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# What defines insularity for plants in edaphic islands?

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The theory of island biogeography postulates that size and isolation are key drivers of biodiversity on islands. This theory has been applied not only to true (e.g. oceanic) islands but also to terrestrial island-like systems (e.g. edaphic islands). Recently, a debate has opened as to whether terrestrial island-like systems function like true islands. However, identifying the effect of insularity in terrestrial systems is conceptually and methodologically challenging because recognizing species source(s) and measuring isolation is not as straightforward as for true islands. We contribute to the debate by proposing an approach to contextualize the definition of insularity and to identify the role of isolation in terrestrial island-like systems. To test this approach, we explored the relationship between insularity predictors and specialist species richness of edaphic islands in three systems in Europe (spring fens, mountaintops, and outcrops). We detected that insularity affected specialist richness of edaphic islands through island size and target effect (i.e. an emergent property of islands depending on their isolation and size). As predicted by the Theory of Island Biogeography, species richness decreased with increasing isularity. Given the comprehensiveness and ease of implementation of our approach, we encourage its extension to other island-like systems.

Keywords: terrestrial island-like system, island biogeography, island size, isolation, specialist species richness, target effect.

## Introduction: The island biogeographic context

Insular systems, including true islands and other island-like environments, are excellent models to examine the biogeographic forces shaping biodiversity (Carlquist 1974, Lomolino 2000a, Patiño et al. 2017, Ottaviani et al. 2020). Traditionally, insular systems have been explored through the lens of the theory of island biogeography, in which island size and distance from the mainland (i.e. isolation) are the core drivers of diversity (MacArthur and Wilson 1967, Whitehead and Jones 1969, Lomolino 2000b) (Table 1). Recently, a debate has opened whether the biodiversity of

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Table 1. Glossary.

| Term | Definition |
|---|---|
| Connectivity | The state of being connected. Connectivity reduces isolation by joining isolated elements and allowing fluxes of energy, matter and organisms |
| Edaphic island | A special case of a habitat island; landscape patch characterized by distinct soil conditions that make it dissimilar from the surroundings |
| Habitat fragment | One of the pieces of a formerly continuous, broadly-distributed habitat type; it can be created by anthropogenic changes (e.g. land-use) or natural phenomena (e.g. water-level fluctuations) |
| Habitat island | Landscape patch of a distinct habitat type surrounded by other, dissimilar habitat(s) |
| Insularity | The state of being an island. By extension, the possibility/ability to operate as an island, i.e. to be isolated |
| Insularity effect | The effect of insularity-related variables (i.e. island size and isolation, taken separately or in conjunction) on biodiversity (e.g. species richness or functional diversity) |
| Island-like system | Any spatially defined (and confined) system resembling true island(s) |
| Isolation | The state of being spatially separated from a similar ecosystem by a surrounding landscape inhospitable to the establishment, e.g. water for true islands |
| Species source | A continent or a large island which harbors large species populations from which species may migrate and possibly colonize other islands |
| Target effect | The increased probability of a larger island to be colonized by random dispersal than a smaller island given a similar distance to the same species source. It is a correction of the spatial isolation of an island by its size |
| True island | Landmass isolated from other landmasses by water |

Key terms and definitions used in this study (Dawson et al. 2016, Itescu 2019, Carter et al. 2020, Flantua et al. 2020, Ottaviani et al. 2020).

island-like systems – such as edaphic islands (Harrison 1997, Harrison et al. 2006), mountaintops (Sklenář et al. 2014, Jiménez-Alfaro et al. 2021) and inselbergs (Henneron et al. 2019) – is ruled by size and isolation in the same way as for true (e.g. oceanic) islands (Itescu 2019).

Before assessing biodiversity patterns in terrestrial island-like systems (Table 1), we need to acknowledge that 'insularity' is a broad concept that may apply to discontinuous and/or fragmented environments across different geographic and ecological scales (Itescu 2019). To better understand the effect (or lack of thereof) of insularity in terrestrial island-like systems' biota, it is necessary to analyze and contextualize the meaning and role of island size and isolation case-by-case (McGann 2002, Dawson et al. 2016, Itescu et al. 2020). Our main research goal in this work is to explore whether insularity affects the species richness in edaphic island systems. We did so by 1) defining key concepts related to insularity, 2) reviewing suitable insularity metrics, and finally 3) exploring the relationship between insularity metrics and the species richness of habitat specialist plants in three edaphic island systems.

## Defining insularity for edaphic islands

In this study, we focus on edaphic island systems generated by the discontinuous geographic distribution of specific soil types across the landscape (Kruckeberg 1991, Harrison 1997, Harrison et al. 2006) (Table 1). The scattered spatial distribution and the differences in the area among edaphic patches generate gradients of size and isolation resembling those of true islands (Fig. 1). Although biogeographic patterns in edaphic island systems have been studied for a few decades (Kruckeberg 1991, Tapper et al. 2014, Goedecke et al. 2020), the incorporation of ecological insights related to habitat specialization (Horsák et al. 2012, Horsáková et al. 2018, Ottaviani et al. 2020) and isolation components (Diver 2007, Weigelt and Kreft 2013, Carter et al. 2020) may improve our understanding of the effect of insularity on edaphic island biota. Indeed, island size and isolation are usually studied together (MacArthur and Wilson 1967, Lomolino 2000a, Whittaker et al. 2008). However, while the size is an intrinsic physical feature of any multidimensional object, isolation is the truly distinctive and defining feature of islands, largely determining its insular eco-evolutionary dynamics (Whittaker and Fernández-Palacios 2006, Losos and Ricklefs 2009, Cox et al. 2016).

For true islands, isolation is defined as the geographic distance between a given island and its species source (i.e. the nearest continent or one of the largest and species-richest islands in the same archipelago) (MacArthur and Wilson 1967, Whitehead and Jones 1969) (Table 1). Species sources are defined by two key characteristics, both linked to size: 1) species sources have more species than islands. Because of their larger area, species sources can accumulate a higher number of species. Also, larger areas often imply higher habitat diversity, which has a positive effect on species richness (Hortal et al. 2009, Keppel et al. 2016); 2) species sources are less affected by local extinctions compared to islands. This is because the larger area of species sources is associated with availability of resources, and different habitat types (MacArthur and Wilson 1967, Whittaker and Fernández-Palacios 2006, Losos and Ricklefs 2009).

For true islands, water corresponds to the matrix working as an effective barrier, equally inhospitable for all terrestrial organisms regardless of their habitat specialization. For edaphic islands, widely distributed soil types in the landscape form a matrix that would represent an inhospitable habitat only for the establishment of the species specialized to the distinct edaphic conditions forming the islands (Horsák et al. 2012, Horsáková et al. 2018, Ottaviani et al. 2020). Therefore, isolation in edaphic islands occurs in terms of the geographic distance between an edaphic patch and its species source. Given the lack of a direct equivalent of a continent,

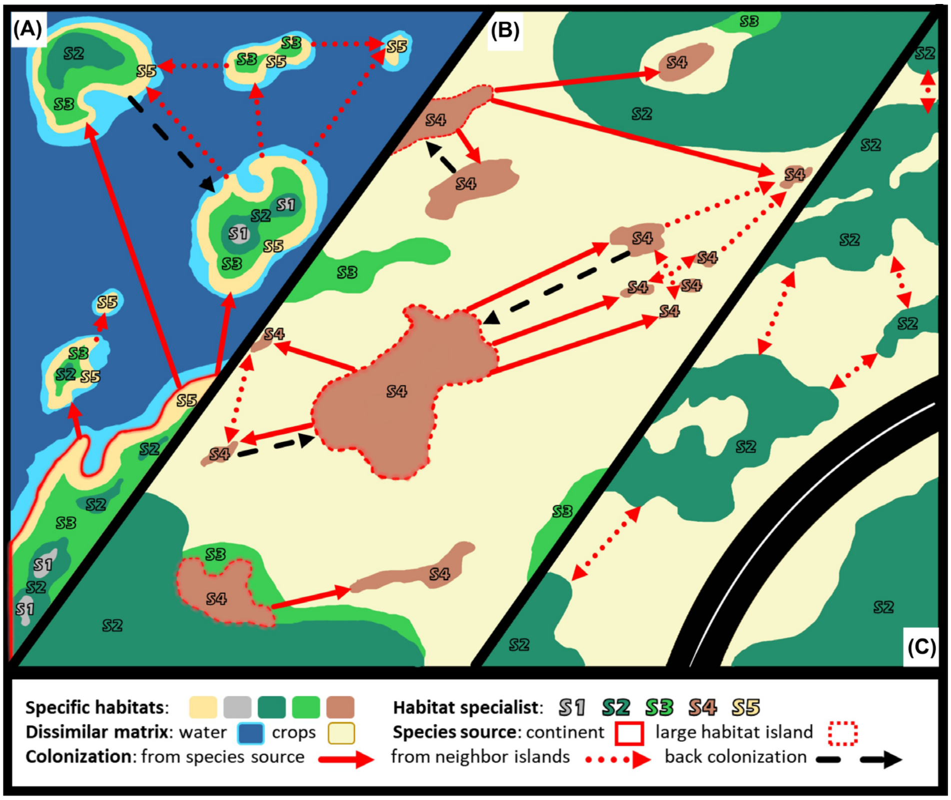


Figure 1. Comparison between true islands (A), edaphic islands (B), and fragmented habitats (C). For more details on definitions, refer to Table 1 and Supporting information.

one or several islands in the edaphic island system are likely to play this role (Table 1; Fig. 1). Within such 'terrestrial archipelagos', we may expect that edaphic islands with the largest size and highest specialist species richness will putatively serve as species sources for the rest of edaphic islands. Although matrix-derived species also occur on edaphic islands, they are expected to be less sensitive to the differences in edaphic conditions between the island and the landscape matrix, thus experiencing less isolation than specialists (Horsák et al. 2018, Horsáková et al. 2018, Dembicz et al. 2020, Goedecke et al. 2020) (Fig. 1).

Besides specialization, dispersal is another important driver of colonization (Yeakley and Weishampel 2000, Fattorini 2009, Aranda et al. 2013, Dambros et al. 2020). Whereas specialization informs about the capacity of species to establish or not on the landscape matrix (Horsák et al. 2012, Horsáková et al. 2018, Ottaviani et al. 2020), dispersal determines whether interisland distances are large enough to prevent species movement across the archipelago (Hájek et al. 2011, Carvalho and Cardoso 2014, Horsák et al. 2015, Irl et al. 2015). Whether interisland distances are not sufficient to prevent effective colonization of edaphic island specialists, this may trigger metapopulation dynamics (Mouquet and Loreau 2003, Leibold et al. 2004). Additionally, dispersal does not only depend on the maximum dispersal distances of the target species (Tamme et al. 2014, Morgan and Venn 2017), but other factors like topography and physical barriers are also important determinants of colonization (Yeakley and Weishampel 2000, Fattorini 2009, Dambros et al. 2020). Therefore, the role of dispersal applies to both true and edaphic islands in a similar way.

On true islands, there is a positive relationship between area, resource availability, and habitat diversity (Table 1) (Hortal et al. 2009, Weigelt and Kreft 2013, Keppel et al. 2016, Henneron et al. 2019). However, on edaphic islands, resource availability and habitat diversity are often homogeneous because each edaphic island corresponds to a single patch of a distinct habitat type characterized by similar soil parameters. Regarding colonization, island size and spatial isolation may operate independently, but they may also combine to produce an emerging property known as the target effect (MacArthur and Wilson 1967, Whitehead and Jones 1969, Lomolino 1990) (Table 2; Fig. 2). Although long-recognized as an intrinsic property of true islands, the target effect has been rarely mentioned in the biogeographic literature (Stracey and Pimm 2009, Fattorini 2010, Carter et al. 2020, Hauffe et al. 2020), and it remains untested in the context of edaphic islands.

## Insularity metrics for edaphic islands

Based on a comprehensive literature screening, we selected nine isolation metrics most commonly used and informative in island biogeography (Gilpin and Diamond 1976,

Table 2. Insularity metrics used in this study.

| Insularity metric | Abbreviation | Description |
|---|---|---|
| Island size | Size | Target edaphic island size |
| Nearest neighbor distance | NND | Distance from the target edaphic island to the closest edaphic island |
| Distance to the nearest species source | DNSS | Distance from the target edaphic island to the closest putative species source |
| Stepping-stone path to the species source | SSP | The shortest possible path from the target edaphic island to the closest putative species source; the path is composed of islands of the same habitat as the target edaphic island (stepping-stones) |
| Number of stepping stones | NSS | Number of islands of the same habitat as the target edaphic island between the target edaphic island and the putative species source |
| Largest gap in the stepping-stone path to the species source | LGSSP | The longest distance among all pairs of stepping stones (see SSP) |
| Number of islands in a buffer radius | NIB | Number of neighboring edaphic islands surrounding the target island established at two scales: local (NIB1) and landscape (NIB2). System-specific and context-dependent |
| Target effect | TE | Natural logarithm of the quotient between the DNSS and the square root of Size (Fig. 2) |

Gilpin 1980, Calabrese and Fagan 2004, Diver 2007, Weigelt and Kreft 2013, Carter et al. 2020, Itescu et al. 2020) (Supporting information). The selected metrics capture different isolation components, namely distance to species source, stepping stones and island network (Carter et al. 2020) (Table 2). The calculation of some of these metrics relies on the identification of putative species sources, as well as on the mapping of all the edaphic islands in the study area. Details about the calculations of insularity metrics are provided in Supporting information. Because species sources for true islands are characterized by a large size and high species richness (MacArthur and Wilson 1967, Carvajal-Endara et al. 2017, Ottaviani et al. 2020) (Fig. 1), we adapted this assumption to edaphic islands by identifying as putative species sources those patches that scored above the third quartile of data distribution for both island size and species richness of specialist plants (hereafter third quartile approach).

## Testing the approach in different edaphic island systems

Here, we focused on three different edaphic island systems in Europe: 1) calcareous spring fens in the western Carpathians (Slovakia and the easternmost Czech Republic; hereafter fens); 2) acidic alpine grasslands in Cantabrian mountaintops (northwestern Spain; hereafter mountaintops) and; 3) shallow-soil acidophilous grasslands in Moravian granite outcrops (southern Czech Republic; hereafter outcrops) (Fig. 3). We worked with vascular plant specialist species of each focal

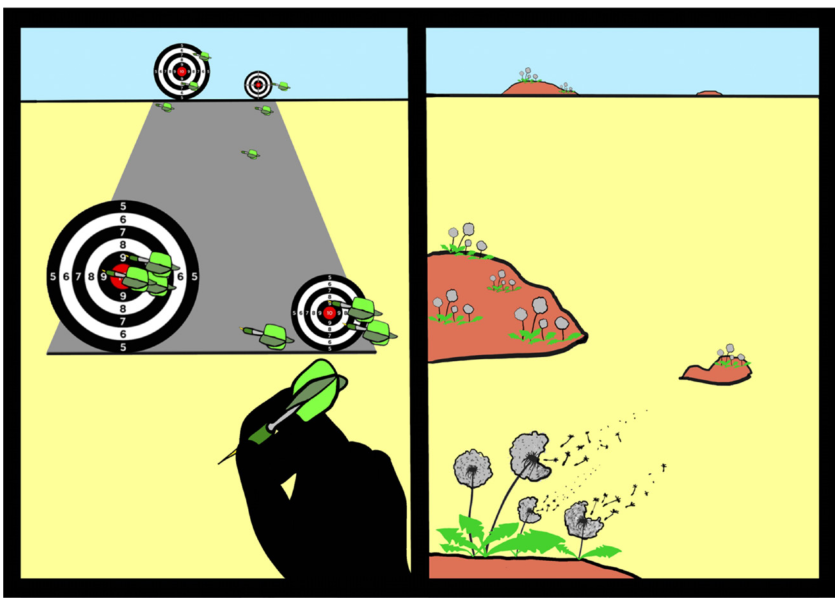

Figure 2. Schematic representation of the target effect. (A) Target effect as an emergent property of multidimensional objects (such as islands) – hitting the target is harder with increasing distance and decreasing size. (B) The target effect applies to both true and edaphic islands because with increasing distance and decreasing size, they have a lower probability of being colonized.

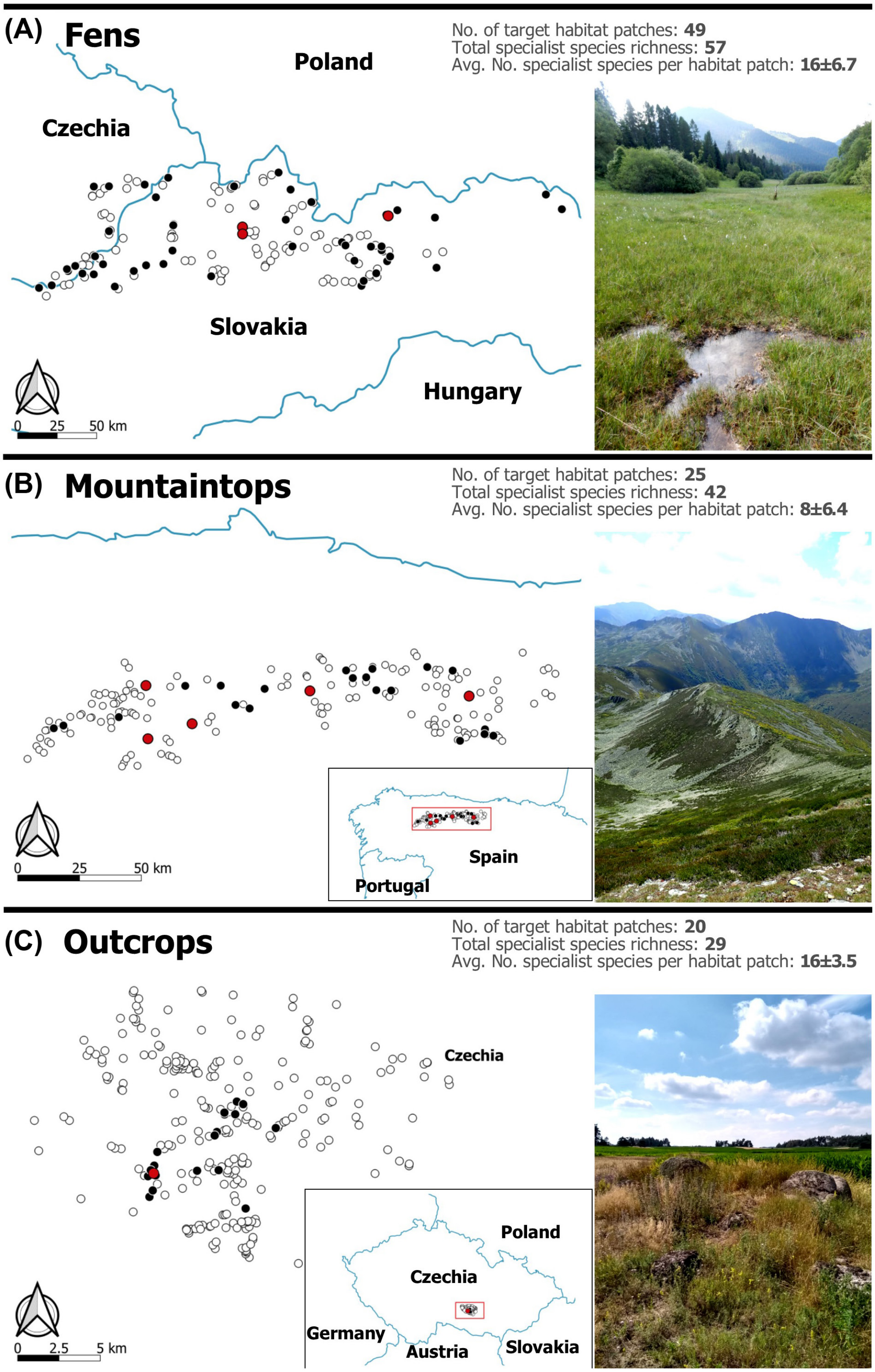


Figure 3. Geographical setting and characteristics of the studied edaphic island systems: western Carpathian calcareous fens (A), Cantabrian acidic mountaintops (B), Moravian granite outcrops (C). Red-filled dots correspond to putative species sources, black-filled dots to floristically surveyed habitat patches and empty dots to non-surveyed patches of the focal habitat.

habitat type (edaphic island). These species are exclusively or tightly associated with the edaphic islands, unable to establish viable populations elsewhere in the landscape matrix.

Briefly, in fens, floristic data were collected at a single 4 m × 4 m plot located at the central part of each island (Horsák et al. 2012, Horsáková et al. 2018). The species inventory at each island was completed by a floristic census of the whole edaphic island. In mountaintops, a total of 284 vegetation plots (size between 10 and 40 $m^2$) were used to sample alpine grasslands in isolated patches on acidic bedrock, with number of plots per island associated with island area. In outcrops, sampling was performed using four 0.5 m × 0.5 m plots per island and complemented by a census of the whole edaphic island, similarly to what was done for fens. We gathered data on 49 edaphic islands for fens, 25 for mountaintops, and 20 for outcrops (Fig. 3). Expert-based selection of habitat specialists was carried out in each study system (Supporting information).

### *Biogeographic data*

We identified and delimited the edaphic islands by combining different techniques. In fens, all known patches found in the western Carpathians were manually georeferenced using a GPS device (Garmin GPSMAP 62st; Horsák et al. 2012, 2018, Horsáková et al. 2018). For mountaintops, we built an edaphic island map by selecting edaphic islands above the regional treeline (1800 m a.s.l.) as those occurring on acidic bedrock only. We differentiated alpine grasslands from rocky and shrub areas based on the Normalized Difference Vegetation Index (NDVI) taken from Sentinel (USGS 2019). For outcrops, the location of edaphic islands was obtained through two sources: a field survey using a GPS device (Garmin eTrex 30×) and a vegetation map provided by the Nature Conservation Agency of the Czech Republic (Härtel et al. 2009). All the GPS points, satellite data, maps and polygon layers were processed and analyzed using QGIS desktop (QGIS 2020) and the Semi-Automatic Classification Plugin (Congedo 2016). All distance-related metrics were calculated using direct aerial Euclidean distance without considering differences in the terrain elevation.

We calculated all the insularity metrics presented in Table 2 for each edaphic island in each system (Supporting information). Using the third-quartile approach described above, we recognized seven potential species sources for fens, five for mountaintops and three for outcrops. However, when calculating the stepping-stone paths (Table 2), we found that some patches preselected as potential species sources were more likely serving as stepping stones (i.e. there were two possible species sources, one located at the nearest Euclidean distance and one located along the stepping-stone path). After correcting this issue (through testing model performance using different numbers of possible species sources), the number of putative species sources was reduced to three for fens and one for outcrops. No reduction was necessary for mountaintops. For fens only (data not available for the other systems), we also considered age of the edaphic island dated on $C^{14}$ of the basal peat layer as an extra indicator of (temporal) isolation (Hájek et al. 2011, Horsák et al. 2015).

### *Data analysis*

First, we checked the normality and linearity of our data. We evaluated the Variance Inflation Factor and tested the multicollinearity between insular predictors (Johnson and Omland 2004, Zuur et al. 2010) (Supporting information) using the function 'vif' in the R package *usdm* (Naimi et al. 2014). Non-collinear predictors were then used in Generalized Linear Models (GLMs) to explore the effect of insularity metrics on specialist species richness in each of the three study systems (Table 2 and Supporting information). Discarded variables, full models, error distribution and links are available in Supporting information. GLMs were fitted using the built-in R function 'glm'. After fitting GLMs containing all selected predictors for each edaphic island system, we performed an automated model selection procedure (Burnham and Anderson 2002, Wagenmakers and Farrell 2004) based on AICc ranking criteria, using the function 'dredge' in the package *MuMIn* (Bartoń 2019). From the full set of possible models, we selected those with a delta AICc < 4 and performed model averaging (Burnham and Anderson 2002) using the function 'model.avg' (package *MuMIn*). As results of the model averaging, we obtained AICc weight, standardized model coefficient, 95% confidence interval and standard error related to each predictor. All the analyses were performed in R ver. 3.6.1 (R<https://www.R-project.org>).

### *Results*

In fens, island size and target effect had the strongest effect on the richness of plant specialists (Fig. 4 and Supporting information). The effect of island size was positive (i.e. larger edaphic islands hosted more specialist species), while the impact of target effect was negative (i.e. fewer specialist species were found on smaller and more isolated edaphic islands). On mountaintops, the species richness of plant specialists was positively linked to island size (Fig. 4 and Supporting information) but it was not significantly related to any other insularity metrics. On outcrops, target effect was the only important predictor (yet only marginally significant at $p < 0.1$) of habitat specialist species richness (Fig. 4 and Supporting information). This relationship was negative, implying that smaller and more isolated edaphic islands hosted fewer habitat specialist species than larger and less isolated ones.

## The effect of insularity on edaphic island plants

The extension of the theory of island biogeography (MacArthur and Wilson 1967) to terrestrial island-like systems has been debated recently (Itescu 2019). Our study contributes to the debate by defining and testing what insularity may mean in edaphic islands.

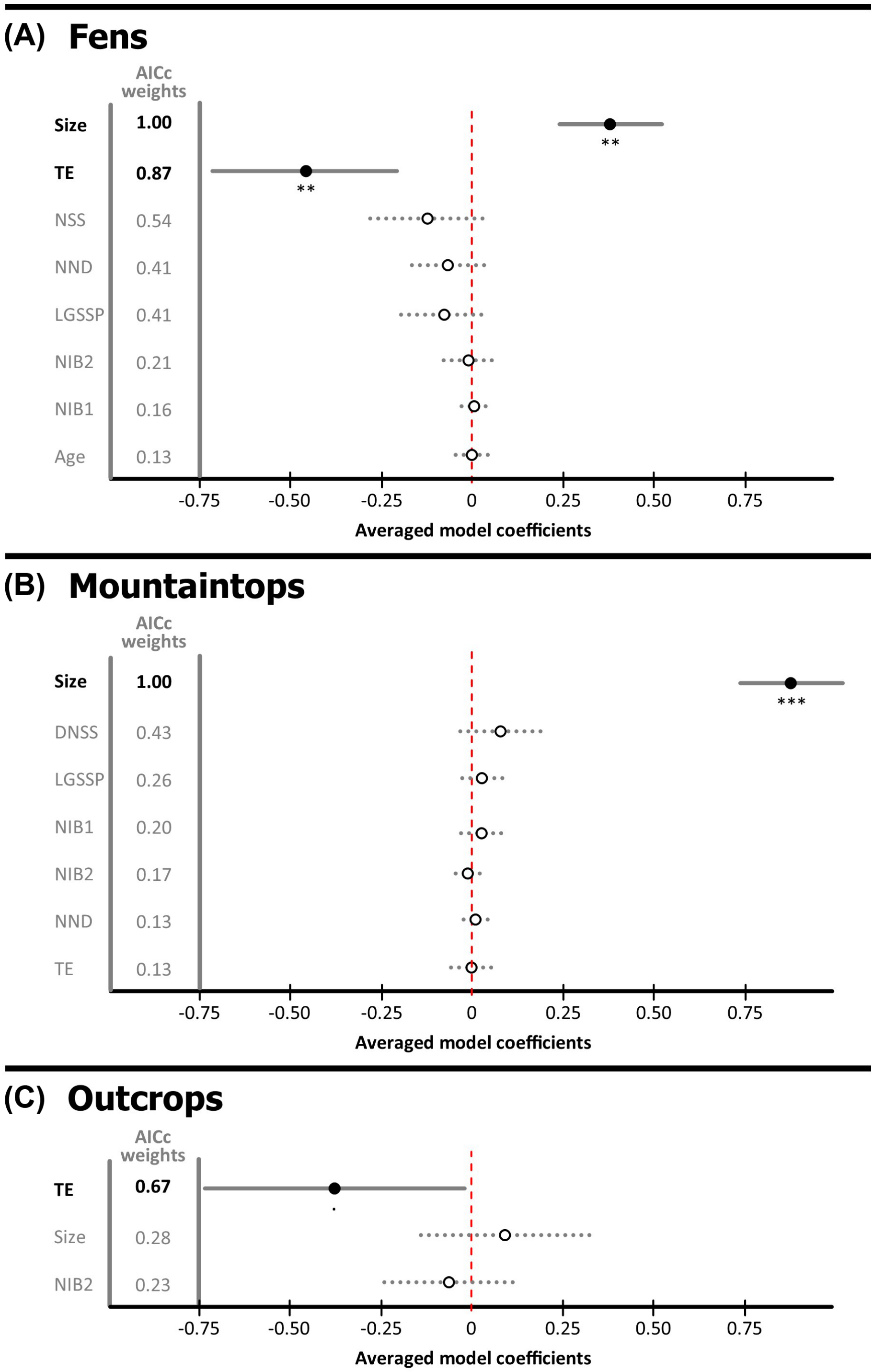


Figure 4. Effects of insularity metrics on the species richness of plant specialist for the studied edaphic island systems. Circles represent predictor standardized averaged model coefficients and lines 95% confidence intervals. Solid circles and lines denote the most important (i.e. informative and significant) insular predictors of edaphic island specialist species richness. For abbreviations, refer to Table 2. Full model outputs are provided in Supporting information. Significance levels: $^{***}< 0.001$; $^{**}< 0.01$; $^{*}< 0.05$;. < 0.1

### *The role of island size and target effect in predicting species richness*

Island size and target effect emerged as the best predictors of edaphic island specialist species richness (Fig. 4 and Supporting information). The positive effect of island size on species richness aligns with the extensive body of evidence in the field of island biogeography (Kalmar and Currie 2006, Kreft et al. 2008, Weigelt and Kreft 2013, Matthews et al. 2016, Whittaker et al. 2017, Ibanez et al. 2018). Indeed, larger edaphic islands confirmed their ability to host more plant specialist species in fens and mountaintops, and indirectly (through target effect) for outcrops.

However, isolation is what uniquely defines true islands; by extension, isolation should also be a key driver of species richness on edaphic islands (Patiño et al. 2017, Itescu 2019, Ottaviani et al. 2020). In our study, isolation occurred in the form of target effect – an emergent property of islands describing that they become harder targets to be colonized with increasing isolation and decreasing size (MacArthur and Wilson 1967, Gilpin and Diamond 1976, Stracey and Pimm 2009) (Fig. 2). Because target effect incorporates island size and isolation into one metric, it may capture the effect of insularity on biota more comprehensively than island size and isolation separately (MacArthur and Wilson 1963, Whitehead and Jones 1969, Gilpin and Diamond 1976). Additionally, target effect is dimensionless and easy to measure, especially when compared to more elaborated and time-consuming connectivity metrics (Tischendorf and Fahrig 2000, Diver 2007, Weigelt and Kreft 2013, Carter et al. 2020). Such properties make this metric very suitable for biogeographic studies.

***Biogeographic insights into the studied edaphic island systems***

We identified that the plant species occurring in the three edaphic island systems experience different degrees of insularity generated by differences in the effect of island size and isolation. For the western Carpathian fens (time-since-formation being approximately 17 Ky; Hájek et al. 2011, Horsák et al. 2015), we revealed the strongest effect of insularity on edaphic island plant specialists, with both island size and target effect playing a key role in shaping the richness of specialists. Additionally, the largest fens also tended to be the oldest and least spatially isolated, further supporting the highest richness of habitat specialists (Horsák et al. 2012). Age provides an estimate of temporal isolation (Nekola 1999, Flantua et al. 2020). However, age and distance to the species source as single predictors did not significantly explain specialist richness in fens.

For Cantabrian mountaintops, edaphic island specialist richness was driven solely by island size. Although a tight species-area relationship is an important property of any insular system (Aranda et al. 2013, Whittaker et al. 2017, Henneron et al. 2019), isolation metrics and target effect did not affect plant specialists. Therefore, the insularity of this system remains doubtful. One possible explanation for the lack of isolation effect in this island-like system may be related to the temporal dynamics of alpine grasslands, which have been historically connected in glacial periods, favoring the immigration of species to new areas through temporary bridges (Flantua et al. 2020), and the persistence of small populations in restricted areas during interglacial periods such as the present (Jiménez-Alfaro et al. 2016).

For Moravian outcrops, target effect was the most important predictor of edaphic island specialist richness, yet its effect was less pronounced than for fens (Fig. 4 and Supporting information). This finding may indicate that, although this system is distinguished by a certain degree of insularity, there are other important ecological drivers that are independent of biogeographic predictors, such as long-term management regimes including grazing pressure, mowing frequency and abandonment (Buchholz et al. 2018).

Finally, no effects of connectivity metrics (i.e. stepping stones and island network) on specialist richness as found in all the three case studies may indicate that our edaphic island systems resemble more true islands than fragmented habitats ruled by metapopulation dynamics (Fahrig 2003) (Fig. 1). In that context, landscape connectivity among the patches is expected to be an important driver of species richness and composition (Mouquet and Loreau 2003, Leibold et al. 2004, Saura et al. 2014, Hanski 2015, Flantua et al. 2020).

## Conclusions and future directions

This study provides a conceptual framework and methodological tools to address a hot topic for island biogeography: whether terrestrial island-like systems (edaphic islands in this case) function as true islands (Patiño et al. 2017, Itescu 2019, Ottaviani et al. 2020). We were able to identify an effect of insularity on the richness of edaphic island plant specialists across different systems. Our findings suggest that the proposed approach is applicable in areas with different environmental conditions (e.g. climate, geology, soil) and spatial scales (fens and mountaintops are distributed over areas spanning tens to hundreds of kilometers, whereas outcrops only across a few kilometers).

We acknowledge that including the role of dispersal would have been ideal because may provide insights into the mechanisms driving colonization on edaphic islands. This approach, however, would require information about the maximum dispersal distance for either all or the vast majority of specialist species so to identify good or bad dispersers. Then, good dispersers should be removed from the models so focusing only on those specialists with limited dispersal abilities (hence, accounting for metapopulation dynamics). Unfortunately, plant traits related to dispersal were not available in a sufficient amount that would have allowed us to reliably identify good and bad dispersers for the three edaphic island systems. Finally, in the absence of data on dispersal, our approach based on the identification of edaphic island specialists appears more conservative.

We encourage broader scrutiny and implementation of the proposed approach to other terrestrial island-like systems, including those dominated by different growth forms than herbs (e.g. woody plants in isolated forest patches; Coelho et al. 2018) or where the difference between islands and the landscape matrix is not defined by edaphic conditions (e.g. elevation; Sklenář et al. 2014). In other systems, we cannot rule out that different island biogeography predictors (alone or in combination) may effectively capture the effect of insularity on island biota.

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### Authors contributions

FEMC conceived the research idea and ran the analyses; FEMC and GO wrote the first draft of the manuscript and led the writing; MCh, MHá, MHo, BJ-A and DZ collected and prepared the floristic data; all co-authors contributed to the analytical setup and revisions of the manuscript.

### Transparent Peer Review

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### Data availability statement

All data is provided in the Supporting information.

## References

Aranda, S. C. et al. 2013. How do different dispersal modes shape the species-area relationship? Evidence for between-group coherence in the Macaronesian flora. – Glob. Ecol. Biogeogr. 22: 483–493.
Bartoń, K. 2019. MuMIn: Multi-model inference. R package version 1.43.6. – <https://cran.r-project.org/web/packages/MuMIn/index.html>.
Buchholz, S. et al. 2018. Reducing management intensity and isolation as promising tools to enhance ground-dwelling arthropod diversity in urban grasslands. – Urban Ecosyst. 21: 1139–1149.
Burnham, K. P. and Anderson, D. R. 2002. Avoiding pitfalls when using information-theoretic methods. – J. Wildl. Manage. 66: 912–918.
Calabrese, J. M. and Fagan, W. F. 2004. A comparison-shopper 's guide to connectivity metrics. – Front. Ecol. Environ. 2: 529–536.
Carlquist, S. J. 1974. Island biology. – Columbia Univ. Press.
Carter, Z. T. et al. 2020. Determining the underlying structure of insular isolation measures. – J. Biogeogr. 47: 1–13.
Carvajal-Endara, S. et al. 2017. Habitat filtering not dispersal limitation shapes oceanic island floras: species assembly of the Galápagos archipelago. – Ecol. Lett. 20: 495–504.
Carvalho, J. C. and Cardoso, P. 2014. Drivers of beta diversity in Macaronesian spiders in relation to dispersal ability. – J. Biogeogr. 41: 1859–1870.
Coelho, M. S. et al. 2018. Forest archipelagos: a natural model of metacommunity under the threat of fire. – Flora 238: 244–249.
Cox, C. B. et al. 2016. Biogeography: an ecological and evolutionary approach. – John Wiley & Sons.
Dambros, C. et al. 2020. The role of environmental filtering, geographic distance and dispersal barriers in shaping the turnover of plant and animal species in Amazonia. – Biodivers. Conserv. 29: 3609–3634.
Dawson, M. N. et al. 2016. Biogeography of islands, lakes, and mountaintops: evolutionary. – In: Encyclopedia of evolutionary biology. Elsevier, pp. 203–210.
Dembicz, I. et al. 2020. Steppe islands in a sea of fields: where island biogeography meets the reality of a severely transformed landscape. – J. Veg. Sci. 32: e12930.
Diver, K. C. 2007. Not as the crow flies: assessing effective isolation for island biogeographical analysis. – J. Biogeogr. 35: 1040–1048.
Fahrig, L. 2003. Effects of habitat fragmentation on biodiversity. – Annu. Rev. Ecol. Evol. Syst. 34: 487–515.
Fattorini, S. 2009. The influence of geographical and ecological factors on island beta diversity patterns. – J. Biogeogr. 37: 1061–1070.
Fattorini, S. 2010. The use of cumulative area curves in biological conservation: a cautionary note. – Acta Oecologica 36: 255–258.
Flantua, S. G. A. et al. 2020. Snapshot isolation and isolation history challenge the analogy between mountains and islands used to understand endemism. – Glob. Ecol. Biogeogr. 29: 1651–1673.
Gilpin, M. E. 1980. The role of stepping-stone islands. – Theor. Popul. Biol. 17: 247–253.
Gilpin, M. E. and Diamond, J. M. 1976. Calculation of immigration and extinction curves from the species area distance relation. – Proc. Natl. Acad. Sci. USA 73: 4130–4134.
Goedecke, F. et al. 2020. Reciprocal extrapolation of species distribution models between two islands – specialists perform better than generalists and geological data reduces prediction accuracy. – Ecol. Indic. 108: 105652.
Hájek, M. et al. 2011. Environmental and spatial controls of biotic assemblages in a discrete semi-terrestrial habitat: comparison of organisms with different dispersal abilities sampled in the same plots. – J. Biogeogr. 38: 1683–1693.
Hanski, I. 2015. Habitat fragmentation and species richness. – J. Biogeogr. 42: 989–993.
Harrison, S. 1997. How natural habitat patchiness affects the distribution of diversity in Californian serpentine chaparral. – Ecology 78: 1898–1906.
Harrison, S. et al. 2006. Regional and local species richness in an insular environment: serpentine plants in California. – Ecol. Monogr. 76: 41–56.
Härtel, H. et al. (Eds) 2009. Mapování biotopů v České republice. Východiska, výsledky, perspektivy. – Agentura ochrany přírody a krajiny ČR.
Hauffe, T. et al. 2020. Lake expansion elevates equilibrium diversity via increasing colonization. – J. Biogeogr. 47: 1849–1860.
Henneron, L. et al. 2019. Habitat diversity associated to island size and environmental filtering control the species richness of rock-savanna plants in neotropical inselbergs. – Ecography 42: 1536–1547.
Horsák, M. et al. 2012. The age of island-like habitats impacts habitat specialist species richness. – Ecology 93: 1106–1114.
Horsák, M. et al. 2015. Drivers of aquatic macroinvertebrate richness in spring fens in relation to habitat specialization and dispersal mode. – J. Biogeogr. 42: 2112–2121.
Horsák, M. et al. 2018. Spring-fen habitat islands in a warming climate: partitioning the effects of mesoclimate air and water

temperature on aquatic and terrestrial biota. – Sci. Total Environ. 634: 355–365.
Horsáková, V. et al. 2018. Principal factors controlling the species richness of European fens differ between habitat specialists and matrix-derived species. – Divers. Distrib. 24: 742–754.
Hortal, J. et al. 2009. Island species richness increases with habitat diversity. – Am. Nat. 174: E205–E217.
Ibanez, T. et al. 2018. Regional forcing explains local species diversity and turnover on tropical islands. – Glob. Ecol. Biogeogr. 27: 474–486.
Irl, S. D. H. et al. 2015. Climate vs topography – spatial patterns of plant species diversity and endemism on a high-elevation island. – J. Ecol. 103: 1621–1633.
Itescu, Y. 2019. Are island-like systems biologically similar to islands? A review of the evidence. – Ecography 42: 1298–1314.
Itescu, Y. et al. 2020. The diverse nature of island isolation and its effect on land bridge insular faunas. – Glob. Ecol. Biogeogr. 29: 262–280.
Jiménez-Alfaro, B. et al. 2016. Anticipating extinctions of glacial relict populations in mountain refugia. – Biol. Conserv. 201: 243–251.
Jiménez-Alfaro, B. et al. 2021. Post-glacial determinants of regional species pools in alpine grasslands. – Glob. Ecol. Biogeogr. 30: 1101–1115.
Johnson, J. B. and Omland, K. S. 2004. Model selection in ecology and evolution. – Trends Ecol. Evol. 19: 101–108.
Kalmar, A. and Currie, D. J. 2006. A global model of island biogeography. – Glob. Ecol. Biogeogr. 15: 72–81.
Keppel, G. et al. 2016. Habitat diversity predicts orchid diversity in the tropical south-west Pacific. – J. Biogeogr. 43: 2332–2342.
Kreft, H. et al. 2008. Global diversity of island floras from a macroecological perspective. – Ecol. Lett. 11: 116–127.
Kruckeberg, A. R. 1991. An essay: geoedaphics and island biogeography for vascular plants. – Aliso 13: 225–238.
Leibold, M. A. et al. 2004. The metacommunity concept: a framework for multi-scale community ecology. – Ecol. Lett. 7: 601–613.
Lomolino, M. V. 1990. The target area hypothesis: the influence of island area on immigration rates of non-volant mammals. – Oikos 57: 297.
Lomolino, M. V. 2000a. A call for a new paradigm of island biogeography. – Glob. Ecol. Biogeogr. 9: 1–6.
Lomolino, M. V. 2000b. A species-based theory of insular zoogeography. – Glob. Ecol. Biogeogr. 9: 39–58.
Losos, J. B. and Ricklefs, R. E. 2009. the theory of island biogeography revisited. – Princeton Univ. Press.
MacArthur, R. H. and Wilson, E. O. 1963. An equilibrium theory of Insular zoogeography. – Evolution 17: 373–387.
MacArthur, R. H. and Wilson, E. O. 1967. The theory of Island biogeography. – Princeton Univ. Press.
Matthews, T. J. et al. 2016. On the form of species–area relationships in habitat islands and true islands. – Glob. Ecol. Biogeogr. 25: 847–858.
McGann, T. D. 2002. How insular are ecological 'Islands'? An example from the granitic outcrops of the new England Batholith of Australia. – Proc. R. Soc. Queensl. 110: 1–13.
Morgan, J. W. and Venn, S. E. 2017. Alpine plant species have limited capacity for long-distance seed dispersal. – Plant Ecol. 218: 813–819.
Mouquet, N. and Loreau, M. 2003. Community patterns in source-sink metacommunities. – Am. Nat. 162: 544–557.
Naimi, B. et al. 2014. Where is positional uncertainty a problem for species distribution modelling? – Ecography 37: 191–203.
Nekola, J. C. 1999. Paleorefugia and neorefugia: the influence of colonization history on community pattern and process. – Ecology 80: 2459–2473.
Ottaviani, G. et al. 2020. Linking plant functional ecology to island biogeography. – Trends Plant Sci. 25: 329–339.
Patiño, J. et al. 2017. A roadmap for island biology: 50 fundamental questions after 50 years of the theory of island biogeography. – J. Biogeogr. 44: 963–983.
Saura, S. et al. 2014. Stepping stones are crucial for species' long-distance dispersal and range expansion through habitat networks. – J. Appl. Ecol. 51: 171–182.
Sklenář, P. et al. 2014. Island biogeography of tropical alpine floras. – J. Biogeogr. 41: 287–297.
Stracey, C. M. and Pimm, S. L. 2009. Testing island biogeography theory with visitation rates of birds to British islands. – J. Biogeogr. 36: 1532–1539.
Tamme, R. et al. 2014. Predicting species' maximum dispersal distances from simple plant traits. – Ecology 95: 505–513.
Tapper, S. L. et al. 2014. Prolonged isolation and persistence of a common endemic on granite outcrops in both mesic and semi-arid environments in southwestern Australia. – J. Biogeogr. 41: 2032–2044.
Tischendorf, L. and Fahrig, L. 2000. On the usage and measurement of landscape connectivity. – Oikos 90: 7–19.
Wagenmakers, E. J. and Farrell, S. 2004. AIC model selection using Akaike weights. – Psychon. Bull. Rev. 11: 192–196.
Weigelt, P. and Kreft, H. 2013. Quantifying island isolation – insights from global patterns of insular plant species richness. – Ecography 36: 417–429.
Whitehead, D. R. and Jones, C. E. 1969. Small islands and the equilibrium theory of insular biogeography. – Evolution 23: 171.
Whittaker, R. J. and Fernández-Palacios, J. M. 2006. Island biogeography: ecology, evolution, and conservation. – Oxford Univ. Press.
Whittaker, R. J. et al. 2008. A general dynamic theory of oceanic island biogeography. – J. Biogeogr. 35: 977–994.
Whittaker, R. J. et al. 2017. Island biogeography: taking the long view of nature's laboratories. – Science 357: eaam8326.
Yeakley, J. A. and Weishampel, J. F. 2000. Multiple source pools and dispersal barriers for Galapagos plant species distribution. – Ecology 81: 893.
Zuur, A. F. et al. 2010. A protocol for data exploration to avoid common statistical problems. – Methods Ecol. Evol. 1: 3–14.

**What defines insularity for plants in edaphic islands?**
**Supplementary material 1**

| Further comparison between oceanic islands, edaphic islands, and fragmented habitats. | | | |
|---|---|---|---|
| | **True (ocanic) islands** | **Edaphic islands** | **Fragmented habitats** |
| **Species source** | Fixed and well-defined, usually a continent. | Fixed but putative, generally one of the largest edaphic island(s). | Dynamic and undefined, patches may act as both sinks or sources. |
| **Habitat types** | Several habitats may occur on a single island. | All patches belong to a single habitat type. | All fragments correspond to a single habitat type. |
| **Specialists vs generalists** | Each individual landmass is an island for both specialists and generalists. | Each patch is an island mainly for habitat specialists. | Habitat fragments serve as islands neither for specialist nor generalists. |
| **Matrix dissimilarity** | The ocean constitutes an inhospitable matrix preventing the establishment of all the species from the terrestrial habitats. | The matrix is dissimilar, inhospitable and, to some degree, impermeable mainly for edaphic island specialists. | Habitat fragments may expand, contract, merge, disappear or re-appear in the matrix. |
| **Colonization** | Main colonization flux is from the species source to islands. Back colonization (i.e. from islands to species source) occurs rarely. | Main colonization flux is from the species source to islands. Back colonization is likely to occur. Inter-island colonization may be important in highly connected parts of the system. | Main colonization flux is from one fragment to another fragment. Inter-fragment colonization is highly dynamic. Fragments may play different roles (sink or source) for different species and changing with time. |

## What defines insularity for plants in edaphic islands?
## Supplementary material 2

### Further Description of insularity metrics

**Island size** corresponds to the area of the target edaphic island.

**Distance to the nearest species source** and **Nearest neighbor distance** corresponds to the Euclidean distance between a target island and its nearest putative species source or neighbor, respectively (MacArthur and Wilson 1963, 1967).

For **Number of islands in a buffer radius**, the optimal size of the buffer for measuring the amount of focal habitat depends on the spatial scale of the study system (Weigelt and Kreft 2013). Therefore, we designed independent sets of buffer radius, two for each edaphic island system (local and landscape scale), considering the distribution of their inter-island distances. We used these buffers to calculate a proxy of the available habitat to specialist species by counting the number of target edaphic islands surrounding a given target edaphic island.

Regarding connectivity metrics (**Stepping-stone path, Number of stepping stones and Largest gap in the stepping-stone path**), we built stepping-stone paths connecting the target edaphic islands with their nearest putative species source (Gilpin 1980, Carter et al. 2020). We followed two main criteria to build these paths: 1) keeping the number of stepping-stones as low as possible and 2) making sure that inter-island distances along the path never exceeded the direct distance between the target edaphic island and its putative species source. The **Largest gap in the stepping-stone path** represents the longest distance a species has to overcome to disperse from the putative source (Kalmar and Currie 2006, Diver 2007).

**Target effect** was calculated as the natural logarithm of the ratio between the Distance to the nearest species source and the square root of the Island size (Fig. 3). The conceptual origin of Target effect can be traced back to MacArthur and Wilson (1963) and Gilpin and Diamond (1976) where it was associated with immigration rates. This metric, in the way we have formulated it, rescales the distance to the species source accordingly to the size of the target island (e.g. smaller and more isolated islands should be harder to colonize, accounting fewer species, than less isolated and larger ones).

**What defines insularity for plants in edaphic islands?**
**Supplementary material 3**

**Supplementary Table 1 - Habitat specialist richness and biogegraphic predictors (Western Carpathian fens)**

| Island ID | Plant specialist richness | Age (years) | Island size (m2) | Nearest neighbor distance (m) | Number of islands in Buffer 1 (2.8 km) | Number of islands in Buffer 2 (42 km) | Distance to the nearest species source (m) |
|---|---|---|---|---|---|---|---|
| B10 | 33 | 10932 | 30000 | 1339 | 3 | 42 | 90314 |
| C24 | 14 | 636 | 912 | 1402 | 4 | 60 | 25519 |
| D31 | 26 | 1064 | 6000 | 1872 | 3 | 66 | 33002 |
| D32 | 15 | 4967 | 860 | 8053 | 1 | 51 | 45582 |
| G35 | 14 | 2789 | 820 | 10542 | 1 | 24 | 43787 |
| G36 | 14 | 7692 | 15000 | 1021 | 4 | 45 | 21577 |
| G39 | 9 | 469 | 1000 | 2552 | 2 | 44 | 103192 |
| H43 | 12 | 670 | 3380 | 10027 | 1 | 51 | 53861 |
| H54 | 21 | 12473 | 3000 | 2379 | 4 | 45 | 19254 |
| H57 | 13 | 730 | 1500 | 1333 | 2 | 42 | 111441 |
| H60 | 13 | 665 | 1520 | 312 | 5 | 49 | 93018 |
| J63 | 10 | 1737 | 700 | 2917 | 2 | 51 | 86081 |
| K65 | 14 | 1958 | 1700 | 578 | 2 | 44 | 105771 |
| K66 | 7 | 735 | 800 | 5707 | 1 | 46 | 94998 |
| K69 | 15 | 908 | 800 | 2342 | 3 | 45 | 36204 |
| K70 | 14 | 1738 | 850 | 218 | 2 | 42 | 54911 |
| K71 | 8 | 988 | 214 | 1308 | 4 | 57 | 82590 |
| K72 | 27 | 7449 | 16000 | 2917 | 2 | 61 | 32874 |
| K73 | 17 | 1480 | 1000 | 29 | 2 | 56 | 37572 |
| L77 | 24 | 11049 | 18000 | 163 | 3 | 57 | 34657 |
| M84 | 11 | 880 | 530 | 6370 | 1 | 35 | 123574 |
| M87 | 26 | 12824 | 20000 | 3321 | 2 | 47 | 46259 |
| M89 | 9 | 426 | 80 | 5115 | 1 | 46 | 65716 |
| M90 | 12 | 813 | 3000 | 13350 | 1 | 2 | 98130 |
| M92 | 8 | 8878 | 2200 | 4303 | 1 | 54 | 89308 |
| M93 | 7 | 908 | 2800 | 2517 | 2 | 56 | 87175 |
| M94 | 29 | 12160 | 5000 | 496 | 3 | 65 | 496 |
| N99 | 10 | 442 | 750 | 1333 | 2 | 42 | 111767 |
| O101 | 12 | 1681 | 539 | 2816 | 2 | 57 | 72493 |
| P107 | 22 | 11030 | 15000 | 2917 | 2 | 60 | 32074 |
| P113 | 16 | 1621 | 500 | 275 | 4 | 61 | 45239 |
| P118 | 20 | 12029 | 4900 | 6637 | 1 | 37 | 6637 |
| P119 | 16 | 1816 | 1300 | 3432 | 2 | 45 | 27965 |
| R140 | 25 | 10432 | 15000 | 3494 | 2 | 44 | 35711 |
| R142 | 28 | 16975 | 11000 | 496 | 3 | 65 | 496 |
| R143 | 9 | 475 | 700 | 13350 | 1 | 2 | 107258 |
| S156 | 24 | 3711 | 2390 | 2846 | 2 | 52 | 21733 |
| S158 | 12 | 6619 | 970 | 8550 | 1 | 49 | 56489 |
| S162 | 9 | 2293 | 300 | 578 | 2 | 44 | 106317 |
| S164 | 13 | 2705 | 500 | 449 | 2 | 54 | 42784 |
| T168 | 18 | 270 | 2500 | 4558 | 1 | 51 | 40176 |
| T170 | 21 | 1905 | 1130 | 3321 | 2 | 49 | 42944 |
| T172 | 11 | 4399 | 246 | 5991 | 1 | 46 | 96601 |
| V177 | 16 | 3575 | 15000 | 3243 | 3 | 62 | 27196 |
| V179 | 16 | 14075 | 8600 | 21684 | 1 | 21 | 28881 |
| V180 | 13 | 3201 | 1000 | 8407 | 1 | 57 | 64098 |
| V191 | 19 | 8168 | 500 | 3432 | 3 | 43 | 25081 |
| V192 | 27 | 5892 | 10000 | 1339 | 3 | 45 | 1339 |
| Z202 | 9 | 641 | 675 | 6797 | 1 | 23 | 131620 |

## Supplementary Table 2 - Habitat specialist richness and biogegraphic predictors (Cantabrian mountaintops)

| Island ID | Plant specialist richness | Age (years) | Island size (m2) | Nearest neighbor distance (m) | Number of islands in Buffer 1 (11 km) | Number of islands in Buffer 2 (48 km) | Distance to the nearest species source (m) |
|---|---|---|---|---|---|---|---|
| 58 | 13 | - | 30040434 | 114 | 10 | 73 | 8278 |
| 73 | 2 | - | 937416 | 135 | 14 | 65 | 25139 |
| 79 | 4 | - | 31898864 | 97 | 4 | 66 | 1941 |
| 92 | 8 | - | 3091364 | 156 | 15 | 62 | 28367 |
| 97 | 5 | - | 7449065 | 1084 | 3 | 69 | 9227 |
| 100 | 5 | - | 3048664 | 57 | 20 | 74 | 4212 |
| 104 | 2 | - | 231431 | 170 | 11 | 74 | 21076 |
| 109 | 6 | - | 15445145 | 42 | 12 | 65 | 5361 |
| 115 | 4 | - | 5554750 | 1116 | 7 | 49 | 8115 |
| 118 | 5 | - | 557615 | 1298 | 13 | 69 | 12336 |
| 126 | 9 | - | 3350411 | 360 | 13 | 74 | 15644 |
| 140 | 2 | - | 4495245 | 814 | 5 | 63 | 7791 |
| 144 | 5 | - | 14793219 | 147 | 12 | 83 | 7537 |
| 149 | 7 | - | 2756251 | 763 | 4 | 54 | 11081 |
| 154 | 16 | - | 28161550 | 266 | 11 | 52 | 32990 |
| 162 | 6 | - | 16073301 | 168 | 12 | 75 | 1267 |
| 167 | 3 | - | 431864 | 190 | 11 | 84 | 18881 |
| 182 | 11 | - | 45418539 | 293 | 4 | 65 | 1881 |
| 184 | 4 | - | 11388667 | 154 | 15 | 80 | 17056 |
| 203 | 11 | - | 36222225 | 408 | 8 | 75 | 1881 |
| 243 | 33 | - | 134580200 | 134 | 12 | 74 | 45100 |
| 261 | 3 | - | 715015 | 553 | 15 | 65 | 6106 |
| 266 | 4 | - | 216176 | 553 | 15 | 64 | 8683 |
| 270 | 3 | - | 188952 | 104 | 11 | 62 | 9910 |
| 271 | 5 | - | 1578438 | 224 | 14 | 71 | 9166 |

## Supplementary Table 3 - Habitat specialist richness and biogegraphic predictors (Moravian outcrops)

| Island ID | Plant specialist richness | Age (years) | Island size (m2) | Nearest neighbor distance (m) | Number of islands in Buffer 1 (0.2 km) | Number of islands in Buffer 2 (1 km) | Distance to the nearest species source (m) |
|---|---|---|---|---|---|---|---|
| B17 | 11 | - | 543 | 5 | 2 | 6 | 12045 |
| B7 | 17 | - | 7719 | 24 | 1 | 5 | 10153 |
| B8 | 15 | - | 1084 | 43 | 1 | 4 | 10458 |
| H29 | 18 | - | 1720 | 306 | 0 | 2 | 4032 |
| H33 | 10 | - | 931 | 270 | 0 | 6 | 6024 |
| N1 | 17 | - | 938 | 108 | 2 | 7 | 8526 |
| N11 | 15 | - | 777 | 249 | 0 | 5 | 6989 |
| N12 | 11 | - | 617 | 249 | 0 | 4 | 6643 |
| N2 | 18 | - | 3237 | 17 | 1 | 8 | 9312 |
| N4 | 13 | - | 503 | 6 | 2 | 7 | 8618 |
| P20 | 18 | - | 8972 | 346 | 0 | 4 | 709 |
| P21 | 21 | - | 1512 | 74 | 1 | 6 | 347 |
| P22 | 23 | - | 4145 | 179 | 0 | 6 | 0 |
| P23 | 16 | - | 361 | 179 | 0 | 7 | 273 |
| P24 | 18 | - | 5618 | 219 | 0 | 5 | 582 |
| P26 | 21 | - | 2471 | 437 | 0 | 1 | 2213 |
| P28 | 18 | - | 1736 | 437 | 0 | 2 | 1588 |
| P39 | 14 | - | 824 | 74 | 1 | 6 | 376 |
| T49 | 13 | - | 410 | 6 | 1 | 3 | 2003 |
| V34 | 17 | - | 14115 | 735 | 0 | 0 | 9112 |

| Length of the stepping stone path to the nearest species source (m) | Number of stepping stones | Largest gap in the stepping stone path (m) | Target effect (log[distance to the nearest species sources / sqrt (target island area)]) |
|---|---|---|---|
| 143663 | 24 | 19770 | 6.3 |
| 28862 | 4 | 13465 | 6.7 |
| 50398 | 9 | 8282 | 6.1 |
| 86371 | 11 | 23143 | 7.3 |
| 62511 | 3 | 23648 | 7.3 |
| 21633 | 1 | 19254 | 5.2 |
| 240429 | 32 | 23143 | 8.1 |
| 96398 | 12 | 23143 | 6.8 |
| 19254 | 0 | 19254 | 5.9 |
| 252353 | 35 | 23143 | 8.0 |
| 230689 | 31 | 23143 | 7.8 |
| 162085 | 22 | 23143 | 8.1 |
| 246282 | 33 | 23143 | 7.8 |
| 180231 | 27 | 23143 | 8.1 |
| 43598 | 7 | 19254 | 7.2 |
| 137736 | 20 | 23143 | 7.5 |
| 195021 | 28 | 23143 | 8.6 |
| 53311 | 8 | 19254 | 5.6 |
| 56292 | 6 | 15206 | 7.1 |
| 61831 | 9 | 19254 | 5.6 |
| 268338 | 38 | 23143 | 8.6 |
| 56628 | 11 | 19254 | 5.8 |
| 133879 | 18 | 23143 | 8.9 |
| 100169 | 2 | 69884 | 7.5 |
| 223394 | 29 | 23143 | 7.6 |
| 133836 | 17 | 23143 | 7.4 |
| 496 | 0 | 496 | 1.9 |
| 253685 | 36 | 23143 | 8.3 |
| 115619 | 14 | 23143 | 8.0 |
| 50395 | 7 | 19254 | 5.6 |
| 91482 | 16 | 10388 | 7.6 |
| 6637 | 0 | 6637 | 4.6 |
| 33086 | 5 | 19254 | 6.7 |
| 56818 | 8 | 23143 | 5.7 |
| 496 | 0 | 496 | 1.6 |
| 113519 | 3 | 69884 | 8.3 |
| 26023 | 2 | 19254 | 6.1 |
| 123475 | 17 | 23143 | 7.5 |
| 246860 | 34 | 23143 | 8.7 |
| 103015 | 15 | 23143 | 7.6 |
| 43496 | 5 | 15206 | 6.7 |
| 53307 | 10 | 19254 | 7.2 |
| 231887 | 30 | 23143 | 8.7 |
| 70994 | 11 | 10388 | 5.4 |
| 30285 | 1 | 23648 | 5.7 |
| 107212 | 13 | 23143 | 7.6 |
| 29654 | 4 | 19254 | 7.0 |
| 1339 | 0 | 1339 | 2.6 |
| 282599 | 40 | 23143 | 8.5 |

| Length of the stepping stone path to the nearest species source (m) | Number of stepping stones | Largest gap in the stepping stone path (m) | Target effect (log[distance to the nearest species sources / sqrt (target island area)]) |
|---|---|---|---|
| 16910 | 13 | 3427 | 0.4 |
| 19869 | 16 | 3427 | 3.3 |
| 1941 | 0 | 1941 | -1.1 |
| 18980 | 15 | 3427 | 2.8 |
| 20043 | 16 | 3427 | 1.2 |
| 9061 | 6 | 3427 | 0.9 |
| 4331 | 2 | 1695 | 3.8 |
| 2658 | 1 | 1695 | 0.3 |
| 1889 | 2 | 1115 | 1.2 |
| 4721 | 2 | 2460 | 2.8 |
| 3542 | 2 | 1695 | 2.1 |
| 22791 | 17 | 3427 | 1.3 |
| 3902 | 2 | 1959 | 0.7 |
| 24366 | 19 | 3427 | 1.9 |
| 30761 | 23 | 4506 | 1.8 |
| 1267 | 0 | 1267 | -1.2 |
| 18635 | 14 | 3606 | 3.4 |
| 2034 | 0 | 2034 | -1.3 |
| 4075 | 4 | 1695 | 1.6 |
| 2034 | 0 | 2034 | -1.2 |
| 18158 | 11 | 3606 | 1.4 |
| 6117 | 1 | 3196 | 2.0 |
| 6669 | 2 | 3196 | 2.9 |
| 7299 | 2 | 3196 | 3.1 |
| 9747 | 6 | 3196 | 2.0 |

| Length of the stepping stone path to the nearest species source (m) | Number of stepping stones | Largest gap in the stepping stone path (m) | Target effect (log[distance to the nearest species sources / sqrt (target island area)]) |
|---|---|---|---|
| 9807 | 19 | 1093 | 6.2 |
| 8898 | 20 | 1093 | 4.7 |
| 8483 | 19 | 1093 | 5.8 |
| 4917 | 7 | 1135 | 4.6 |
| 6381 | 11 | 1135 | 5.3 |
| 8228 | 19 | 1093 | 5.6 |
| 5552 | 11 | 1093 | 5.5 |
| 5302 | 10 | 1093 | 5.6 |
| 7444 | 15 | 1093 | 5.1 |
| 8120 | 18 | 1093 | 6.0 |
| 647 | 2 | 346 | 2.0 |
| 227 | 0 | 227 | 2.2 |
| 0 | 0 | 0 | 0.0 |
| 179 | 0 | 179 | 2.7 |
| 553 | 1 | 326 | 2.0 |
| 1623 | 3 | 534 | 3.8 |
| 1186 | 2 | 534 | 3.6 |
| 301 | 1 | 227 | 2.6 |
| 1494 | 3 | 847 | 4.6 |
| 10168 | 21 | 1135 | 4.3 |

**What defines insularity for plants in edaphic islands?**
**Supplementary material 4**

**Supplementary Table 4 - Habitat specialists for Western Carpathian calcareous fens**

| Island-ID | Blysmus compressus | Carex appropinquata | Carex chordorrhiza | Carex davalliana | Carex diandra | Carex dioica | Carex echinata | Carex flava |
|---|---|---|---|---|---|---|---|---|
| **B10** | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 |
| **C24** | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| **D31** | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
| **D32** | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| **G35** | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| **G36** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **G39** | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| **H43** | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| **H54** | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| **H57** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **H60** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **J63** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| **K65** | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| **K66** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **K69** | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| **K70** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| **K71** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **K72** | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 |
| **K73** | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| **L77** | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| **M84** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **M87** | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| **M89** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| **M90** | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| **M92** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **M93** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **M94** | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| **N99** | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| **O101** | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| **P107** | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| **P113** | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| **P118** | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| **P119** | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| **R140** | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| **R142** | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
| **R143** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **S156** | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| **S158** | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| **S162** | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| **S164** | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| **T168** | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| **T170** | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| **T172** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **V177** | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| **V179** | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| **V180** | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| **V191** | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| **V192** | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| **Z202** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

**Supplementary Table 5 - Habitat specialists for Cantabrian mountaintops' acidophilus grasslands**

| Island-ID | Agrostis tileni | Alchemilla fulgida | Alchemilla saxatilis | Alchemilla transiens | Androsace cantabrica | Antennaria dioica | Anthemis cretica subsp. carpatica | Arabis alpina |
|---|---|---|---|---|---|---|---|---|
| **58** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **73** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **79** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **92** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **97** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **100** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **104** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **109** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **115** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **118** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **126** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **140** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **144** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **149** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **154** | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| **162** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **167** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **182** | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| **184** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **203** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **243** | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| **261** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **266** | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| **270** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **271** | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

**Supplementary Table 6 - Habitat specialists for Moravian outcrops' shallow-soil acidophilus grasslands**

| Island-ID | Agrostis vinealis | Artemisia campestris | Centaurea stoebe s.lat. | Dianthus deltoides | Euphrasia stricta | Festuca ovina | Festuca rupicola | Helianthemum grandiflorum s.lat. |
|---|---|---|---|---|---|---|---|---|
| **B17** | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| **B7** | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| **B8** | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| **H29** | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| **H33** | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| **N1** | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| **N11** | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| **N12** | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| **N2** | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| **N4** | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| **P20** | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 |
| **P21** | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| **P22** | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| **P23** | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| **P24** | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| **P26** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **P28** | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| **P39** | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 |
| **T49** | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| **V34** | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |

| Carex hostiana | Carex lasiocarpa | Carex lepidocarpa | Carex limosa | Carex nigra | Carex panicea | Carex pulicaris | Carex viridula | Centaurium littorale ssp. uliginosu |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

| Armeria duriaei | Bellardiochloa variegata | Botrychium lunaria | Campanula scheuchzeri | Dianthus langeanus | Festuca eskia | Festuca indigesta | Festuca summilusitana | Gentiana lutea |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |

| Helichrysum arenarium | Hieracium pilosella | Jasione montana | Jovibarba globifera | Koeleria macrantha | Lychnis viscaria | Phleum phleoides | Pimpinella saxifraga s.str. | Potentilla heptaphylla |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |

| Cladium mariscus | Dactylorhiza incarnata | Dactylorhiza maculata | Dactylorhiza majalis agg. | Drosera anglica | Drosera rotundifolia | Eleocharis quinqueflora | Epipactis palustris | Equisetum variegatum |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |

| Hypericum richeri subsp. burseri | Jasione crispa | Juncus trifidus | Luzula hispanica | Luzula nutans | Lychnis alpina | Minuartia recurva | Omalotheca supina | Omalotheca sylvatica |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

| Potentilla tabernaemontani | Pulsatilla grandis | Scleranthus perennis | Sedum acre | Sedum sexangulare | Seseli osseum | Silene nutans s.lat. | Thymus pulegioides | Verbascum chaixii ssp. austriacum |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |

| Eriophorum angustifolium | Eriophorum latifolium | Glaux maritima | Gymnadenia densiflora | Hydrocotyle vulgaris | Juncus alpinus | Juncus alpinoarticulatus | Juncus subnodulosus | Ligularia sibirica |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |

| Oreochloa blanka | Paronychia polygonifolia | Phyteuma hemisphaericum | Plantago alpina | Potentilla crantzii | Pulsatilla vernalis | Ranunculus amplexicaulis | Rumex suffruticosus | Scorzoneroides pyrenaica |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Veronica dillenii | Veronica prostrata | Veronica verna |
|---|---|---|
| 1 | 0 | 0 |
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 0 | 1 | 0 |
| 1 | 1 | 0 |
| 0 | 0 | 0 |
| 1 | 1 | 1 |
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 1 | 0 |
| 1 | 1 | 1 |
| 0 | 1 | 0 |
| 1 | 1 | 0 |
| 0 | 1 | 0 |
| 1 | 1 | 1 |
| 0 | 1 | 0 |
| 0 | 0 | 0 |
| 0 | 1 | 0 |

| Liparis loeselii | Menyanthes trifoliata | Parnassia palustris | Pedicularis palustris | Pedicularis sceptrum-carolinum | Pinguicula alpina | Pinguicula vulgaris | Plantago maritima | Polygala amarella |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Sedum candolleanum | Silene acaulis | Silene ciliata | Silene foetida | Teesdaliopsis conferta | Thymelaea coridifolia subsp. dendrobryum | Trifolium alpinum |
|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 |
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| 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| 0 | 0 | 1 | 0 | 1 | 0 | 0 |
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| 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 1 | 1 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Primula farinosa | Scheuchzeria palustris | Schoenus ferrugineus | Sesleria uliginosa | Swertia perennis | Tofieldia calyculata | Trichophorum pumilum | Triglochin maritimum | Triglochin palustre | Utricularia minor | Valeriana dioica |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

| Valeriana simplicifolia | Viola palustris |
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**What defines insularity for plants in edaphic islands?**
**Supplementary material 5**

**Supplementary Table 7 - Variance Inflation Factor and test for multicollinearity between biogegraphic predictors (Western Carpathian fens)**

| Variables | VIF of the full set of variables | Discarded | VIF of the remained variables |
|---|---|---|---|
| Age | 3.1 | | 2.8 |
| Island size (Size) | 3.1 | | 2.0 |
| Nearest neighbor distance (NND) | 3.2 | | 3.2 |
| Number of islands in Buffer 1 (NIB1) | 1.9 | | 1.9 |
| Number of islands in Buffer 2 (NIB2) | 3.2 | | 3.1 |
| Distance to the nearest species source (DNSS) | 28.3 | X | - |
| Stepping stone path to the nearest species source (SSP) | 100.3 | X | - |
| Number of stepping stones (NSS) | 90.8 | | 2.7 |
| Largest gap in the stepping stone path (LGSSP) | 9.6 | | 3.6 |
| Target effect (TE) | 6.6 | | 5.3 |

2 variables from the 10 input variables have collinearity problem: **SSP DNSS**
After excluding the collinear variables, the linear correlation coefficients ranges between:
min correlation ( NSS ~ NIB2 ): -0.03
max correlation ( LGSSP ~ NIB2 ): -0.74

**GLM model after VIF analysis:** Fen plant specialist species richness ~ Age + IS + NND + NIB1 + NIB2 + NSS + LGSSP + TE [Poisson (identity)]

**Supplementary Table 8 - Variance Inflation Factor and test for multicollinearity between biogegraphic predictors (Cantabrian mountaintops)**

| Variables | VIF of the full set of variables | Discarded | VIF of the remained variables |
|---|---|---|---|
| Island size (Size) | 11.0 | | 4.1 |
| Nearest neighbor distance (NND) | 1.7 | | 1.6 |
| Number of islands in Buffer 1 (NIB1) | 3.3 | | 1.7 |
| Number of islands in Buffer 2 (NIB2) | 1.6 | | 1.4 |
| Distance to the nearest species source (DNSS) | 15.9 | | 5.0 |
| Stepping stone path to the nearest species source (SSP) | 191.8 | X | - |
| Number of stepping stones (NSS) | 127.1 | X | - |
| Largest gap in the stepping stone path (LGSSP) | 16.0 | | 1.4 |
| Target effect (TE) | 10.1 | | 5.0 |

2 variables from the 9 input variables have collinearity problem: **SSP NSS**
After excluding the collinear variables, the linear correlation coefficients ranges between:
min correlation ( LGSSP ~ NND ): -0.02
max correlation ( TE ~ DNSS ): 0.52

**GLM model after VIF analysis:** Mountaintop plant specialist species richness ~ IS + NND + NIB1 + NIB2 + DNSS + LGSSP + TE [Poisson (log)]

**Supplementary Table 9 -Variance Inflation Factor and test for multicollinearity between biogegraphic predictors (Moravian outcrops)**

| Variables | VIF of the full set of variables | Discarded | VIF of the remained variables |
|---|---|---|---|
| Island size (Size) | 15.2 | | 1.3 |
| Nearest neighbor distance (NND) | 10.9 | X | - |
| Number of islands in Buffer 1 (NIB1) | 6.7 | X | - |
| Number of islands in Buffer 2 (NIB2) | 3.3 | | 1.2 |
| Distance to the nearest species source (DNSS) | 93.8 | X | - |
| Largest gap in the stepping stone path (LGSSP) | 51.8 | X | - |
| Number of stepping stones (NSS) | 96.9 | X | - |
| Stepping stone path to the nearest species source (SSP) | 187.7 | X | - |
| Target effect (TE) | 85.9 | | 1.1 |

6 variables from the 9 input variables have collinearity problem: **NND NIB1 DNSS LGSSP NSS SSP**
After excluding the collinear variables, the linear correlation coefficients ranges between:
min correlation ( TE ~ NIB2 ): 0.05
max correlation ( NIB2 ~ Size): -0.42

**GLM model after VIF analysis:** Outcrops plant specialist species richness ~ IS + NIB2 + TE [GLM family: Quasipoisson (log)]

**What defines insularity for plants in edaphic islands?**
**Supplementary material 6**

**Supplementary Table 10 - GLM selection and model averaging (Western Carpathian fens)**

| Predictor | AICc weights | Std. Avg. Coeff. | Adjusted Standard Error | z value | Pr(>\|z\|) |
|---|---|---|---|---|---|
| Island size | 1.00 | 0.38 | 0.15 | 2.62 | 0.01 |
| Target effect | 0.87 | -0.53 | 0.20 | 2.66 | 0.01 |
| Number of stepping stones | 0.54 | -0.23 | 0.15 | 1.57 | 0.12 |
| Nearest neighbor distance | 0.41 | -0.16 | 0.11 | 1.44 | 0.15 |
| Largest gap in the stepping stone path | 0.41 | -0.18 | 0.14 | 1.30 | 0.19 |
| Number of islands in buffer 2 | 0.21 | -0.04 | 0.16 | 0.24 | 0.81 |
| Number of islands in buffer 1 | 0.16 | 0.04 | 0.11 | 0.35 | 0.73 |
| Age | 0.13 | 0.03 | 0.15 | 0.18 | 0.85 |

**Supplementary Table 11 - GLM selection and model averaging (Cantabrian mountaintops)**

| Predictor | AICc weights | Std. Avg. Coeff. | Adjusted Standard Error | z value | Pr(>\|z\|) |
|---|---|---|---|---|---|
| Island size | 0.92 | 0.11 | 0.03 | 3.71 | <0.01 |
| Dist. to the species source | 0.62 | 0.06 | 0.03 | 1.70 | 0.09 |
| Largest gap in the stepping stone path | 0.32 | 0.04 | 0.03 | 1.43 | 0.15 |
| Number of islands in buffer 1 | 0.25 | 0.04 | 0.03 | 1.23 | 0.22 |
| Target effect | 0.20 | -0.06 | 0.10 | 0.55 | 0.58 |
| Number of islands in buffer 2 | 0.12 | -0.02 | 0.03 | 0.70 | 0.48 |
| Nearest neighbor distance | 0.10 | 0.03 | 0.03 | 0.85 | 0.40 |

**Supplementary Table 12 - GLM selection and model averaging (Moravian outcrops)**

| Predictor | AICc weights | Std. Avg. Coeff. | Adjusted Standard Error | z value | Pr(>\|z\|) |
|---|---|---|---|---|---|
| Target effect | 0.66 | -0.03 | 0.01 | 2.47 | 0.01 |
| Island size | 0.27 | 0.02 | 0.01 | 1.09 | 0.27 |
| Number of islands in buffer 2 | 0.25 | -0.01 | 0.01 | 1.02 | 0.31 |