Workshop

Phytodiversity of Palaearctic grasslands

Introduction to the working group and to the database

Jürgen Dengler

History of the project…

2001: Swantje Löbel's Diplom thesis on Öland (Sweden):

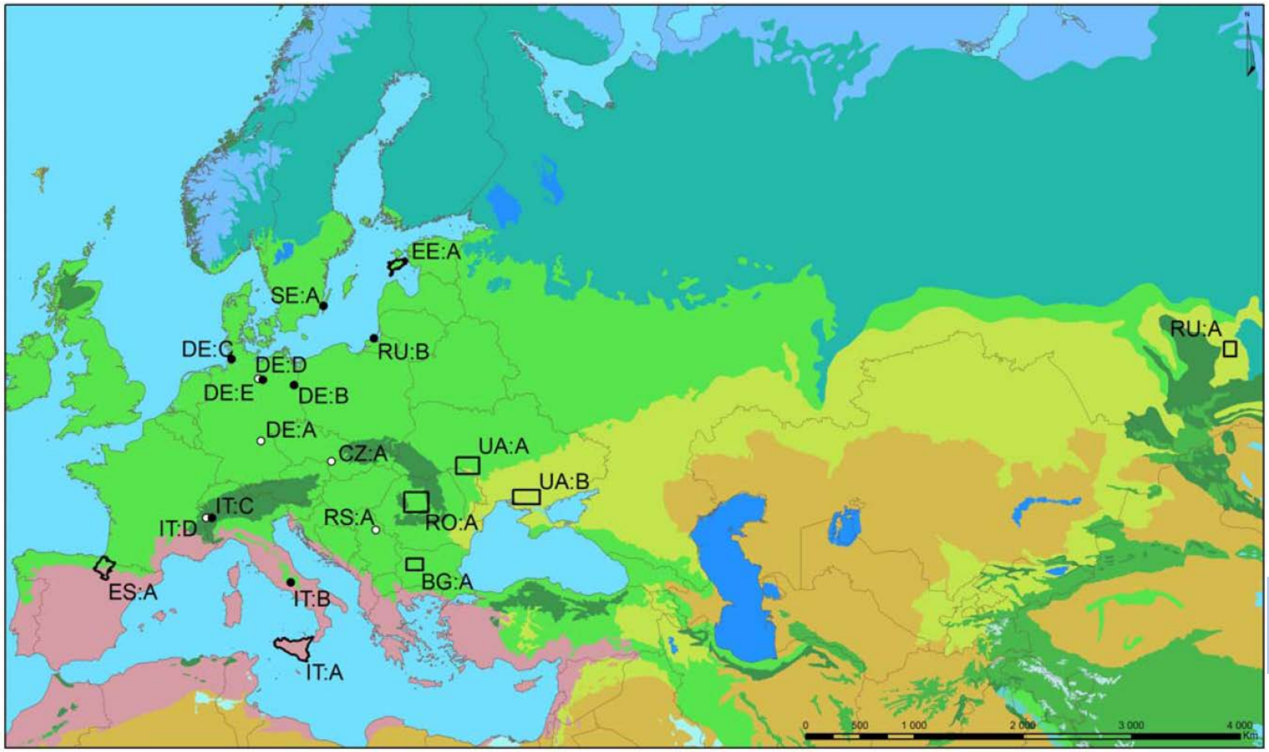
Löbel, S. 2002. *Trockenrasen auf Öland: Syntaxonomie – Ökologie – Biodiversität*. Diplom thesis, Institute of Ecology and Environmental Chemistry, University of Lüneburg, Lüneburg.

2004: Steffen Boch's Diplom thesis on Saaremaa (Estonia):

Boch, S. 2005. *Phytodiversität, Charakterisierung und Syntaxonomie der Trockenrasen auf Saaremaa (Estland)*. Diplom thesis, Institute of Ecology and Environmental Chemistry, University of Lüneburg, Lüneburg.

2nd root: EDGG Research Expeditions

- EDGG = Eurasian Dry Grassland Group (www.edgg.org)
- Research Expeditions (now: Field Workshops) since 2009



Dengler et al. 2016. *Bull. Eurasian Dry Grassland Group* 31: 12-26.

Impressions from the EDGG Field Workshops

Dengler et al. 2016. *Bull. Eurasian Dry Grassland Group* 31: 12-26.

Overview of EDGG Research Expeditions / Field Workshops

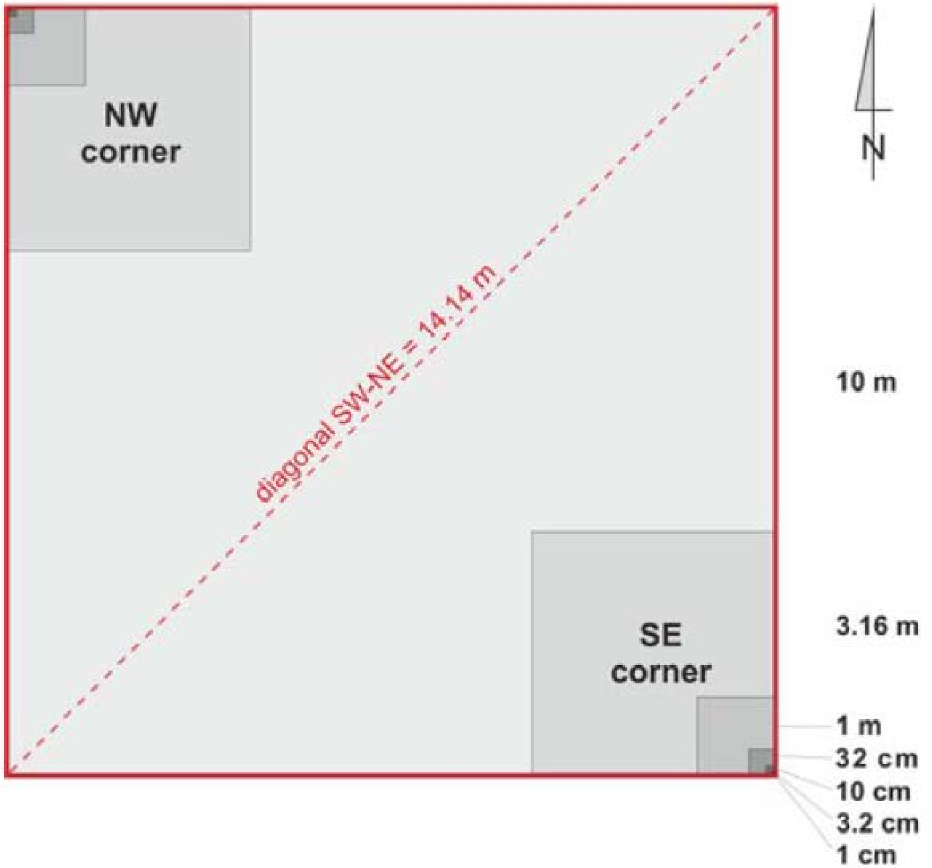
No.	Period	Research area	Altitudes [m a.s.l.]	Participants	Countries	Nested-plot series	10-m²-plots
1	14–26 July 2009	Transylvania (Romania)	321–670	6	3	20	63
2	10–25 July 2010	Central Podolia (Ukraine)	73–251	18	8	21	226
3	14–24 August 2011	NW Bulgarian mountains	633–1460	9	5	15	98
4	29 March – 5 April 2012	Sicily (Italy)	4–1200	14	5	21	67
5	15–23 May 2012	N Greece	1–1465	16	6	14	31
6	22 July – 1 August 2013	Khakassia (Russia)	300–700	14	7	39	133

7 – 2014 – Navarre (Spain)
8 – 2015 – S Poland
9 – 2016 – Serbia
10 – 2017 – Central Italy
11 – 2018 – Inneralpine valleys of the Eastern Alps

Sampling design of the EDGG Field Workshops

Standardised **multi-scale** and **multi-taxon** sampling of plant diversity and composition data of (dry) grasslands across the Palaearctic biogeographic realm

- **„Biodiversity plots“** with seven grain sizes: 0.0001, 0.001, 0.01, 0.1, 1, 10 an 100 m²
- Additional **„normal plots“** of 10 m²
- Placed subjectively within different grassland areas, and within each area, with the aim to capture the full ecological and floristical gradient
- All **terricolous taxa of the vegetation** (vascular plants, bryophytes, lichens, macro-“algae“)
- **Shoot presence**
- **Environmental data** for all 10-m² (sub-) plots



- Detailed **methodological description** in Dengler et al. (2016, *Bull. Eurasian Dry Grassland Group* 32: 13-30)

Outcomes of the EDGG Field Workshops

- So far **9 EDGG Research Expeditions/Field Workshops**
- **Phytosociological publications:**
  - 1st expedition - Transylvania
  - 2nd expedition - Ukraine
  - 3rd expedition - Bulgaria
- **Biodiversity publications:**
  - 1st expedition - Transylvania: Turtureanu et al. 2014
  - 2nd expedition – Ukraine: Kuzemko et al. 2016
  - 6th expedition – Siberia: Polyakova, Dembicz et al. 2016
  - 3rd expedition – Bulgaria: Velev, Dembicz et al. in prep.
- **Biodiversity publications from similar studies:**
  - Saaremaa: Dengler & Boch 2008
  - Uckermark: Dengler et al. 2004
  - Gran Paradiso National Park: Baumann et al. 2016

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Scale- and taxon-dependent biodiversity patterns of dry grassland vegetation in Transylvania

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ABSTRACT

Patterns of biodiversity may vary across spatial scales and between taxonomic groups; therefore, specific studies are needed to provide insights into factors driving community structure. Semi-natural grasslands are among the most biodiverse ecosystems, providing a suitable model for examining key ecological mechanisms. We analysed dry grasslands in Transylvania (Romania), which harbor extraordinarily species-rich plant communities, including the global maxima for two small grain sizes. We sampled data of vascular plants, bryophytes, and lichens in both nested and separate plots. We used soil, topographic, climatic, and land-use variables as predictors. Species richness at seven grain sizes (0.0001–100 m^2) was modeled as a function of these predictors by generalized linear models, followed by multimodel inference over all possible variable combinations with AIC$_c$. We also fitted power-law species–area relationships (SARs), both across the full range and for each transition of two subsequent plot sizes, as they provide a way of assessing β-diversity (through z-values) and its dependence on environmental variables. We found large differences in factors between scales and taxonomic groups, which generally supports the hypothesis that niche-related variables are important at very fine scales, while heterogeneity and disturbance-associated parameters become influential at larger scales. We explained the differences among the responses of taxonomic groups by their ecology. The exponents of the power-law SARs (z) for total richness were higher than in most other European dry grasslands, demonstrating that β-diversity is also extraordinary here. Further, the z-values showed strong and unexpected scale dependence, peaking at 0.01–0.1 m^2, and exponentially decreasing above these grain sizes. In conclusion, our study highlights the strong scale dependence of diversity-environment relationships, both in the case of α- and β-diversity, while emphasizing the importance to study multiple taxonomic groups.

1. Introduction

In Europe, some of the most biodiverse and threatened habitats are found in agricultural landscapes (Billeter et al., 2008; Oppermann et al., 2012). In contrast to the more homogenous natural vegetation cover, these cultural landscapes are characterized by a mosaic of many different natural, semi-natural and artificial habitat types. The so-called semi-natural open habitats have been shaped mainly through traditional low-intensity agricultural practices, which have supported the enrichment and diversification of the vegetation (Oppermann et al., 2012; van Elsen, 2000). In particular, semi-natural grassland ecosystems may support extraordinarily high numbers of plant species compared to other community types, both at small scale (Hájková et al., 2011;

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ORIGINAL PAPER

Scale- and taxon-dependent patterns of plant diversity in steppes of Khakassia, South Siberia (Russia)

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Abstract The drivers of plant richness at fine spatial scales in steppe ecosystems are still not sufficiently understood. Our main research questions were: (i) How rich in plant species are the natural steppes of Southern Siberia compared to natural and semi-natural grasslands in other regions of the Palaearctic? (ii) What are the main environmental drivers of the diversity patterns in these steppes? (iii) What are the diversity–environment relationships and do they vary between spatial scales and among different taxonomic groups?

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3rd root: Studies on Species-Area Relationships

- Presentation already on IAVS Conference 2007 in Swansea
- Data compilation later on together with Salza Todorova/Palpurina

Journal of Biogeography (J. Biogeogr.) (2009) **36**, 728–744

ORIGINAL ARTICLE

Which function describes the species–area relationship best? A review and empirical evaluation

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ABSTRACT

Aim The aims of this study are to resolve terminological confusion around different types of species–area relationships (SARs) and their delimitation from species sampling relationships (SSRs), to provide a comprehensive overview of models and analytical methods for SARs, to evaluate these theoretically and empirically, and to suggest a more consistent approach for the treatment of species–area data.

Location Curonian Spit in north-west Russia and archipelagos world-wide.

Methods First, I review various typologies for SARs and SSRs as well as mathematical models, fitting procedures and goodness-of-fit measures applied to SARs. This results in a list of 23 function types, which are applicable both for untransformed (S) and for log-transformed (log S) species richness. Then, example data sets for nested plots in continuous vegetation (n = 14) and islands (n = 6) are fitted to a selection of 12 function types (linear, power, logarithmic, saturation, sigmoid) both for S and for log S. The suitability of these models is assessed with Akaike's information criterion for S and log S, and with a newly proposed metric that addresses extrapolation capability.

Results SARs, which provide species numbers for different areas and have no upper asymptote, must be distinguished from SSRs, which approach the species richness of one single area asymptotically. Among SARs, nested plots in continuous ecosystems, non-nested plots in continuous ecosystems, and isolates can be distinguished. For the SARs of the empirical data sets, the normal and quadratic power functions as well as two of the sigmoid functions (Lomolino, cumulative beta-P) generally performed well. The normal power function (fitted for S) was particularly suitable for predicting richness values over ten-fold increases in area. Linear, logarithmic, convex saturation and logistic functions generally were inappropriate. However, the two sigmoid models produced unstable results with arbitrary parameter estimates, and the quadratic power function resulted in decreasing richness values for large areas.

Main conclusions Based on theoretical considerations and empirical results, I suggest that the power law should be used to describe and compare any type of SAR while at the same time testing whether the exponent z changes with spatial scale. In addition, one should be aware that power-law parameters are significantly influenced by methodology.

Keywords

Curve fitting, goodness-of-fit, logarithmic function, macroecology, model selection, power function, saturation function, sigmoid function, species sampling relationship, species–area relationship.

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Sampling-Design Effects on Properties of Species-Area Relationships – A Case Study from Estonian Dry Grassland Communities

Jürgen Dengler · Steffen Boch

Abstract Despite widespread use of species-area relationships (SARs), dispute remains over the most representative SAR model. Using data of small-scale SARs of Estonian dry grassland communities, we address three questions: (1) Which model describes these SARs best when known artifacts are excluded? (2) How do deviating sampling procedures (marginal instead of central position of the smaller plots in relation to the largest plot; single values instead of average values; randomly located subplots instead of nested subplots) influence the properties of the SARs? (3) Are those effects likely to bias the selection of the best model? Our general dataset consisted of 16 series of nested-plots (1 cm^2–100 m^2, any-part system), each of which comprised five series of subplots located in the four corners and the centre of the 100-m^2 plot. Data for the three pairs of compared sampling designs were generated from this dataset by subsampling. Five function types (power, quadratic power, logarithmic, Michaelis-Menten, Lomolino) were fitted with non-linear regression. In some of the communities, we found extremely high species densities (including bryophytes and lichens), namely up to eight species in 1 cm^2 and up to 140 species in 100 m^2, which appear to be the highest documented values on these scales. For SARs constructed from nested-plot average-value data, the regular power function generally was the best model, closely followed by the quadratic power function, while the logarithmic and Michaelis-Menten functions performed poorly throughout. However, the relative fit of the latter two models increased significantly relative to the respective best model when the single-value or random-sampling method was applied, however, the power function normally remained far superior.

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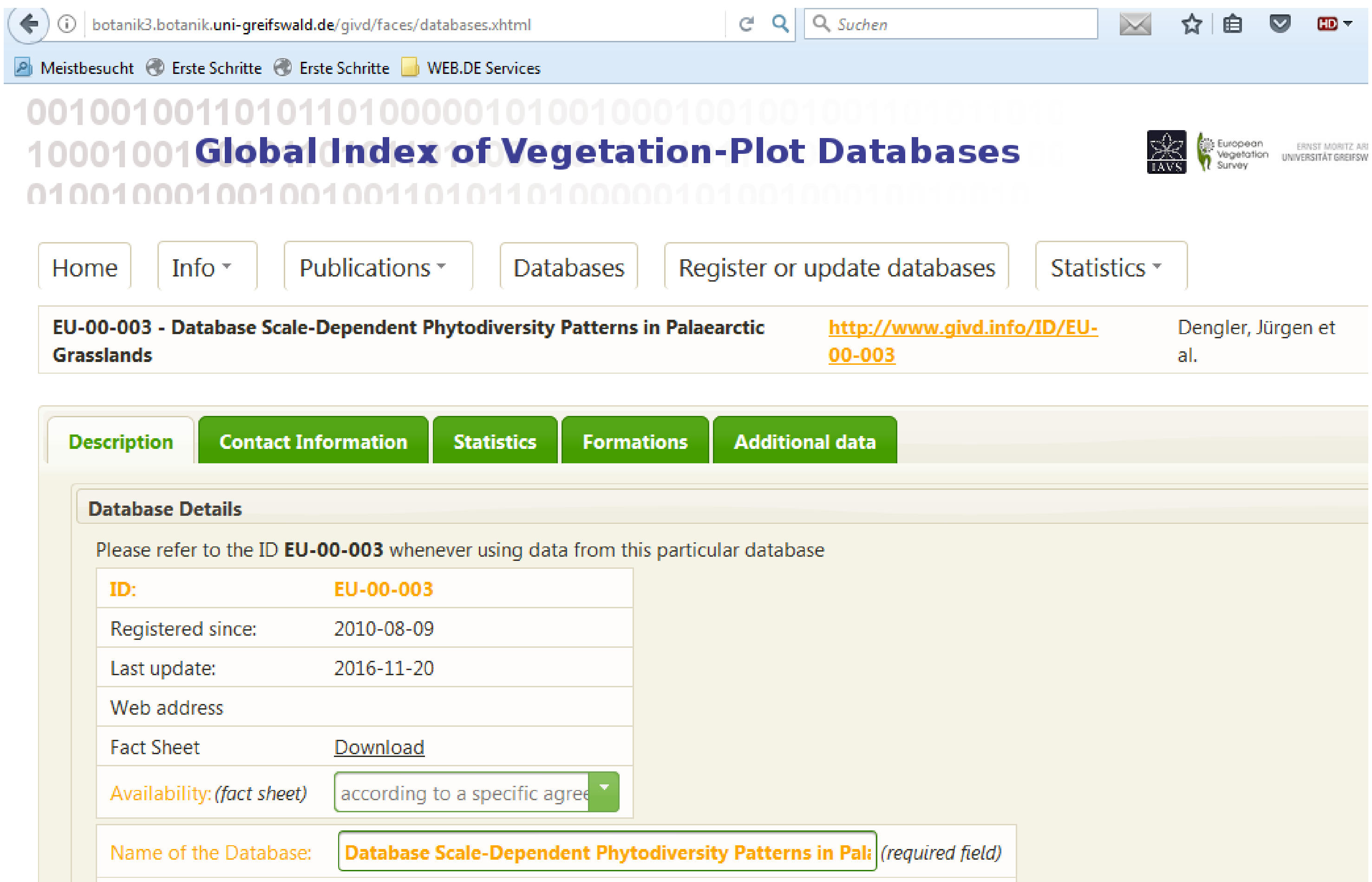
Springer

2016: Restart of the activities for a common database in the framework of EDGG

- Data overview paper in the EDGG Bulletin
- Methodological paper in the EDGG Bulletin
- Call for data
- Start of richness data and metadata compilation together with Idoia Biurrun
- Idea of the workshop and application to BayFor
- January 2017: Grant approved
- March 2017: Workshop in Bareuth

Registered in GIVD

- GIVD ID: EU-00-003
- Custodian: Jürgen Dengler
  Deputy Custodian: Idoia Biurrun



Also on new Ecoinformatics Portal Bayreuth

https://www.bayceer.uni-bayreuth.de/ecoinformatics/en/forschung

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Database Scale-Dependent Phytodiversity Patterns in Palaearctic Grasslands (EU-00-003)

Aims: The database formerly was named "Database Species-Area Relationships in Palaearctic Grasslands" and started as a repository for the data collected at the Research Expeditions/Field Workshops of the Eurasian Dry Grassland Group (EDGG) and similar multi-scale sampling schemes.

Meanwhile we are looking for are phytodiversity data sampled on **plots of the following standard areas**: 0.0001 m², 0.001 or 0.0009 m², 0.01 m², 0.1 or 0.09 m², 1 m², 10 or 9 m², 100 m², and 1000 or 900 m². We preferentially look for nested-plot multi-scale data, but we also take data for single grain sizes, provided they were carefully sampled with the aim of complete species lists, i.e. we request that plots have been precisely delimited in the field, usually with metal pins and a measuring tape, which typically is not the case for conventional phytosociological relevés. **Nested-plot data with at least four different plot sizes** are also accepted when plot sizes deviate from our standards. Any type of **grassland s.l.** from the whole **Palaearctic biogeographic realm** (Europe, North Africa, West, Central and North Asia). Data of vascular plants and/or terricolous non-vascular plants (bryophytes, lichens and macroalgae) can be provided. While you can provide in the easy-most case just richness counts per plot (together with metadata, such as plot size, coordinates, grassland type), even more valuable are data with species composition and potentially cover + selected environmental data.

Thanks to funding from **BayIntAn program of the Bavarian Research Alliance (BayFor)**, an **international workshop** will be conducted **6-10 March 2017 in Bayreuth** aimed at planning overarching analyses and papers of the data as well as third-party grant proposals based on them. The workshop is mainly for invited participants (colleagues who contributed large datasets or with strong statistical skills in big macroecological

Member of BayCEER

Requirements of the database

- **Grasslands s.l. from the Palaearctic realm**
- **Nested-plot series with at least 4 grain sizes and/or data from standard grain sizes** (0.0001; 0.001 or 0.0009; 0.01; 0.1 or 0.09; 1; 10 or 9; 100; 1000 or 900 or 1024 m^2)
- **Precisely delimited plots, carefully sampled for completeness**
- **Precise coordinates (nearly always)**
- Often: also bryophytes and lichens sampled
- Often: environmental data from the plot

The database (v. 34)

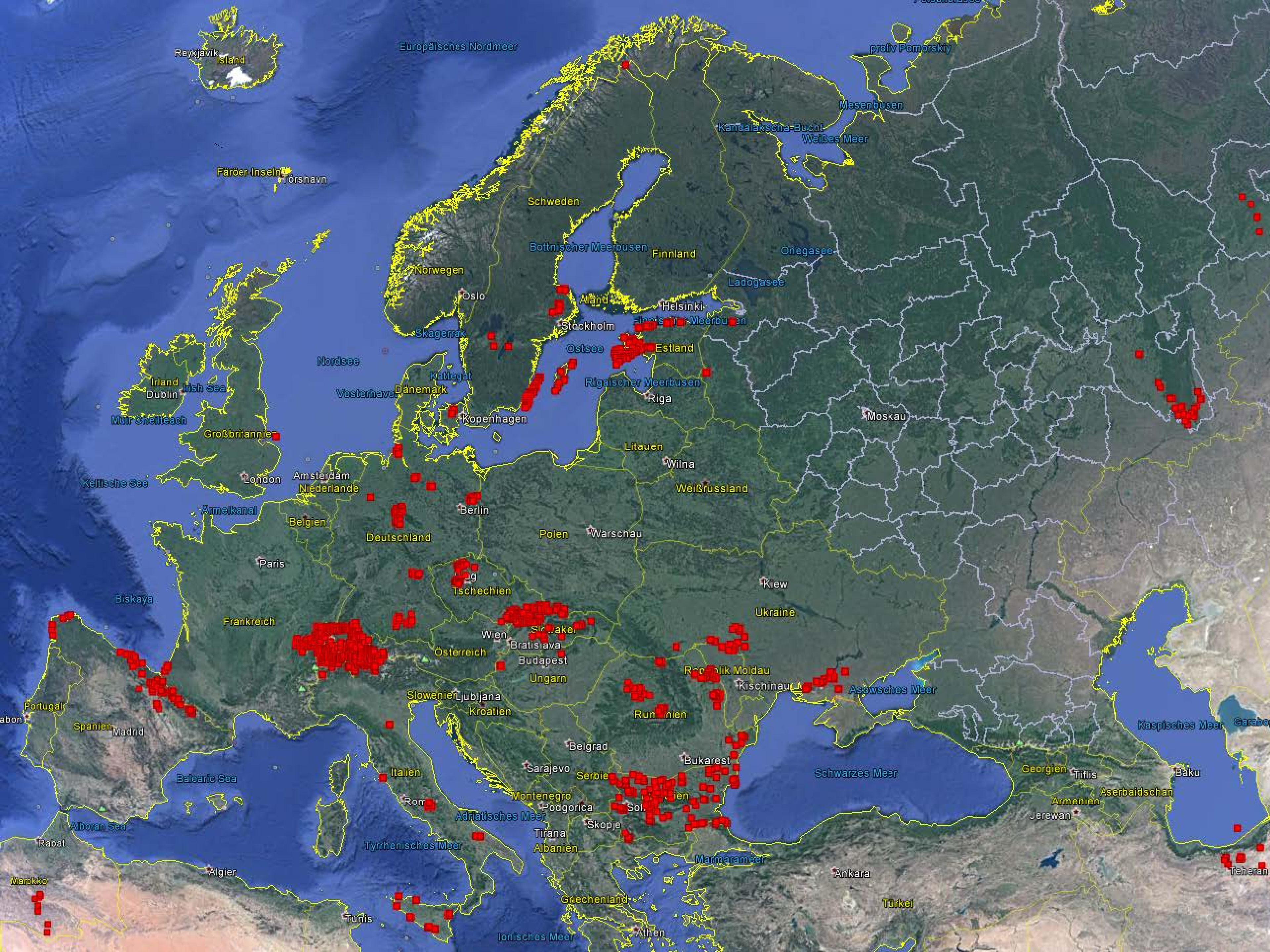
- **Management by Idoia Biurrun**

- **77 datasets**
- **98 data owners**
- **24 countries**
- **24,855 plots**
  - roughly 40% also with bryophytes & lichens
  - for large majority compositional data
- **1,420 nested-plot series**

Area [m²]	All terricolous species	Vascular plants	Non-vascular plants	Bryophytes	Lichens	Fraction non-vascular plants
0.0001	1,315	**1,571**	1,315	1,315	1,315	1,058
0.0004	31	**31**	31	31	31	25
0.0009	388	**388**	388	388	388	377
0.001	940	**1,943**	940	940	940	782
0.002	90	**90**	90	90	90	89
0.0025	31	**31**	31	31	31	30
0.004	0	**48**	0	0	0	0
0.0042	0	**84**	0	0	0	0
0.0079	90	**90**	90	90	90	90
0.01	1,547	**2,969**	1,547	1,568	1,547	1,473
0.01	50	**50**	50	50	50	50
0.016	0	**48**	0	0	0	0
0.04	71	**93**	71	92	71	71
0.0625	344	**344**	344	344	344	344
0.063	0	**48**	0	0	0	0
0.07	135	**135**	135	135	135	135
0.09	195	**279**	195	195	195	195
0.1	938	**1,584**	938	938	938	923
0.25	106	**154**	106	106	106	106
1	1,595	**6,730**	1,595	1,797	1,601	1,592
2.25	0	**28**	0	0	0	0
4	407	**620**	407	428	407	407
9	301	**301**	301	301	301	301
10	1,095	**3,947**	1,095	1,095	1,096	1,095
16	157	**229**	157	157	157	157
20	0	**47**	0	0	0	0
24	0	**28**	0	0	0	0
25	0	**42**	0	0	0	0
40	0	**47**	0	0	0	0
64	0	**54**	0	0	0	0
100	876	**2,609**	876	876	976	876
256	0	**48**	0	0	0	0
1000	0	**133**	0	0	0	0
1024	0	**12**	0	0	0	0
Total	**10,702**	**24,855**	**10,702**	**10,967**	**10,809**	**10,176**

Main plot sizes

- **6,730 1-m² plots**
- **4,248 10-m²** (or 9-m²) **plots**
- **3,019 0.01-m² plots**
- **2,609 100-m² plots**
- **2,331 0.001-m²** (or 0.0009-m²) **plots**
- **1,863 0.1-m²** (0.09-m²) **plots**
- **1,571 0.0001-m² plots**
- **145 1000-m²** (or 1024-m²) **plots**



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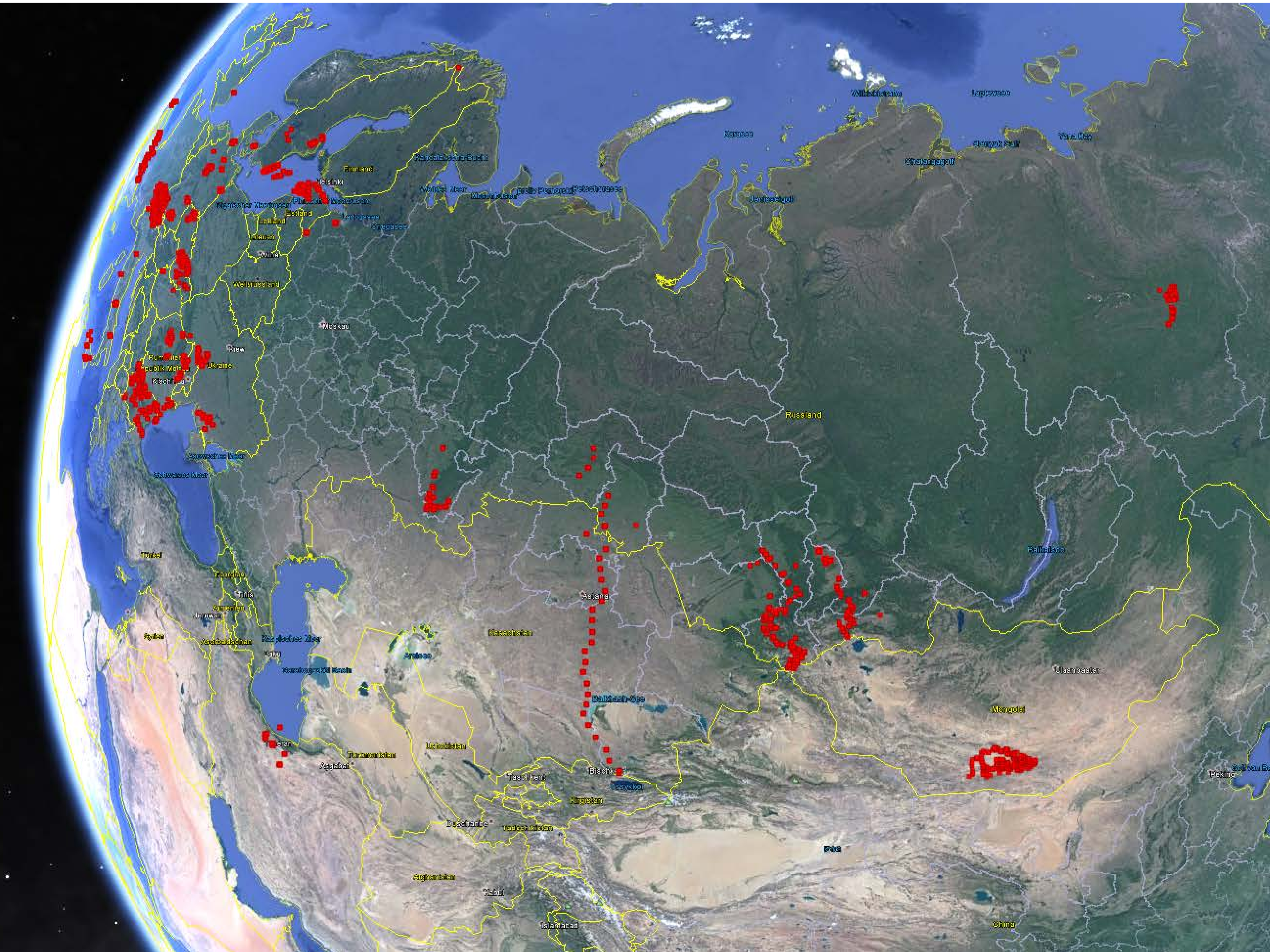
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Lettland
Weißrussland
Moskau
Kiew
Ukraine
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Kasachstan
Astana
Usbekistan
Turkmenistan
Taschkent
Bischkek
Kirgistan
Duschanbe
Tadschikistan
Afghanistan
Kabul
Islamabad
Baikalsee
Ulaanbaatar
Mongolei
China

Compare with the European Vegetation Archive (EVA)

- **c. 350,000 grassland plots with much better spatial coverage** (vs. 25,000 in EDGG database)
- **Compositional data all in one Turboveg 3 database** (vs. not yet integrated in EDGG "database")

Advantages of the EDGG database

- Multi-scale sampling (in many cases)
- Multi-taxon sampling: vascular plants, bryophytes, lichens (in 40%)
- Whole Palaearctic (not only Europe)
- Strong focus on precise plot sizes (delimited in the field) and complete species lists
- Precise coordinates
- Good availability of environmental data from the plots