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Research paper

The value of multi-taxon approaches to improve biodiversity assessment at municipal scales

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Abstract

The value of multi-taxon approaches to improve biodiversity assessment at municipal scales. Municipalities, especially those comprising large urban agglomerations, are increasingly aware of their potential role in conserving biodiversity. The identification of key areas for the conservation of biodiversity has often been based on 'single-taxon approaches' (e.g., birds, butterflies, certain mammal species, etc.). Such approaches can lead to biased conclusions because the spatial distribution pattern of a single taxon could misrepresent ecological complexity and diversity. The aim of the present article was to test whether a multi-taxon approach, considering both α- and β-diversity parameter estimates, improves the analysis of the distribution pattern of species richness, conservation value, and identification of key areas for biodiversity conservation at a local (municipal) level. Data used were collected collected in a standard way in the Donostia/San Sebastián municipality (Spain), using three taxonomic groups: birds, amphibians, and vascular plant species of concern. Although we detected some degree of cross-taxon congruence in the spatial distribution pattern of richness (e.g., bird richness was positively correlated with the one of amphibians), the patterns arising after pooling taxa revealed more complex patterns. For instance, whereas the eastern part of the municipality showed a major conservation value for birds, the western part had more importance for amphibians. Assessment of β-diversity estimates through species turnover also revealed patterns that remained hidden when focusing only on α-diversity (richness). As a result, the combined analyses of several taxonomic groups, together with β-diversity estimates, revealed a higher number of key areas for biodiversity conservation at a local level rather than a single key area which we would have obtained taking only birds into account.

Key words: Amphibians, Birds, Biological conservation, Donostia-San Sebastián, Plants, Urban areas

Resumen

El valor de los métodos basados en múltiples taxones para mejorar la evaluación de la biodiversidad a escala municipal. Los municipios, en especial los que comprenden gran aglomeraciones urbanas, son cada vez más conscientes del papel que podrían desempeñar en la conservación de la biodiversidad. La determinación de las zonas clave para la conservación de la biodiversidad se han fundamentado a menudo en métodos basados en múltiples taxones (por ejemplo, aves, mariposas, ciertas especies de mamíferos, etc.). Estos métodos pueden dar lugar a conclusiones sesgadas, porque el patrón de distribución espacial de un taxón podría distorsionar la complejidad y diversidad ecológicas. La finalidad del presente artículo es comprobar si un método basado en múltiples taxones, que considera las estimaciones de los parámetros de diversidad α y β, permite mejorar el análisis del patrón de distribución de la riqueza de las especies, el valor de conservación y la determinación de las zonas clave para la conservación de la biodiversidad a escala local (municipal). Para ello, utilizamos los datos recopilados de una forma habitual en el municipio de Donostia/San Sebastián (España) pertenecientes a tres grupos taxonómicos: aves, anfibios y especies de plantas vasculares de interés. Pese a que detectamos cierta congruencia entre taxones en cuanto al patrón de distribución espacial de la riqueza (por ejemplo, la riqueza de aves estuvo positivamente correlacionada con la de los anfibios), los patrones que surgieron tras agrupar los taxones resultaron ser más complejos. Por ejemplo, si la parte oriental del municipio tenía un mayor valor de conservación para las aves, la occidental tenía más importancia a los anfibios. La evaluación de las estimaciones de la diversidad β a través de la rotación de las especies también reveló la existencia de patrones que permanecían ocultos cuando se estudiaba solo la diversidad α (riqueza). Como resultado, los análisis combinados que incluyeron varios grupos taxonómicos, además de las estimaciones de la diversidad β, arrojaron un mayor número de zonas clave para la conservación de la biodiversidad a escala local, en lugar de la única zona que habríamos obtenido si solo hubiéramos tenido en cuenta las aves.

Palabras clave: Anfibios, Aves, Conservación biológica, Donostia-San Sebastián, Plantas, Areas urbanas

Introduction

The conservation of biodiversity is developed from an administrative standpoint at several spatial scales and levels of responsibility. Together, these scales range from global agreements, such as the 2030 Agenda for Sustainable Development, to laws and action plans implemented at municipal levels. Biodiversity conservation is essential for sustainable development, not only for ethical reasons (Ibáñez-Álamo et al 2017), but also for several other factors. For instance, higher levels of biodiversity positively impact humans for various reasons, such as socio-economic (Perrings et al 1995, Chapin et al 2000) scientific (Mathey et al 2011, Iglesias-Carrasco et al 2017, Saccavino et al 2018), psychological (Cameron et al 2020, Nghiem et al 2021, Wei et al 2022) and health matters (Daszak et al 2000, Pongsiri et al 2009).

Municipalities, especially those comprising large urban agglomerations, are increasingly aware of their potential role in conserving biodiversity (Morelli et al 2021, Díaz et al 2022). Firstly, because most of the human population lives in large cities it is in these areas where education is key in promoting awareness of the impact that non-responsible use of resources can have on conservation. Secondly, urban zones can also contribute to and be part of biodiversity conservation strategies through proper management of their green spaces (Plummer et al 2020), and even within the grey, built- up matrix (Blanco et al 1997, Schaub et al 2015, Garcia and Granell 2019). Greener cities enhance the quality of life for humans and promote better biodiversity levels and resilience against climate change (Mathey et al 2011, Carvalho et al 2017).

In Europe, two of the chief legislative tools for the conservation of biodiversity are the Directives 92/43/CEE (Habitats) and 2009/147/CE (Birds). Along with national and (if existing) regional species of concern catalogues, and the red lists of species (e.g., BirdLife International 2021, López-Jiménez 2021), public administrations, including municipal bodies, often base their conservation biodiversity priorities on these species or habitat lists. Reflecting this growing concern for the conservation of biodiversity at a local level, many municipalities are investing significant resources to have accurate and detailed spatially explicit inventories of their habitats and species of concern (Anton et al 2017, Arizaga et al 2021) as basic management tools for planning conservation measures.

With 180,000 inhabitants, the municipality of Donostia/San Sebastián (hereafter, DSS) is the main urban area of the province of Gipuzkoa (Northern-Spain). The city's administrative departments have spent several years investing in significant resources to maintain and update biodiversity inventories. Previous studies covering several taxonomic groups, though collected with limited spatial accuracy (Azpiroz 2009), have been updated with very detailed data (collected at 1-km^2 resolution or comparable scales) concerning the presence/absence of amphibians (Rubio and Etxezarreta 2003, Cabido et al 2012, Garin-Barrio and Rubio 2020, Cabido et al 2021) and birds (Arizaga et al 2021). Traditionally, and not only in DSS, the identification of key areas for biodiversity conservation has often been based on 'single-taxon approaches' (e.g., birds, butterflies, certain mammal species, etc.) or one or several habitats. Such approaches can lead to biased overviews (Díaz et al 2020) because the spatial distribution pattern of a single object could misrepresent the ecological complexity and diversity (Franklin 1993). Areas with a higher number of species (α-diversity) may not necessarily be key areas for biodiversity conservation; rather, analysis of β-diversity (the pattern of species turnover among sites) may be more effective if the ultimate aim is the conservation of γ-diversity (i.e., the total diversity found). This can occur for instance when very species-rich sites exclude interesting species in areas with lower local diversity (α-diversity) (Baselga 2010). Thus, beyond estimating α-diversity levels at given areas, estimating β-diversity can be crucial, because from a global biodiversity conservation standpoint, conserving just some very species-rich places may not be sufficient when there are large turnover patterns (i.e., when places differ substantially because of hosting different species assemblages). In these cases, prioritizing the conservation of a larger number of places, and not necessarily the richest ones (Wright and Reeves 1992), might be optimal (Baselga 2010).

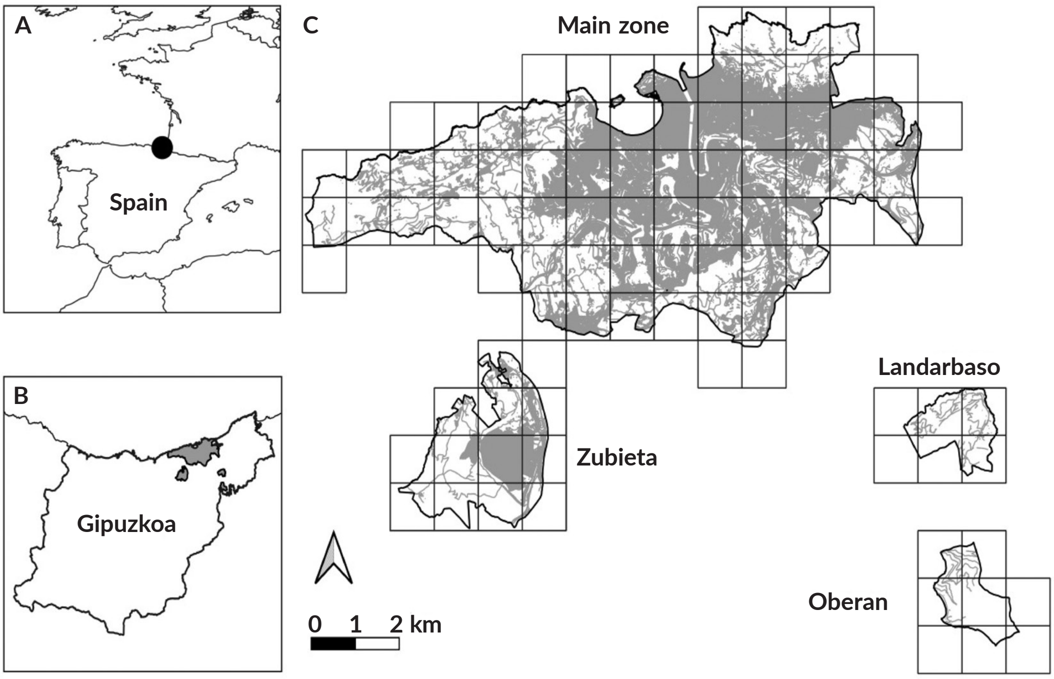

Fig. 1. Location of the municipality of DSS in Spain (A, circle) and the province of Gipuzkoa (B, shaded area). In detail (C), we show the four administrative nuclei of DSS (main zone, Zubieta, Landarbaso, Oberan). The grid represents 1 x 1 km UTM cells, and the grey polygons are urbanized soil.

***Fig. 1**. Ubicación del municipio de Donostia/San Sebastián en España (A, círculo) y la provincia de Guipúzkoa (B, área sombreada). En detalle (C), mostramos los cuatro núcleos administrativos de Donostia/San Sebastián (zona principal, Zubieta, Landarbaso y Oberan). La cuadrícula representa las celdas UTM 1 x 1 km y los polígonos grises corresponden a suelo urbanizado.*

Currently, DSS is well-positioned to develop an updated and multi-taxon diagnosis of the spatial distribution pattern of its biodiversity and to identify key areas for biodiversity conservation using a multi-taxon approach. The aim of the present article was to test whether a multi-taxon approach improves the analysis of the α- and β-diversity distribution patterns, conservation value, and identification of key areas for biodiversity conservation at a local (municipal) level. In this paper, these key areas are defined as those zones (1 x 1 km UTM cells) with either higher α- or β-diversity values.

Material and methods

Study area and data collection

The study was carried out in the municipality of Donostia/San Sebastián (DSS), the capital city of the province of Gipuzkoa (Basque Country, Spain). DSS covers ca. 60 km^2, and it is geographically segregated into four nuclei (fig. 1): the main nucleous , which includes most of the municipality and is comprised of urbanized land including the core area of the city of DSS, and three additional zones (Zubieta, Landarbaso, Oberan) that are more rural, varying in their extent of urbanization. The primary nucleus of DSS (main polygon in fig. 1) is ecologically characterized by a main urban area situated along the eastern-southern-western part of this nucleus by a peripheral matrix of countryside, forming what is known as a U-shaped ecological corridor. Non-urban areas include urban parks, gardens, other green urban areas, and an Atlantic mosaic of native forest (comprising various oak species -genus *Quercus*-, beech *Fagus sylvatica*, mixed Atlantic woods -dominated by several species of willow *Salix* sp., ash *Fraxinus* sp., or maple *Acer* sp. and riparian forest of alders *Alnus glutinosa*), exotic tree plantations (mostly of Monterey pine *Pinus insignis*), grasslands, crops (mainly orchards, maize crops) and scrublands (dominated by gorse *Ulex* sp., heath *Erica* sp.). The flora and fauna of DSS belong to the Eurosiberian region, with some species endemic to the Cantabrian zone, the Iberian Peninsula, and the western Pyrenees (Sanz-Azkue 2007, Azpiroz 2009, Arizaga et al 2020, 2021).

To ensure appropriate proper comparisons across taxonomic groups, it is essential that the scale and sampling effort between groups are also comparable, for if not, observed distribution patterns may be influenced by sampling biases. For this reason, for this study we used only taxa with detailed presence/absence data, collected within a 1 x 1 km UTM grid or equivalent scales. Specifically, data were sourced from: (1) standardized bird censuses carried out for the breeding bird atlas of DSS (Arizaga et al 2021); (2) systematic amphibian monitoring programs in DSS (Cabido et al 2012, Garin-Barrio and Rubio 2020, Cabido et al

Table 1. Mean, minimum and maximum number of species of the target flora and fauna taxa, by 1x1 UTM cells in DSS. Total number of UTM cells: 97: cs, concern species.

Tabla 1. Media y números mínimo y máximo de especies de los taxones de flora y fauna estudiados, por celda UTM 1x1 en Donostia/San Sebastián. Número total de celdas UTM: 97: cs, especies de interés

	Birds	Amphibians	Flora (cs)	Pooled taxa
Mean	31.2	2.0	0.3	33.6
Minimum	9	0	0	9
Maximum	61	8	4	66

2021); and (3) monitoring survey of plant species of concern in DSS (Aranzadi, unpubl. data). Here, we refer to plant species of concern as those species which were included within the Basque Catalogue of Species of Concern. Other studies (e.g., Itsas Enara Ornitologi Elkartea 2022), although valuable, either do not cover the entire municipality or have been addressed at larger spatial scales (so data cannot be referenced to finer scales such as the 1x1 km UTM grid).

To conduct an updated, effective diagnosis, we used data recently collected, particularly from 2015-2022. The only exceptions to this general rule was some flora records which were obtained from 2003 to 2014, and that were also considered in the analyses due to the lack of more recent data.

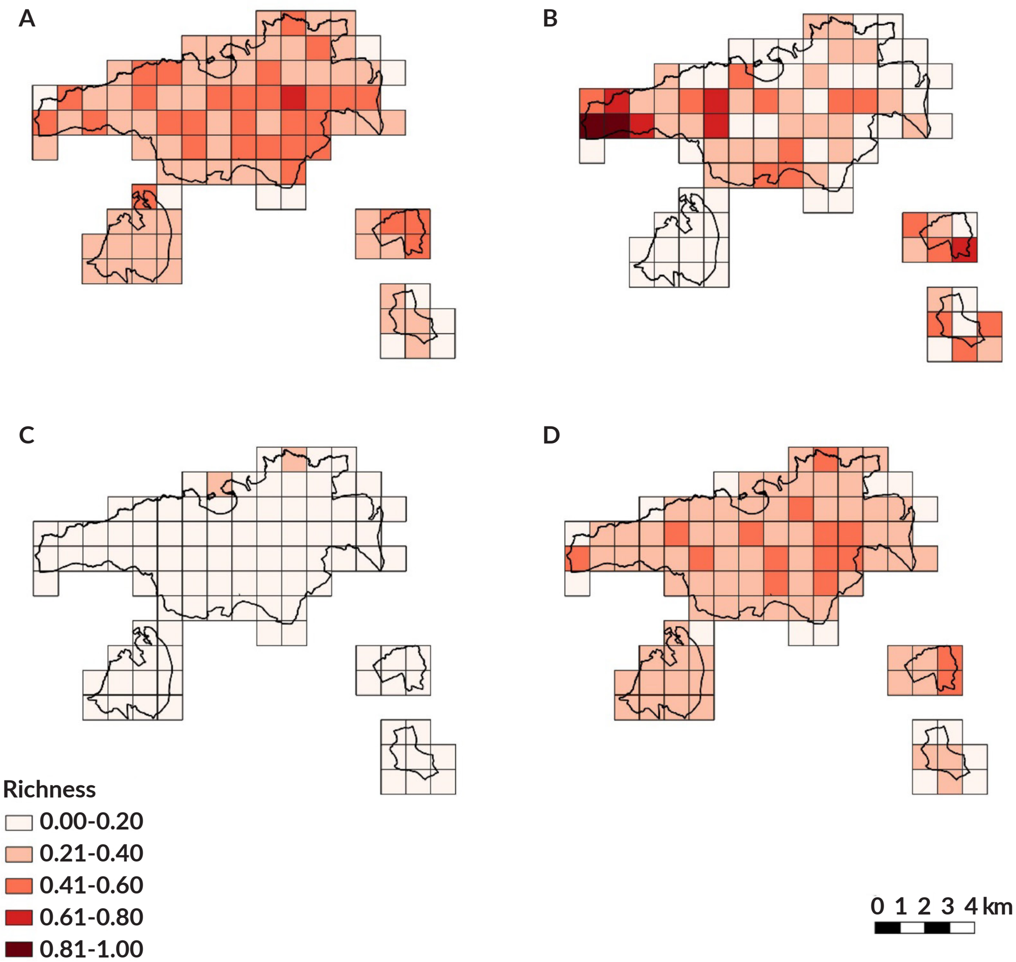

Fig. 2. Spatial distribution patterns (referred to 1-km^2 UTM cells) of the observed richness (number of species) in DSS. Richness values have been standardized to a 0-1 scale (1 = maximum number of species found in all the municipality for each taxonomic group). Maps: A, birds; B, amphibians; C, plant species of concern; D, all taxa pooled.

Fig. 2. Patrones de distribución espacial (referidos a las celdas UTM de 1 km^2) de la riqueza observada (número de especies) en Donostia/San Sebastián. Los valores de la riqueza se han estandarizado a una escala 0-1 (1 = número máximo de especies encontradas en todo el municipio para cada grupo taxonómico). Mapas: A, aves; B, anfibios; C, especies de plantas de interés; D, todos los taxones agrupados.

Table 2. Pearson correlations (we show Pearson R and P-values; these last above the diagonal) of the richness and conservation index of birds, amphibians, plant species of concern and all taxa pooled in DSS. Significant correlations, in bold.

Tabla 2. Correlaciones de Pearson (mostramos los valores R y P de Pearson; este último encima de la diagonal) de los índices de riqueza y conservación de las aves, los anfibios y las especies de plantas de interés y todos los taxones agrupados en Donostia/San Sebastián. Las correlaciones significativas se indican en negrita.

	Birds	Amphibians	Flora	Pooled taxa
Richness				
Birds		0.001	0.243	<0.001
Amphibians	**0.348**		0.548	<0.001
Flora	0.120	0.062		0.059
Pooled taxa	**0.983**	**0.500**	0.192	
Conservation index				
Birds		0.160	0.197	<0.001
Amphibians	0.144		0.444	<0.001
Flora	0.132	0.079		<0.001
Total	**0.782**	**0.601**	**0.508**	

Data analyses

First, we performed calculations for each single-taxon (birds, amphibians, flora) and then, for all taxa, and we pooled the number of species (richness) observed within each 1x1 km UTM cell. Richness values can differ substantially taxonomically (birds, for instance, are much more numerous than amphibians), so richness estimate was scaled to a range from 0 to 1, with '1' being the highest number of species found per taxon or for all taxa pooled.

A commonly applied criterion to determine the importance of an area for biodiversity conservation is to calculate the number of species of concern and their threat level (Franklin 1993). Areas with a higher number of species of concern and hosting species with higher levels of threat are considered more important (Anton et al 2017). We took this approach into account to identify the main distribution patterns of the observed species richness and, subsequently, to identify key areas for the biodiversity conservation in DSS. Specifically, each species was assigned a conservation value based on priority categories derived from the Basque Catalogue of Species of Concern (BCSC) and in the Annexes 2, 4 or 5 of Directive 92/43/CEE and the Annex 1 of Directive 2009/147/CE: (1) maximum priority: 'Endangered' species in the BCSC, conservation value: 4; (2) high priority: 'Vulnerable' species in the BCSC, conservation value: 3; (3) medium priority: 'Rare' species in the BCSC, conservation value: 2; and (4) low priority: species not included in any of the BCSC categories shown above, but listed in the Annexes of the two mentioned Directives, conservation value: 1.

For each 1x1 km UTM cell, we calculated its CI as follows:

$$CI = \Sigma CV/CV_{max}$$

where ΣCV is the sum of the conservation values of the species of concern for each cell (those appearing in the BCSC and/or the above cited Annexes of European Directives 92/43/CEE and 2009/147/CE), and CV_{max} is the cell where we found the highest sum of CV.

We also estimated beta diversity values for each UTM cell so as to assess species turnover patterns. Variation of site-related species composition can be caused by two different phenomena (Baselga 2012): by the replacement of several species by others from site to site (turnover), or by a pattern where poorest sites are species subsets of the richest ones (nestedness). In this work, we were interested in

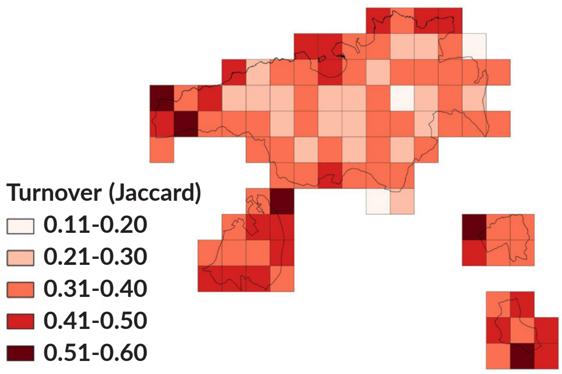

Fig. 3. Geographical distribution of the averaged turnover (how dissimilar a cell was in relation to the occurrence of a unique species) of beta-diversity in DSS, based on pairwise cell comparisons of the Jaccard index of dissimilarity.

Fig. 3. Distribución geográfica de la rotación media (el grado de diferencia de una celda en relación con la presencia de especies únicas) de la diversidad β en Donostia/San Sebastián, basada en comparaciones por pares de celdas del índice de similitud de Jaccard.

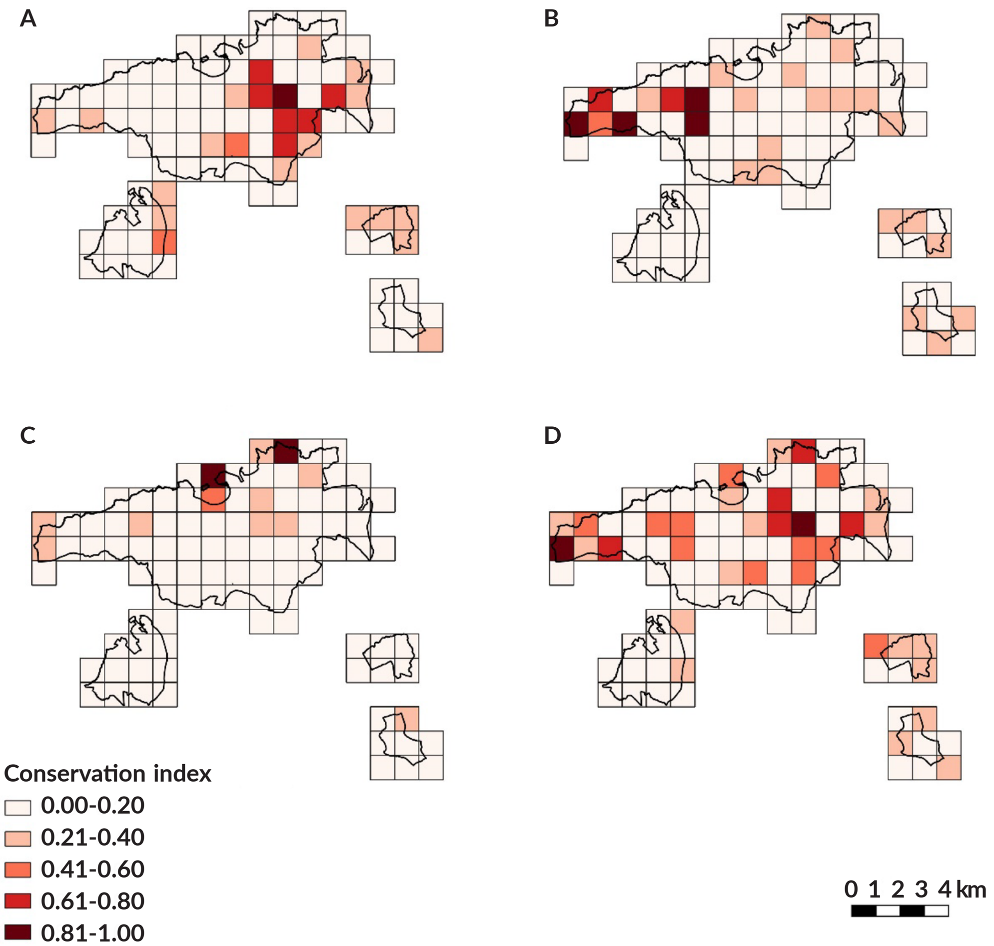

Fig. 4. Conservation index of A) birds; B) amphibians, C) plant species of concern; and D) all taxa pooled in DSS.

Fig. 4. *Índice de conservación de A) las aves; B) los anfibios, C) las especies de plantas de interés; y D) todos los taxones agrupados.*

detecting potential key biodiversity areas that might host unique species besides being zones with lower mean α-diversity levels (i.e., sites with high turnover levels). Using the 'betapart' package (Baselga and Orme 2012) in R (R Core Team 2023), we calculated separately the turnover and nestedness components of β-diversity, so as to obtain a mean turnover estimate for each UTM cell of 1 x 1 km. To do this we calculated the turnover component between pairs of cells, and then averaged such values to obtain a single turnover value for each UTM cell. The turnover was calculated using the Jaccard dissimilarity index (Baselga 2012).

We calculated Pearson correlations to estimate the degree of cross-taxon congruence in the spatial distribution pattern of richness and CI.

Results

We detected a total of 90 species of birds, 8 species of amphibians, and 12 species of plants of concern (for further details see annex 1). The mean, minimum and maximum number of species per cell was 33.6 species (range 9-66; table 1).

The spatial distribution pattern of birds in DSS revealed a single cell of 1 km^2 comprising more than 60% of the avian species found in total in the entire municipality (fig. 2A). Following this cell, we detected 16 cells where the richness achieved 40-60% of the total richness, with most of these occuring along the green peripheral matrix forming the U-shaped (eastern-southern-western) ecological corridor of DSS, along with some main urban parks. For the amphibians, richness reached maximum values in 3 cells (fig. 2B), all within the western part of the municipality (Igeldo area). High richness values were also observed in four other cells, three of which were also in Igeldo. In the remaining DSS, observed amphibian richness was lower and was always linked to the presence of adequate wetlands generally associated with green zones of local importance, either in some chief urban parks or along the aforementioned U-shaped ecological corridor. The richness of the vascular plant species of concern was low overall (< 20% of the total richness found for the entire municipality), with the only exception being two coastal cells with slightly higher values (fig. 2C). After pooling these three taxa (birds, amphibians, flora), the spatial distribution pattern of richness showed a positive, significant correlation with that found for birds and amphibians (fig. 2D; table 2).

For the β-diversity estimates, the averaged turnover values ranged from 0.11 (in one of the cells with a higher observed richness) to 0.55 (for details see fig. 3). Overall, we obtained higher turnover values (i.e., cells comprising a higher amount of unique species) along the coast and the eastern extreme of the municipality, and in points of the peripheral nuclei of the southern part of the municipality. Moreover, turnover values showed a significant negative correlation with richness (r = -0.42; P < 0.001), indicating that many of the cells with lower levels of α-diversity, however, hosted a higher amount of unique species.

The spatial distribution pattern of the conservation index resembled the patterns obtained for richness, though local differences between taxa were even more pronounced (see for instance the difference in patterns fig. 4A-4C), and clearly, the figure obtained for all taxa pooled (fig. 4D) provided a more complex pattern than any of the taxa considered independently. In this context, we found no significant correlation between the indices when considering taxon-by-taxon pairwise comparisons, but there was a significant correlation of each taxon with the conservation index considering all taxa pooled (table 2).

Discussion

This is the first such study for the city of Donostia/San Sebastián (DSS) and, as far as we know, one of the few studies for Spain that addresses a spatially explicit analysis of the distribution pattern of species richness and its conservation value, taking into account a multi-taxon approach in urbanized environments (e.g., Díaz et al 2022). A fundamental decision in assessing biodiversity is the selection of one or more study taxa, a choice that is often made using criteria such as historical precedents, ease of detection, or available technical or taxonomic expertise. More robust approaches entail selecting taxa that best represent the information on unmeasured groups. In the present study we used three taxonomic groups of concern: birds, amphibians and vascular plant species, these being the only groups for which we had detailed and updated presence/absence data collected in 1 x 1 km UTM cells for the entire municipality.

Even though we detected some degree of cross-taxon congruence in the spatial distribution pattern of richness (e.g., bird richness was positively correlated with the one of amphibians), the patterns arising after pooling taxa seemed to be more complex, and complete than those obtained for each taxon independently. This result confirms findings from studies carried out in other areas and ecological contexts (Kotze and Samways 1999), including urban areas (MacGregor-Fors et al 2015), where multi-taxon approaches offered better biodiversity assessments. For instance, whereas the eastern half of the municipality had a major conservation value for birds, it was the western part that proved to be of higher importance for amphibians. As a result, the combined analyses of these two taxa, together with the plant species of concern, revealed 2-3 key areas for biodiversity conservation, rather than the single one which we would have identified if we only had taken birds into account. This pattern, therefore, supports the idea that a multi-taxa approach improves biodiversity assessment at the municipal scale. Previous works have shown that birds and vascular plants (though in our case this latter dataset was constrained to only a few species of concern) can often be used as surrogates of other taxa (e.g., Westgate et al 2017), although the mentioned authors also recognized that this can depend on contexts. In our case, we observed that amphibians were one of the key conservation areas.

Future research with more taxa, such as insects (for example butterflies, dragonflies, and groups of pollinators) and mammals, might help to determine which taxa are the best combination for biodiversity assessment at a local (municipal) scale. Apart from providing spatially-explicit biodiversity distribution patterns (which are key to identifying biodiversity hotspots and priority conservation areas), the long-term monitoring of these 'target' taxa would be basic to evaluate the biodiversity conservation status in the municipality and determine the efficacy of management and conservation policies.

Another result to highlight was that β-diversity analysis revealed that many of the cells with lower α-diversity levels hosted a higher number of unique species. We attribute this pattern, at least in part, to several particularities of the municipality: (1) habitats close to the coast host fewer species overall than inland oareas, with the latter comprising heterogeneous landscapes with crops, small forest patches, meadows and small towns or farms that constitute the traditional Atlantic countryside. Nevertheless, the cells along the coast are richer in unique species, as observed with certain plants or birds. Therefore, overall, these coastal cells have a very high local conservation value as they host several unique species. (2) some zones located further away from the urban core areas also contain different habitat (the clearest example would be the forest masses of Oberan), which again house species not present in other areas of the municipality. Thus, it can be concluded that the assessment of β-diversity estimates can reveal patterns that remained hidden when focusing only on α-diversity (richness).

Further studies are needed in future to address and assess biodiversity in this area.

Similar studies have shown that the most widely-used single biodiversity measure, that is, species richness, can miss more than 80% of the biodiversity (γ-diversity) of a biological system (Lyashevska and Farnsworth 2012). Thus, not only the multi-taxon scale but also the incorporation of indices related to the functional and structural diversity will allow us to better capture multidimensional complexity of ecosystems and, ultimately, obtain finer patterns within the spatial distribution of biodiversity

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Conflicts of interest

No conflicts declared.

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Annex 1. List of species of birds, amphibians and plant species of concern detected in DSS. For each species, we show: the category in the Basque Catalogue of Threatened Species (BC: RA, rare; IE, especial interest; VU, vulnerable; EN, endangered), whether the species is listed in various Annexes of the Birds and Habitats Directive (BD, HB), and the number of 1x1 km UTM cells in which the species has been detected (N): A I, Annex I; A II, Annex II; A IV, Annex IV; A V, Annex V.

Anexo 1. *Lista de las especies de aves, anfibios y plantas de interés detectadas en Donostia/San Sebastián. Para cada especie, mostramos: la categoría del Catálogo Vasco de Especies Amenazadas (BC; RA, rara; IE, de interés especial; VU, vulnerable; PE, en peligro de extinción), si la especie figura en diferentes anexos de la Directiva Aves y la Directiva Hábitats (BD, HB) y el número de celdas UTM 1x1 km en las que se ha detectado la especie (N):* A I, Annex I; A II, Annex II; A IV, Annex IV; A V, Annex V.

	BC	BD (AI)	HD (A II, A IV)	HD (A V)	N
Birds	-	-	-	-	2
Accipiter gentilis	RA	-	-	-	4
Accipiter nisus	-	-	-	-	4
Acrocephalus scirpaceus	RA	-	-	-	64
Aegithalos caudatus	-	-	-	-	28
Anas platyrhynchos	-	-	-	-	26
Anthus trivialis	-	-	-	-	51
Apus apus	-	-	-	-	1
Ardea cinerea	-	-	-	-	1
Asio otus	-	-	-	-	1
Athene noctua	-	-	-	-	1
Bubo bubo	RA	Yes	-	-	58
Buteo buteo	-	-	-	-	10
Caprimulgus europaeus	IE	Yes	-	-	82
Carduelis carduelis	-	-	-	-	75
Certhia brachydactyla	-	-	-	-	39
Cettia cetti	-	-	-	-	9
Charadrius dubius	VU	-	-	-	58
Chloris chloris	-	-	-	-	5
Cinclus cinclus	-	-	-	-	17
Cisticola juncidis	-	-	-	-	44
Columba livia f. *domestica*	-	-	-	-	59
Columba palumbus	-	-	-	-	13
Corvus corax	-	-	-	-	76
Corvus corone	-	-	-	-	16
Cuculus canorus	-	-	-	-	84
Cyanistes caeruleus	-	-	-	-	10
Delichon urbicum	-	-	-	-	61
Dendrocopos major	-	-	-	-	18
Dryobates minor	-	-	-	-	7
Dryocopus martius	RA	Yes	-	-	2
Emberiza cia	-	-	-	-	4
Emberiza cirlus	-	-	-	-	9
Emberiza citrinella	-	-	-	-	95
Erithacus rubecula	-	-	-	-	3
Falco peregrinus	RA	Yes	-	-	8
Falco subbuteo	RA	-	-	-	22
Falco tinnunculus	-	-	-	-	94
Fringilla coelebs	-	-	-	-	2
Fulica atra	-	-	-	-	17
Gallinula chloropus	-	-	-	-	78
Garrulus glandarius	-	-	-	-	12
Hieraaetus pennatus	RA	Yes	-	-	80
Hippolais polyglotta	-	-	-	-	27
Hirundo rustica	-	-	-	-	23
Jynx torquilla	-	-	-	-	6
Lanius collurio	-	Yes	-	-	2
Larus fuscus	-	-	-	-	2
Larus marinus	-	-	-	-	7
Larus michahellis	-	-	-	-	1
Leiothrix lutea	-	-	-	-	13
Linaria cannabina	-	-	-	-	8
Locustella naevia	-	-	-	-	40
Lophophanes cristatus	-	-	-	-	8
Milvus migrans	-	Yes	-	-	4
Milvus milvus	EN	Yes	-	-	65
Motacilla alba	-	-	-	-	21
Motacilla cinerea	-	-	-	-	50
Muscicapa striata	-	-	-	-	3
Otus scops	-	-	-	-	95
Parus major	-	-	-	-	79
Passer domesticus	-	-	-	-	7
Passer montanus	-	-	-	-	51
Periparus ater	-	-	-	-	3
Pernis apivorus	RA	Yes	-	-	3
Gulosus aristotelis	VU	-	-	-	63
Phoenicurus ochruros	-	-	-	-	84
Phylloscopus ibericus/collybita	-	-	-	-	50
Pica pica	-	-	-	-	61
Picus sharpei	-	-	-	-	27
Poecile palustris	-	-	-	-	20
Prunella modularis	-	-	-	-	62
Pyrrhula pyrrhula	-	-	-	-	84
Regulus ignicapilla	-	-	-	-	1
Riparia riparia	VU	-	-	-	28
Saxicola rubicola	-	-	-	-	78
Serinus serinus	-	-	-	-	69
Sitta europaea	-	-	-	-	49
Streptopelia decaocto	-	-	-	-	3
Streptopelia turtur	-	-	-	-	64
Strix aluco	-	-	-	-	6
Sturnus vulgaris	-	-	-	-	89
Sylvia atricapilla	-	-	-	-	11
Sylvia borin	-	-	-	-	8
Curruca melanocephala	-	-	-	-	4
Curruca undata	-	Yes	-	-	2
Tachybaptus ruficollis	RA	-	-	-	95
Troglodytes troglodytes	-	-	-	-	97
Turdus merula	-	-	-	-	94
Turdus philomelos	-	-	-	-	14
Tyto alba	-	-	-	-	2
Amphibians					
Alytes obstetricans	-	-	Yes	-	53
Bufo spinosus	-	-	-	-	35
Hyla meridionalis	PE	-	Yes	-	6
Lissotriton helveticus	-	-	-	-	46
Pelophylax perezi	-	-	-	Yes	30
Rana temporaria	-	-	-	Yes	8
Salamandra salamandra	-	-	-	-	10
Triturus marmoratus	-	-	Yes	-	7
Plants of concern	-	-	-	-	
Armeria euscadiensis	VU	-	-	-	3
Cochlearia aestuaria	VU	-	-	-	3
Frankenia laevis subsp. *laevis*	RA	-	-	-	2
Ilex aquifolium	-	-	-	-	8
Narcissus bulbocodium	-	-	-	Yes	2
Narcissus pseudonarcissus	RA	-	Yes	-	2
Pinguicula lusitanica	RA	-	-	-	1
Quercus suber	RA	-	-	-	4
Ruscus aculeatus	-	-	-	Yes	2
Taxus baccata	-	-	-	-	2
Vandenboschia speciosa	VU	-	Yes	-	1
Woodwardia radicans	VU	-	Yes	-	1