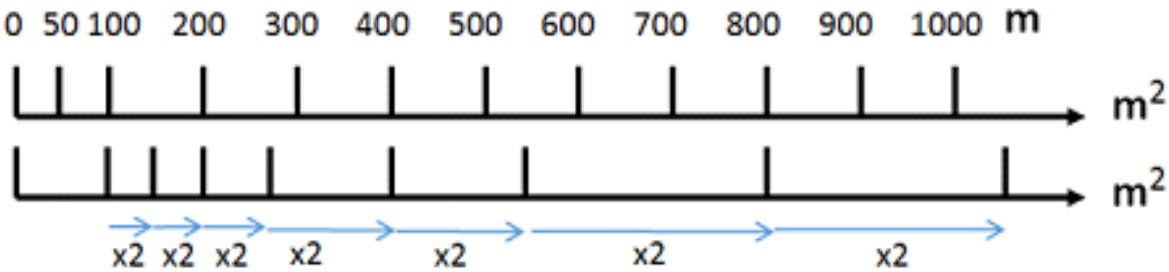
8 Appendix B1: Indices used for bat community assessment. For assessment of Habitat Specialization Index, see Appendix F and Figure2.6.

Bat species	Habitat Specialization Index(SSI)	Foraging type
<i>Barbastella barbastellus</i>	3.6	Mixed strategist
<i>Eptesicus serotinus</i>	1.5	Aerial hawking
<i>Myotis spp.(mainly daubentonii)</i>	3.2	Gleaner
<i>Nyctalus leisleri</i>	0.9	Aerial hawking
<i>Nyctalus noctula</i>	1.6	Aerial hawking
<i>Pipistrellus kuhlii</i>	0.7	Aerial hawking
<i>Pipistrellus nathusii</i>	3.1	Aerial hawking
<i>Pipistrellus pipistrellus</i>	0.5	Aerial hawking
<i>Plecotus spp (mainly austriacus)</i>	1.4	Gleaner

9 Appendix B2: Bush cricket species specialization and traits: *dispersal ability according to (Reinhardt et al. 2005; Marini et al. 2010); ** the SSI calculation is explained in Appendix F, and see 2.6 and Appendix E for explanations of the identification processes.

Species name	Dispersal ability*	SSI**	Species with uninterrupted calls
<i>Tettigonia viridissima</i>	Mobile	0.42	yes
<i>Phaneroptera nana</i>	Mobile	0.27	no
<i>Leptophye punctatissima</i>	Sedentary	0.55	no
<i>Platycleis tessellata</i>	Sedentary	1.42	no
<i>Platycleis albopunctata</i>	Intermediate	0.49	no
<i>Conocephalus dorsalis</i>	Sedentary	NA	no
<i>Ruspolia nitidula</i>	Mobile	0.52	yes
<i>Metrioptera roeselii</i>	Intermediate	NA	yes
<i>Pholidoptera griseoaptera</i>	Sedentary	0.91	no
<i>Uromenus rugosicollis</i>	Sedentary	NA	no
<i>Phaneroptera falcata</i>	Mobile	0.27	yes

10 Appendix C: Correspondence scale of areas (m²) depending on the buffer size (in meters)



Increment according to doubling area

11 Appendix D: Correlations between variables

Table D1: Correlations between characteristics of hedgerows (density, structural diversity and potential wood production) and covariables at each spatial scale. The important correlations between variables (correlation coefficient $|\rho| \geq 0.5$; Freckleton, 2002) are indicated in bold

		time after sunset	date	temperature	wind	distance from hedgerow	Proportion of grassland
50 m	Density	0.023	0.149	0.058	0.156	-0.055	-0.221
	Diversity	-0.193	0.092	0.157	0.142	0.064	0.006
	Production	-0.020	0.132	0.116	0.085	-0.011	-0.277
100 m	Density	0.028	0.269	0.099	0.106	0.156	-0.227
	Diversity	0.061	0.217	0.019	0.117	0.078	-0.171
	Production	-0.069	0.226	0.106	0.042	0.126	-0.254
200 m	Density	-0.020	0.274	0.085	0.037	0.154	-0.025
	Diversity	0.201	0.073	-0.015	-0.008	0.114	0.023
	Production	-0.123	0.198	0.173	0.006	0.219	0.099
300 m	Density	-0.075	0.273	0.192	-0.007	0.139	0.159
	Diversity	0.092	-0.119	-0.014	-0.108	0.055	0.254
	Production	-0.130	0.157	0.209	-0.015	0.177	0.136
400 m	Density	-0.041	0.203	0.159	-0.053	0.131	0.150
	Diversity	0.191	-0.017	0.040	-0.121	0.032	0.418
	Production	-0.083	0.108	0.196	-0.065	0.150	0.175
500 m	Density	-0.051	0.156	0.159	-0.066	0.088	0.208
	Diversity	0.339	0.005	-0.039	-0.092	0.018	0.569
	Production	-0.096	0.072	0.191	-0.095	0.119	0.190
600 m	Density	-0.050	0.183	0.173	-0.060	0.044	0.276
	Diversity	0.389	-0.003	-0.130	-0.093	-0.035	0.535
	Production	-0.088	0.095	0.177	-0.065	0.089	0.234
700 m	Density	-0.100	0.173	0.196	-0.055	0.067	0.219
	Diversity	0.388	-0.020	-0.169	-0.053	-0.075	0.472
	Production	-0.104	0.122	0.187	-0.052	0.088	0.227
800 m	Density	-0.082	0.174	0.164	-0.015	0.077	0.276
	Diversity	0.418	0.005	-0.039	-0.092	0.018	0.584
	Production	-0.103	0.072	0.191	-0.095	0.119	0.166
900 m	Density	-0.029	0.186	0.138	-0.002	0.064	0.387
	Diversity	0.376	0.040	-0.211	0.040	0.060	0.605
	Production	-0.079	0.161	0.159	-0.051	0.045	0.345
1000 m	Density	-0.015	0.188	0.106	0.012	0.046	0.496
	Diversity	0.413	0.055	-0.182	0.043	0.058	0.579
	Production	-0.085	0.172	0.143	-0.048	0.042	0.415

Table D2: Spearman correlations between characteristics of hedgerows (density, structural diversity and potential wood production) for a 500 m buffer.

	Density	Diversity	Production
Density	1	rho= 0.117, p value =0.241	rho= 0.961, p value < 0.001
Diversity	rho= 0.117, p value =0.241	1	rho= 0.124, p value =0.215
Production	rho= 0.961, p value < 0.001	rho= 0.124, p value =0.215	1

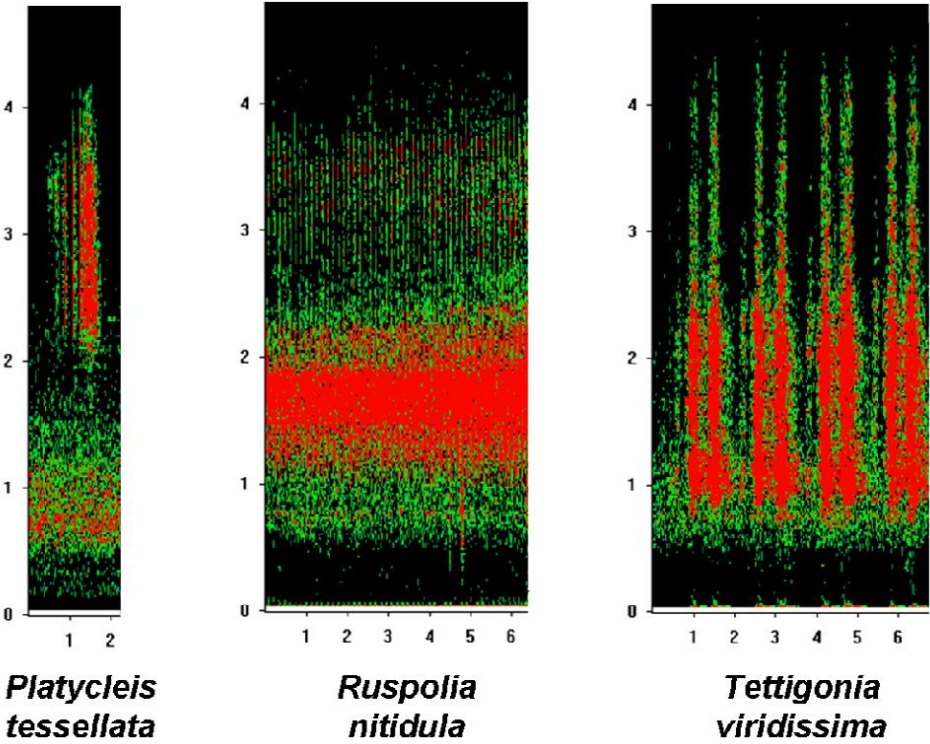
References:

Freckleton, R.P., 2002. On the misuse of residuals in ecology: regression of residuals vs. multiple regression. *J. Anim. Ecol.* 71, 542–545.

952 12 **Appendix E: Sonograms and information on sound files**

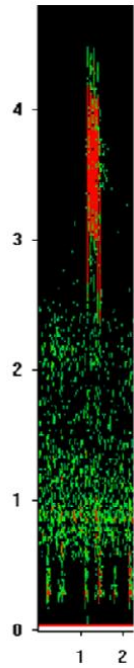
953

954 Orthoptera activities records

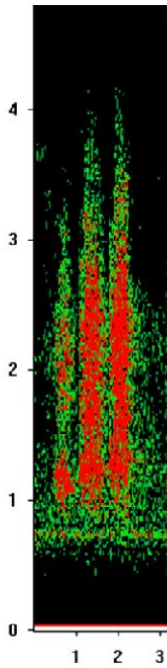


955

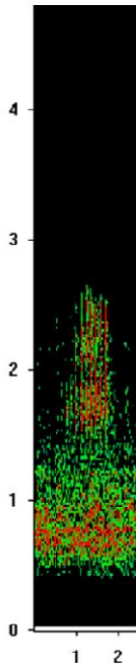
956



Leptophyes punctatissima

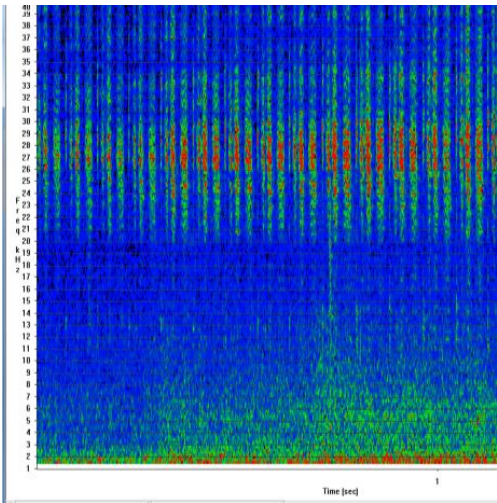
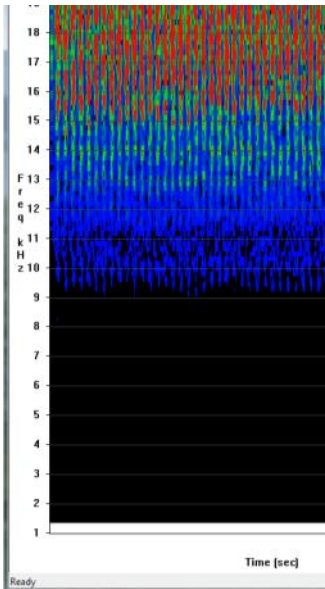


Pholidoptera griseoptera



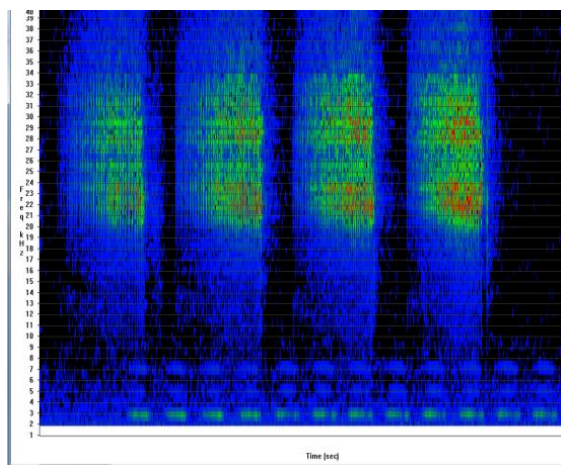
Phaneroptera nana

Metrioptera rosellii



Platycleis albopunctata

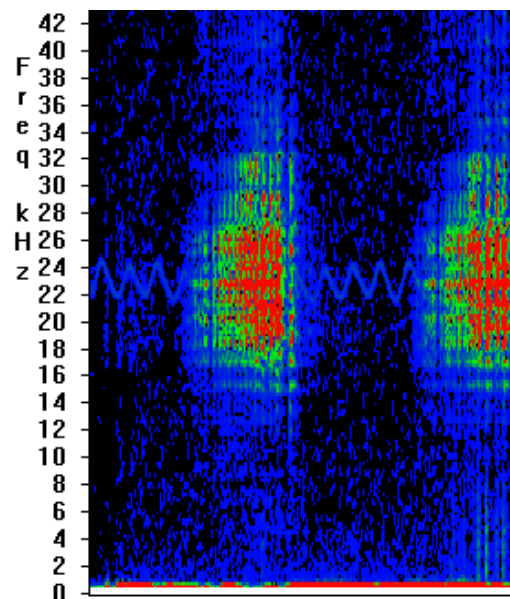
Conocephalus dorsalis



964

965

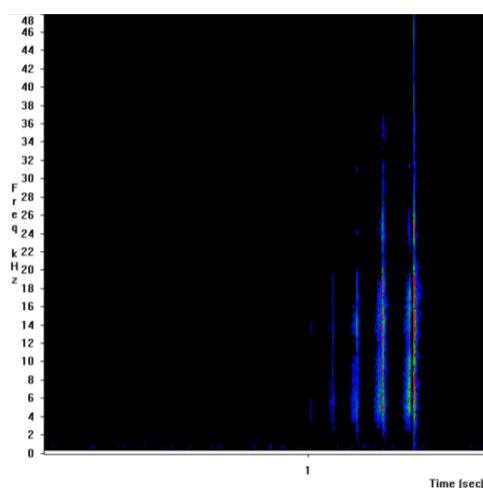
Phaneroptera falcata



966

967

Uromenus rugosicollis



968

969

970 Sonograms of the main species detected

971 Software: Syrinx; x-axis: time x10 (seconds); y-axis: frequency (KHz)

972

973 Sound files:

974 Some samples of Orthoptera sounds of the main species are given in the present zip file.

975 To make the recordings audible, the sampling rate has been divided by ten (from

976 96000 ks/s to 9600 ks/s).

977

Species name	File name
<i>Leptophyes punctatissima</i>	LEPPUN.wav
<i>Phaneroptera nana</i>	PHANAN.wav
<i>Pholidoptera griseoptera</i>	PHOGRI.wav
<i>Platycleis tessellata</i>	PLATES.wav
<i>Ruspolia nitidula</i>	RUSNIT.wav
<i>Tettigonia viridissima</i>	TETVIR.wav

978

979 **Bat activity records**

980

981 We used Syrinx software version 2.6 (Burt, 2006) for spectrogram and Adobe Audition for spectral
 982 analysis, we used Scan'R (Binary Acoustic Technology, 2010) to isolate each bat vocalization and
 983 automatethe measurement of relevant parameters (Gannon et al., 2004, Obrist et al., 2004, Barataud
 984 2012). Species identification of sounds was performed by Lea Noel and Aurelie Lacoeyuilhe, and
 985 verified by coordinators of the French Bat Monitoring Program (Jean-François Julien & Christian
 986 Kerbiriou)

987

988 The main relevant parameters used were as follows:

989 Call duration (msec)

990 Time elapsed since previous detection (msec)

991 Maximum frequency detected (Fmax, KHz)

992 Minimum frequency detected (Fmin, KHz)

993 Total Bandwidth [Fmax - Fmin] (KHz)

994 Frequency at strongest sound pressure level (KHz)

995 Location of Dominant Frequencies (% of total duration)

- 996 High end of characteristic (KHz) [Similar to Fk]
- 997 Low end of characteristic (KHz) [Similar to Fc]
- 998 Global slope of the call (KHz per msec)
- 999 Time of the heel or High Fc (percent of duration)
- 1000 Upper slope [start to High Fc] (KHz per msec)
- 1001 Lower slope [High Fc to Low Fc] (KHz per msec)
- 1002 Fundamental frequency (KHz)
- 1003 2nd harmonic frequency (KHz)
- 1004 Curvature measurement as a way to characterize the shape of bat calls (see Jolly 1997)
- 1005 Curve fit error parameter; a measurement of how much error exists between the curvature model
- 1006 and the actual shape of the call

1007

1008 **References**

1009

1010 Barataud, M., 2012. Ecologie acoustique des chiroptères d'Europe. Identification des espèces,
 1011 études de leurs habitats et comportements de chasse. Biotope, Mèze ; Muséum national d'histoire
 1012 naturelle, Paris (collection Inventaires et biodiversité), 344 p.

1013

1014 Gannon, W.L., O'Farell M.J., Corben, C., Bedrick, E., 2004. Call character Lexicon and analysis
 1015 of field recorded bat echolocation calls. Echolocation in bats and dolphins- Edited by J.A. Thomas,
 1016 CF Moss, and Vater. 2004. University of Chicago Press, Chicago, IL, USA, 604 pp.

1017

1018 Obrist, M. K., Boesch, R., Flückiger, P. F., 2004. Variability in echolocation call design of 26
 1019 Swiss bat species: consequences, limits and options for automated field identification with a
 1020 synergetic pattern recognition approach. Mammalia 68 (4), 307-322.

13 Appendix F: Assessment of Habitat Specialization species index and community specializations indices

Habitat Specialization species indices were assessed using data from the French Bat Survey

French Bat Survey.

Volunteer-based standardized monitoring schemes have been widely implemented in Europe and North America (Jiguet et al., 2012). In France, the National Museum of Natural History (MNHN) initiated the French Bat Survey (BS) in 2006. This scheme offers a dataset of 6774 sites with both habitat characterizations and bat identifications (28 species and 960 500 bat calls).

Counting methods

The French BS recruits keen volunteers to count bats twice per year: once from 15th June to 31st July, and a second time from 15th August to 30th September. Two different versions are used: road survey by car and count point. Count point: this method consists of a square of 2 km per-side randomly chosen (by the MNHN) within a radius of 10 km from the observer's home, (i.e., in average one square randomly chosen from among 80 possible squares). Within this square ten point counts are chosen by the observer with at least five points counts representative of the habitats of the square and the other being located in 'favorable' places for bats such wetlands, wood edges, etc. Road survey: the choice of the circuit is delegated to the volunteers because the main constraint is related to their safety. The circuit must be performed at night at low speed (recording at constant speed: 30 ± 5 km/h), and this excludes non-paved roads, roads with heavy traffic and high-speed roads. Only volunteers, with their local knowledge of the field, are able to identify such roads. All roads are thus of similar size, approximately 10 meters across. Observers were asked to choose a road circuit of at least 30 km and located within a 10 km radius around their house. The circuit must

not overlap itself. The second requirement is to design a circuit that crosses, as proportionally as possible, the different habitats present in the area. To avoid biases in habitat sampling (we assume that observers would tend to follow rich habitats), the MNHN validates the circuit and randomly defines a starting point on the circuit. Starting from this point, the circuit is divided into ten 2-km road segments, separated by 1-km road segments in which no recording is performed. These sampling designs allow quite good correlations between the habitat proportions sampled and the habitat proportions present at the national scale ($R^2 = 0.94$), except for urban areas which were slightly more represented in our sampling.

Assessment of specializations indices

The French national bat monitoring volunteers were involved in collecting habitat variables on a detailed and adapted basis. Habitat information is recorded on the first reconnaissance visit to the circuit. The appropriate habitat codes are chosen from an established hierarchical system allowing the description of more than 950 habitat types, which is very similar to the widely used habitat codes in bird monitoring schemes (see Crick 1992 for the UK and Barnagaud et al., 2012 for the French monitoring) but is adapted to account for bat foraging specifics and particularly linear element (for more details about the French Bat monitoring see the website [<http://vigienature.mnhn.fr/page/relevés-d-habitats>]). Habitat classes are collected in a radius of 100 m around the sampled point and grouped into 18 classes to obtain sufficient numbers of samples per class (for more methodological information see Julliard et al., 2006; DeVicтор et al., 2008; Kerbiriou et al. 2010).

Specialization species index (SSI)

We calculated the species specialization index (SSI), which is the degree of habitat specialization for a species, as the coefficient of variation ($SD/mean$) of its densities across habitats following the

1071 approach of Julliard et al.(2006). SSI is thus independent of species habitat preferences. However, it
1072 is also possible to assess the species specializations for forest habitats by calculating the average
1073 density of a species inventoried in forest habitats divided by the average density in non-forest
1074 habitats.

1075

1076

1077 Table F1: Habitat Specialization Index

Bat species	Habitat Specialization Index
<i>Barbastella barbastellus</i>	3.64
<i>Eptesicus serotinus</i>	1.50
<i>Myotis myotis</i>	NA
<i>Myotis daubentonii</i>	3.48
<i>Myotis mystacinus</i>	3.86
<i>Myotis nattereri</i>	2.40
<i>Nyctalus leisleri</i>	0.95
<i>Nyctalus noctula</i>	1.58
<i>Pipistrellus kuhlii</i>	0.75
<i>Pipistrellus nathusii</i>	3.06
<i>Pipistrellus pipistrellus</i>	0.54
<i>Pipistrellus pygmaeus</i>	1.79
<i>Plecotus</i> spp (mainly <i>austriacus</i>)	1.36
<i>Rhinolophus hipposideros</i>	NA

1078

1079 Assessment of bat community specializations indices

1080 The Community Specialisation Index (CSI) is calculated as the arithmetic mean of the species
1081 specialization index (SSI) of the species detected, weighted by the abundances (Julliard et al., 2006)
1082 (Eq. (2)).

1083
$$CSI_j = \frac{\sum_{i=1}^n a_{ij} (SSI_i)}{\sum_{i=1}^n a_{ij}} \quad (2)$$

1084 where n is the total number of species recorded, a_{ij} is the abundance of individuals of species i (with
1085 a specialization index SSI) in segment j (Devictor et al., 2008).

1086

1087 To calculate the *Myotis* group CSI, we used the total number of calls identified as from *Myotis*

1088 species and the average of the CSI values calculated for identified *Myotis* species.

1089

1090 The CSI reflects the relative abundance of more or less specialized species in local assemblages

1091 and is therefore expected to decrease following the relative declines of specialists (species with a

1092 high SSI). For the analyses, we used only sites with a non-null abundance (n = 44 for bats and n=33

1093 for Orthoptera, i.e., 65% and 85% of the respective data sets) because a null CSI does not describe a

1094 generalist community.

1095

1096 **References:**

1097 Barataud, M. 2012. Ecologie acoustique des chiroptères d'Europe. Identification des espèces,

1098 études de leurs habitats et comportements de chasse. Biotope, Mèze ; Muséum national d'histoire

1099 naturelle, Paris (collection Inventaires et biodiversité), 344 p.

1100 Barnagaud J-Y, Devictor V, Jiguet F, Barbet-Massin M, Le Viol I, et al. (2012) Relating Habitat

1101 and Climatic Niches in Birds. PLoS ONE 7(3), e32819. doi:10.1371/journal.pone.0032819

1102 Crick, H.Q.P. (1992): A bird-habitat coding system for use in Britain and Ireland incorporating

1103 aspects of land-management and human activity. Bird Study 39, 1-12

1104 Devictor, V., Julliard, R., Jiguet, F., 2008. Distribution of specialist and generalist species along

1105 spatial gradients of habitat disturbance and fragmentation. Oikos 117, 507–514.

1106 Jiguet, F., Devictor, V., Julliard, R., Couvet, D., 2012. French citizens monitoring ordinary birds

1107 provide tools for conservation and ecological sciences. Acta Oecol. 44, 58–66.

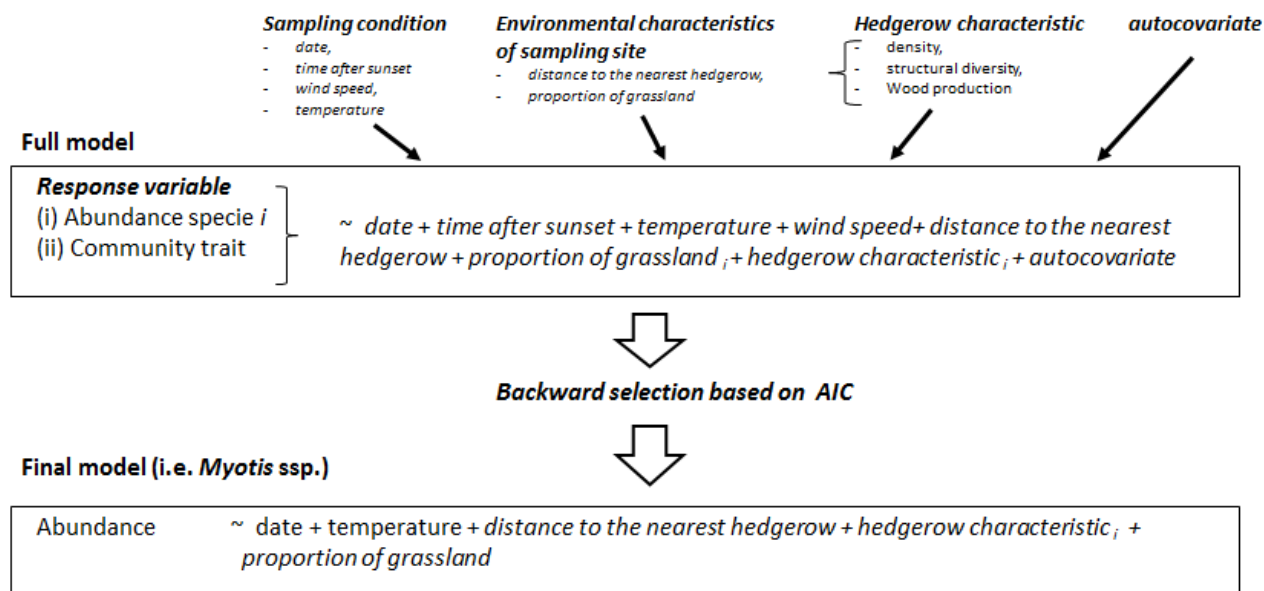
1108 Julliard, R., Clavel, J., Devictor, V., Jiguet, F., Couvet, D., 2006. Spatial segregation of

1109 specialists and generalists in bird communities. Ecol. Lett. 9, 1237-1244.

- 1110 Kerbiriou, C., Bas, Y., Dufrêne, L., Robert, A., Julien, J.F., 2010. Long term trends monitoring of
1111 bats, from biodiversity indicator production to species specialization assessment. Society for
1112 Conserv. Biol. - 24th Annual Meeting, 3 - 7 July, 2010, Edmonton, Alberta, Canada.
- 1113 Marnell, F., Presetnik, F.P., 2010. Protection of over ground roosts for bats. EUROBATS
1114 Publication Series No 4. UNEP/EUROBATS Secretariat, Bonn, Germany.
- 1115

14 Appendix G: Details of the statistical analysis

Appendix G1. Graphical abstract of the calculation at a given scale



Appendix G2 Models used (=final models) for each species and community to assess the influence of variables density, structural diversity and potential wood production

For all the species and communities, we used a zero-inflated GLM with a negative binomial distribution (ZANB) except for *Plecotus* spp., both CSI analyses, and the gleaner group for which we used a GLM with a negative binomial distribution (GLM.nb) (Zuur et al. 2010). For some species such as *B. barbastellus* and the Orthoptera species that had uninterrupted calls, we reported (pres/abs) for presence/absence and used the binomial model of the ZANB; for the others, we used the count model (Zuur et al 2009). Thus, our statistical models were structured as follows:

1132

1133 ❖ Orthoptera

1134 • presence/absence response variable

1135 *T. viridissima*~ date+TAS+temperature+wind+dist_hedgerow+PG+X+autocov

1136 *R. nitidula* ~ date+TAS+temperature+wind+dist_hedgerow+PG+X+autocov

1137 *M. roeselii* ~ date+TAS+temperature+wind+dist_hedgerow+PG+X+autocov

1138 *P. falcata* ~dist_hedgerow+PG+X

1139 • activity

1140 *P. griseoptera*~ date+TAS+temperature+wind+dist_hedgerow+PG+X+autocov

1141 *U. rugosicollis*~ date+TAS+temperature+wind+dist_hedgerow+PG+X+autocov

1142 *P. nana*~ dist_hedgerow+PG+X+autocov

1143 *L. punctissima*~ date+TAS+temperature+wind+dist_hedgerow+PG+X+autocov

1144 *P. albopunctata*~dist_hedgerow+PG+X

1145 *C. dorsalis*~ date+TAS+temperature+wind+dist_hedgerow+PG+X+autocov

1146 *P. tessellata*~ date+TAS+temperature+wind+dist_hedgerow+PG+X+autocov

1147 *Mobility*~ date+TAS+temperature+wind+dist_hedgerow+PG+X+autocov

1148 *Sedentary*~ date+TAS+temperature+wind+dist_hedgerow+PG+X+autocov

1149 *Intermediate* ~ date+TAS+temperature+wind+dist_hedgerow+PG+X+autocov

1150 *CSI*~ date+TAS+temperature+wind+dist_hedgerow+PG+X+autocov

1151

1152 ❖ Chiroptera

1153 • presence/absence response variable

1154 *B. barbastellus*~ dist_hedgerow+PG+X

1155 • activity

1156 *Myotis spp.* ~ date+TAS+temperature+dist_hedgerow+PG+X

1157 *N. noctula*~date+dist_hedgerow+PG+X

1158 *P. pipistrellus* ~date+TAS+temperature+wind+dist_hedgerow+PG+X+autocov

1159 *P. kuhlii*~ date+TAS+temperature+wind+dist_hedgerow+PG+X+autocov

1160 *P. nathusii*~ date+TAS+temperature+wind+dist_hedgerow+PG+X+autocov

1161 *Plecotus spp.* ~ *date*+*TAS*+*temperature*+*wind*+*dist_hedgerow*+*PG*+*X*+*autocov*

1162 *E. Serotinus*~ *date*+*TAS*+*temperature*+*wind*+*dist_hedgerow*+*PG*+*X*+*autocov*

1163 *N. leisleri*~ *date*+*TAS*+*temperature*+*wind*+*dist_hedgerow*+*PG*+*X*+*autocov*

1164 *Aerial* ~*date*+*TAS*+*temperature*+*wind*+*dist_hedgerow*+*PG*+*X*+*autocov*

1165 *Gleaner*~ *date*+*TAS*+*temperature*+*wind*+*dist_hedgerow*+*PG*+*X*+*autocov*

1166 *CSI*~ *date*+*TAS*+*temperature*+*wind*+*dist_hedgerow*+*PG*+*X*+*autocov*

1167

1168 Where

1169 *date* is the date in continuous format

1170 *TAS* is the time after sunset (in minutes)

1171 *wind* is the wind speed (in km/s)

1172 *dist_hedgerow* is the distance to the nearest hedgerow

1173 *PG* is the proportion of grassland

1174 *X* is replaced by the hedgerows characteristic i.e., density or diversity or productivity index.

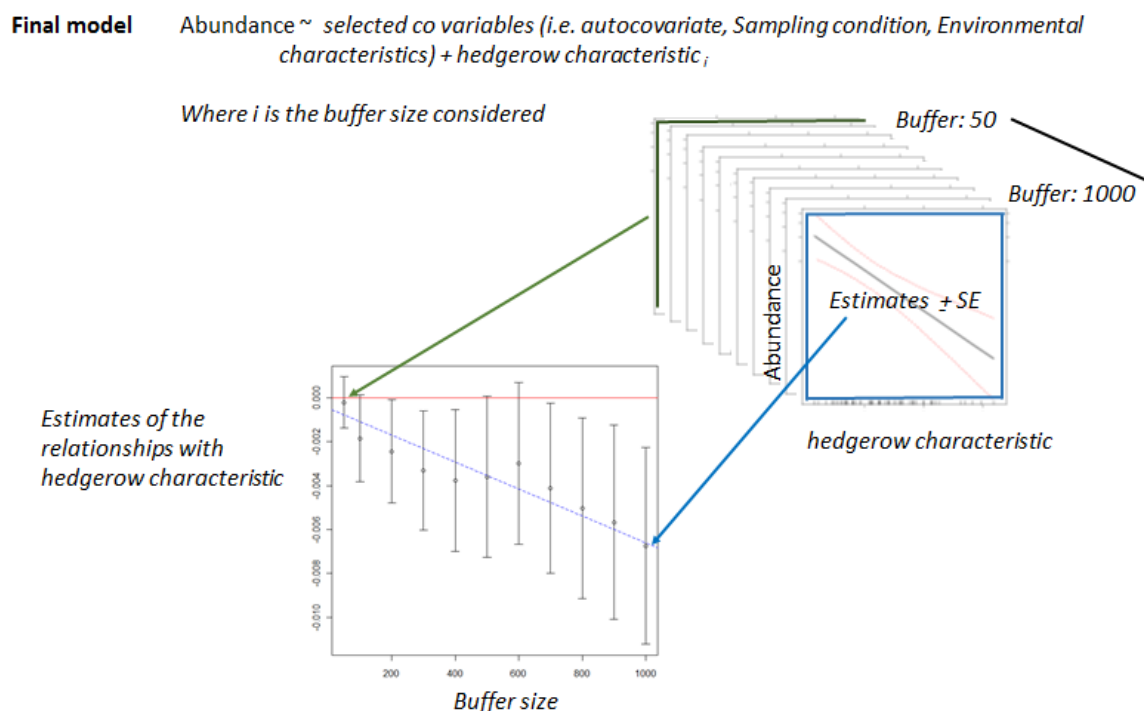
1175 *autocov* is an autocovariate function (i.e., a distance-weighted function of neighboring response

1176 values; Dormann et al. 2007) with the *autocov_dist* function in R (package *spdep*, Bivand et al.

1177 2011).

1178

Appendix G3. Graphical abstract of the calculation across scale



Model used to test the variation of effect across scales

Estimate of the relationships \sim Buffer size, weight ($1/SE^2$)

References

Bivand, R., and contributors. 2011. spdep: Spatial dependence: weighting schemes, statistics and models. R package version 0.5-40. <http://CRAN.R-project.org/package=spdep>

Dormann, C.F., McPherson, J.M., Araújo, M.B., Bivand, R., Bolliger, J., Carl, G., Davies, R.D., Hirzel, A., Jetz, W., Daniel Kissling, W., Kühn, I., Ohlemüller, R., Peres-Neto, P.R., Reineking, B., Schröder, B., Schurr, F.M., Wilson, R. 2007. Methods to account for spatial autocorrelation in the analysis of species distributional data: a review. *Ecography* 30, 609-628.

15 Appendix H: Inflection points and slopes for species and groups with segmented method for linear landscape element density, diversity and production

		Linear landscape element density						Linear landscape element diversity						Linear landscape element productivity					
Species		Estimate	SE	t value	CI (95%).l	CI (95%).u	inflection point	Estimate	SE	t value	CI (95%).l	CI (95%).u	inflection point	Estimate	SE	t value	CI (95%).l	CI (95%).u	inflection point
<i>T. viridissima</i>	slope1	-2.90E-04	0.027	-0.011	-0.064	0.064	613.67	-0.001	0.002	-0.295	-0.006	0.004	479.33						
	slope2	0.109	0.100	1.091	-0.127	0.344		0.005	0.004	1.262	-0.004	0.014							
<i>R. nitidula</i>	slope1	-1.052	0.225	-4.681	-1.583	-0.521	110.61							-7.06E-07	2.57E-06	-0.275	-6.79E-06	5.38E-06	649.03
	slope2	0.069	0.024	2.879	0.012	0.126								3.10E-06	1.04E-05	0.299	-2.14E-05	2.76E-05	
<i>U. rugosicollis</i>	slope1							0.001	0.002	0.309	-0.005	0.007	490.53						
	slope2							0.029	0.009	3.049	0.006	0.051							
Mobility	slope1							0.001	1.82E-04	3.299	1.70E-04	0.001	526.39						
	slope2							-0.001	3.46E-04	-4.108	-0.002	-0.001							
<i>B. barbastellus</i>	slope1							0.011	0.010	1.117	-0.012	0.035	198.95						
	slope2							-0.001	0.001	-0.916	-0.004	0.002							
<i>N. noctula</i>	slope1							0.008	0.004	1.778	-0.003	0.018	428.84						
	slope2							-0.010	0.006	-1.796	-0.023	0.003							
<i>P. pipistrellus</i>	slope1							0.006	0.001	6.843	0.004	0.008	633.41						
	slope2							-0.013	0.005	-2.702	-0.025	-0.002							
Aerial	slope1							0.006	0.001	5.399	0.003	0.008	530.93						
	slope2							-0.009	0.003	-2.903	-0.016	-0.002							
Gleaner	slope1							-0.005	0.003	-2.079	-0.011	0.001	629.60	6.60E-05	1.27E-05	5.217	3.61E-05	9.60E-05	234.34
	slope2							0.005	0.012	0.442	-0.023	0.033		-1.79E-05	4.61E-06	-3.876	-2.87E-05	-6.96E-06	

16 Appendix I: Average activities of bats and bush-crickets

Figure I1: Bat activities (mean numbers of contacts per minute and per site). *Barbastella barbastellus* (barbar), *Eptesicus serotinus* (eptser), *Myotis spp.* (myossp), *Nyctalus leisleri* (nyclei), *Nyctalus noctula* (nycnoc), *Pipistrellus kuhlii* (pikul), *Pipistrellus nathusii* (pinat), *Pipistrellus pipistrellus* (pippip), *Plecotus spp* (plesp)

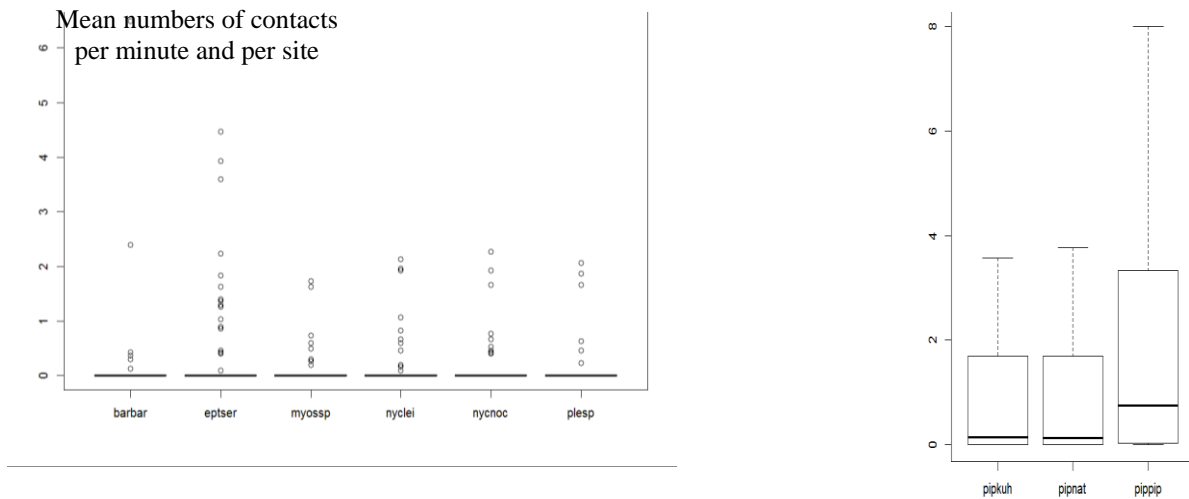
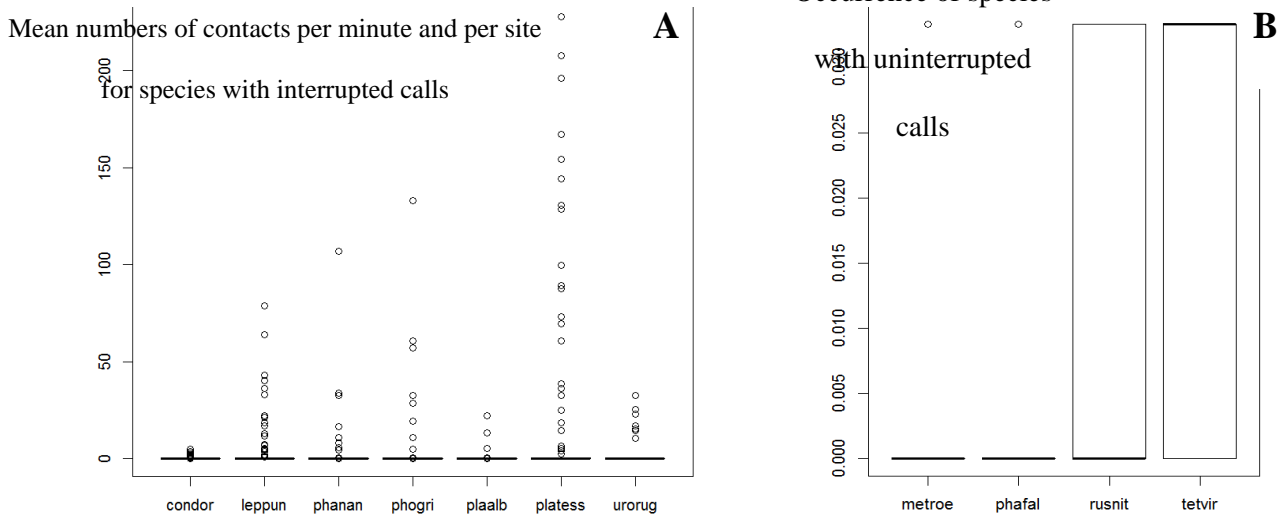


Figure I2: Bush-cricket activities (A: mean numbers of contact per minute and per site for species with interrupted calls; *Conocephalus dorsalis* (condor), *Leptophye punctatissima* (leppun), *Phaneroptera nana* (phanan), *Pholidoptera griseoaptera* (phogri), *Platycleis albopunctata* (plaalb), *Platycleis tessellata* (plates), *Uromenus rugosicollis* (urorug). B: occurrence of species with uninterrupted calls *Metrioptera roeselii* (metroe), *Phaneroptera falcata* (phafal), *Ruspolia nitidula* (rusnit), *Tettigonia viridissima* (tevir).



17 Appendix J: Effects of density, diversity and wood production

Table J1: Effect of Density (estimate (Est), SE and p value)

		Species /traits	50 m			100 m			200 m			300 m			400 m			500 m			600 m			700 m			800 m			900 m			1000 m		
			Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue			
Orthoptera	continuous calls	<i>T. viridissima</i>	-11.92	24.31	0.62	8.33	32.63	0.80	12.82	45.13	0.78	9.12	53.56	0.86	-11.45	62.18	0.85	-19.00	73.36	0.80	-8.89	79.46	0.91	6.27	81.91	0.94	15.87	84.13	0.85	33.20	90.18	0.71	36.95	83.11	0.66
		<i>R. nitidula</i>	42.77	32.16	0.18	-9.82	42.84	0.82	-19.01	57.88	0.74	-21.53	67.77	0.75	2.72	79.23	0.97	38.50	96.19	0.69	44.88	108.75	0.68	28.85	111.97	0.80	9.75	114.53	0.93	21.55	123.86	0.86	24.05	114.26	0.83
		<i>M. roeselii</i>	-12.24	23.82	0.61	-1.70	32.91	0.96	37.01	45.52	0.42	42.34	54.48	0.44	52.65	63.04	0.40	63.96	75.56	0.40	77.51	86.73	0.37	66.83	89.65	0.46	40.41	92.73	0.66	33.19	99.21	0.74	13.93	94.61	0.88
		<i>P. falcata</i>	22.26	76.93	0.77	-25.11	96.61	0.79	-50.19	147.61	0.73	-67.08	157.41	0.67	-45.10	160.13	0.78	-47.48	180.57	0.79	-48.09	202.32	0.81	-50.26	211.34	0.81	4.26	224.53	0.98	43.78	238.00	0.85	70.23	207.94	0.74
	non-continuous calls	<i>L. punctatissima</i>	5.76	21.67	0.79	-28.85	30.30	0.34	-23.77	49.79	0.63	-21.14	51.29	0.68	-22.24	62.22	0.72	30.69	73.00	0.67	53.44	71.64	0.46	48.06	69.06	0.49	52.69	66.21	0.43	73.65	64.65	0.25	91.77	51.23	0.07
		<i>C. dorsalis</i>	41.83	26.75	0.12	22.03	21.29	0.30	32.06	27.94	0.25	-17.42	33.66	0.60	-11.22	44.37	0.80	-18.27	62.03	0.77	-31.59	82.89	0.70	-29.73	94.74	0.75	-11.97	106.55	0.91	49.14	135.07	0.72	95.01	76.65	0.22
		<i>P. griseoaptera</i>	5.15	67.38	0.94	51.20	116.94	0.66	163.70	127.11	0.20	278.99	125.29	0.03	311.25	141.47	0.03	354.58	149.36	0.02	335.72	128.54	0.01	368.40	136.20	0.01	339.94	128.16	0.01	345.92	130.00	0.01	346.58	123.66	0.01
		<i>P. nana</i>	199.80	84.84	0.02	138.12	135.79	0.31	254.23	116.21	0.03	371.44	194.97	0.06	174.41	295.36	0.55	94.23	274.59	0.73	131.43	323.18	0.68	205.51	2498.71	0.93	179.65	NaN	NaN	411.94	227.43	0.07	250.30	347.98	0.47
		<i>U. rugosicollis</i>	-27.41	3.21	0.00	-68.83	7.78	0.00	-62.25	6.53	0.00	-93.92	7.38	0.00	-187.19	10.80	0.00	-265.60	11.77	0.00	-384.47	15.53	0.00	-441.07	20.14	0.00	-554.36	30.69	0.00	-614.64	44.04	0.00	NA	NA	NA
		<i>P. tessellata</i>	-4.71	52.67	0.93	9.64	71.34	0.89	15.65	67.09	0.82	-8.36	72.05	0.91	-16.63	97.65	0.86	-23.97	129.87	0.85	-27.57	143.00	0.85	-20.57	152.46	0.89	-55.27	191.97	0.77	-69.07	239.22	0.77	-94.89	217.71	0.66
		<i>P. albopunctata</i>	-24.03	76.99	0.75	-283.00	47.28	0.00	-202.25	878.74	0.82	-81.33	NaN	NaN	11.69	643.00	0.99	68.08	1001.76	0.95	180.85	5909.55	0.98	223.94	NaN	NaN	323.95	NaN	NaN	1017.17	324.85	0.00	558.78	567.55	0.32
		CSI	6.83	21.05	0.75	1.04	30.28	0.97	-6.35	41.39	0.88	-2.54	48.24	0.96	-3.35	56.52	0.95	3.05	65.89	0.96	10.66	71.92	0.88	13.07	76.21	0.86	22.97	81.30	0.78	31.86	90.76	0.73	34.05	101.70	0.74
	Mobility trait	Mobility	0.99	6.80	0.88	2.30	9.42	0.81	4.46	13.28	0.74	5.16	15.79	0.74	9.34	17.85	0.60	12.83	21.24	0.55	14.94	23.93	0.53	15.23	24.41	0.53	16.78	25.19	0.51	19.08	26.67	0.47	22.37	9.52	0.02
		Sedentary	-7.29	25.37	0.77	-41.86	40.14	0.30	-49.08	48.76	0.31	-60.38	53.40	0.26	-69.44	63.91	0.28	-65.94	73.13	0.37	-49.77	72.24	0.49	-60.22	75.04	0.42	-71.39	78.79	0.36	-77.70	85.93	0.37	-49.94	86.88	0.57
		Intermediate	18.51	8.91	0.04	34.69	11.88	0.00	59.21	20.80	0.00	44.58	28.65	0.12	38.23	32.44	0.24	35.81	43.18	0.41	-10.85	49.12	0.83	-15.95	51.00	0.75	-21.40	51.00	0.67	-27.25	51.90	0.60	-31.77	54.61	0.56
Chiroptera	<i>B. barbastellus</i>	-18.39	38.23	0.63	58.87	51.73	0.26	97.56	72.11	0.18	93.85	81.35	0.25	94.38	94.81	0.32	92.54	115.81	0.42	95.01	123.55	0.44	120.65	129.62	0.35	123.74	131.32	0.35	125.15	141.91	0.38	124.32	137.45	0.37	
	<i>E. serotinus</i>	-53.03	18.04	0.00	-42.94	68.86	0.53	40.59	65.02	0.53	-48.08	59.03	0.42	-73.36	61.41	0.23	-77.57	54.08	0.15	-78.00	49.33	0.11	-84.52	47.42	0.07	-113.84	43.16	0.01	-119.23	51.67	0.02	-20.21	71.71	0.78	
	<i>Myotis spp.</i>	-39.60	18.52	0.03	45.82	1.51	0.00	126.78	43.67	0.00	170.75	53.89	0.00	261.13	72.47	0.00	306.27	79.86	0.00	332.40	87.57	0.00	304.06	78.24	0.00	326.50	30.19	0.00	403.42	101.14	0.00	429.73	NaN	NaN	
	<i>N. leisleri</i>	-26.23	43.47	0.55	14.20	32.49	0.66	6.98	48.54	0.89	-39.68	68.87	0.56	-42.63	101.25	0.67	-109.54	124.98	0.38	-114.24	113.79	0.32	-95.00	104.39	0.36	-102.28	109.27	0.35	-80.11	128.67	0.53	-48.71	125.40	0.70	
	<i>N. noctula</i>	11.72	10.99	0.29	-1.93	9.03	0.83	15.78	20.99	0.45	39.31	18.31	0.03	47.29	19.65	0.02	55.90	22.83	0.01	56.30	29.73	0.06	51.19	33.40	0.13	39.01	33.46	0.24	33.75	35.27	0.34	34.68	36.83	0.35	
	<i>P. kuhlii</i>	20.03	24.64	0.42	45.98	29.58	0.12	73.62	43.59	0.09	82.64	58.71	0.16	79.31	67.69	0.24	69.09	80.60	0.39	112.76	89.22	0.21	141.81	94.35	0.13	157.16	104.27	0.13	185.76	111.94	0.10	44.10	116.31	0.70	
	<i>P. nathusii</i>	16.41	16.88	0.33	36.84	23.42	0.12	56.56	31.34	0.07	65.86	36.56	0.07	73.34	40.82	0.07	84.35	47.72	0.08	106.26	50.57	0.04	119.74	52.44	0.02	137.01	55.26	0.01	153.94	59.84	0.01	167.27	56.34	0.00	
	<i>P. pipistrellus</i>	-21.20	16.90	0.21	-16.86	20.64	0.41	-9.93	25.69	0.70	1.52	29.97	0.96	10.78	34.44	0.75	12.95	40.61	0.75	13.42	47.43	0.78	11.41	51.72	0.83	14.91	57.47	0.80	13.97	64.24	0.83	17.55	57.63	0.76	
	<i>Plecotus spp.</i>	114.90	82.63	0.16	33.29	10.02	0.00	94.70	15.23	0.00	99.51	16.13	0.00	69.81	18.37	0.00	45.96	21.56	0.03	31.06	21.12	0.14	27.17	22.04	0.22	40.66	22.36	0.07	68.48	23.57	0.00	64.38	24.73	0.01	

		CSI	1.48	8.80	0.87	3.05	12.14	0.80	3.05	16.50	0.85	5.92	19.67	0.76	4.17	22.73	0.85	6.44	26.76	0.81	10.86	30.14	0.72	12.02	31.45	0.70	14.56	33.20	0.66	15.43	36.01	0.67	13.84	38.99	0.72
	Foreign aerial	Aerial	4.49	22.52	0.84	43.04	31.82	0.18	65.14	40.04	0.10	76.99	47.52	0.11	101.42	51.09	0.05	113.76	60.48	0.06	143.81	67.69	0.03	157.05	73.15	0.03	170.06	81.01	0.04	190.76	86.49	0.03	215.30	72.32	0.00
		Gleaner	-35.78	39.79	0.37	162.07	61.85	0.01	238.21	87.94	0.01	270.35	97.83	0.01	160.65	97.26	0.10	134.25	115.76	0.25	174.39	132.45	0.19	244.90	148.52	0.10	298.81	157.62	0.06	328.65	176.86	0.06	336.35	194.37	0.08

Table J2: Effect of Diversity (estimate (Est.), SE and p value)

		Species /traits	50 m			100 m			200 m			300 m			400 m			500 m			600 m			700 m			800 m			900 m			1000 m		
			Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue			
Orthoptera	continuous calls	<i>T. viridissima</i>	-0.77	0.86	0.37	0.61	0.77	0.43	0.70	0.92	0.45	-0.48	0.95	0.61	-0.41	1.28	0.75	-0.55	1.94	0.78	0.37	2.27	0.87	0.74	2.66	0.78	0.61	3.13	0.84	0.97	3.47	0.78	2.70	3.74	0.47
		<i>R. nitidula</i>	-0.11	1.01	0.92	0.40	0.99	0.69	0.58	1.08	0.59	0.13	1.15	0.91	-0.31	1.59	0.85	-0.10	2.53	0.97	-4.05	3.19	0.20	-3.77	3.76	0.32	-4.62	4.68	0.32	-2.89	5.15	0.58	-3.95	5.79	0.49
		<i>M. roeselii</i>	-0.79	0.85	0.36	1.75	0.96	0.07	3.16	1.22	0.01	1.72	1.32	0.19	2.06	1.61	0.20	3.48	2.40	0.15	1.61	2.56	0.53	1.85	3.06	0.55	1.34	3.93	0.73	2.54	4.68	0.59	5.92	4.58	0.20
		<i>P. falcata</i>	-0.28	2.49	0.91	0.52	1.95	0.79	-0.42	2.04	0.84	0.07	1.96	0.97	2.02	2.53	0.43	5.05	3.24	0.12	5.23	3.88	0.18	5.77	4.72	0.22	5.63	6.57	0.39	3.17	8.04	0.69	0.14	6.59	0.98
	non-continuous calls	<i>L. punctatissima</i>	1.30	0.52	0.01	-0.77	0.70	0.27	0.70	0.77	0.36	-0.21	0.80	0.79	-1.31	1.22	0.28	-0.57	1.85	0.76	-4.50	1.62	0.01	-5.51	1.46	0.00	-5.82	1.88	0.00	-8.36	2.32	0.00	-7.59	2.05	0.00
		<i>C. dorsalis</i>	-0.44	0.84	0.60	1.13	0.89	0.20	0.84	0.88	0.34	0.80	1.64	0.63	0.22	2.61	0.93	-1.18	4.42	0.79	1.78	4.42	0.69	-1.69	5.64	0.76	-4.54	6.19	0.46	-5.25	5.82	0.37	-3.32	7.42	0.65
		<i>P. griseoptera</i>	-2.44	1.74	0.16	-2.43	2.32	0.29	3.97	3.74	0.29	1.48	5.59	0.79	1.37	5.67	0.81	1.04	6.62	0.88	-4.72	5.84	0.42	-8.38	5.65	0.14	-9.71	5.55	0.08	-14.23	7.16	0.05	-16.70	4.40	0.00
		<i>P. nana</i>	-4.93	6.53	0.45	6.51	3.31	0.05	3.32	2.31	0.15	5.17	2.28	0.02	-21.27	9.79	0.03	13.71	7.56	0.07	-27.09	7.35	0.00	-24.22	6.79	0.00	-31.48	13.32	0.02	-43.48	14.91	0.00	-54.84	11.08	0.00
		<i>U. rugosicollis</i>	-2.71	0.38	0.00	-0.27	0.06	0.00	-0.22	0.09	0.01	-0.58	0.29	0.05	-3.24	1.50	0.03	-3.12	1.18	0.01	5.16	1.66	0.00	3.70	0.91	0.00	6.08	1.24	0.00	14.04	6.55	0.03	12.30	1.37	0.00
		<i>P. tessellata</i>	-0.63	NA	NA	0.42	1.01	0.68	0.26	1.21	0.83	0.23	1.79	0.90	0.64	2.11	0.76	3.08	3.79	0.42	4.19	4.46	0.35	8.84	7.79	0.26	15.25	10.81	0.16	10.91	12.17	0.37	22.67	4.64	0.00
		<i>P. albopunctata</i>	-0.77	1.96	0.69	-5.74	0.34	0.00	-9.35	3.42	0.01	-12.23	4.04	0.00	-19.08	3.75	0.00	-18.13	3.50	0.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Mobility trait	CSI	-0.09	0.76	0.91	-0.18	0.68	0.79	-0.11	0.73	0.88	0.25	0.82	0.76	0.38	1.07	0.72	0.43	1.62	0.79	0.32	1.93	0.87	0.17	2.22	0.94	-0.20	2.63	0.94	-0.44	3.16	0.89	-0.73	3.64	0.84
		Mobility	-0.02	0.22	0.94	0.15	0.24	0.55	0.12	0.26	0.64	0.09	0.30	0.75	0.25	0.39	0.53	0.40	0.56	0.47	0.19	0.64	0.76	0.10	0.76	0.90	-0.09	0.92	0.92	-0.18	1.02	0.86	-0.36	0.38	0.34
		Sedentary	0.38	1.08	0.73	0.09	0.69	0.89	0.10	0.91	0.91	-0.24	1.09	0.83	0.03	1.31	0.98	1.23	1.93	0.52	0.51	2.23	0.82	1.19	2.65	0.65	1.91	2.93	0.51	1.44	3.39	0.67	1.57	2.59	0.54
		Intermediate	0.66	0.32	0.04	1.29	0.38	0.00	1.05	0.68	0.13	-0.89	0.65	0.17	-0.96	0.80	0.23	-0.81	1.18	0.49	-0.73	1.27	0.57	0.63	1.63	0.70	1.64	1.73	0.34	2.46	1.96	0.21	2.01	2.08	0.33
Chiroptera		<i>B. barbastellus</i>	0.74	1.32	0.58	1.15	1.28	0.37	2.94	1.99	0.14	2.50	2.26	0.27	1.45	2.07	0.48	1.55	2.90	0.59	1.35	3.67	0.71	0.73	4.27	0.87	2.34	5.03	0.64	1.98	5.51	0.72	3.81	5.70	0.50
		<i>E. serotinus</i>	-0.28	0.46	0.54	0.78	0.41	0.06	1.32	0.53	0.01	3.97	1.01	0.00	3.04	1.26	0.02	3.57	1.51	0.02	3.41	1.22	0.00	3.72	1.07	0.00	4.33	0.82	0.00	6.19	0.77	0.00	6.00	1.25	0.00
		<i>Myotis spp.</i>	1.49	0.51	0.00	1.16	0.86	0.18	3.84	1.91	0.04	5.80	1.62	0.00	5.29	1.40	0.00	7.59	1.96	0.00	8.66	2.20	0.00	10.89	2.99	0.00	31.51	8.46	0.00	15.36	8.10	0.06	46.68	7.53	0.00
		<i>N. leisleri</i>	0.25	1.71	0.88	1.56	1.01	0.12	1.63	1.52	0.28	0.94	2.33	0.68	0.98	2.45	0.69	4.19	4.23	0.32	4.50	3.82	0.24	5.29	3.11	0.09	6.76	2.73	0.01	6.73	3.63	0.06	10.65	3.11	0.00
		<i>N. noctula</i>	0.44	0.57	0.44	-0.20	0.51	0.70	2.03	0.51	0.00	-0.81	1.35	0.55	4.29	2.32	0.06	3.48	2.26	0.12	0.18	2.32	0.94	0.22	2.23	0.92	-0.80	1.96	0.68	-1.63	1.80	0.36	-2.39	1.64	0.14
		<i>P. kuhlii</i>	1.04	0.84	0.22	0.57	0.92	0.53	1.60	0.74	0.03	1.43	1.03	0.17	3.46	1.70	0.04	3.60	2.45	0.14	3.35	3.05	0.27	2.04	3.17	0.52	1.82	3.56	0.61	0.24	4.01	0.95	2.79	3.80	0.46
		<i>P. nathusii</i>	1.21	0.52	0.02	-0.44	0.63	0.49	1.73	0.67	0.01	1.36	0.95	0.15	1.33	1.35	0.32	1.98	1.92	0.30	-1.67	1.93	0.39	-4.56	2.10	0.03	-5.07	2.46	0.04	-6.57	2.94	0.03	-4.57	2.93	0.12
		<i>P. pipistrellus</i>	-0.56	0.50	0.27	-0.66	0.43	0.13	-0.39	0.49	0.43	0.47	0.63	0.46	1.68	0.95	0.08	2.07	1.31	0.11	3.45	1.79	0.05	1.73	1.97	0.38	0.81	2.14	0.70	-1.05	2.43	0.67	-2.11	2.33	0.37
		<i>Plecotus spp.</i>	-3.40	0.39	0.00	0.07	0.17	0.67	0.31	0.22	0.17	0.19	0.23	0.40	-0.97	0.27	0.00	-2.97	0.49	0.00	-4.89	0.68	0.00	-5.11	0.76	0.00	-3.42	0.75	0.00	-3.74	0.81	0.00	-3.33	0.85	0.00
	Foraging trait	CSI	-0.05	0.30	0.86	0.05	0.29	0.87	0.09	0.33	0.77	0.28	0.40	0.48	0.31	0.53	0.56	0.36	0.80	0.66	0.04	0.95	0.97	-0.32	1.12	0.77	-0.90	1.35	0.50	-0.91	1.56	0.56	-0.93	1.77	0.60
		Aerial	0.45	0.71	0.53	0.48	0.78	0.53	1.35	0.69	0.05	1.76	0.88	0.05	3.84	1.37	0.01	4.61	1.87	0.01	4.63	2.49	0.06	1.89	2.64	0.47	0.69	2.88	0.81	-1.42	3.27	0.67	-0.65	3.40	0.85
		Gleaner	-2.13	1.19	0.07	0.41	0.95	0.67	0.30	1.06	0.78	-0.13	1.06	0.90	-1.24	1.41	0.38	-3.32	2.39	0.17	-5.96	3.25	0.07	-7.12	3.79	0.06	-9.58	4.30	0.03	-7.94	4.63	0.09	-6.83	4.95	0.17

Table J3: Effect of Production (estimate (Est.), SE and p value)

		Species /traits	50 m			100 m			200 m			300 m			400 m			500 m			600 m			700 m			800 m			900 m			1000 m		
			Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue	Est.	SE	Pvalue			
Orthoptera	continuous calls	<i>T. viridissima</i>	-2.94E-05	1.07E-03	9.78E-01	1.21E-04	1.41E-03	9.32E-01	9.07E-04	2.12E-03	6.69E-01	1.38E-03	2.68E-03	6.07E-01	6.64E-04	3.05E-03	8.28E-01	5.64E-04	3.56E-03	8.74E-01	6.98E-04	3.94E-03	8.59E-01	1.19E-03	4.12E-03	7.72E-01	1.63E-03	4.23E-03	6.99E-01	2.70E-03	4.48E-03	5.47E-01	3.35E-03	4.11E-03	4.15E-01
		<i>R. nitidula</i>	1.67E-03	1.37E-03	2.24E-01	-3.89E-04	1.81E-03	8.30E-01	-3.25E-04	2.56E-03	8.99E-01	-1.34E-04	3.16E-03	9.66E-01	4.11E-04	3.77E-03	9.13E-01	1.85E-03	4.51E-03	6.82E-01	2.01E-03	5.19E-03	6.99E-01	9.00E-04	5.44E-03	8.69E-01	3.51E-04	5.59E-03	9.50E-01	9.25E-04	6.00E-03	8.77E-01	1.75E-03	5.57E-03	7.53E-01
		<i>M. roeselii</i>	1.83E-04	1.09E-03	8.67E-01	7.95E-04	1.46E-03	5.86E-01	2.52E-03	2.03E-03	2.14E-01	2.61E-03	2.53E-03	3.02E-01	2.49E-03	2.94E-03	3.96E-01	3.22E-03	3.53E-03	3.61E-01	4.23E-03	4.20E-03	3.14E-01	3.47E-03	4.40E-03	4.31E-01	1.81E-03	4.50E-03	6.87E-01	1.32E-03	4.74E-03	7.80E-01	8.85E-05	4.60E-03	9.85E-01
		<i>P. falcata</i>	1.27E-03	2.74E-03	6.42E-01	1.26E-04	3.76E-03	9.73E-01	-7.14E-04	6.73E-03	9.16E-01	-2.78E-03	8.14E-03	7.33E-01	-2.54E-03	7.91E-03	7.48E-01	-2.63E-03	8.94E-03	7.69E-01	-3.09E-03	1.03E-02	7.64E-03	-3.37E-03	1.08E-02	7.55E-03	8.80E-05	1.14E-02	9.94E-01	2.37E-03	1.16E-03	8.39E-03	2.70E-03	1.02E-02	7.91E-01
	non-continuous calls	<i>L. punctatissima</i>	-2.87E-05	8.83E-04	9.74E-01	-1.09E-03	1.22E-03	3.73E-01	-1.38E-05	2.53E-03	9.96E-01	6.51E-05	2.59E-03	9.80E-01	-6.72E-04	3.10E-03	8.28E-01	2.08E-03	3.55E-03	5.59E-01	3.10E-03	3.54E-03	3.81E-01	2.71E-03	3.46E-03	4.34E-01	2.51E-03	3.35E-03	4.54E-01	3.34E-03	3.27E-03	3.07E-01	4.18E-03	2.68E-03	1.19E-01
		<i>C. dorsalis</i>	2.36E-03	1.06E-03	2.64E-02	1.27E-03	8.93E-04	1.55E-01	1.85E-03	1.15E-03	1.09E-01	1.47E-03	1.55E-03	9.24E-01	3.42E-04	2.14E-03	8.73E-01	6.16E-04	3.13E-03	8.44E-01	8.19E-04	4.43E-03	8.53E-01	6.03E-04	4.82E-03	9.01E-01	7.24E-04	5.03E-03	8.86E-01	2.68E-03	5.86E-03	6.47E-01	3.51E-03	3.54E-03	3.21E-01
		<i>P. griseoaptera</i>	1.75E-04	3.35E-03	9.58E-01	3.43E-03	5.02E-03	4.95E-01	1.11E-02	6.19E-03	7.26E-02	1.95E-02	6.13E-03	1.46E-03	2.41E-02	7.97E-03	2.49E-02	2.55E-02	8.53E-03	2.79E-02	2.27E-02	7.35E-03	1.99E-02	2.37E-02	7.87E-03	2.63E-02	2.12E-02	7.31E-03	3.69E-02	2.01E-02	7.19E-03	5.27E-02	1.98E-02	6.98E-03	4.60E-03
		<i>P. nana</i>	9.29E-03	1.55E-02	5.49E-01	5.66E-03	4.73E-03	2.31E-01	5.07E-03	5.79E-03	3.81E-01	6.46E-03	7.41E-03	3.83E-01	1.15E-03	9.42E-03	9.03E-01	-1.13E-02	1.17E-02	9.23E-01	-6.12E-04	1.37E-02	9.64E-01	6.77E-04	1.41E-02	9.62E-01	5.40E-02	1.53E-02	7.25E-01	2.55E-02	1.48E-02	8.57E-02	3.04E-02	1.72E-02	7.70E-02
		<i>U. rugosicollis</i>	-9.14E-04	1.37E-04	2.83E-11	4.63E-03	1.10E-03	2.47E-05	-1.23E-03	4.65E-04	8.46E-03	-1.16E-03	5.63E-04	3.96E-02	-1.54E-03	7.61E-04	4.24E-02	-1.91E-03	7.27E-04	8.72E-03	-3.38E-03	1.03E-03	9.82E-04	-4.93E-04	1.31E-03	1.58E-04	-9.45E-03	2.23E-03	2.18E-05	-9.78E-03	2.77E-03	4.26E-04	-4.47E-03	1.29E-03	5.54E-04
		<i>P. tessellata</i>	1.13E-03	6.43E-03	8.60E-01	2.34E-03	NA	NA	2.36E-03	3.17E-03	4.56E-03	1.75E-03	3.62E-03	6.29E-01	1.81E-03	4.73E-03	7.02E-01	1.57E-03	5.79E-03	7.87E-01	3.66E-03	6.13E-04	9.52E-01	-6.38E-04	6.50E-03	9.22E-01	-2.09E-03	8.06E-03	7.95E-03	-3.08E-03	1.00E-02	7.59E-02	-5.12E-01	1.06E-02	6.29E-01
		<i>P. albopunctata</i>	-5.32E-04	3.05E-03	8.61E-01	-9.66E-03	3.53E-03	6.14E-03	-1.87E-02	8.33E-03	2.51E-02	-2.10E-02	6.85E-03	2.18E-02	-1.76E-02	6.12E-03	4.10E-02	-2.75E-02	1.03E-02	7.73E-01	-5.80E-02	3.09E-02	6.06E-02	7.79E-02	7.47E-02	2.97E-01	1.21E-01	1.05E-02	1.09E-03	5.75E-02	1.75E-02	1.02E-03	NA	NA	NA
	Mobility trait	CSI	5.18E-04	9.35E-04	5.80E-01	2.39E-04	1.29E-03	8.54E-01	-2.27E-04	1.83E-03	9.01E-01	-1.21E-05	2.23E-03	9.96E-01	-6.96E-05	2.65E-03	9.79E-01	2.47E-04	3.08E-03	9.36E-01	5.73E-04	3.51E-04	8.70E-01	6.18E-03	3.80E-03	8.71E-01	1.14E-03	4.03E-03	7.78E-01	1.61E-03	4.39E-03	7.14E-01	1.72E-03	4.80E-03	7.19E-01
		Mobility	7.55E-05	2.73E-04	7.82E-01	9.60E-05	3.81E-04	8.01E-01	2.91E-04	5.65E-04	6.07E-01	4.62E-04	7.10E-04	5.15E-04	6.32E-04	8.13E-04	4.37E-04	7.92E-04	9.64E-04	4.11E-04	8.94E-04	1.12E-04	4.24E-04	8.85E-04	1.16E-04	4.45E-04	9.83E-04	1.19E-04	4.09E-04	1.11E-03	1.25E-03	3.76E-01	1.26E-03	4.76E-04	8.34E-03
		Sedentary	-2.06E-04	1.17E-03	8.60E-01	-1.85E-03	1.98E-03	3.51E-01	-2.44E-03	2.36E-03	3.01E-03	-3.32E-03	2.72E-03	2.22E-03	-3.78E-03	3.23E-03	2.42E-03	-3.60E-03	3.67E-03	3.27E-03	-2.99E-03	3.68E-03	4.17E-03	-4.12E-03	3.86E-03	2.87E-03	-5.03E-03	4.11E-03	2.21E-03	-5.67E-03	4.42E-03	2.00E-03	-6.75E-03	4.49E-03	1.32E-01
		Intermediate	9.20E-04	3.68E-04	1.23E-02	1.63E-03	5.48E-04	2.92E-03	2.24E-03	1.01E-03	2.69E-02	1.67E-03	1.35E-03	2.15E-03	1.82E-03	1.57E-03	2.47E-03	2.06E-03	2.06E-03	3.15E-03	-2.42E-03	2.37E-03	9.92E-04	-8.79E-04	2.40E-03	7.14E-03	-1.43E-03	2.36E-03	5.46E-03	-1.78E-03	2.38E-03	4.54E-03	-2.10E-03	2.52E-03	4.04E-01
Chiroptera	<i>B. barbastellus</i>	-9.63E-06	1.80E-03	9.96E-01	3.03E-03	2.23E-03	1.73E-03	5.57E-03	3.25E-03	8.67E-03	5.11E-03	3.82E-03	1.81E-03	4.72E-03	4.44E-03	2.88E-03	5.21E-03	5.36E-03	3.31E-03	5.32E-03	5.83E-03	3.61E-03	6.62E-03	6.17E-03	2.83E-03	6.21E-03	6.04E-03	3.04E-03	6.44E-03	6.32E-03	3.08E-03	6.46E-03	6.04E-03	2.85E-01	
	<i>E. serotinus</i>	-2.01E-03	6.44E-04	1.81E-03	-4.35E-03	1.66E-03	8.86E-03	1.59E-03	2.63E-03	5.47E-03	-1.33E-03	2.74E-03	6.26E-03	-2.47E-03	3.12E-03	4.28E-03	-3.01E-03	2.78E-03	2.79E-03	-3.01E-03	2.58E-03	2.43E-03	-2.98E-03	2.52E-03	2.35E-03	-4.11E-03	2.49E-03	9.86E-02	-4.22E-03	2.84E-03	1.37E-03	1.16E-03	3.41E-03	7.34E-01	
	<i>Myotis spp.</i>	-2.54E-03	1.24E-03	4.04E-02	2.79E-03	1.57E-02	7.49E-02	6.46E-03	1.43E-03	6.51E-06	7.91E-03	2.43E-03	1.13E-03	9.92E-03	2.68E-03	2.16E-04	1.27E-02	3.29E-03	1.07E-02	1.41E-02	3.56E-03	7.77E-03	1.41E-02	3.55E-03	7.51E-02	1.50E-02	3.73E-03	5.66E-05	1.84E-02	4.45E-03	3.72E-05	1.97E-02	1.57E-03	4.19E-03	
	<i>N. leisleri</i>	-6.22E-04	2.22E-03	7.80E-01	5.47E-04	1.53E-03	7.21E-01	7.12E-04	2.23E-03	7.50E-01	1.07E-04	3.26E-03	9.74E-01	-5.22E-04	5.12E-03	9.19E-01	-4.19E-03	6.66E-03	5.29E-01	-5.04E-03	6.40E-03	4.31E-03	-3.63E-03	5.67E-03	5.22E-03	-3.93E-03	6.10E-03	5.19E-03	-2.24E-03	6.90E-03	7.45E-01	-1.23E-03	6.50E-03	8.50E-01	
	<i>N. noctula</i>	6.86E-04	4.58E-04	1.34E-01	-2.58E-05	1.87E-03	9.89E-01	6.93E-04	9.96E-04	4.86E-01	1.72E-03	8.65E-03	4.68E-02	2.02E-03	9.99E-04	4.33E-02	2.68E-03	1.13E-02	1.76E-02	3.13E-03	1.53E-03	4.11E-02	2.87E-03	1.77E-03	1.05E-03	2.12E-03	1.72E-03	2.17E-03	1.82E-03	1.76E-03	3.00E-03	1.85E-03	1.78E-03	2.97E-01	
	<i>P. kuhlii</i>	2.04E-03	8.79E-04	2.02E-02	2.58E-03	1.17E-03	2.73E-02	4.22E-03	1.91E-03	2.70E-02	5.43E-03	2.50E-03	2.96E-02	5.33E-03	3.18E-03	9.34E-02	4.91E-03	3.83E-03	2.00E-01	6.79E-03	4.25E-03	1.11E-03	8.11E-03	4.42E-03	6.64E-02	9.08E-03	4.74E-03	5.53E-02	1.08E-02	4.96E-03	2.89E-02	1.08E-02	4.96E-03	2.89E-02	
	<i>P. nathusii</i>	1.25E-03	6.77E-04	6.39E-02	1.25E-03	6.77E-04	6.39E-02	2.93E-03	1.38E-03	3.38E-02	3.82E-03	1.72E-02	2.59E-02	4.15E-02	1.94E-02	3.27E-02	4.92E-03	2.23E-02	2.76E-02	6.13E-03	2.43E-02	1.15E-02	6.87E-02	2.54E-03	6.78E-03	7.45E-03	2.67E-03	5.27E-03	8.13E-03	2.81E-03	3.87E-03	8.68E-03	2.69E-03	1.29E-03	
	<i>P. pipistrellus</i>	-7.49E-05	6.77E-04	9.12E-01	-5.01E-04	8.28E-04	5.45E-01	-3.03E-04	1.10E-03	7.84E-01	4.73E-04	1.40E-03	7.35E-01	9.21E-04	1.68E-03	5.84E-01	1.14E-03	1.96E-03	5.61E-03	1.47E-03	2.30E-03	5.23E-03	1.62E-03	2.51E-03	5.20E-03	1.91E-03	2.77E-03	4.90E-03	2.24E-03	2.98E-03	4.53E-03	2.59E-03	2.67E-03	3.32E-01	
	<i>Plecotus</i>																																		

Foraging trait	CSI	1.57E-04	3.83E-04	6.82E-01	1.57E-04	5.26E-04	7.65E-01	9.90E-05	7.29E-04	8.92E-01	2.02E-04	9.05E-04	8.23E-01	2.09E-04	1.06E-03	8.44E-01	3.52E-04	1.24E-03	7.77E-01	5.73E-04	1.45E-03	6.92E-01	5.75E-04	1.53E-03	7.07E-01	6.85E-04	1.60E-03	6.69E-01	7.34E-04	1.72E-03	6.69E-01	7.30E-04	1.86E-03	6.95E-01
	Aerial	1.59E-03	9.23E-04	8.57E-02	2.15E-03	1.22E-03	7.86E-02	3.33E-03	1.70E-03	5.00E-02	4.90E-03	2.09E-03	1.91E-02	5.97E-03	2.33E-03	1.04E-02	6.68E-03	2.71E-03	1.39E-02	8.31E-03	3.07E-03	6.81E-03	9.04E-03	3.32E-03	6.52E-03	9.81E-03	3.61E-03	6.55E-03	1.08E-02	3.72E-03	3.71E-03	1.17E-02	3.22E-03	2.81E-04
	Gleaner	-4.72E-04	1.49E-03	7.52E-01	4.45E-03	1.84E-03	1.55E-02	6.35E-03	2.65E-03	1.64E-02	8.76E-03	3.29E-03	7.76E-03	5.82E-03	3.71E-03	1.17E-01	4.51E-03	4.47E-03	3.14E-01	5.58E-03	5.09E-03	2.73E-01	8.49E-03	5.60E-03	1.29E-01	9.86E-03	5.78E-03	8.79E-02	1.14E-02	6.17E-03	6.47E-02	1.23E-02	6.67E-03	6.45E-02

18 Appendix K: Density figures for bats and bush crickets

Figure K1: Effects of the density of linear landscape elements on bats at different spatial scales. On the Y-axis: estimates of the relationships between density and activity of 4 different species and community specialization and activity of aerial and gleaner species. We present 6 graphs: 4 species (a, b, c, d) with various ecologies and 2 traits (e, f). In graph 1.e., we present the effect of the density of linear landscape elements on the aerial bat species. We show that 1) using in the 1000 m buffer as an example, the activity of aerial species is positively correlated with the density of linear elements (the estimate reported from the modeling at 1000 meters - with its standard error - is positive, i.e., above zero, and this effect is significant as indicated by asterisks ; and 2) the scale effect from 50 meters to 1000 meters was significant and is visualized by the dotted line. The activity of aerial bat species was significantly and positively correlated with the linear landscape element density in a 1000 m buffer. The scale effect was significant, and there is a positive scale effect for these communities (above zero). When we did not detect a linear scale effect, we assessed a potential breakpoint value (see Appendix I).

Estimates of the relationships with density of linear landscape

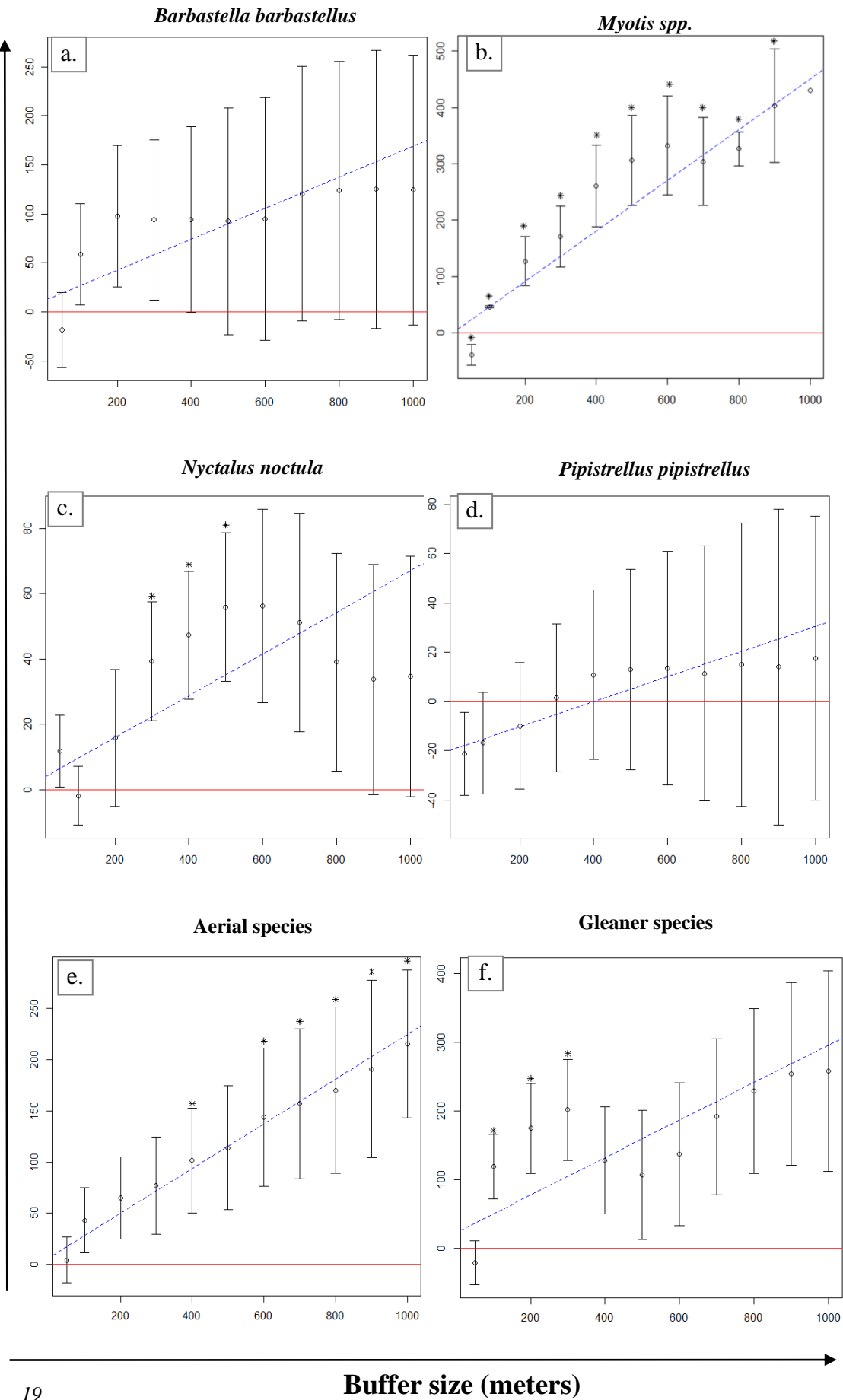
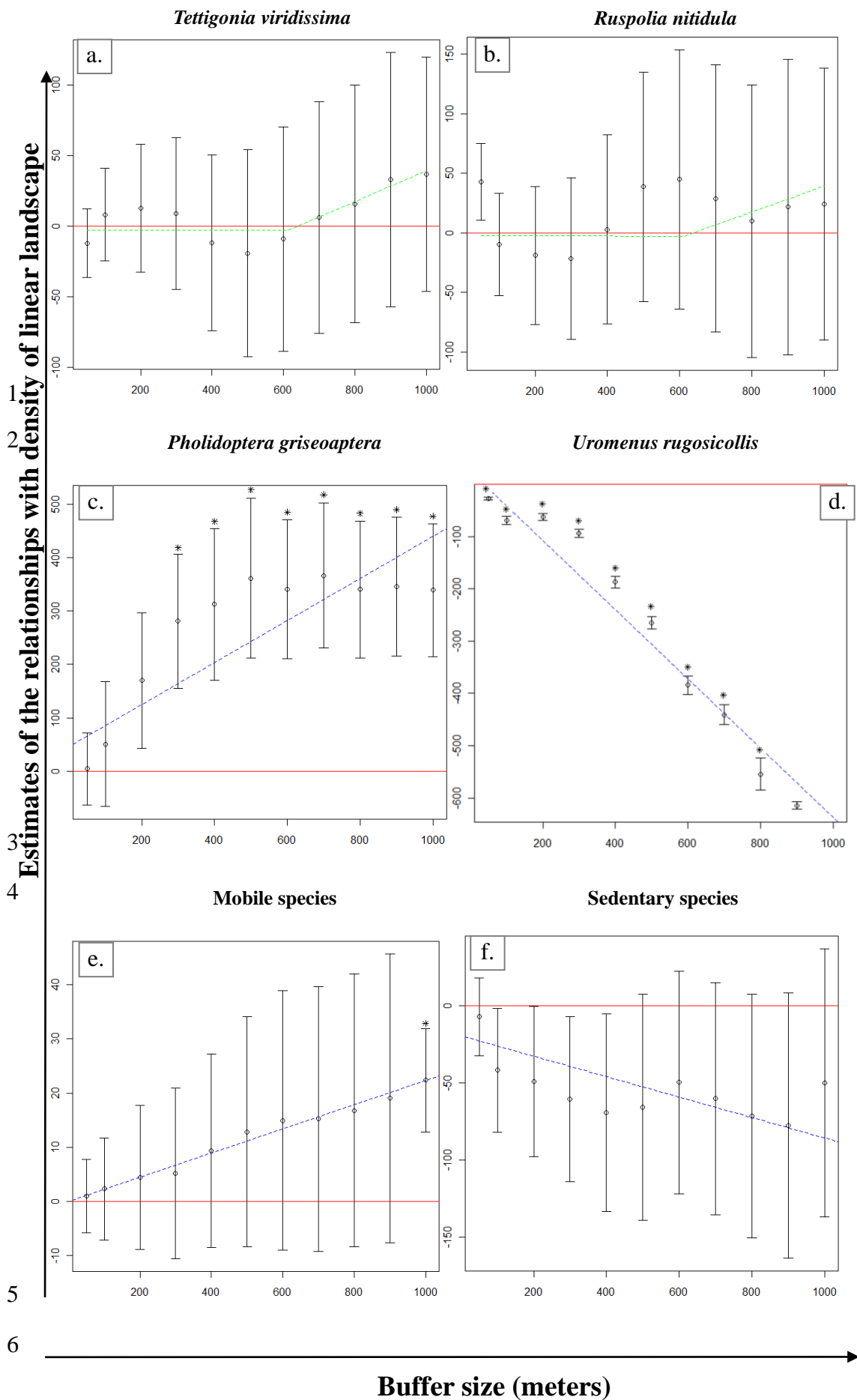


Figure K2: Effect of the density of linear landscape elements on bush crickets at different spatial scales. On the Y-axis: estimates of the relationships between density and activity for 4 different species, community specialization and activity of mobile and sedentary species (see also Appendix J)



7 20 **Appendix L: Diversity figures for bats and bush crickets**

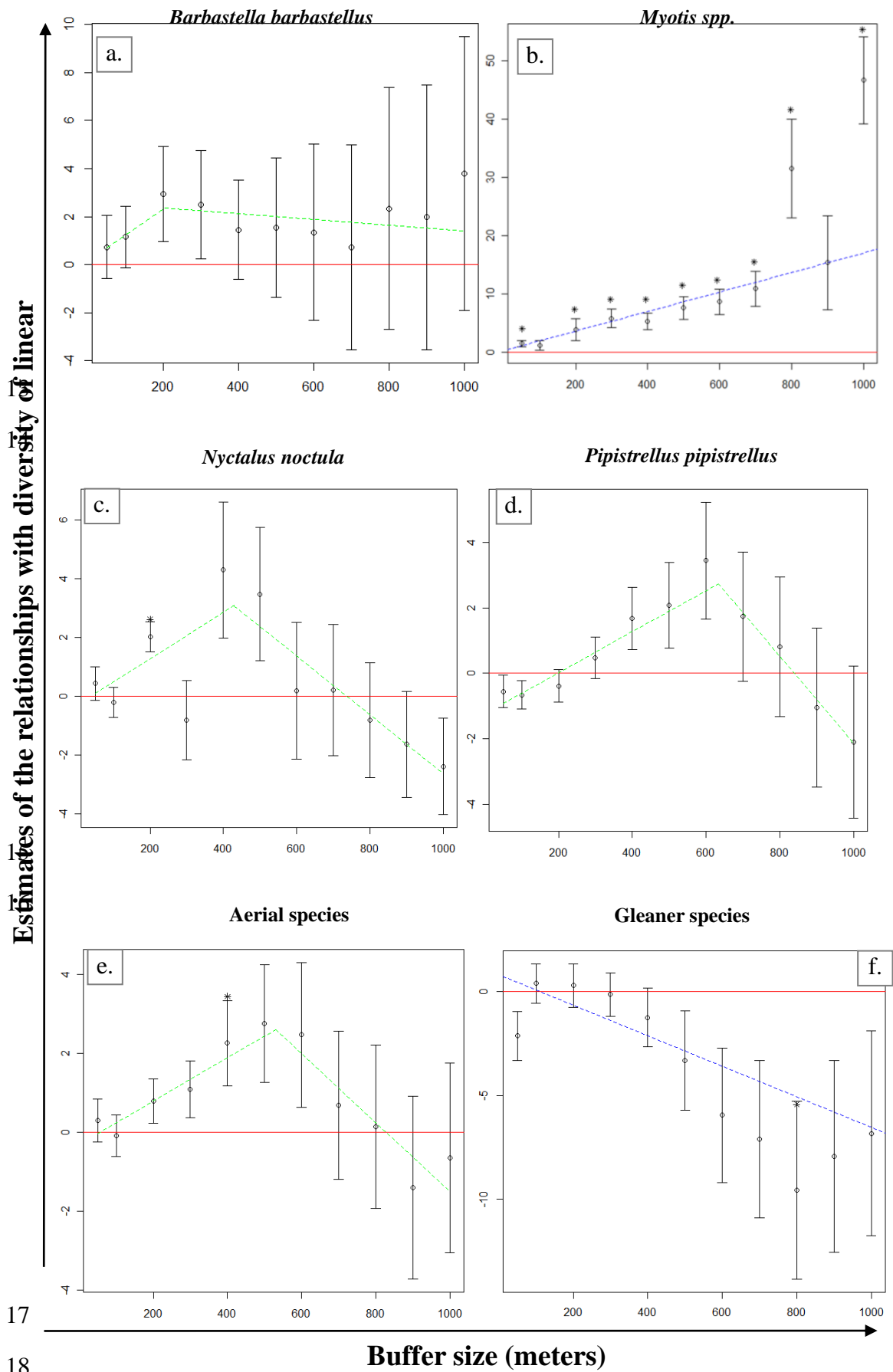
8

9 *Figure L1: Effect of the diversity of linear landscape elements on bats at different spatial scales. On the Y-axis:*

10 *estimates of the relationships between diversity and activity for 4 different species and community specialization*

11 *and activity of aerial and gleaner species (see also supplementary material G)*

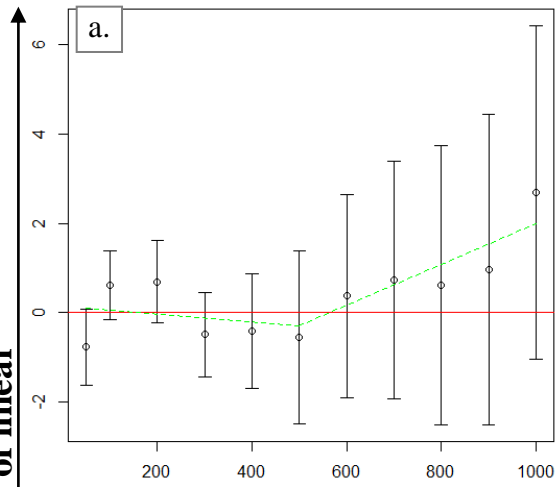
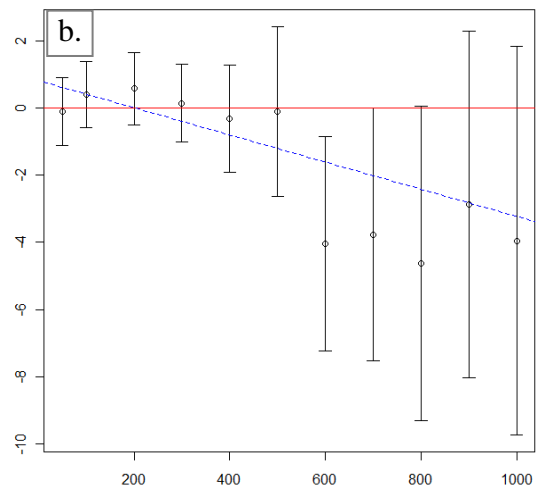
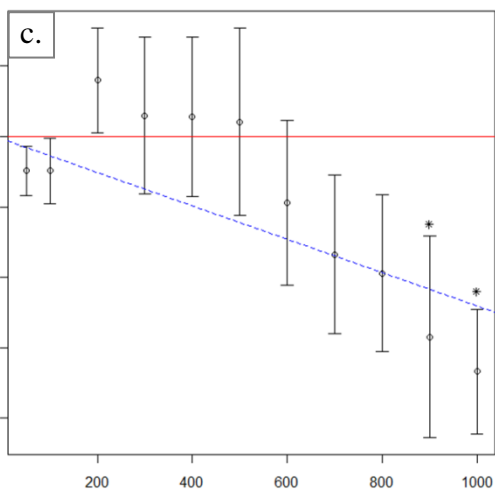
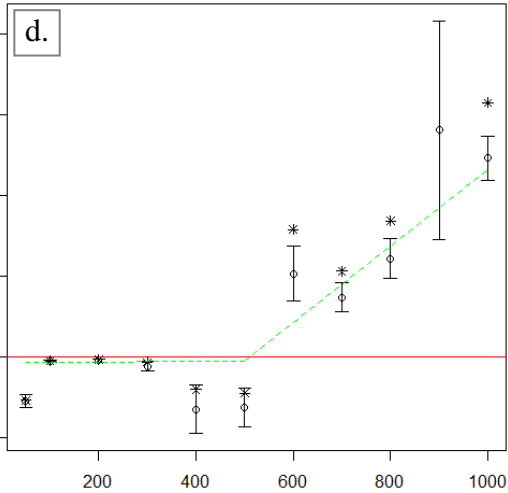
12



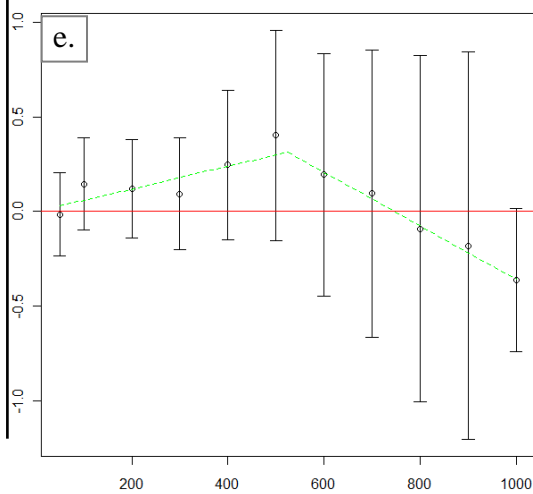
19

20 *Figure L2: Effect of the diversity of linear landscape elements on bush crickets at different spatial scales. On the*
21 *Y-axis: estimates of the relationships between diversity and activity for 4 different species, community*
22 *specialization and activity of mobile and sedentary species (see also Appendix J)*

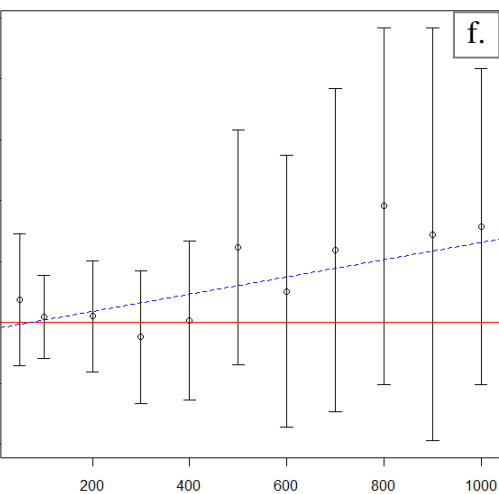
23

Tettigonia viridissima*Ruspolia nitidula**Pholidoptera griseoaptera**Uromenus rugosicollis*

Mobile species



Sedentary species



Buffer size (meters)