The decline of the European nightjar (*Caprimulgus europaeus*) in Switzerland: habitat change or drop in food supply? New guidelines for habitat management

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Summary

Over the last centuries, forests have undergone strong structural changes, with a general increase in vegetation density, often accompanied by a concomitant drop in biodiversity. Today, natural disturbances of woodland are either suppressed or their effects readily mitigated. The loss of natural forest dynamics has thus led to progressive habitat homogenization, which threatens species linked to the earlier stages of secondary vegetation succession, such as the European nightjar Caprimulgus europaeus. The densification of forest stands can affect their suitability as foraging grounds for this species, for instance by impeding accessibility, or alter prey supply. We assessed both habitat structural changes and food supply (moths, their main prey) in forest stands recently abandoned with habitat restorations and stands still occupied by nightjars in the Southern Swiss Alps. Occupied and abandoned sites differed significantly in relation to vegetation structure and moth abundance. Compared to abandoned restored sites, occupied sites harbored more snags, which might be used as song perches, while their ground cover showed a higher amount of mineral substrate, which is likely to hinder vegetation growth. In contrast, abandoned sites were less open, which is best highlighted by denser deciduous shrub and regeneration layers. Moreover, moth abundance and species richness were higher in occupied sites. In order to maintain and create favorable habitats for the nightjar, we recommend to promote semi-open habitats with a high degree of heterogeneity, including snags and patches of bare ground or mineral substrate. Such habitats are best created through natural hazards and we strongly recommend to tolerate if not promote natural disturbances in forests where feasible. In artificially restored habitats, these habitat requirements might be achieved by a combination of mechanical interventions and appropriate grazing to counteract vegetation succession.

Keywords: European nightjar, forest management, moth community, vegetation structure

1 Introduction

2 In the last centuries the management of Swiss forests has changed 3 considerably. Starting at the time of industrialization forests were overexploited to harvest firewood and charcoal leading to a dramatic 4 decline of woodlands (Steiger 1994). In the last century deforestation was 5 illegal without afforestation (Angst 2012) and led to a recovery of 6 7 woodland that currently covers around 30% of Switzerland. This positive trend is reinforced by ongoing changes in land use such as the 8 9 abandonment of agricultural land due to socio-economic and ecological drivers (Rey Benayas 2007; Gehrig-Fasel, Guisan & Zimmermann 2007; 10 11 Kräuchi, Brang & Schönenberger 2000). Forests in Valais cover roughly 21% of the surface (BAFU 2013) and their primary function is the 12 reduction of the frequency of natural hazards. In these kinds of protective 13 forests any management that opens the forest structure (e.g. open 14 15 forests, clear cuts) are not an integral part of harvest management as 16 they weaken the protective effect, which might increase the probability for natural hazards as avalanches, erosion or flooding. These hazards are 17 expected to have a large impact as they are associated with economic 18 19 damage and the safety of the local human population (Kräuchi, Brang & 20 Schönenberger 2000).

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22 However, these natural hazards are an important driver of forest (Kulakowski, Bebi & Rixen 2011). Such ecosystem 23 ecosystems disturbances create new pioneer habitats that develop through several 24 25 natural successional stages that harbor their locally adapted faunal and floral community. A reduction of these natural disturbances and an 26 27 increase in harvest management is known to lead to a homogenization of 28 forest structures with its concomitant negative effects on biodiversity (Spiecker 2003). While true forest species might benefit from this process 29 (Fonderflick et al. 2010), we expect an overall negative impact on 30 biodiversity. Moreover, given the lack of pioneer habitats and early 31

successional stages, these habitats are known to be important for
 numerous endangered species, e.g. the diurnal butterfly scarce fritillary
 Euphydryas maturna (Freese *et al.* 2006) and bird species like the Ortolan
 bunting *Emberiza hortulana* (Menz, Brotons & Arlettaz 2009).

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37 The European nightjar *Caprimulgus europeaus* is a nocturnal bird species reacting negatively to a loss of open habitats in wooded areas. In 38 Great Britain nightjars inhabit forest plantation, heaths (Sharps 2013) and 39 clear fells (Glutz von Blotzheim & Bauer 1980) within the first 10 years 40 after plantations or the occurrence of the disturbance. Within this time 41 period, the habitat remains semi-open, while trees are growing higher 42 43 than two to three meters afterwards, resulting in an unsuitable habitat for the nightjar (Ravenscroft 1989). A study in Valais showed a preference of 44 20-50% of forest coverage (Sierro et al. 2001). The requirement of an 45 open habitat is due to their hunting strategies and a minimum of 50m in 46 47 width of a clearing is needed (Wichmann 2004). Nightjars are mainly 48 feeding on the wing (Jackson 2003) and therefore need space, as they are 49 flying and hunting close to the vegetation similar to some bat species, as 50 for example Myotis nattereri or Eptesicus serotinus (Norberg 1986). As 51 found in bats (Gould 1955), nightjars are mainly feeding on moths (Glutz von Blotzheim & Bauer 1980), which can make up to 80% of the diet 52 53 (Sierro et al. 2001). Especially large profitable moths seem to be a 54 preferred prey item for adults and older chicks (Sierro et al. 2001).

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56 The nightjar is an endangered bird species in Switzerland (Keller et al. 2010). Roughly 80% of the Swiss population is located in the canton of 57 58 Valais where it is a priority species for conservation measures (Posse *et al.* 59 2011). In the last five decades the nightjar population is decreasing and 60 habitat restoration measures for this nocturnal species are needed. Nowadays, the nightjar has a single stronghold in central Valais where few 61 new pioneer habitats have been colonialized after forest fires. All 62 previously occupied sites in lower Valais have been abandoned. With the 63 change in land use, especially the lack of grazing activities (Rigling et al. 64

65 2006b), open forests have been transformed to unsuitable habitats with a66 dense bush and scrub layer.

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In Valais, habitat restoration activities have been implemented in 68 abandoned sites since 2001 to create suitable habitats for the nightjar. 69 These actions ranged from clear cuts varying in size (up to 2ha) to sites 70 71 where the tree layer was only partly removed. Several of these sites were maintained by grazing with highland cattle resulting in a mix of habitat 72 restoration measures. Positive effects on the nightjar population are still 73 missing highlighted by the very low population of the species since the 74 start of the restoration measures (unpublished report by A. Sierro in 75 2011, Swiss Ornithological Institute). Despite an intensive monitoring 76 77 program there were only few observations of displaying males in managed sites without any proof of nidifications. The lack of re-colonization in clear 78 79 cuts is surprising given the colonization of clear cuts in the UK (Scott *et al.* 80 1998) but it remains to be investigated which underlying factors hinder the establishment of new territories for successful breeding. 81

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83 Factors important for nightjar territories may on the one hand be related to habitat characteristics but additionally on the abundance and 84 availability of prey for adult and juvenile birds. Here we aim at testing 85 whether abandoned and managed sites differ, which may deliver an 86 explanation why managed sites are not re-colonialized. We specifically 87 investigate whether abandoned sites with management applications differ 88 89 in vegetation structure and/or food resources from occupied sites. Given 90 the importance of moths for the successful raising of a brood we quantified the abundance and richness of the moth community during the 91 entire breeding stage of the nightjar and additionally measured the 92 vegetation structure on different spatial scales. These results are expected 93 94 to translate into management recommendations in favor of the European nightjar that could be implemented in further species recovery programs 95 on a national and international scale. 96

97 Materials and methods

98 STUDY AREA AND STUDY DESIGN

The study was conducted in Switzerland in the canton of Valais between 99 Martigny and Visp. Based on a long term monitoring program of the 100 101 nightjar in Valais we selected all occupied nightjar sites (O; N=13) and 102 sites that have been abandoned in the last 30 years (A; N=22, unpublished report by Antoine Sierro in 2005, Swiss Ornithological 103 Institute). Within the abandoned sites we divided two categories based on 104 105 spatial arrangement within the valley, namely 12 sites in the lower Valais 106 (LV; between Martigny and Sion) and 10 sites in the upper Valais (UV; between Sion and Leuk). In all abandoned sites habitat restoration 107 108 activities for the nightjar were performed in the last decade, while no such 109 specific management has been done in occupied sites.

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111 VEGETATION STRUCTURE

For all 35 sites we estimated the vegetation structure in September and 112 October 2013. The number of sampling plots was adjusted to the size of 113 the site. This design accounts for spatial dependence of sampling plots 114 between sites but results in differences in sampling plots per site ranging 115 116 from one to six plots per site. In case the random position of a sampling 117 plot was at the forest edge, its center was moved in order that only the clearing was sampled. For a matter of precision, habitat variables were 118 119 estimated on two different scales (10×10 m plot and 15 m-radius plot). Each 10 x 10 m plot was divided in four equal squares (5 x 5 m) in order 120 to ensure the correct mapping of small structures as bare ground 121 122 variables and vegetation covers (Table 1). Snags and an openness factor 123 for different heights of the vegetation were estimated on a larger scale, 124 i.e. a 15 m-radius plot (Table 2). Regeneration, shrub and tree layer is 125 defined as the cover on different height ranges.

127 MOTH SAMPLING

Within all 35 sites, moth were sampled on a random spot (QGis 1.7.4, 128 QGIS Development Team, 2013) when possible at least 20 m from the 129 130 edge once in the month May, June and July for 4 hours starting at sunset 131 under good weather condition (15.6±3.3 °C, no precipitation). Each site 132 category (occupied, abandoned sites upper Valais and abandoned sites lower Valais) was represented in each sampling night. Moths were 133 sampled using an automatic 12 V 15 W classic light trap with super actinic 134 bulb (bioform entomology & equipment, Nürnberg) and stored upon 135 136 capture in pure ethyl acetate. Each trap was emptied the next day and moths were stored in a plastic bag, while the ethyl acetate was removed. 137 138 Samples were frozen for later identification at -18 °C.

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Moths were identified to family and species/morphospecies level, 140 141 which is an approach that can be done by non-specialists (Derraik et al. 142 2002). Dividing Lepidoptera to morphospecies is a good approximation to 143 taxonomic species, especially to gain an estimation of species richness 144 (Oliver & Beattie 1996), which allows the calculations of abundance, species richness and community composition. Micro moths and small 145 Geometridae and Noctuidae (smaller than 0.8 cm) were excluded from the 146 analysis, because it is reported that nightjars mainly feed on larger moth 147 148 (Sierro et al. 2001). Moth abundance and moth biomass were correlated 149 for the subsample of the month May (r = 0.56, P < 0.001) and for all 150 further analyses we therefore only considered moth abundance.

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152 STATISTICAL ANALYSIS

All analyses were performed using the freeware R version 3.0.2. (R Development Core Team 2013). Differences in vegetation structure variables between occupied and abandoned sites were analyzed using the mean of the plots per site. To test the most important variables explaining the occurrence of the nightjar a model selection approach was used (function 'dredge' in the package 'MuMin', Bartoń 2013). In a first run all

variables were tested in a univariate generalized linear model with a binomial error structure, with presence/absence as response variable and each vegetation structure element as an explanatory variable. Variables contributing significantly to the presence of the nightjar were tested for correlation. Of the correlated pairs (Spearman's $r \ge |0.7|$) the least performing one according the AIC was discarded for the model selection approach.

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For the moth analysis we compared abandoned versus occupied 167 168 sites and additionally split the abandoned sites between the lower and the 169 upper Valais. In a first step we used mixed effect models with gaussian 170 error distribution with the abundance or species richness of all captured 171 moths as response variables, site category and month as explanatory 172 variables and site as random factor. In a second step we excluded the 173 unknown species and families from the dataset. This dataset was used to 174 test differences in the moth community between occupied and abandoned 175 sites and in relation to month we run a detrended correspondence analysis 176 (DCA) from the vegan package (function decorana, Oksanen et al 2013). 177 In addition we tested the strength of relationships among moth communities in relation to season (month) and the different site 178 179 categories with mantel tests (function mantel in vegan package, Oksanen et al 2013). 180

181 **Results**

182 VEGETATION STRUCTURE

Using a univariate approach, abandoned sites had a denser deciduous 183 regeneration cover (estimate: -0.12 ± 0.05 , z = -2.38, P < 0.05) and 184 higher amounts of litter (-0.13 \pm 0.06, z = -1.96, P = 0.05) compared to 185 186 occupied sites. Stone (0.2 \pm 0.09, z = 2.15, P < 0.05), gravel (0.25 \pm 187 0.11, z = 2.34, P < 0.05) and bare ground cover (0.05 ± 0.03, z = 1.97, P < 0.05) showed higher values in occupied sites compared to abandoned 188 189 sites. On the larger 15 m-radius plot deciduous shrub layer (-0.03 \pm 0.01, 190 z = -2.26, P < 0.05), regeneration layer (-0.06 ± 0.02, z = -2.53, P < 0.02191 0.05) and deciduous regeneration layer (-0.04 \pm 0.02, z = -2.21, P <192 0.05) were higher in the abandoned sites. Regeneration layer of the group 193 "other" (not pines, spruce or deciduous species; 0.04 ± 0.02 , z = 1.96, P < 1.960.05) and snags (0.4 \pm 0.19, z = 2.14, P < 0.05) were more abundant in 194 195 the occupied sites while all the other variables did not differ (Table 3, 10 x 196 10 m plot and Table 4, 15 m-radius plot). Using a model selection 197 approach the most competitive model consists of four variables, namely snags, the amount of gravel and the densities of the regeneration layer 198 and the deciduous shrub layer (Table 5; Fig. 1). The next best model 199 $(\Delta AIC = 1.18)$ consists of the same variables but without deciduous shrub 200 layer. From the third to the fifth model the difference of AIC varies 201 between 1.7 and 1.9. The models consist of combination of variables 202 203 included in the model selection (snags, gravel regeneration layer, 204 deciduous shrub layer, stones and deciduous regeneration cover) but not 205 bare ground and litter.

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207 MOTH

A total of 8414 moths were captured from 11 different families (Arctiidae: N = 614, Cossidae: N = 4, Drepanidae: N = 6, Geometridae: N = 963, Lasiocampidae: N = 345, Limacodidae: N = 13, Lymantriidae: N = 30, Noctuidae: N = 6063, Notodontidae: N = 142, Sphingidae: N = 192, Thytiridae: N = 14) and 8 individuals of an unknown family.

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214 Moth abundance between occupied sites and abandoned sites differ in relation to month (site category * month: 32.34 ± 13.14 , t = 2.46, P =215 0.02), with an overall increase over the season (36.62 \pm 8.15, t = 4.5, P 216 217 < 0.001; Fig. 2). The interaction is best explained by increasing site category difference during the season (May: 20.42 ± 14.00 , t = 1.46, P =218 0.157; June: 33.93 \pm 12.8, t = 2.65, P = 0.01; July: 84.82 \pm 29.55, t =219 220 2.87, P < 0.01; see Fig. 3). Species richness of moths differs between the category occupied and abandoned (4.03 \pm 1.96, t = 2.06, P = 0.05), but 221 222 the differences stay the same between the months $(1.34 \pm 2.22, t = 0.6, t)$ 223 P = 0.55). Overall occupied sites harbored more individuals and showed a higher species richness. 224

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226 The same trend is visible when comparing occupied versus 227 abandoned sites in the upper Valais only. These two categories differ in relation to month (site category * month: -44.96 \pm 16.04, t = -2.8, P <228 229 0.01) and this interaction could be best explained by the increase in 230 difference between the occupied and the abandoned sites in the upper Valais (May: -22.75 ± 17.83 , t = -1.28, P = 0.21; June: -41.35 ± 15.45 , t231 = -2.68, P = 0.01; July: -112.83 ± 34.96, t = -3.23, P < 0.01). Again, the 232 effects on species richness were similar to the overall comparison with no 233 detectable interaction between site category and month (-4.12 \pm 2.66, t 234 235 = -1.55, P = 0.13), but a significant difference in relation to site 236 categories (-7.33 \pm 2.2, t = -3.33, P < 0.01), where occupied sites 237 showed more species compared to abandoned sites.

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When comparing occupied sites to abandoned sites in lower Valais only we find similar effects on moth abundance (site category * month: - 22.35 ± 14.81 , t = -1.509, P = 0.14; month: 49.24 ± 6.62 , t = 7.44, P < 0.001; site category: 36.8 ± 17.14 , t = -2.15, P = 0.04). However, no effects on species richness were found (site * month: 0.93 ± 2.47 , t = 0.38, P = 0.71; month: 10.5 ± 1.07 , t = 9.86, P < 0.001; site category: - 1.37 ± 2.07, t = -0.66, P = 0.51).

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247 An analysis of the moth community shows significant differences between occupied versus abandoned sites (DCA1: 0.32 \pm 0.13, t = 2.37, 248 P = 0.02; DCA2: -0.5 ± 0.18, t = -2.7, P = 0.01) with significant changes 249 in the moth community over the season (DCA1: -1.71 ± 0.05 , t = -31.55, 250 P < 0.001; DCA2: 0.3 ± 0.12, t = 2.55, P = 0.01) while there were no 251 252 detectable interactions between site category and month on the first axis 253 (DCA1 * Month: 0.01 ± 0.11 , t = 0.07, P = 0.94) but on the second axis 254 (DCA2 * Month: 0.3 ± 0.12 , t = 2.55, P = 0.01). The interaction could be 255 best explained by the change in difference of the site categories between the months (May: -0.61 ± 0.33 , t = -1.87, P = 0.07; June: -0.88 ± 0.22 , t 256 257 = -3.94, P < 0.001; July: -0.04 ± 0.11 , t = -0.36, P = 0.72).

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259 When comparing the moth community between occupied and abandoned sites in upper Valais we detect a significant differences that 260 261 vary in relation to season (site category *month: -0.59 ± 0.13 , t = -4.46, P < 0.001). This interaction can be best explained by very strong 262 263 differences in May (1.47 \pm 0.3, t = 4.86, P < 0.001; Fig. SI1) and June $(1.3 \pm 0.24, t = 5.52, P < 0.001;$ Fig. SI2) and weaker but still highly 264 significant differences late in the season in July (0.31 \pm 0.11, t = 2.93, P 265 266 < 0.01; Fig. SI3).

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The moth community differed between occupied and abandoned sites in the lower Valais (DCA1: -0.43 ± 0.15, t = -2.87, P < 0.01; DCA2: 0.11 ± 0.16, t = 0.71, P = 0.49) with strong seasonal effect on the first axis (DCA1: -1.71 ± 0.05, t = -31.62, P < 0.001), but not on the second axis (DCA2: -0.003 ± 0.06, t = -0.05, P = 0.96) and without interaction (DCA1: 0.02 ± 0.13, t = 0.14, P = 0.89; DCA2: -0.1 ± 0.12, t = -0.83, P= 0.41, Fig. 5).

275 **Discussion**

This study demonstrates significant differences in vegetation structure and moth abundance and richness between occupied and abandoned sites of the European nightjar in Valais, Switzerland. Our data can not entirely clarify the relative importance of both factors on the absence of nightjars in abandoned sites but may help to guide future restoration measures in order to create suitable habitats for this endangered and elusive nocturnal bird species.

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284 Vegetation structure differed between occupied and abandoned sites with snags being significantly more abundant in the sites with displaying 285 286 nightjars. Our results fit the findings by Wichmann (2004) who states that 287 the availability of song perches is an important factor for habitat selection of the European nightjar. When singing from exposed perches, a male's 288 289 song may carry further with positive effects on mate attraction (Sprau et 290 al. 2012). Sitting well camouflaged on elevated horizontal branches may additionally reduce predation risk when resting during the day and may be 291 292 part of the specie's hunting strategy described below. We propose for 293 future habitat restoration measures to leave existing standing dead trees 294 or to create new perches by cutting trees and leave them in the managed 295 area.

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297 The proportion of gravel was an additional factor that was higher in 298 occupied versus abandoned sites. While several variables (e.g., amounts 299 of bare ground, gravel & stone) indicating the openness of the habitat 300 were significant in the univariate approach our model selection approach 301 highlights the importance of gravel compared to other aspects of bare 302 ground. The amount of gravel might be an indicator of the amount of bare 303 ground, from which the nightjar may benefit in several ways. Firstly, 304 nightjars are known to lay their eggs in bare and very shallow scrapes 305 (Berry 1979) where breeding birds with their brownish colors and their brownish eggs are best camouflaged. Certain vegetation is still needed as 306

307 it is assumed that the cover reduces extensive heat loss (Sierro 1991). Secondly, bare ground covered by gravel may hinder or slow down 308 vegetation growth on a long term, resulting in sparse ground vegetation 309 310 (Ceacero et al. 2012). This may be important for a nightjar's hunting 311 strategy. Nightjars are known to sit on the ground or on snags searching the sky for flying prey, which are better visible as silhouette when spotting 312 313 them against the slightly bright night sky. From the ground or an elevated 314 spot prey is chased and caught on the wing (Jackson 2003). This hunting 315 strategy requires an open habitat with sparse vegetation on different 316 layers. Our results support this hypothesis where the regeneration cover up to 1.3m was denser in abandoned sites. Occupied sites showed only 317 40% cover in the regeneration layer compared to 65% in abandoned 318 319 sites. The deciduous shrub layer was denser in abandoned sites with coverage of 90%, while in the occupied only 65% was covered. The 320 321 densification of these layers indicates an ongoing succession, which is 322 expected to hinder hunting efficiency (Fig. 1c/d).

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324 The difficulty of an appropriate management is to create a mix of 325 habitats combining some ground cover and patches of bare ground. By 326 creating clearings without or little canopy cover too high amounts of 327 sunlight may be hitting the ground, which may promote the rapid growth of ground vegetation and results in a dense sward. A possible solution is 328 329 to keep a layer of canopy cover ranging between 30-60% (Sierro et al. 2001) by leaving a few old trees that may additionally be important for 330 331 cavity breeding species. Such a management would result in a habitat 332 with high variation in sun exposure leading to a more open habitat. In 333 addition, it is fundamental to have an appropriate maintenance that could 334 be realized by annual grazing. Grazing is known to favor the occurrence of 335 the nightjar by creating or maintaining open habitats (Sharps 2013) but 336 may additionally have positive effects on the abundance and richness of 337 potential prey species (Stein, Gerstner & Kreft 2014).

339 In occupied sites moths were more abundant and showed a higher species richness than in abandoned sites. The effect was most pronounced 340 341 at the end of the breeding season in July where food for dependent offspring is most needed. A more open habitat combined with a higher 342 343 abundance of moths is expected to translate into an enhanced availability of moths for an aerial foraging species as the nightjar. This concept of 344 345 increased prey availability in semi-open habitats is similar to findings in insectivorous ground-foraging birds, where a sparse ground vegetation 346 347 enhances prey detectability and herewith their availability (Arlettaz et al. 348 2012; Vickery & Arlettaz 2012).

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350 In addition, we detected differences in moth abundance and species richness between lower and upper Valais. While the moth community 351 352 shows some similarities the observed differences can have several origins. 353 Firstly, the south-facing and dry slopes of the lower Valais are dominated 354 by deciduous tree species as the downy oak (Quercus rubescens), while 355 the upper Valais and especially the Pfynwald is dominated by pine species 356 (Rigling et al. 2006a). Given the host-specificity of moth species it is 357 therefore not surprising to find considerable variation in the moth 358 community between regions. The difference in moth abundance could 359 additionally be explained by the extent of the timespan between 360 restoration measures and the time of sampling since moth abundance is expected to be reduced after habitat measures (Summerville 2011). Given 361 that sites in the upper Valais have been managed more recently (2005-362 363 2012) than in the lower Valais (start in 2001) we could understand a 364 shorter time of resilience of the moth community in the upper Valais.

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In summary, our studies suggest that ideal nightjar habitats constitute a complex mix of open habitats that facilitate aerial foraging with a high abundance of moths that need a diverse mix of host plants. This combination of requirements is problematic since fertile soils provide ideal growing conditions for herbs and grasses on a short-term and

371 bushes on a mid-term. Without ongoing proper habitat management such sites will become unsuitable due to natural succession, which has 372 previously been suppressed by grazing and the inability to inhibit natural 373 374 disturbances as wildfires. Additionally we suggest abandoning the idea of 375 small clearings all over the Valais but focusing on a few sites only. 376 Especially the Pfynwald could act as large-scale experiment for 377 management. Already five clearings were created within this forest and by increasing the number of managed areas they have a realistic potential to 378 379 be recolonized, also given the small distances to the currently occupied 380 sites. For the long-term maintenance of the managed areas we propose 381 controlled grazing schemes that could increase heterogeneity and keep 382 the habitat open on the lower strata. In addition we suggest, to lighten 383 the forest surrounding the current clearings. The combination of these management suggestions could lead to an increase of the population of 384 385 the nightjar and given an increase in overall heterogeneity to a boost of 386 faunal and floral biodiversity.

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517 Tables

Table 1. On a fine scale vegetation structure is estimated on a 10 x 10 m

519 plot.

	Variable	Definition	Unit
Canopy cover	Deciduous Canopy cover	> 5 m	%
	Coniferous Canopy cover	> 5 m	%
Shrub cover	Shrub cover	> 1.3 < 5 m	%
Regeneration cover	Deciduous regeneration	< 1.3 m	%
	cover		
	Coniferous regeneration	< 1.3 m	%
	cover		
Ground vegetation cover	Herbs cover		%
	Grass cover		%
Ground vegetation	Herbs height		cm
height	Grass height		cm
Bare ground	Rock cover	> 1 m ²	%
	Stones cover	$> 10 \text{ cm}^2 < 1 \text{ m}^2$	%
	Gravel cover	< 10cm ²	%
	Sand cover		%
	Soil cover	Humus	%
		Dead plant	%
		material < 10 cm	
	Litter cover	Ø	
	Bare ground		%
Lying dead wood		< 1.3 m, > 10	amount
	Lying dead wood	cm Ø	
Snags		> 1.3 m, >10 cm	amount
	Standing dead wood	Ø	

- **Table 2.** On the large scale vegetation structure is measured on a 15 m-
- 521 radius plot.

	Variable	Definition	Unit
Tree layer		Cover at 5 m	%
	Tree layer Pines (K)	height	
	Tree layer Spruce (F)		%
	Tree layer Others (Oth)		%
	Tree layer Deciduous (D)		%
Shrub layer		Cover between 1.3	%
	Shrub layer Pines (K)	- 5 m	
	Shrub layer Spruce (F)		%
	Shrub layer Others (Oth)		%
	Shrub layer Deciduous (D)		%
Regeneration	Regeneration layer Pines (K)	Cover < 1.3 m	%
layer	Regeneration layer Spruce (F)		%
	Regeneration layer Others		%
	(Oth)		
	Regeneration layer Deciduous (D)		%
Snags	Standing dead wood	>1.3 m, >10 cm Ø	amount

Table 3. Results of the univariate binomial models of the vegetation
523 structure variables of the 10 x 10 m plot.

Variable	Estimate ± se	z-value	p-value	AIC
Deciduous canopy cover	-0.05 ± 0.06	-0.83	0.41	49.24
Coniferous canopy cover	0.37 ± 0.2	1.88	0.06	41.63
Canopy cover	0.03 ± 0.03	0.85	0.4	49.44
Shrub cover	-0.03 ± 0.02	-1.33	0.18	48.12
Deciduous regeneration cover	-0.12 ± 0.05	-2.38	0.018	42.36
Coniferous regeneration cover	0.06 ± 0.06	0.94	0.35	49.27
Regeneration cover	-0.08 ± 0.04	-1.91	0.06	45.83
Herbs cover	0.05 ± 0.04	1.33	0.18	8.33
Herbs height	-0.08 ± 0.05	-1.6	0.11	47.26
Grass cover	-0.01 ± 0.02	-0.74	0.46	49.61
Grass height	0.01 ± 0.05	0.13	0.90	50.16
Ground vegetation cover	-0.001 ± 0.01	-0.07	0.95	50.18
Ground vegetation height	-0.06 ± 0.06	-0.97	0.33	49.18
Rocks	0.26 ± 0.17	1.57	0.12	45.58
Stones	0.2 ± 0.09	2.15	0.03	43.14
Gravel	0.25 ± 0.11	2.34	0.02	38.54
Sand	0.38 ± 0.77	0.49	0.62	48.25
Soil	0.03 ± 0.05	0.71	0.48	49.68
Litter	-0.13 ± 0.06	-1.96	0.05	43.84
Bare ground	0.05 ± 0.03	1.97	0.05	45.76
Lying dead wood	-0.28 ± 0.38	-0.73	0.47	49.62
Snags	2.57 ± 1.58	1.63	0.1	46.67

Table 4. Results of the univariate binomial models of the vegetation
525 structure variables of the 15 m-radius plot.

Variable	Estimate ± se	z-value	p-value	AIC
Tree layer	0.12 ± 0.07	1.78	0.07	44.76
Tree layer K	0.004 ± 0.01	0.37	0.71	50.05
Tree layer F	0.08 ± 0.12	0.65	0.52	49.74
Tree layer Oth	0.24 ± 0.27	0.89	0.37	43.96
Tree layer D	-0.01 ± 0.01	-1.07	0.28	48.98
Shrub layer	-0.01 ± 0.02	-0.73	0.47	49.63
Shrub layer K	0.04 ± 0.02	1.81	0.07	45.94
Shrub layer F	-0.19 ± 0.32	-0.6	0.55	49.78
Shrub layer Oth	0.04 ± 0.02	1.63	0.1	46.5
Shrub layer D	-0.03 ± 0.01	-2.26	0.02	43.49
Regeneration layer	-0.06 ± 0.02	-2.53	0.01	41.47
Regeneration layer K	0.01 ± 0.02	0.51	0.61	49.92
Regeneration layer F	-0.15 ± 0.29	-0.53	0.6	49.88
Regeneration layer Oth	0.04 ± 0.02	1.96	0.05	44.95
Regeneration layer D	-0.04 ± 0.02	-2.21	0.03	43.85
Snags	0.4 ± 0.19	2.14	0.03	43.48

Table 5. These five models results from a model selection approach with a Δ AIC smaller than 2. Snags and gravel were always included in these five models. Results include difference in Akaike's information criterion (AIC) of the current and the best model (Δ AIC), the AIC weight of the given model (w_i), the number of estimated model parameters (K), and the model deviance.

Model	ΔΑΙΟ	Wi	К	Deviance
snags + gravel +				
regeneration layer + deciduous shrub layer	0	0.156	5	16.49
snags + gravel +				
regeneration layer	1.18	0.087	4	20.404
snags + gravel +				
deciduous regeneration cover + deciduous shrub layer	1.76	0.065	5	18.252
snags + gravel +				
deciduous shrub layer	1.84	0.062	4	21.06
snags + gravel +				
regeneration layer + deciduous shrub layer + stones	1.9	0.061	6	15.456

532 Figures



Fig. 1. Boxplots show variables of the best model. Snags (a) and gravel
(b) are increased in the occupied (blue) sites, while deciduous shrub layer
(C) and regeneration layer (d) are higher in the abandoned (yellow) sites.



Fig.

Fig. 2. Moth abundance is separated into three groups (abandoned lower
Valais: yellow, abandoned upper Valais: green, occupied sites: blue)
regarding three months. There is a strong increase from May to July in the
occupied sites and the abandoned sites in the lower Valais, but not in the
upper Valais.



Fig. 3. Total moth abundance in the abandoned sites (yellow) is lowerthan in the occupied sites (blue).



Fig.4. DCA analysis of all species represents the three different months in

red (May), orange (June), yellow (July). All species are represented in black and a few are named as representatives of the three months.



552 Fig. 5. DCA Analysis represents all species (black dots) separated in the different groups. Abundant upper Valais and lower Valais are shown in 553 green and yellow respectively, the occupied sites are colored in blue. 554 Phoesia gnoma, Silene lunularia and Bupalus piniarius are more related to 555 556 the abandoned sites in the upper Valais, while Rhyparia purpurata, 557 Catephia alchymista and Dysgonia algira are more related to the occupied 558 sites. There are no conspicuous species in the lower Valais abandoned 559 sites.

560 Supporting Information

561 **Table SI1**. Moth species are alphabetically listed. DCA1 and DCA2 are

562 shown for each species and the belonging family.

Species	Family	DCA1	DCA2	Species	Family	DCA1 I	DCA2
AA	Noctuidae	1.8964	1.5189	BY	Noctuidae	1.9131	0.0365
AB	Geometridae	1.7994	-0.8153	BZ	Noctuidae	1.1622	1.0017
Abromias_sublustris	Noctuidae	-0.9784	0.8396	с	Noctuidae	2.0310	-0.3764
AC	Thyatiridae	5.7949	-0.1811	CA	Noctuidae	1.5729	0.7130
AD	Noctuidae	3.0713	-0.7299	Calliteara_pudibunda	Lymantriidae	1.5557	1.8472
Aedia_funesta	Noctuidae	-1.9695	-0.4826	Catephia_alchymista	Noctuidae	-1.3193	-1.3383
AF	Geometridae	4.6486	-0.1638	Cerura_vinula	Notodontidae	3.0043	1.6591
Agrius_convolvuli	Sphingidae	-0.7871	0.9804	СН	Noctuidae	2.5424	-1.0611
АН	Noctuidae	1.0115	1.4035	Chersotis_andereggii	Noctuidae	-0.6502	0.8375
AI	Noctuidae	4.6205	0.7425	Chiasmia_claratha	Geometridae	2.4238	-0.5041
AJ	Noctuidae	3.0770	1.1399	Cidaria_fulvata	Geometridae	0.8649	0.0061
AL	Noctuidae	1.9811	-1.5661	CJ	Geometridae	0.0616	0.5635
Amphipyra_berbera	Noctuidae	-0.8902	0.8020	CL	Geometridae	1.6577	-2.2192
AN	Geometridae	6.0246	0.0061	Clostera_pigra	Notodontidae	1.7065	1.3227
Angerona_prunaria	Geometridae	-2.0818	0.3044	СМ	Arctiidae	1.6577	-2.2192
AO	Geometridae	6.0246	0.0061	со	Noctuidae	2.6697	-1.8399
AP	Geometridae	5.7106	-0.3522	Coscinia_cribraria	Arctiidae	1.7949	0.2727
Apeira_syringaria	Geometridae	-1.8028	0.9117	Cossus_cossus	Cossidae	-0.5690	0.9331
Aplocera_plagiata	Geometridae	0.2392	1.7214	СР	Noctuidae	0.3397	-1.8756
Apoda_limacodes	Limacodidae	-1.9147	-0.0380	CR	Noctuidae	1.6577	-2.2192
AR	Noctuidae	5.0620	0.3094	Cryphia_algae	Noctuidae	-1.7004	0.1620
AS	Noctuidae	4.8210	0.0409	СТ	Noctuidae	1.0543	-1.7671
Atolmis_rubricollis	Arctiidae	-1.8246	0.2674	CV	Noctuidae	1.3918	-1.7512
AU	Noctuidae	-0.4548	0.8443	CY	Noctuidae	-1.5500	-0.6304
Autographa_gamma	Noctuidae	-0.7105	-0.8634	Cyclophora_annularia	Geometridae	1.0473	2.8572
AV	Geometridae	1.9007	0.0839	Cyclophora_linearia	Geometridae	2.9086	-1.2938
AX	Noctuidae	2.4260	-0.5199	DA	Geometridae	-0.5058	-1.0642
AY	Noctuidae	2.7669	-1.7046	DC	Noctuidae	-0.6060	1.0287
AZ	Noctuidae	2.7139	-0.9660	Deilephila_elpenor	Sphingidae	0.4861	-0.2466
В	Noctuidae	2.7537	-0.2614	Deilephila_porcellus	Sphingidae	0.6503	0.0708
BB	Noctuidae	0.8053	0.4994	Dendrolimus_pini	Lasiocampidae	-0.6359	1.4977
BD	Noctuidae	3.0635	-1.2961	Diachrysia_chrysitis	Noctuidae	-1.3117	-0.5387
Bena_bicolorana	Noctuidae	-1.8761	-0.0466	Diacrisia_sannio	Arctiidae	-0.8902	0.8020
BG	Noctuidae	2.5321	1.4890	Dicycla_oo	Noctuidae	-1.8811	-0.3498
BI	Noctuidae	2.5992	0.0756	DO	Geometridae	2.3603	-1.1233
Biston_betularia	Geometridae	0.1704	1.4207	DP	Noctuidae	2.3603	-1.1233
BJ	Noctuidae	1.0584	0.8323	DQ	Geometridae	6.0246	0.0061
BN	Noctuidae	-0.0695	0.6388	DR	Noctuidae	5.4739	0.0452
во	Geometridae	2.5992	0.0756	Drepana_falcataria	Drepanidae	0.8514	1.8812
BP	Noctuidae	-0.4803	1.1832	Drymonia_ruficornis	Notodontidae	1.7764	0.6498
BR	Geometridae	2.8184	0.8468	DW	Noctuidae	-0.3681	0.9815
BS	Geometridae	2.0703	-1.3203	Dysauxes_ancilla	Arctiidae	-1.7588	1.0087
BT	Noctuidae	2.1403	1.8942	Dysgonia_algira	Noctuidae	-0.6748	-1.3421
BU	Noctuidae	1.8623	-1.1387	EA	Geometridae	0.6152	-1.1904
Bupalus_piniarius	Geometridae	1.5351	2.3963	Earias_clorana	Noctuidae	-0.1927	0.1212

Species	Family	DCA1	DCA2	Species	Family	DCA1	DCA2
EB	Geometridae	-1.0713	-0.3311	GD	Noctuidae	-1.5493	1.1994
EC	Noctuidae	0.2780	1.1585	GE	Noctuidae	-0.6024	1.0289
ED	Noctuidae	-0.1980	1.1961	GF	Noctuidae	-0.9475	1.0577
EE	Noctuidae	0.4780	1.0667	GG	Noctuidae	-0.8288	1.2194
EF	Noctuidae	-0.6343	0.0855	GH	Noctuidae	1.5114	1.6990
EG	Noctuidae	0.7867	1.7560	GI	Noctuidae	1.5114	1.6990
EH	Noctuidae	-1.0899	0.9160	GJ	Geometridae	-1.0861	1.0900
EI	Noctuidae	0.8331	1.6479	GK	Geometridae	0.2714	1.3052
EK	Geometridae	0.7836	-2.3551	GL	Geometridae	0.4249	1.4366
EL	Noctuidae	-0.0823	0.5858	GM	Noctuidae	-1.7934	0.0578
Enargia_paleacea	Noctuidae	-1.7440	0.7542	GN	Noctuidae	-1.1193	0.7085
Epicallia_villica	Arctiidae	0.5486	-0.0042	GO	Noctuidae	0.4892	1.7302
EQ	Geometridae	0.8649	0.0061	GP	Geometridae	0.8953	2.8914
ER	Geometridae	0.7045	1.5980	GS	Geometridae	-0.8281	1.1382
ES	Geometridae	-1.5880	0.5633	GT	Noctuidae	0.1176	1.3880
EU	Geometridae	1.3030	1.7305	GV	Noctuidae	2.9350	0.9104
Euproctis_chrysorrhoea	Lymantriidae	-1.7814	0.3579	GW	Geometridae	-0.5846	-1.0922
Eutelia_adularix	Noctuidae	0.9194	-2.2349	GX	Noctuidae	-0.5846	-1.0922
EW	Noctuidae	0.5160	1.8475	НА	Arctiidae	-1.7778	-0.1880
EX	Noctuidae	-1.5057	0.2810	Habrosyne_pyritoides	Thyatiridae	-1.8615	-0.0997
EZ	Noctuidae	-2.0532	-0.4723	Hadena_compta	Noctuidae	-0.8740	-0.6224
FA	Noctuidae	0.8649	0.0061	Hadena confusa	Noctuidae	-0.6302	0.7768
FB	Geometridae	0.8649	0.0061	Harpyia_milhauseri	Notodontidae	2.3996	1.6536
FC	Geometridae	0.8649	0.0061	нс	Noctuidae	-0.1567	-1.9756
FD	Geometridae	0.4422	1.7063	HE	Noctuidae	2.9789	-1.2765
FE	Geometridae	0.6490	1.4843	Heliothis peltigera	Noctuidae	-1.8625	-0.4601
FG	Noctuidae	-0.0815	1.3643	Heliothis viriplaca	Noctuidae	-0.4095	0.7748
FI	Noctuidae	-0.5891	0.8986	HF .	Noctuidae	-0.1561	0.3466
FJ	Noctuidae	1.3030	1.7305	HG	Noctuidae	2.3701	-0.8313
FK	Noctuidae	0.3963	1.3753	нн	Noctuidae	-0.6104	0.8393
FL	Geometridae	0.7620	0.2915	н	Noctuidae	-0.6970	0.6758
FN	Noctuidae	0.7620	0.2915	нк	Noctuidae	-0.3673	-0.6355
FP	Noctuidae	2.1429	0.3761	HL	Noctuidae	0.1077	-1.2232
FQ	Geometridae	-0.2963	0.7231	HN	Arctiidae	-1.9725	-0.0936
FR	Geometridae	1.4511	-1.7922	НР	Geometridae	-1.5966	-0.7961
FU	Noctuidae	0.2926	-1.6212	HR	Arctiidae	-1.8186	-0.0905
Furcula bifida	Notodontidae	0 3064	1 2460	ня	Noctuidae	-1 4340	-0 5005
Furcula biscuspis	Notodontidae	2 4288	3 2735	нт	Noctuidae	-1 9440	-0.0327
Furcula furcula	Notodontidae	2.4200	0.8468	ни	Noctuidae	-1 5962	-0 7504
FX	Geometridae	0.8649	0.0061	HV	Noctuidae	-1.7411	-0.0788
F7	Geometridae	0 6402	1 0338	нх	Noctuidae	-1 6582	-0 4335
·-	Noctuidae	2 12/15	0.1873	HV	Noctuidae	-1 0161	0.0067
GA	Noctuidae	1 5070	-0 5181	Hyles eunhorbiae	Snhingidae	-1.9101	-0.0007
GB	Noctuidae	1 /511	-1 7922	Hyles vesnertilio	Snhingidae	0.505	1 62/10
60	Noctuidae	-1 5600	-0.4702	Hyles vespetilio	Sphingidae	-0 7871	1.0249
	- occurac	-1.3030	0.4/02	ingics_vespetillo	Springluae	-0.7071	0.5004

Species	Family	DCA1	DCA2	Species	Family	DCA1	DCA2
Hyloicus_pinastri	Sphingidae	1.8230	1.9914	UL	Noctuidae	-2.0046	0.1597
Hypena_obesalis	Noctuidae	5.8161	-0.0745	VL	Geometridae	-1.7871	-0.7020
HZ	Noctuidae	-1.4471	-0.6483	WL	Noctuidae	-1.4256	0.1722
I	Noctuidae	1.8722	1.8295	XL	Noctuidae	-1.4885	-0.3466
IA	Noctuidae	-1.8121	0.2347	YL	Noctuidae	-2.0281	-0.5521
IB	Noctuidae	-0.9417	0.4777	JZ	Noctuidae	-0.6502	0.8375
IC	Geometridae	-1.9137	-0.1856	к	Noctuidae	1.1462	-0.0769
ID	Geometridae	-1.3958	-0.1004	КА	Noctuidae	-0.9516	0.8212
IE	Geometridae	-1.2786	-0.8885	КВ	Noctuidae	-1.4034	0.8148
IF	Noctuidae	-0.8902	0.8020	КС	Noctuidae	-2.0089	-0.5049
IG	Noctuidae	-1.8219	-0.1534	KD	Noctuidae	-1.8462	0.8136
IL	Geometridae	-0.8902	0.8020	KE	Noctuidae	-2.0055	0.6689
IM	Geometridae	-0.8902	0.8020	KF	Noctuidae	-1.8899	0.6959
IN	Arctiidae	-0.8902	0.8020	KG	Noctuidae	-2.2230	-0.6527
10	Geometridae	-0.8902	0.8020	КН	Noctuidae	-1.8395	0.3154
IP	Noctuidae	-0.8555	0.8073	КІ	Geometridae	-1.9065	-0.1132
IQ	Noctuidae	-0.7686	0.8204	КЈ	Noctuidae	-2.4692	-0.6337
IR	Noctuidae	-0.8902	0.8020	КК	Geometridae	-2.4692	-0.6337
IS	Noctuidae	0.4822	-0.2702	KL	Geometridae	-1.9772	0.4422
IT	Noctuidae	-1.3177	0.4951	KM	Geometridae	-1.9772	0.4422
IU	Noctuidae	-0.8902	0.8020	Laothoe_populi	Sphingidae	2.0708	2.0336
IV	Noctuidae	-1.1850	0.2953	Laspeyria_flexula	Noctuidae	-1.9772	0.4422
IW	Noctuidae	-0.8902	0.8020	Lithosia_quadra	Arctiidae	-2.0826	0.1552
IX	Noctuidae	-0.8902	0.8020	Lomaspilis_marginata	Geometridae	-2.0532	-0.4723
IY	Noctuidae	-1.1038	0.6323	Lygephila_lusoria	Noctuidae	-2.2013	-0.3293
IZ	Geometridae	-0.8902	0.8020	Lymantria_monacha	Lymantriidae	-2.3478	0.4523
J	Geometridae	0.7787	1.6305	М	Arctiidae	1.6611	2.2041
JA	Geometridae	-1.4264	-1.0928	Macrothylacia_rubi	Lasiocampidae	2.3028	1.0525
JB	Geometridae	-0.8902	0.8020	Malacosoma_castrensis	Lasiocampidae	-1.0549	-0.0178
JC	Noctuidae	-2.4928	0.4973	Malacosoma_neustria	Lasiocampidae	-2.0194	0.6945
D	Geometridae	-1.7070	0.9087	Miltochrista_miniata	Arctiidae	-2.0271	0.2214
JE	Geometridae	-1.6863	0.1290	Mimas_tiliae	Sphingidae	0.4165	0.2407
JF	Geometridae	-1.1099	-0.5940	Minucia_lunaris	Noctuidae	1.9322	0.8044
H	Noctuidae	-1.1099	-0.5940	Noctua_fimbriata	Noctuidae	-1.7607	0.0596
II	Geometridae	-1.1099	-0.5940	Noctua_janthe	Noctuidae	-0.6502	0.8375
11	Geometridae	-1.8028	0.9117	Noctua_pronuba	Noctuidae	-0.7680	0.1124
JK	Geometridae	-1.8028	0.9117	Notodonta_dromedarius	Notodontidae	1.5645	1.3938
JL	Noctuidae	-0.8797	0.3555	Notodonta_ziczac	Notodontidae	1.8235	0.7196
JN	Noctuidae	-1.8028	0.9117	0	Notodontidae	1.8964	1.5189
OL	Noctuidae	-2.1188	0.2775	Odontoptera_bidentata	Geometridae	-0.6170	-0.0445
JP	Geometridae	-1.7680	0.2580	Opisthograptis_luteolata	Geometridae	1.2670	1.8256
JQ	Noctuidae	-1.0194	-1.6403	Ρ	Noctuidae	0.3114	1.0750
JR	Noctuidae	-1.5817	-0.1353	Panolis_flammea	Noctuidae	2.0315	1.1265
JS	Arctiidae	-1.8566	-0.1646	Paracolax_tristalis	Noctuidae	-2.0529	-0.3063
TL	Noctuidae	-1.7871	-0.7020	Peridea_anceps	Notodontidae	2.5711	2.3597

Species	Family	DCA1	DCA2
Phalera_bucephala	Notodontidae	-0.4572	1.5164
Phlogophora_meticulosa	Noctuidae	0.1151	-1.4484
Phoesia_gnoma	Notodontidae	2.4200	3.0299
Phragmatobia_fuliginosa	Arctiidae	1.0502	0.2129
Phragmatobia_luctifera	Arctiidae	3.1882	0.2085
Phyllodesma_tremulifolia	Lasiocampidae	2.4692	1.6226
Phytometra_viridaria	Noctuidae	2.8184	0.8468
Polyphaenis_sericata	Noctuidae	-1.9099	-0.3744
PQ	Noctuidae	0.3326	-1.4859
Pseudoips_prasinana	Noctuidae	-2.0150	-0.5725
Pterostoma_palpina	Notodontidae	0.8259	1.5212
Ptilodon_capucina	Notodontidae	2.6692	2.2696
Ptilodon_cucullina	Notodontidae	-0.8116	0.2097
Pyrrhia_umbra	Noctuidae	-0.8345	-0.1645
R	Noctuidae	3.0105	-0.8305
Rhyparia_purpurata	Arctiidae	1.0726	-2.1283
S	Noctuidae	0.1444	0.6170
Scoliopteryx_libatrix	Noctuidae	-1.2978	-0.4718
Scopula_decorata	Geometridae	-0.9319	-1.4570
Selenia_lunularia	Geometridae	1.8535	1.5475
Sideridis_lampra	Noctuidae	-1.4655	0.2426
Sphinx_ligustri	Sphingidae	0.7439	1.3938
Stauropus_fagi	Notodontidae	-0.6398	0.5730
Syngrapha_ain	Noctuidae	-0.8902	0.8020
Т	Noctuidae	-0.3420	0.1039
Tethea_ocularis	Thyatiridae	0.7457	1.5334
Thaumetopoea_pityocampa	Notodontidae	-1.8920	0.1706
Thyatira_batis	Thyatiridae	0.9574	2.8083
Tyta_luctuosa	Noctuidae	-1.1528	-1.0893
U	Noctuidae	1.1838	1.0866
V	Noctuidae	-0.8433	-0.7762
Watsonalla_binaria	Drepanidae	0.4484	0.9085
Watsonarctia_casta	Arctiidae	3.4598	0.3511
Xestia_triangulum	Noctuidae	-2.0478	0.1301
Y	Noctuidae	1.9788	-1.5234
Zeuzera pyrina	Cossidae	-1.7680	0.2580



Fig. SI1. The DCA Analysis is shown with moth captured in May.





Figure SI2. The DCA Analysis is shown with moth captured in June.





Figure SI3. The DCA Analysis is shown with moth only captured in July.