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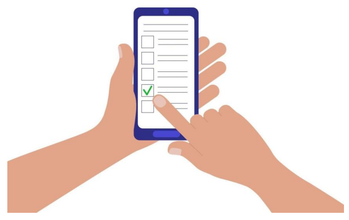
biodt.eu

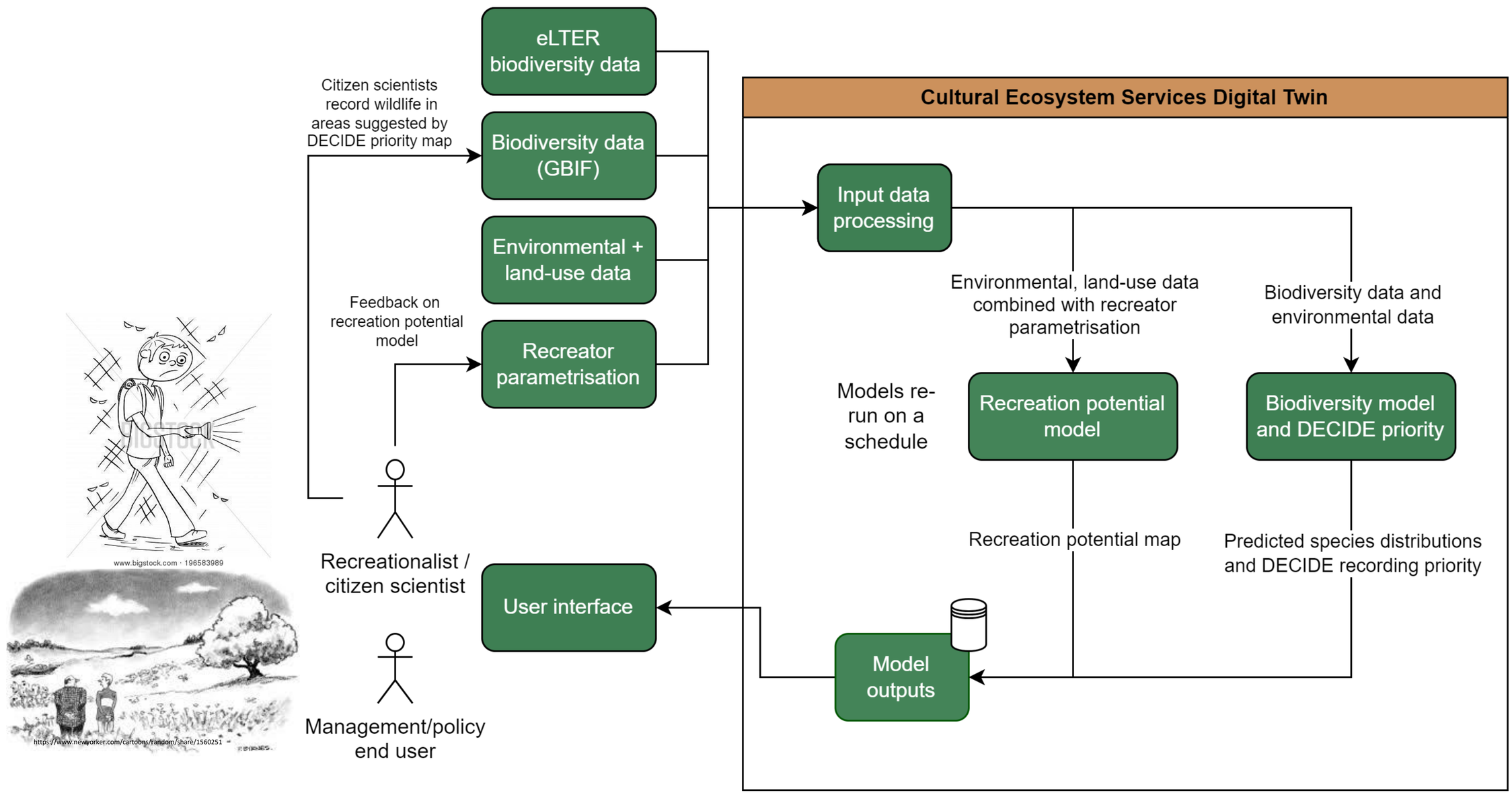
An invitation to participate in research

The aim of the research is to develop a digital twin integrating a customised recreation potential model to quantify the cultural ecosystem services of the physical landscape and species distribution models to quantify the biodiversity component for an area.

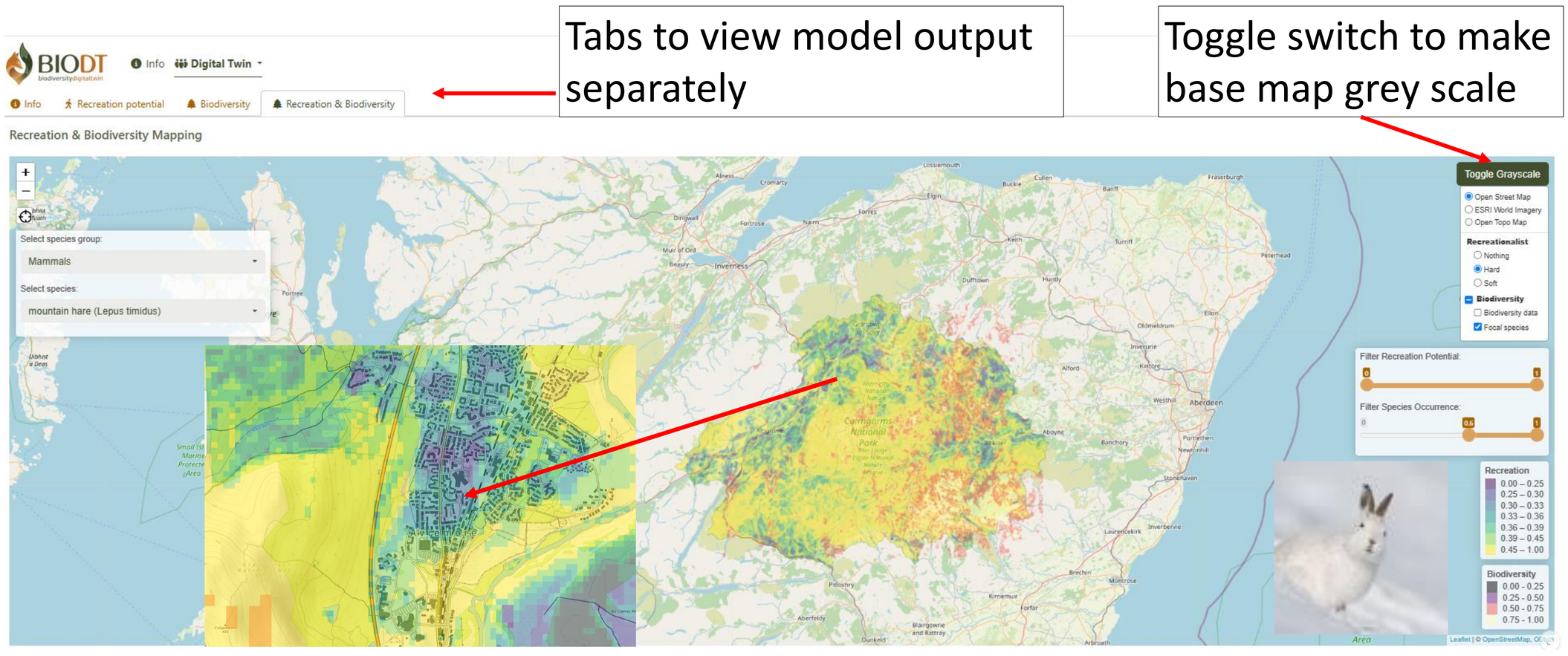


Please provide your views on the utility of this digital twin by scanning this QR code .

Conceptual schema of the Recreation and Biodiversity Cultural Ecosystem Services Prototype Digital Twin.



Example output from the prototype digital twin: Cairngorms National Park highlighting recreational potential for hard recreationalists and probability of viewing mountain hare



Map around Aviemore enlarged by using +/- zooming in/out function

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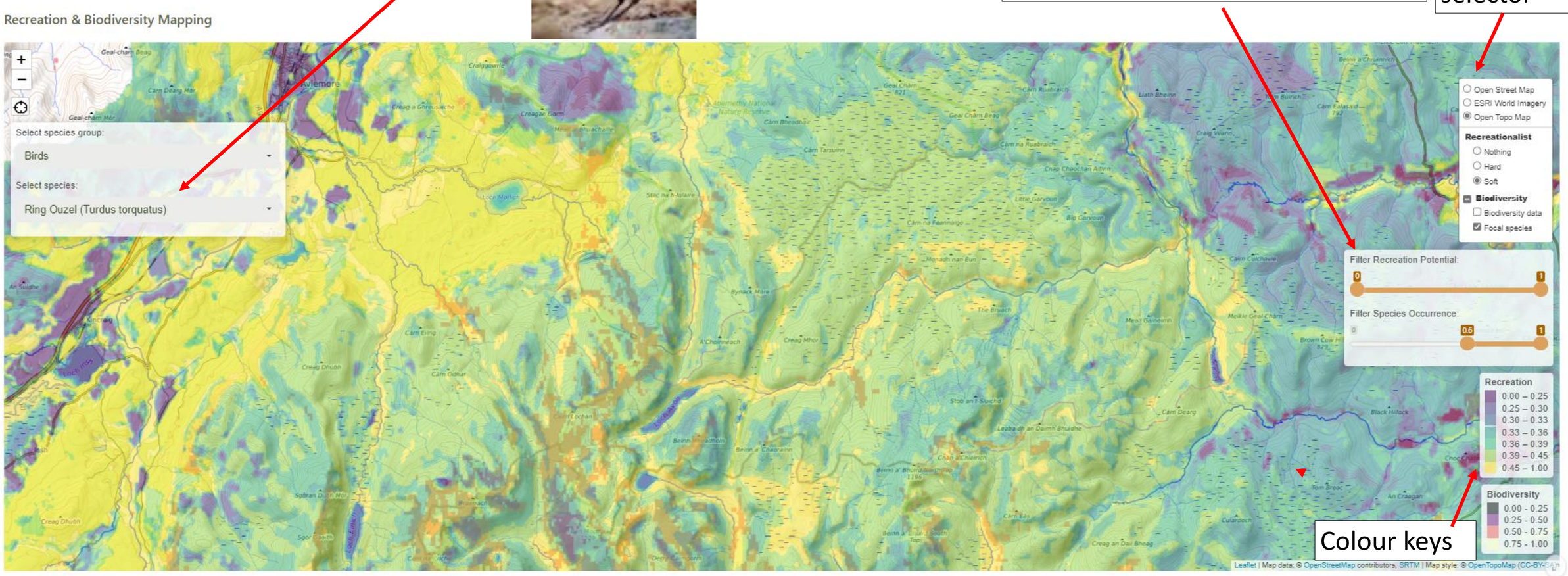
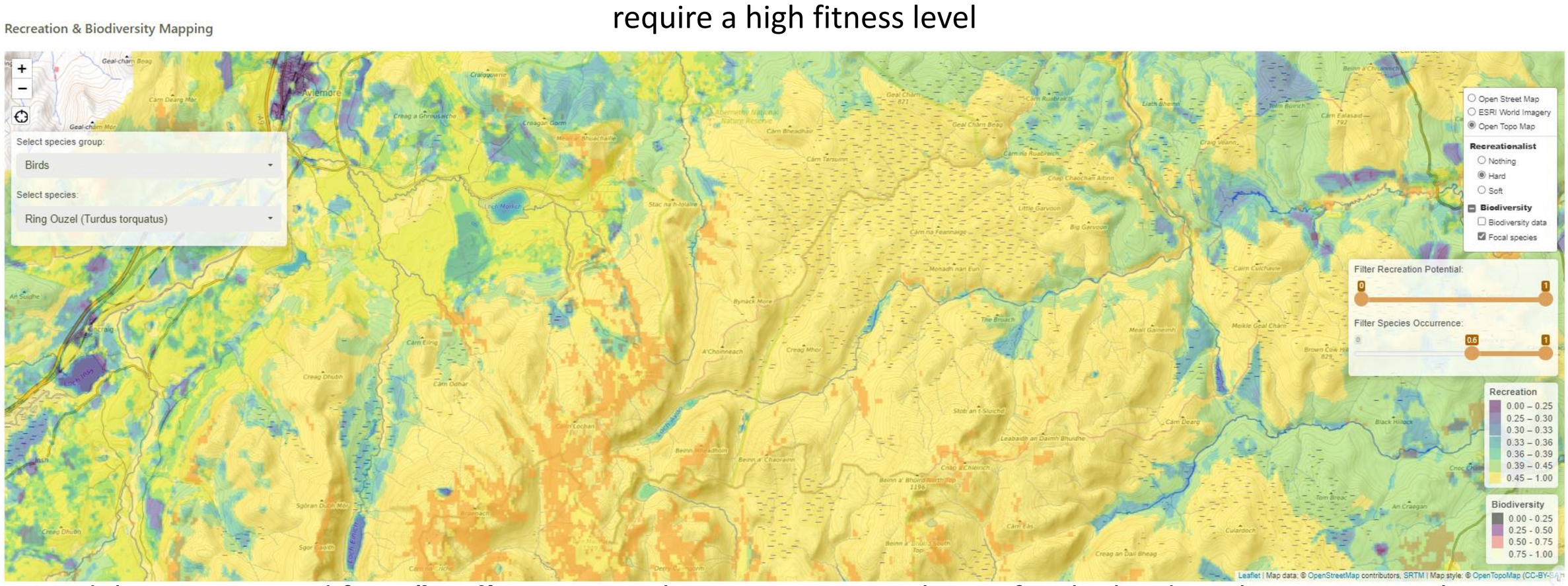
Examples of output

Cairngorms National Park The maps below show differences in the recreation potential of areas in Aviemore in response to user parameterization of the model. Areas with a higher recreation potential (appear yellow) were predicted to be more desirable to the user. The maps also show areas filtered to show 70% or more occurrence of Ring Ouzel (*Turdus torquatus*).

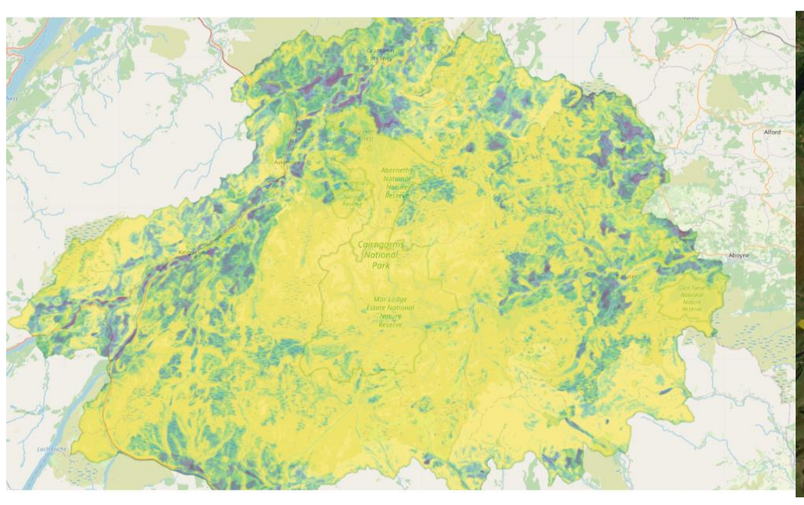


Model parameterised for a **‘soft’** recreationalist i.e. some who prefers gentle slopes and activities that do not require a high fitness level

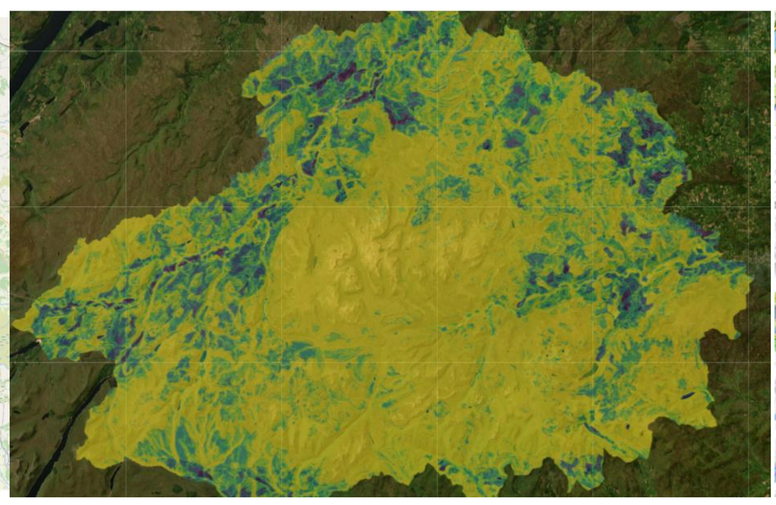


Model parameterised for a **‘hard’** recreationalist i.e. someone who prefers high-adrenaline activities that require a high level of fitness

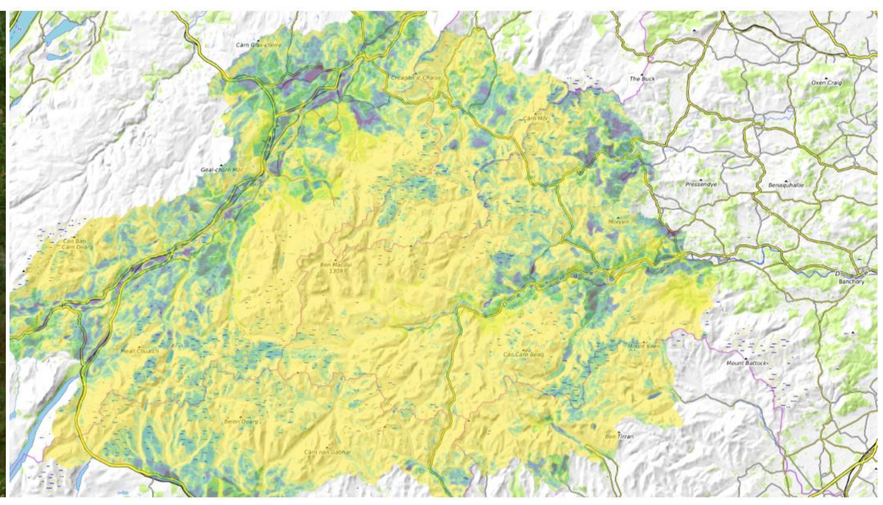
Choice of three base maps – all can be toggled to grey scale



Open Street Map



ESI World Imagery



Open Topo Map

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Parameterising the recreational model

Table of four components and scores selected for 87 parameters

order	Component	Sub- component	Description	Recreationalist Soft	Hard
1	Infrastructure features that influence recreational potential	Paths	Path	7	5
2		Road Tracks	Motorway	0	0
3			A Road	0	0
4			B Road	3	0
5			Minor / local road	5	0
6			Access roads / Track	8	8
7		Cycle Network	On Road: Paved Surface	5	2
8			Traffic Free: Unpaved Surface	6	8
9			Traffic Free: Paved Surface	10	6
10			On Road: Unpaved Surface	5	7
11	Natural features which influence recreational potential	Landform	Foothills	8	7
12			Mountains	4	10
13			Terraces	3	5
14			Flood plain	2	1
15			Beaches / Dunes	9	7
16			Rocks / Scree	1	6
17			Depressions	1	1
18			Hills	4	8
19			Lowlands	8	3
20			Rock Walls	1	10
21			Uplands	7	7
22			Valley sides	2	7
23			Valley bottom	7	3
24			Built-up areas	1	1
25			Saltings	0	0
26			Hummocks / mounds / moraines	3	3
27		Slope	easy	10	1
28			gentle slope	8	1
29			medium slope	6	2
30			steep slope	4	4
31			very steep slope	3	10
32			extremely steep slope	1	8
33		Soil	Peat / Organic	3	6
34			Mineral	5	2
35	Influence of water features on recreational potential	Lakes	Pond	5	1
36			Lochan	3	3
37			Small Lochs	3	5
38			Medium Lochs	5	4
39			Large Lochs	7	7
40			Major Lochs	10	7
41		Rivers	Minor river or tributary	4	3
42			Unnamed minor stream or tributary	1	3
43			Major river or tributary	8	7
44			Named minor stream or tributary	2	3
45			Water body	8	5
46			Tidal river or estuary	7	4
47			Canal	7	3
48	The suitability of land to support recreational potential	Land cover	Alpine and subalpine grassland	2	8
49			Arable land and market gardens	4	2
50			Arctic, alpine and subalpine scrub	2	8
51			Bare field / exposed soil	1	1
52			Base-rich fens and calcareous spring mires	5	2
53			Broadleaved deciduous woodland	9	7
54			Built-up area	3	1
55			Coastal dunes and sandy shore	10	7
56			Coastal shingle	6	3
57			Dry grassland	3	5
58			Freshwater	9	7
59			Inland cliffs, rock pavements and outcrops	3	10
60			Lines of trees, small planted woodlands, early-stage woodland and coppice	6	2
61			Littoral sediment / saltmarsh	4	2
62			Mesic grassland	5	4
63			Mixed deciduous and coniferous woodland	9	5
64			Non-native coniferous plantation	7	2
65			Raised and blanket bog	5	1
66			Riverine and fen scrubs	4	2
67			Rock cliffs, ledges and shores	6	10
68			Scots pine woodland	9	7
69			Screes	1	5
70			Seasonally wet and wet grassland	5	5
71			Temperate montane scrub	3	7
72			Temperate shrub heathland	7	7
73			Valley mires, poor fens and transition mires	3	1
74			Windthrown woodland	1	1
75			Woodland fringes and clearings and tall forb stands	3	1
76		Landscape designation	NNR Reserve	7	6
77			National Park	10	10
78			Nature Reserve	6	3
79			Regional Park	4	2
80			RSPB Reserve	6	1
81			SAC	6	3
82			SPA	5	3
83			SSSI	3	2
84			SWT Reserve	3	2
85			Wild Land Areas	3	7
86			Country Park	8	1
87			HNV	5	4

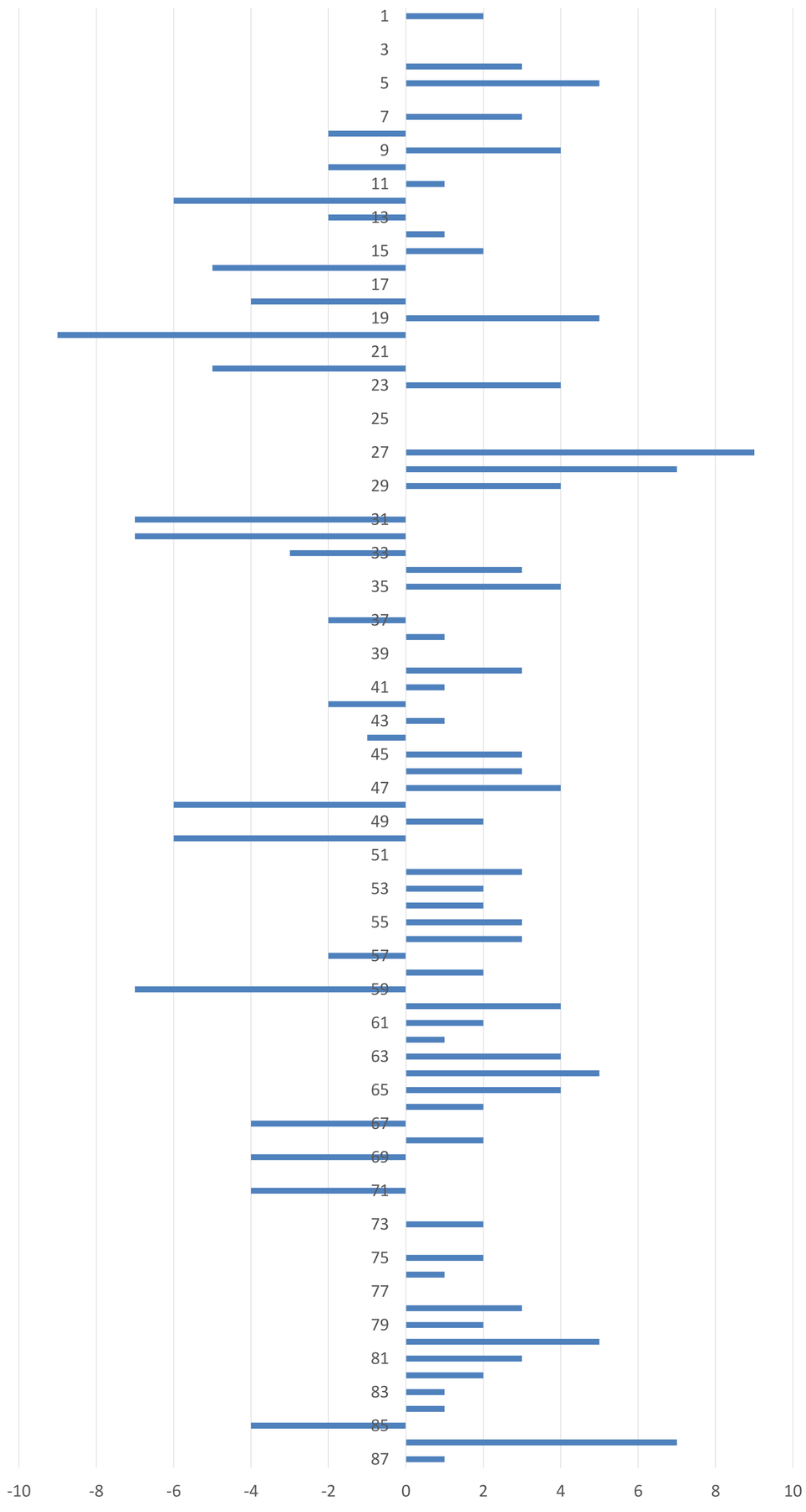
The model (based on Zulian et al. 2028, Dick et al. 2022) enables the individual parameterisation of 87 features on a scale from 0-10 for each pixel of a raster map. Water and infrastructure features are recognised as particularly important for recreation so Euclidean distance is applied in the surrounding 1500 m.

These scores are then combined within the four components and normalised before totalling to give a recreational potential score between 0-1 which is then outputted as a raster map.

Maps plotted in quantile colour range

Dick, J., Andrews, C., Orenstein, D. E., Teff-Seker, Y., & Zulian, G. (2022). A mixed-methods approach to analyse recreational values and implications for management of protected areas: A case study of Cairngorms National Park, UK. Ecosystem Services, 56, 101460. https://doi.org/10.1016/j.ecoser.2022.101460

Zulian, G., Stange, E., Woods, H., Carvalho, L., Dick, J., et al., 2018. Practical application of spatial ecosystem service models to aid decision support. Ecosyst. Serv. 29 (Pt C), 465–480. https://doi.org/10.1016/j.ecoser.2017.11.005.



Difference in the scores between soft and hard recreationalist

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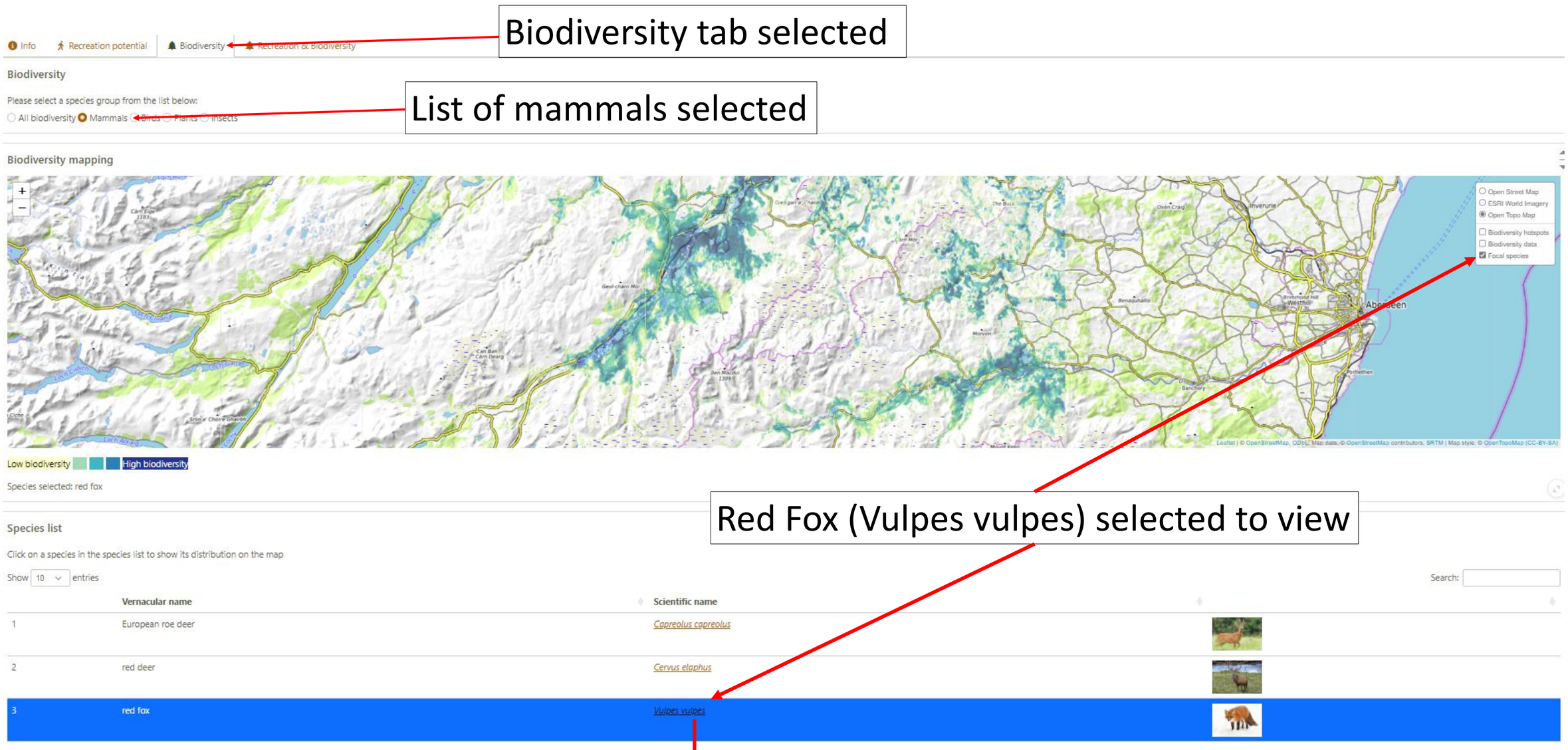
Biodiversity model

We fitted Species Distribution Models (SDMs) using citizen science records of species occurrence obtained from GBIF (and in future, eLTER) as response variables, and bioclimatic variables available on Google's Earth Engine Data Catalog as explanatory variables. Models were fitted using R packages, flexsdm (Velazco et al., 2022) and terra (Hijmans et al., 2024). The app can additionally visualise the mean estimated probability of occurrence by grouping predictions across selections of multiple species.

Hijmans, R. J., Bivand, R., Pebesma, E., & Sumner, M. D. (2024). terra: Spatial Data Analysis (Version 1.7-71) [Computer software]. https://cran.r-project.org/web/packages/terra/index.html

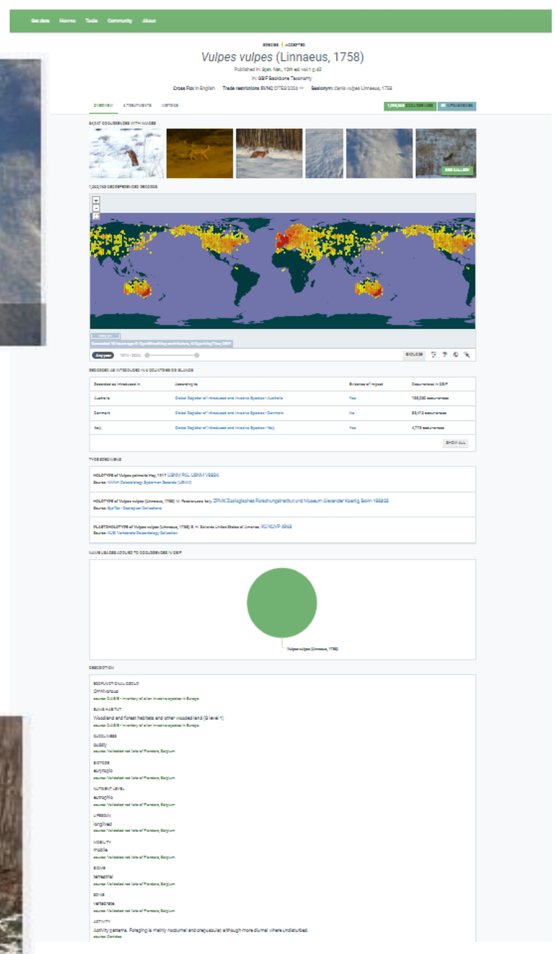
Velazco, S. J. E., Rose, M. B., de Andrade, A. F. A., Minoli, I., & Franklin, J. (2022). flexsdm: An r package for supporting a comprehensive and flexible species distribution modelling workflow. Methods in Ecology and Evolution, 13(8), 1661–1669 https://doi.org/10.1111/2041-210X.13874

Bioclimatic variables dataset: https://developers.google.com/earth-engine/datasets/catalog/WORLDCLIM_V1_BIO



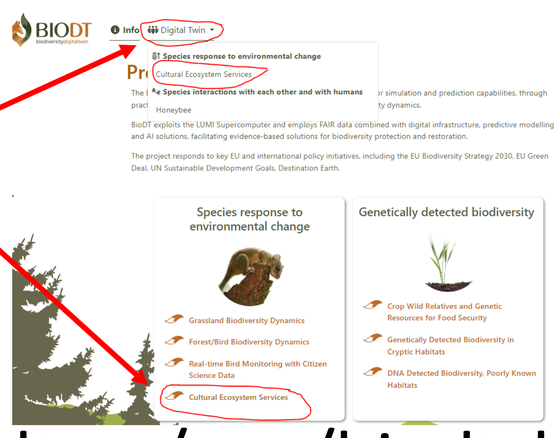
Red Fox (Vulpes vulpes) selected to view

Additional information available to view with link to Global Biodiversity Information Facility (GBIF) website



You can access the prototype digital twin via this QR code

Click on: Cultural Ecosystem Services



app.biodt.eu/app/biodtshiny

If you would like more information please contact Jan Dick

jand@ceh.ac.uk