Krkonoše out of breath

- full of visitors and fragmented habitats

TransParcNet Meeting 2025
Jelenia Góra - Sobieszow

RNDr. Dušan Romportl, Ph.D. (Charles University & SPECLab - Spatial Ecology and Conservation Lab, Landscape Research Institute)

Mgr. Martin Erlebach, Ph.D. (Palacký University Olomouc)

Výzkumný ústav pro krajinu, v. v. i.

PŘÍRODOVĚDECKÁ FAKULTA Univerzita Karlova

Faculty of Science
Palacký University Olomouc

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Why tourism monitoring & assessment in the Krkonoše Mts.?

2. 5. 2025, Dom Śląski

2. 5. 2025, Dom Śląski, Sněžka/Śnieżka

- one of the **most visited** (and endangered) protected areas
- **high tourism intensity** = high pressure on the environment; more offences; …
- identification of **main trends and peaks** in tourism intensity
- impact on **habitat and protected species assessment** (predictive modeling)

Project RekreENVI scope & objectives

- The main aim of the project is to propose a **comprehensive monitoring and evaluation of tourism impacts** in the Krkonoše area, as a model example of a PA exposed to increasing recreational pressure

- Data based analyses on the **forms and intensity of tourism** and the overall anthropic impact

- Assessment of the main **spatial, environmental, socio-economic** and **demographic impacts**

Contents and goals

1) Introduction of selected types of tourism data (M. Erlebach)

- to demonstrate actual trends in tourism intensity
- spatiotemporal distribution of visitors
- data combination and complementarity

2) Use of data on the spatiotemporal distribution of tourism (D. Romportl)

- models of habitat suitability for selected species
- environmental impact assessment (habitats fragmentation)
- localised prioritisation in nature conservation

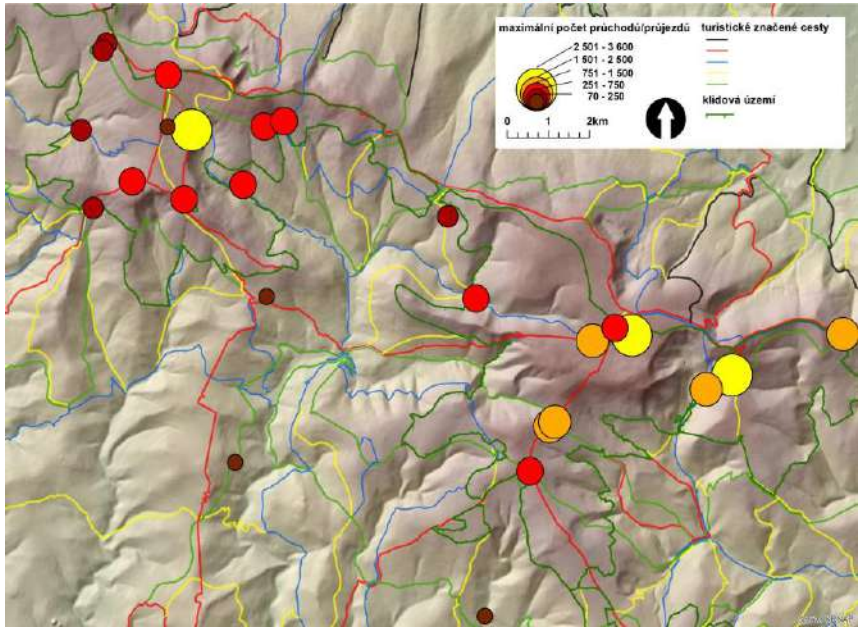
RekreENVI project

Program **Prostředí pro život**

Project outputs

Set of maps for nature conservation management
Proposals for measures

Spatiotemporal visitors data



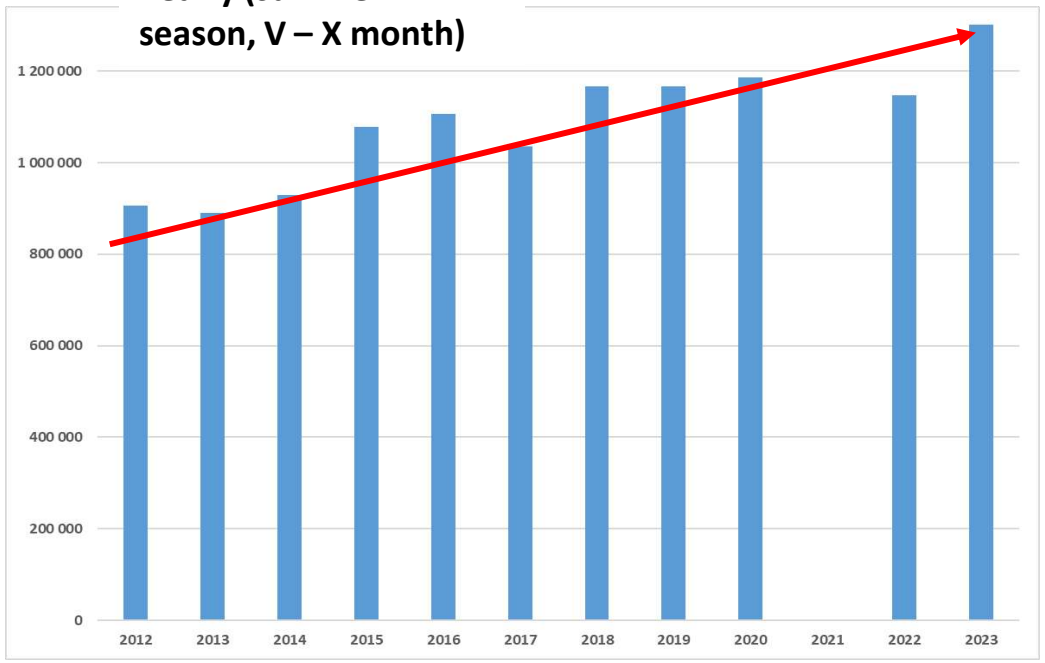
Eco-Counters

- PYRO (pedestrian), ZELT (cars, bicycles) sensors
- 28 permanent + 3 movable counters (most protected localities)
- monthly – weekly – daily – hourly data (long-term continuous period)
- permanent methodology of collecting data
- comparability (spatial and temporal)

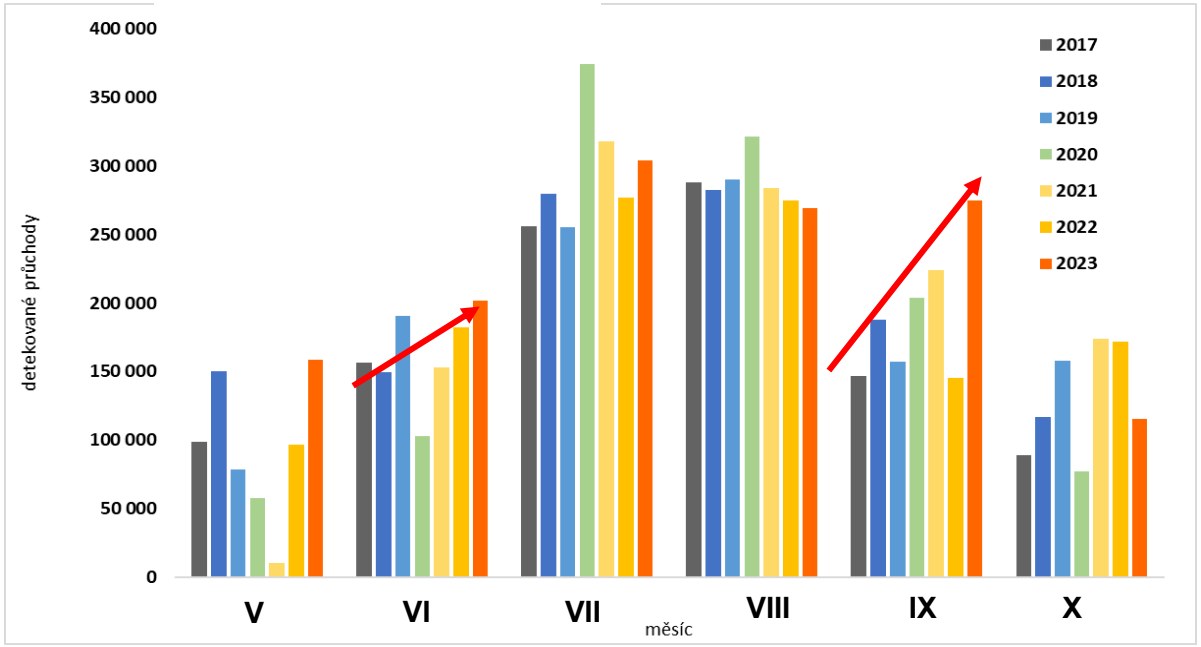
Selected limits

- climate (snow, freeze, …)
- underestimated and overestimated data depending on the type of path

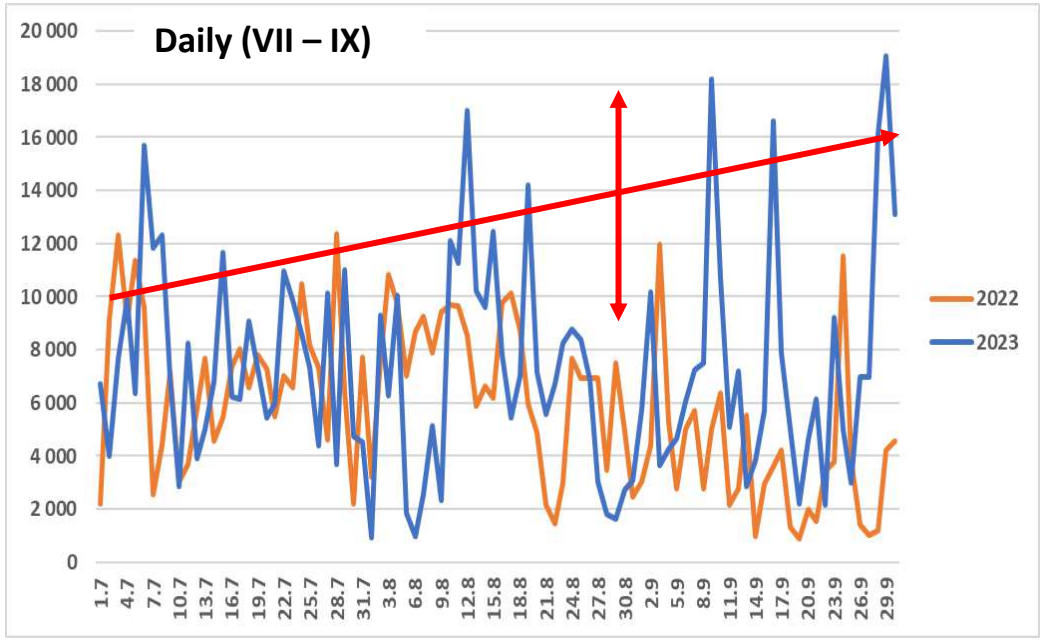
Yearly (summer season, V – X month)



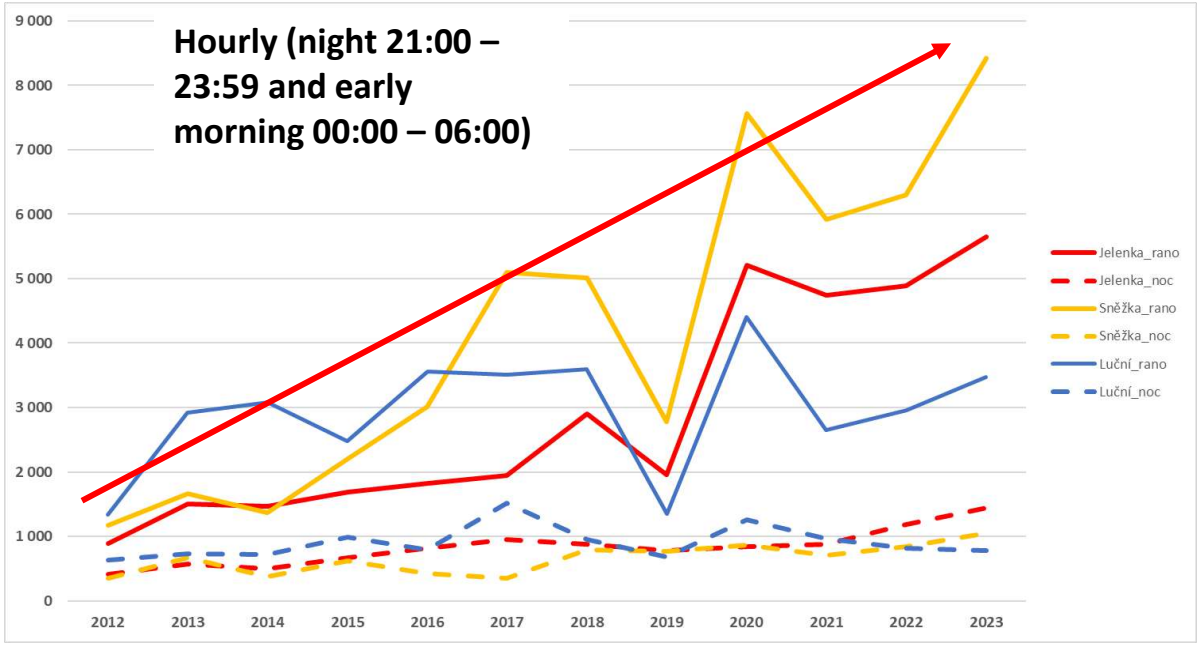
Monthly (V – X month)



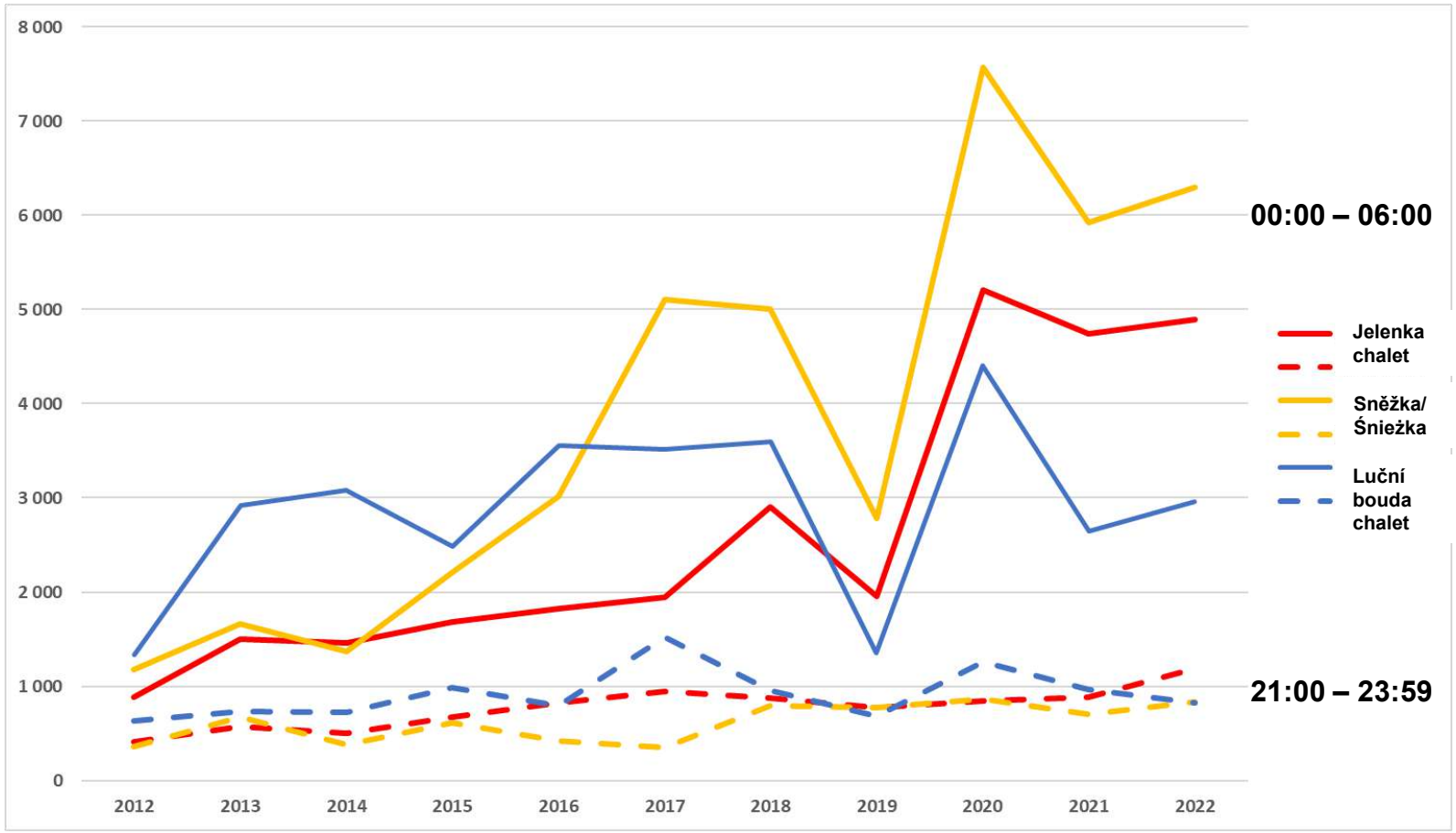
Daily (VII – IX)



Hourly (night 21:00 – 23:59 and early morning 00:00 – 06:00)

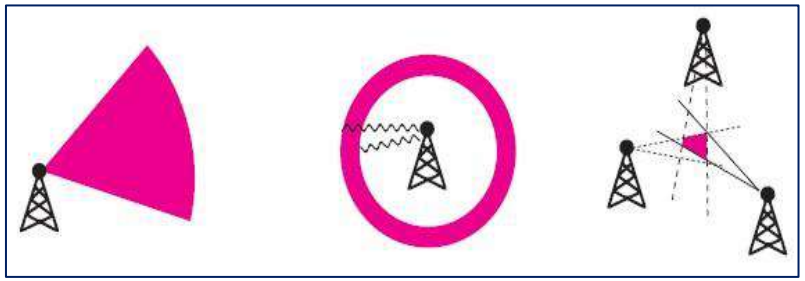


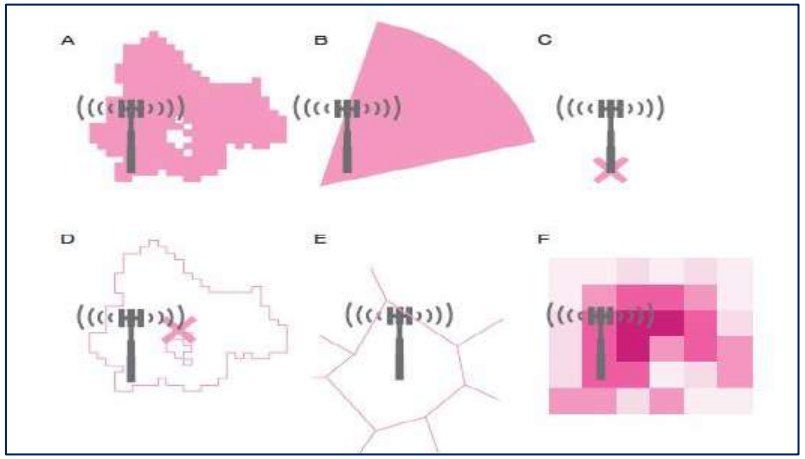
Spatiotemporal visitors data



night time "overtourism" (Sněžka) - sunrise and sunset

Spatiotemporal visitors data





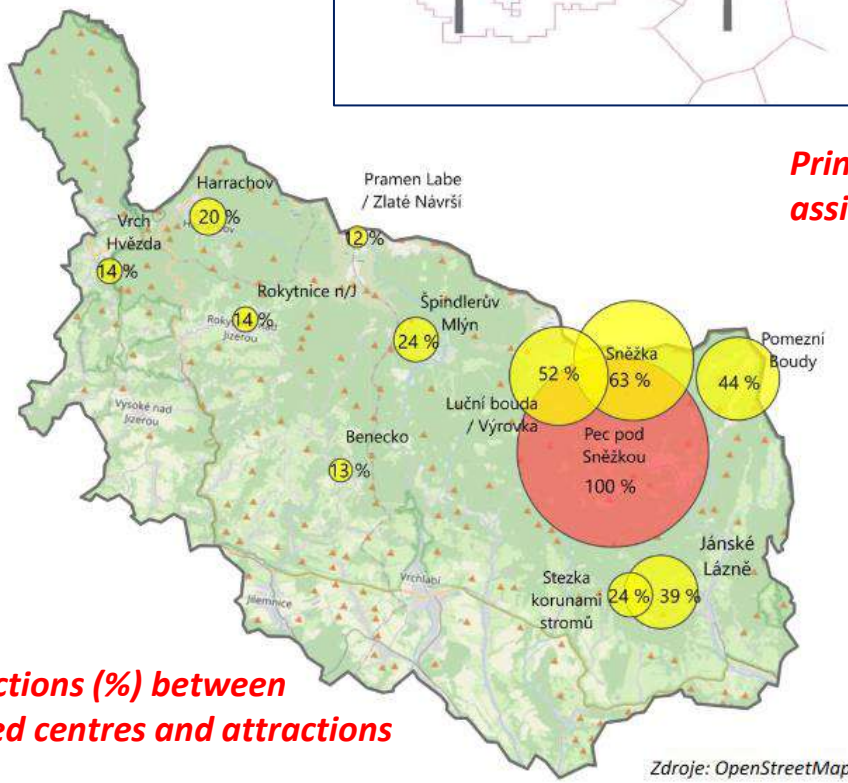
Mobile phone location Data

- mobile operators (T-Mobile)
- year-round daily data (no climate limits)
- 12 selected localities (centres and attractions)
- origin – destination data
- residents and international visitors
- exact number of visitors throughout the territory and in the locations

Selected limits

- low spatial detail of the information (mobile signal)
- costs (€60,000 per year; 2025)

Principle of SIM card assign to the BTS unit



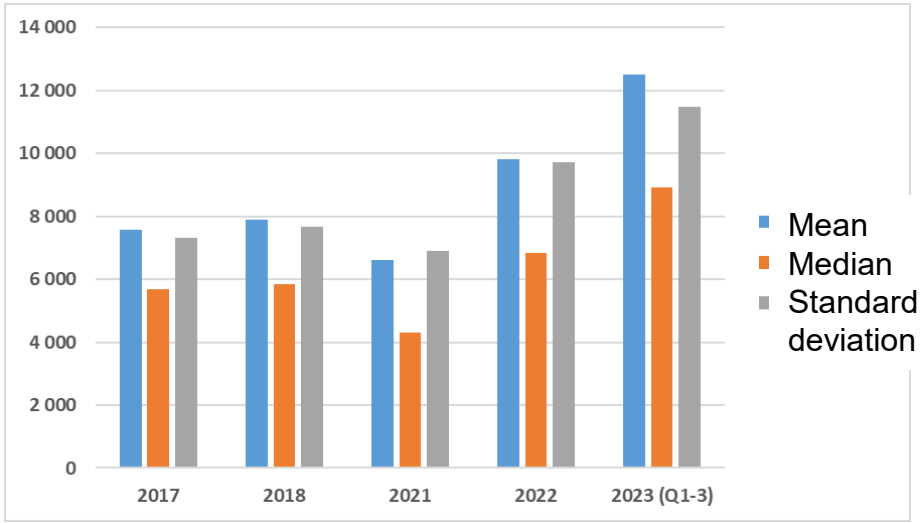
Interactions (%) between selected centres and attractions

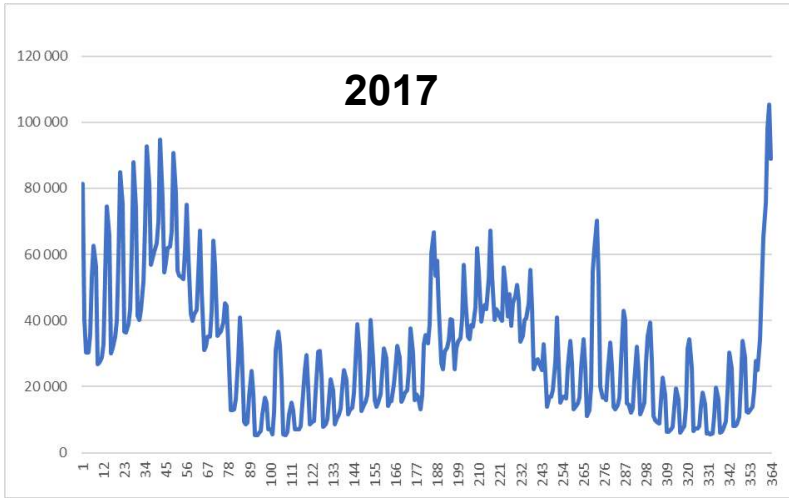
Mobile Phone Location Data

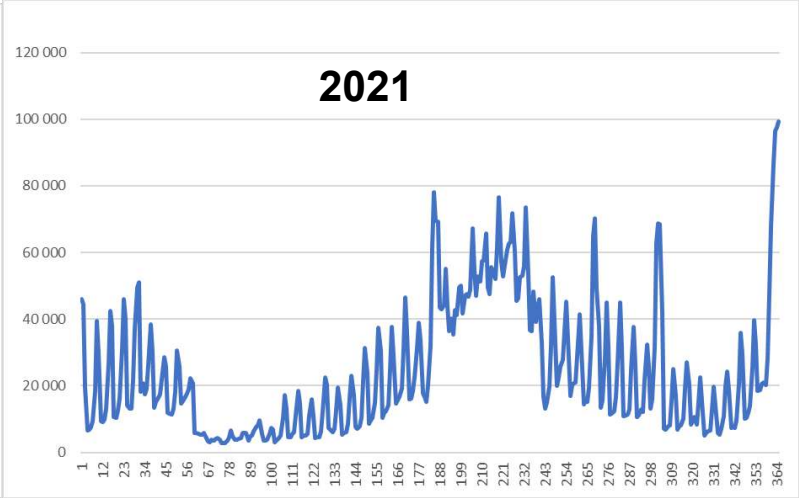
- **3,564,966** individual visitors (in 2022)
- **12,111,212** visited days (in 2022)

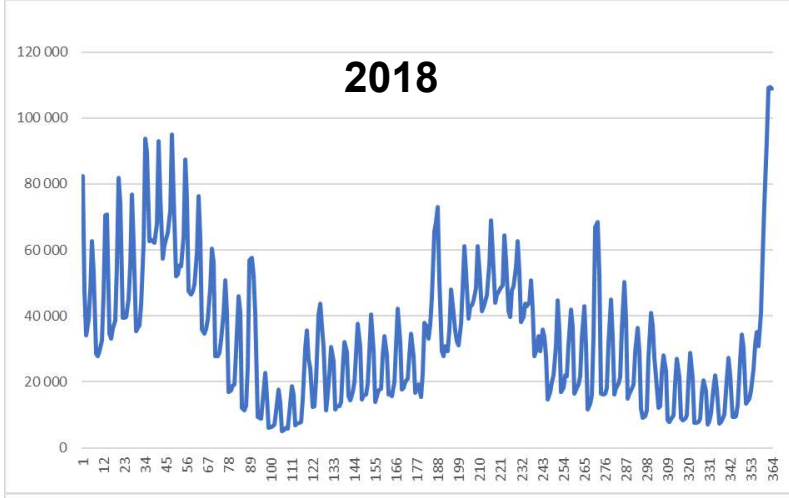
- peaks identification
- changing (weekly) rhythmicity of visitors

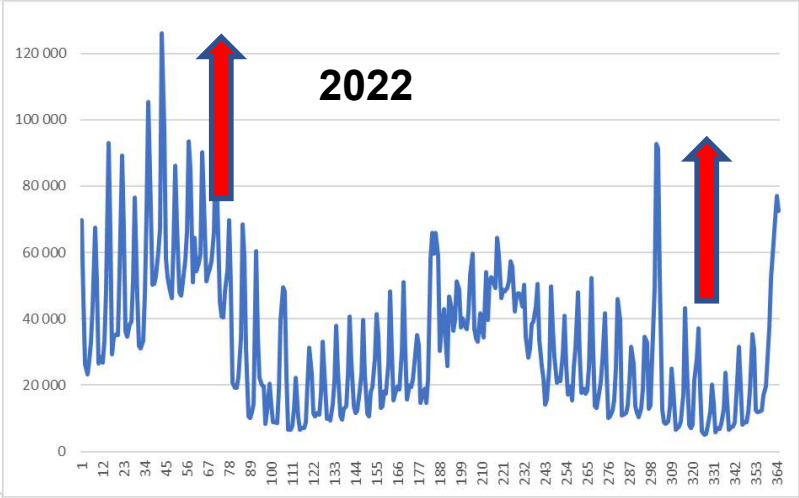
Changing the intensity of the rhythms

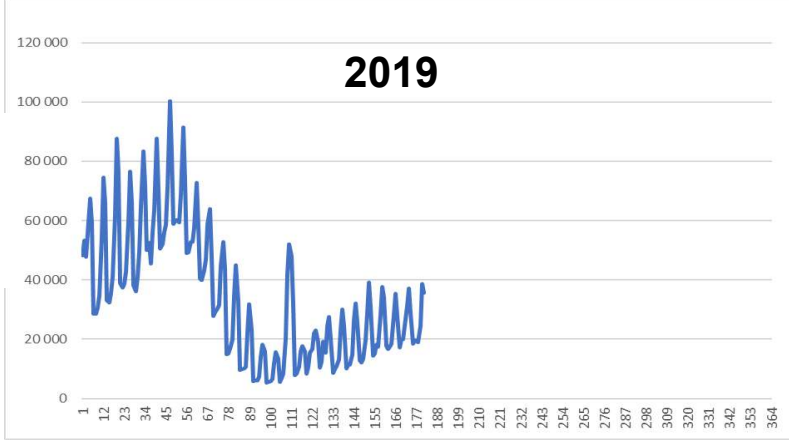


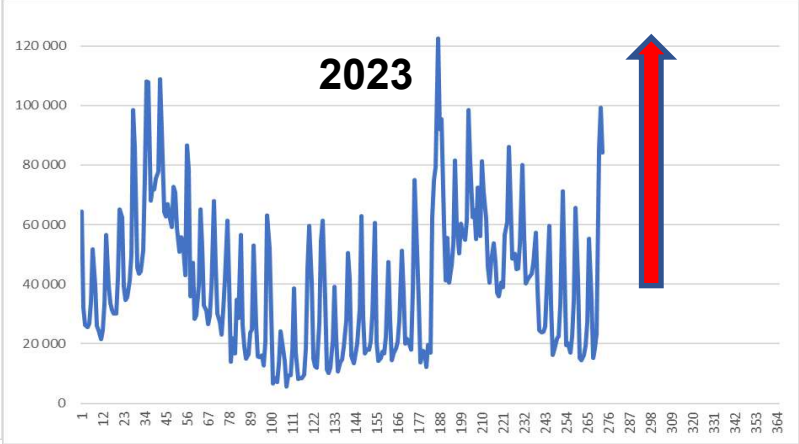












Spatiotemporal visitors data

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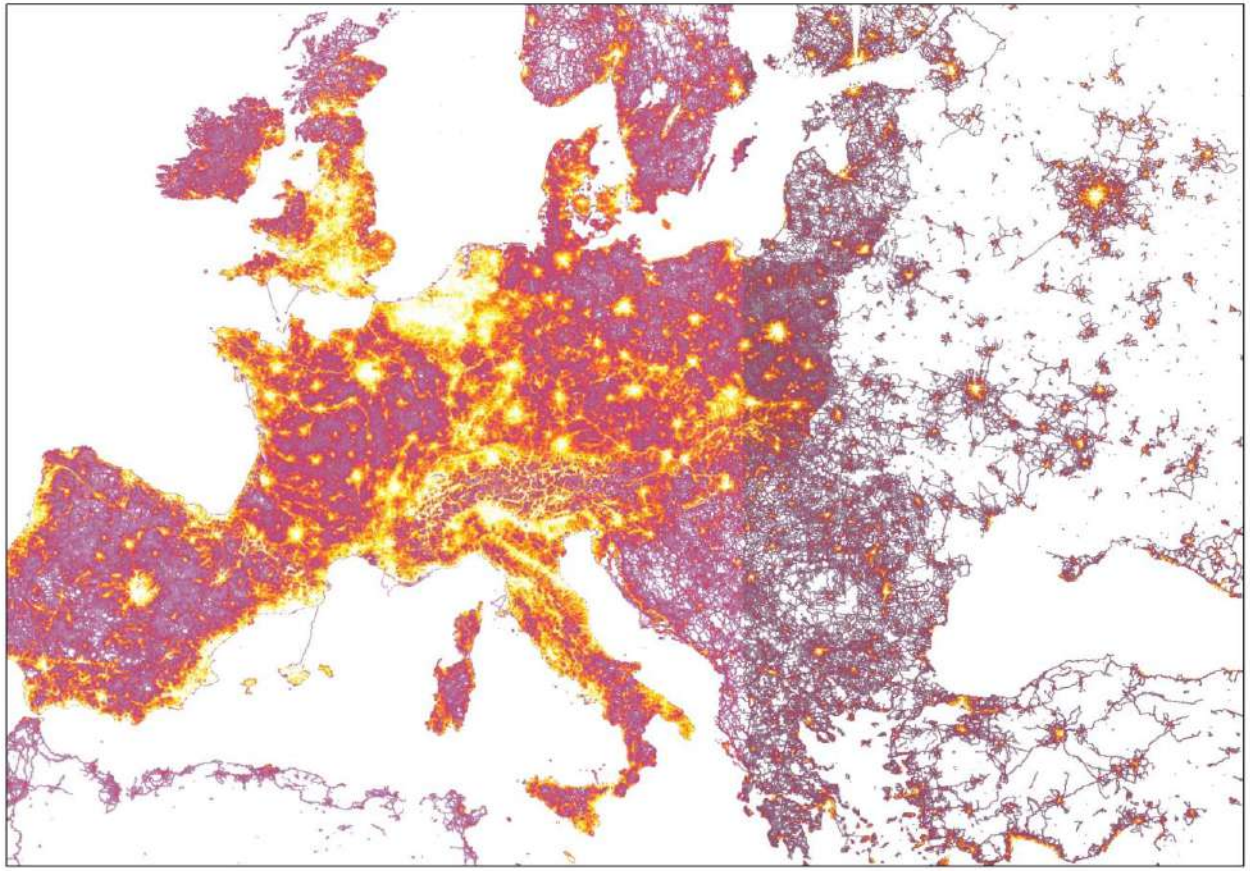
Mobile sport tracker applications

(Crowdsourced data)

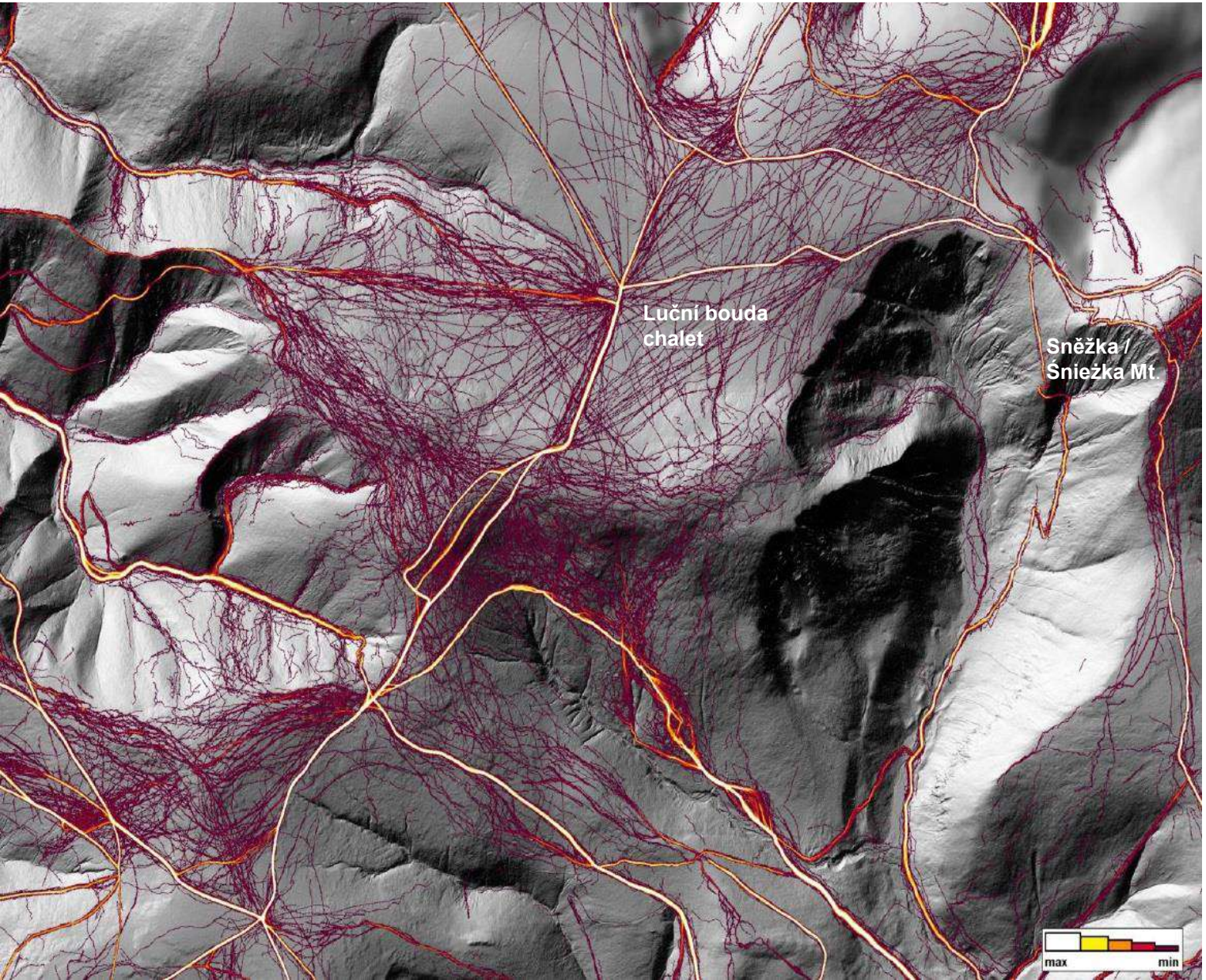
- STRAVA and STRAVA METRO
- type of user (sports type)
- intensity by path
- origin – destination data
- users demography
- yearly – hourly data
- high spatial detail



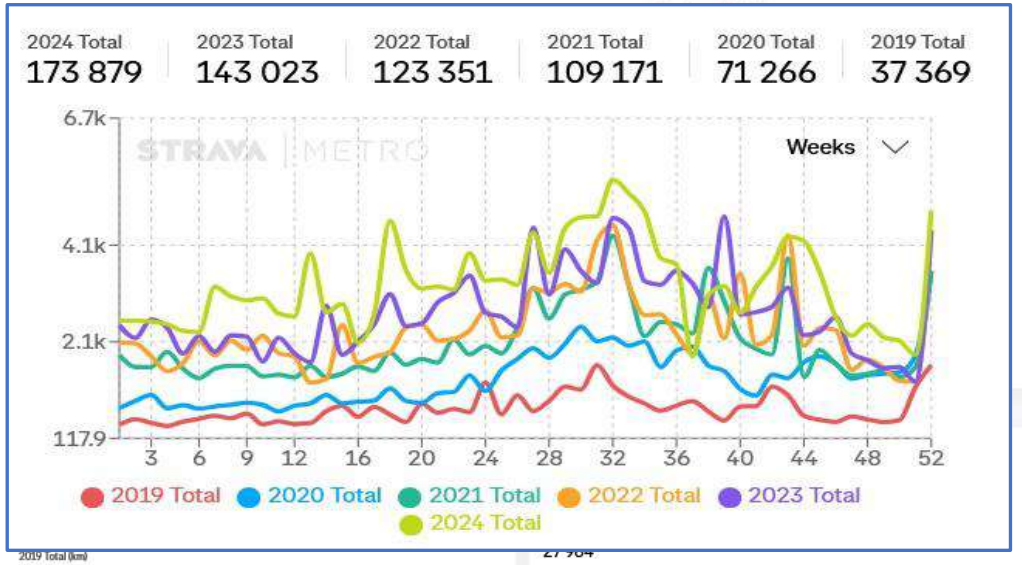
Selected limits

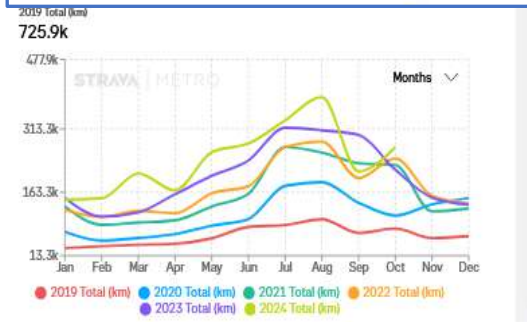
- only people who has app
- provision of data under a contract

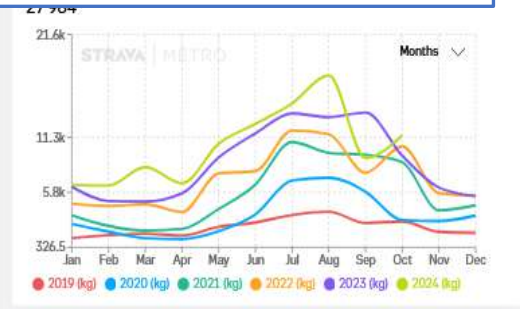
STRAVA heatmap, eastern mountain ridge

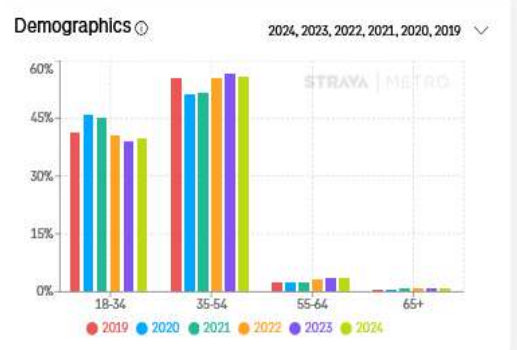


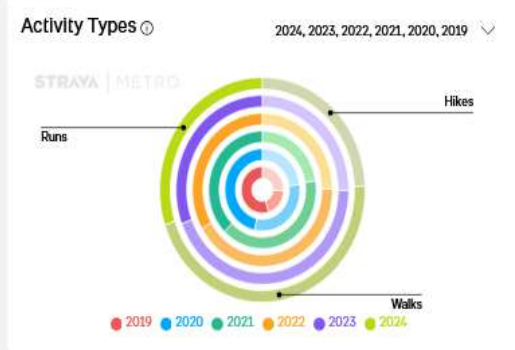
STRAVA METRO











STRAVA METRO and Eco-Counters correlations

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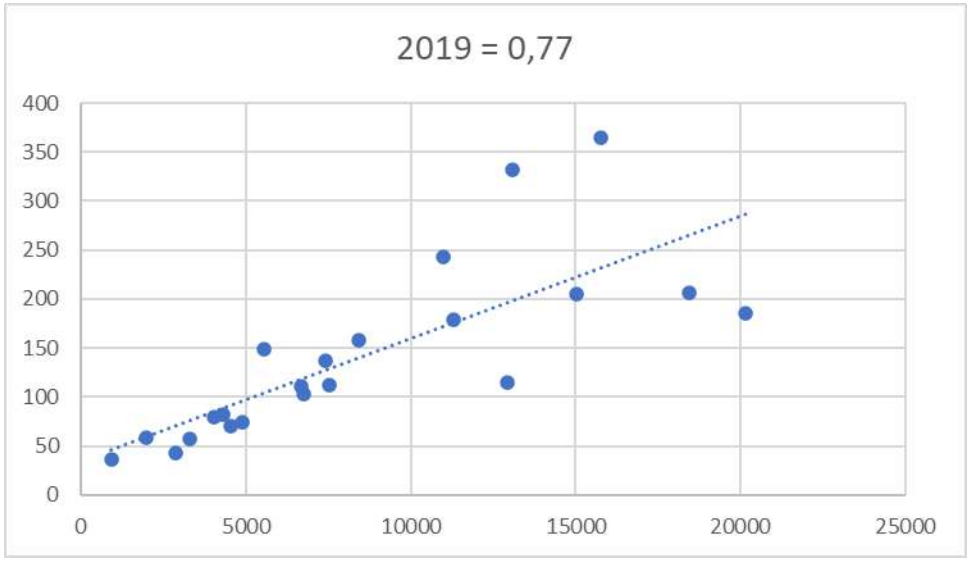
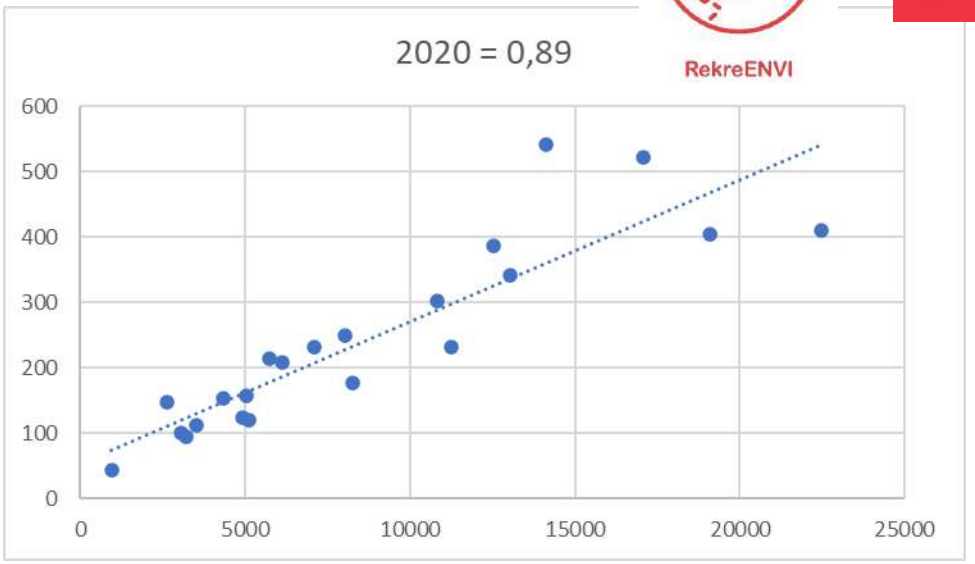
2019



STRAVA

Eco-Counters

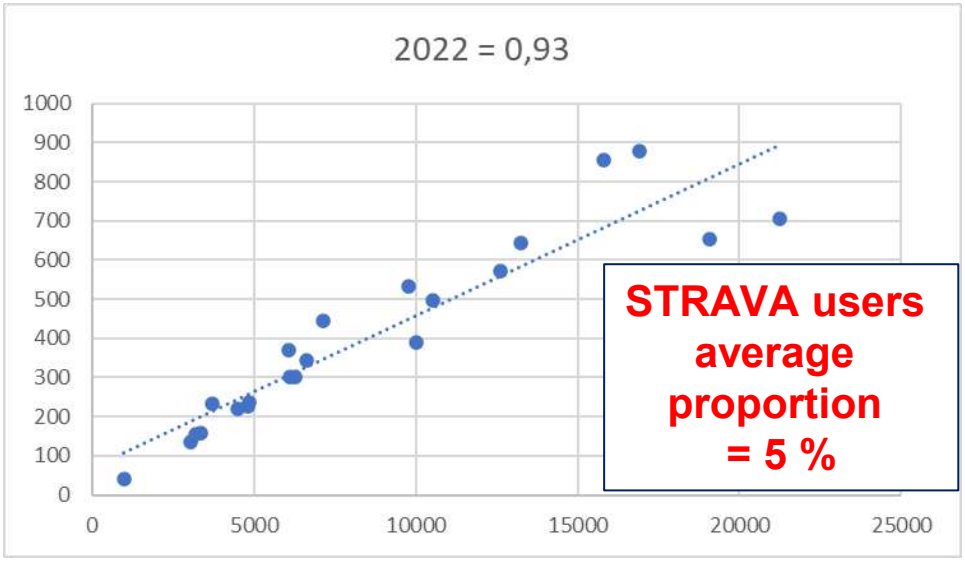
2020



STRAVA

Eco-Counters

2022

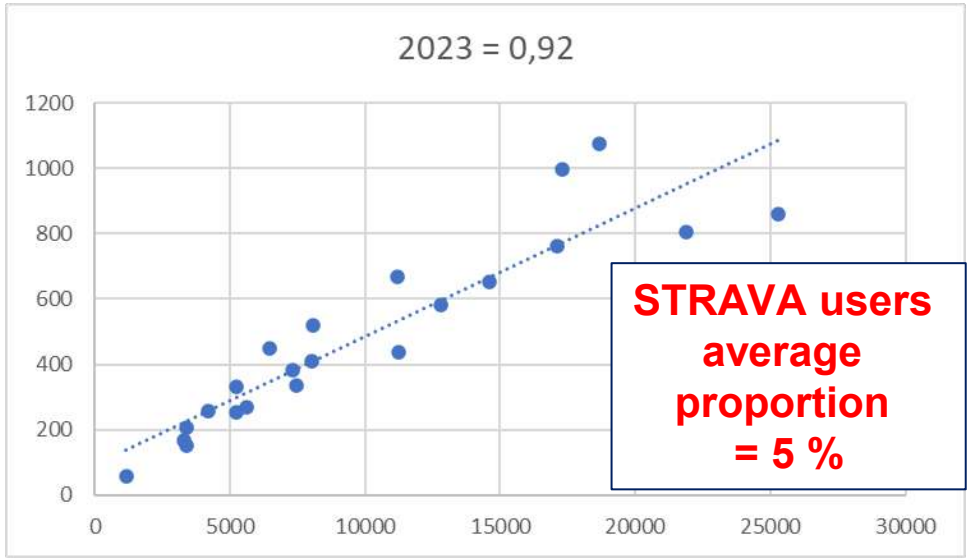


STRAVA users average proportion = 5 %

STRAVA

Eco-Counters

2023



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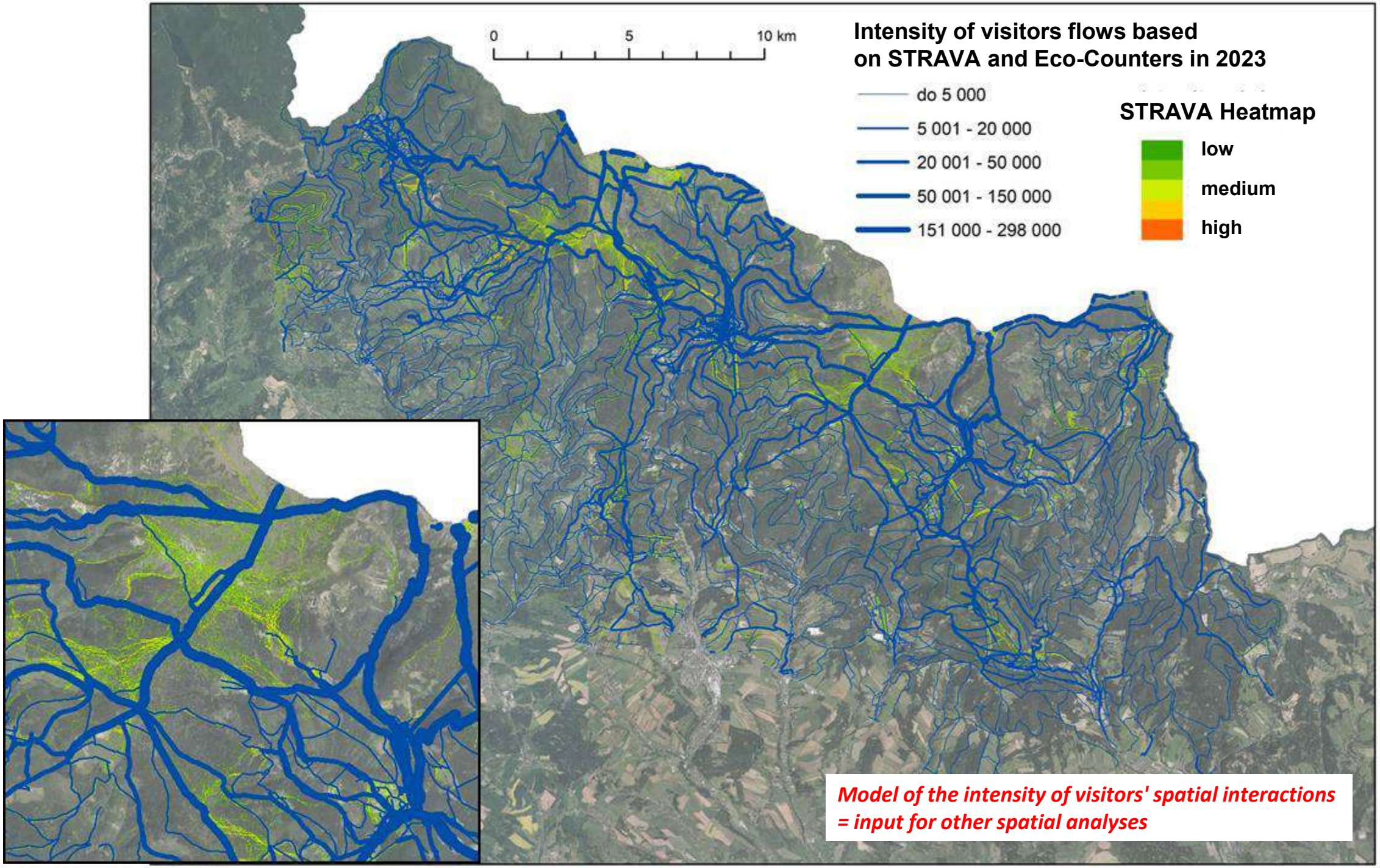
STRAVA

Eco-Counters


0
5
10 km
Intensity of visitors flows based
on STRAVA and Eco-Counters in 2023
do 5 000
5 001 - 20 000
20 001 - 50 000
50 001 - 150 000
151 000 - 298 000
STRAVA Heatmap
low
medium
high
Model of the intensity of visitors' spatial interactions
= input for other spatial analyses

Assessment of the impact on habitats & species

- evaluation of **habitat transformation / degradation & fragmentation**
- impacts on **biodiversity**, esp. on the **distribution** of conservation-relevant species

Black Grouse as a flag species of the Krkonoše Mts.

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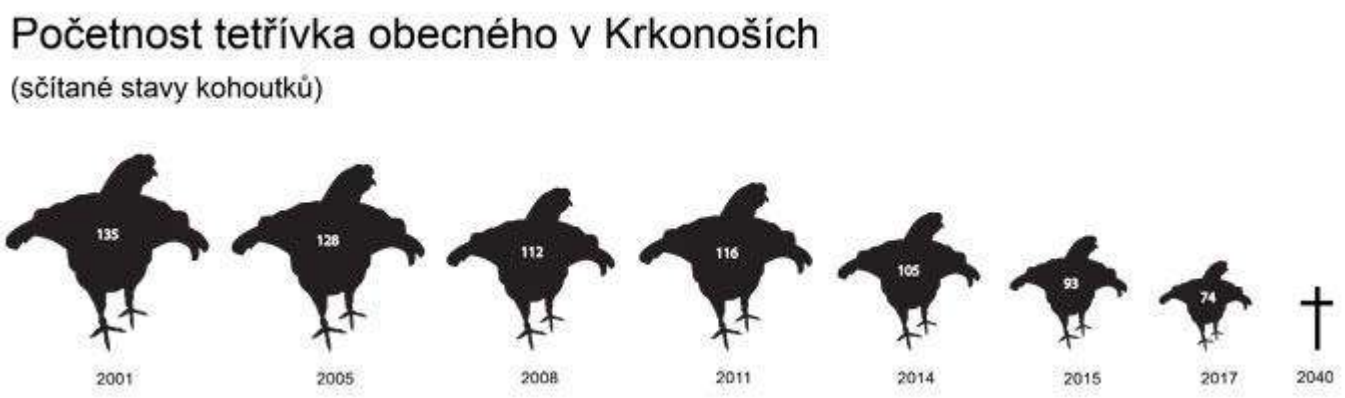
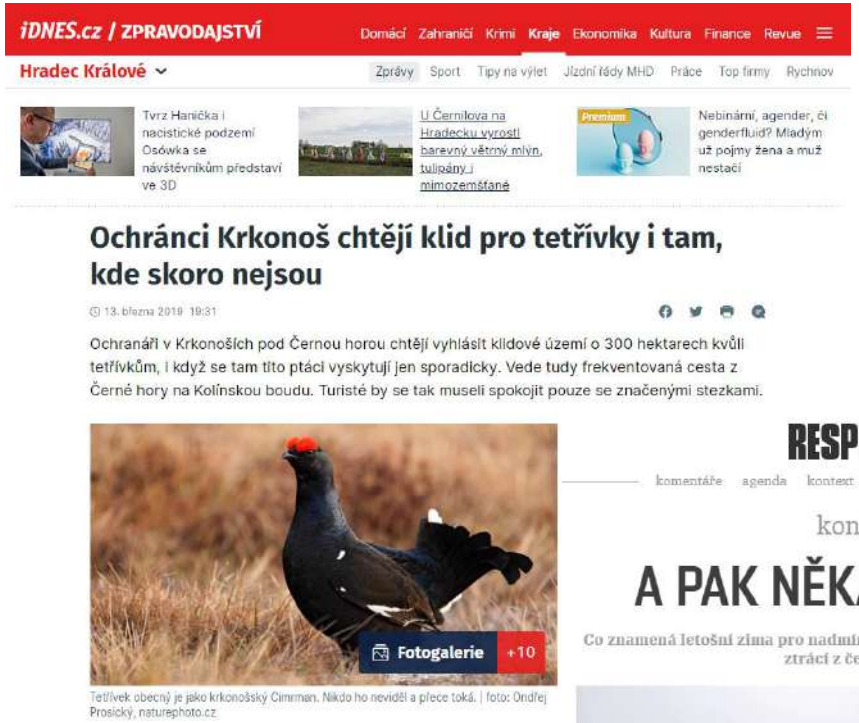
- **Living on the Edge**
  - iconic species of mountain grasslands & open forests / formerly highland meadows
  - **habitat specialist** & **sensitive species** to human disturbance
  - steady **decline** of the populations – **fragmentation & loss of connectivity** – (local) extinctions



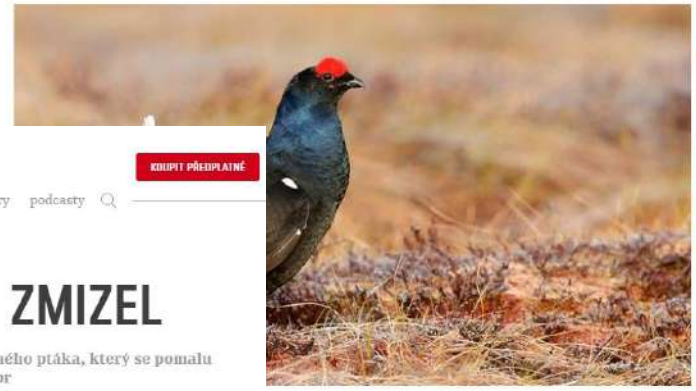
(Flousek 2020)

Black Grouse as a flag species of the Krkonoše Mts.

- **Living on the Edge**
  - „media star“



Tetřívek obecný je jako krkonošský Cimrman. Nikdo ho neviděl a přece toká. | foto: Ondřej Prosický, naturephoto.cz

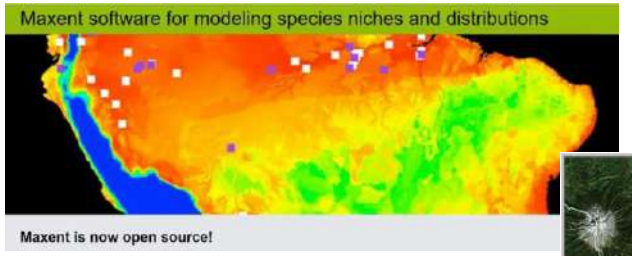


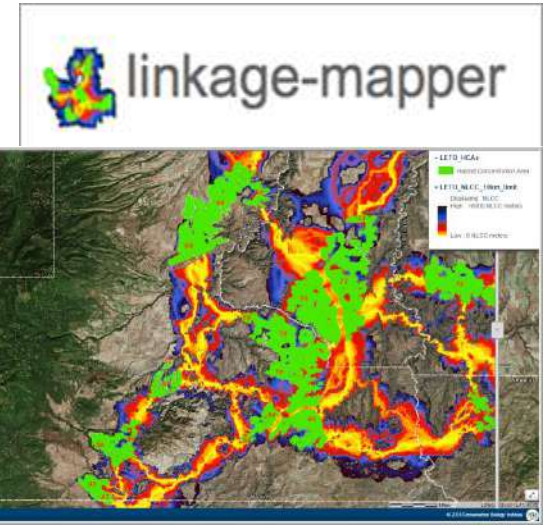

Lidé nikdy tetřívci možná. (Nad Krakonošovou snídaní) • Autor: Matěj Stránský

Tokání tetřívků v divoké přírodě Krkonoš | 10:54 | video: Radek Drahný, Správa KRNAP

Methods

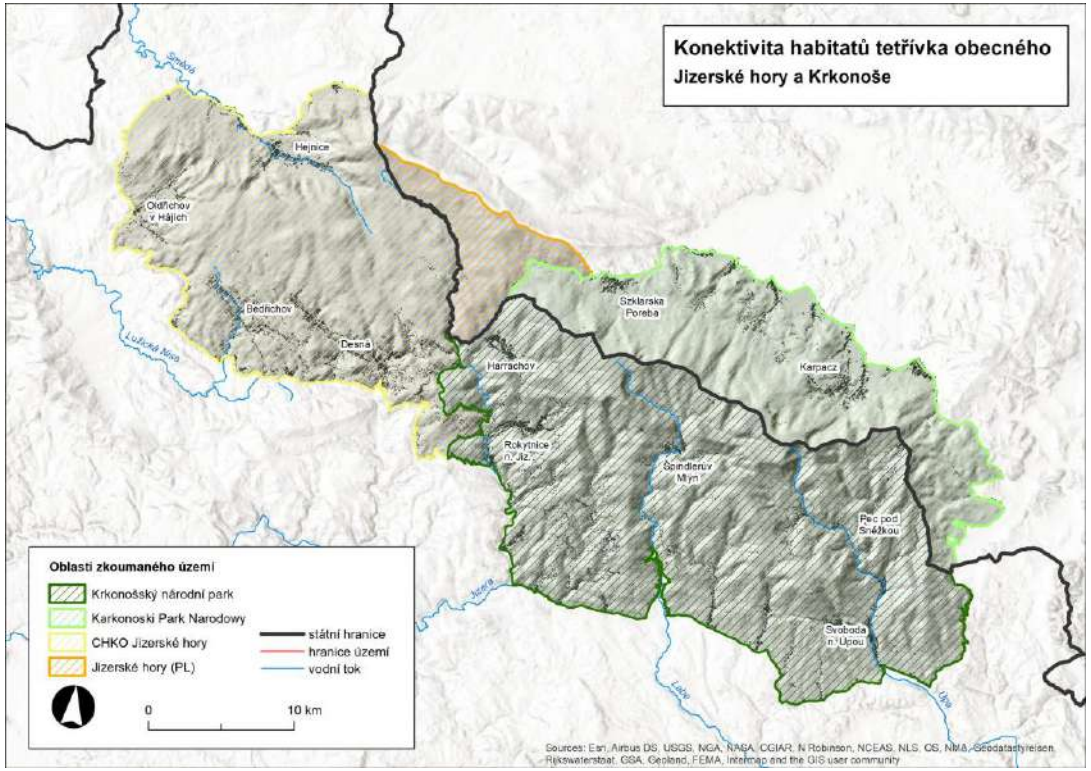
1. **Habitat Suitability Modelling**
   - MAXENT model
   - definition of **core areas & stepping stones** of suitable habitats





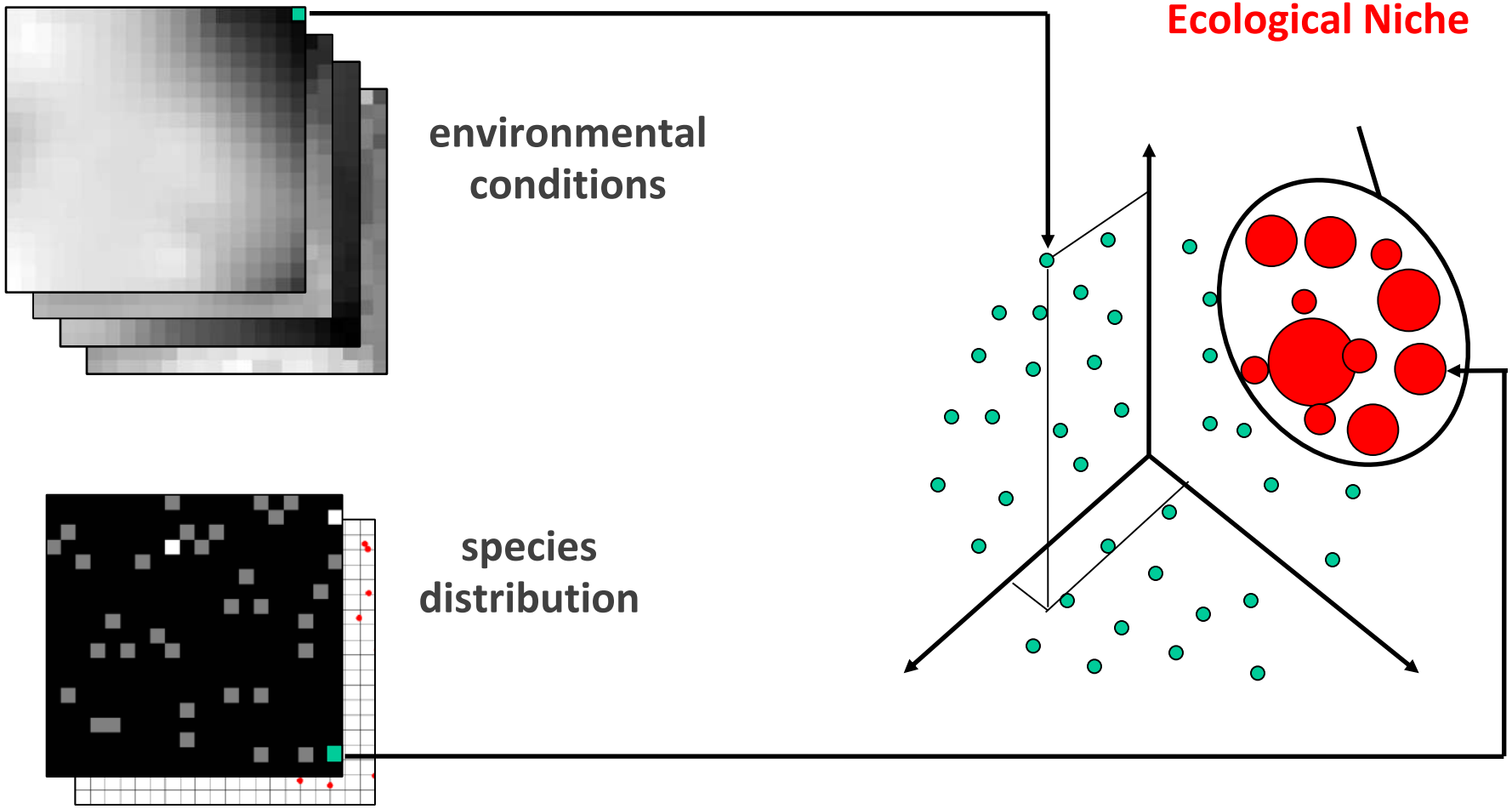
2. **Evaluation of the human impact**
   - assessment of recreation activities in space in time
   - collection & evaluation of data on the intensity of tourism *(summer X winter)* – expert synthesis

3. **Fragmentation & connectivity analysis**
   - analysis of the level of habitat fragmentation



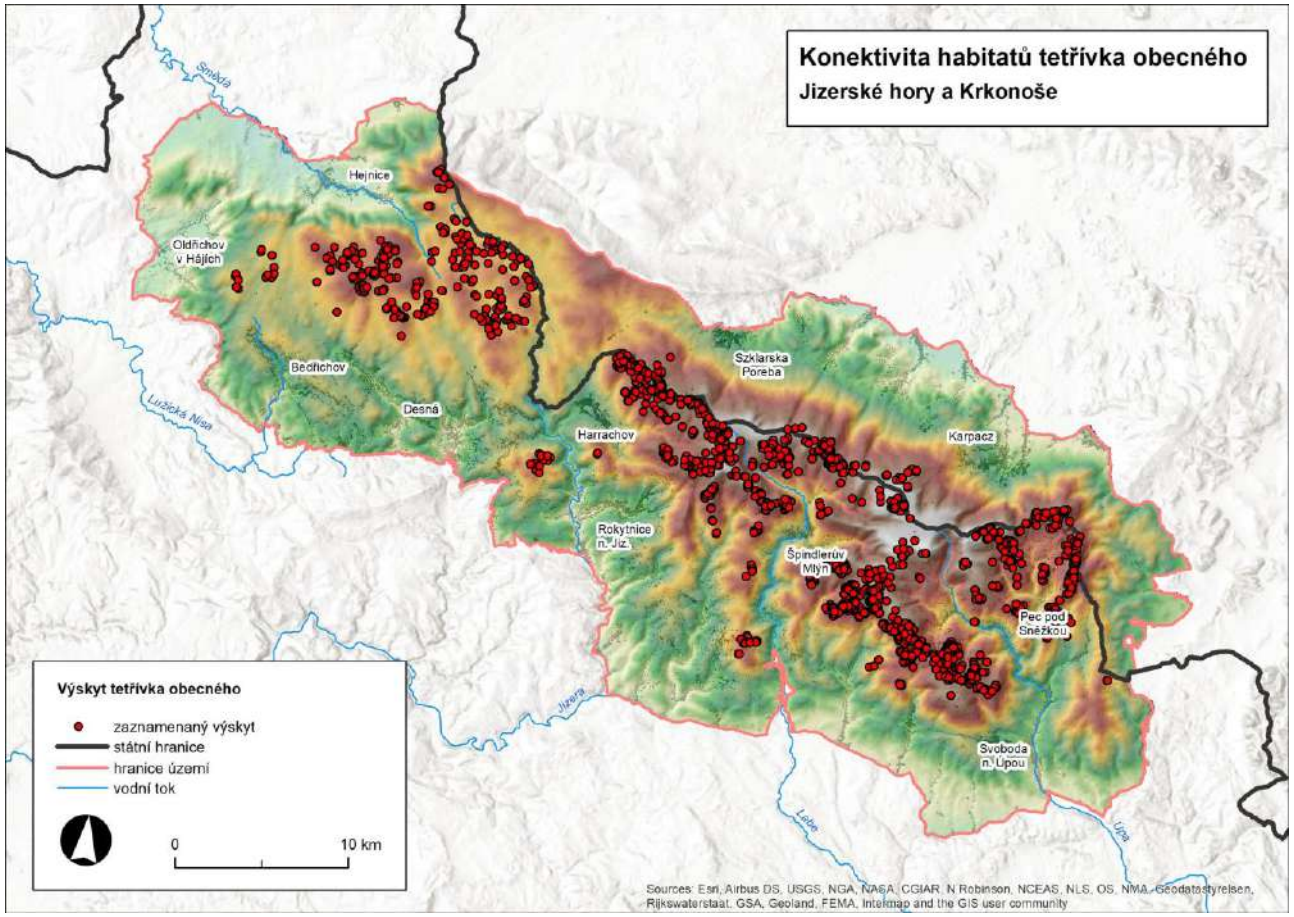
Methods

1. **Habitat Suitability Modelling**
   - complex analysis of the relationship of the species occurence and the environmental conditions



Data inputs

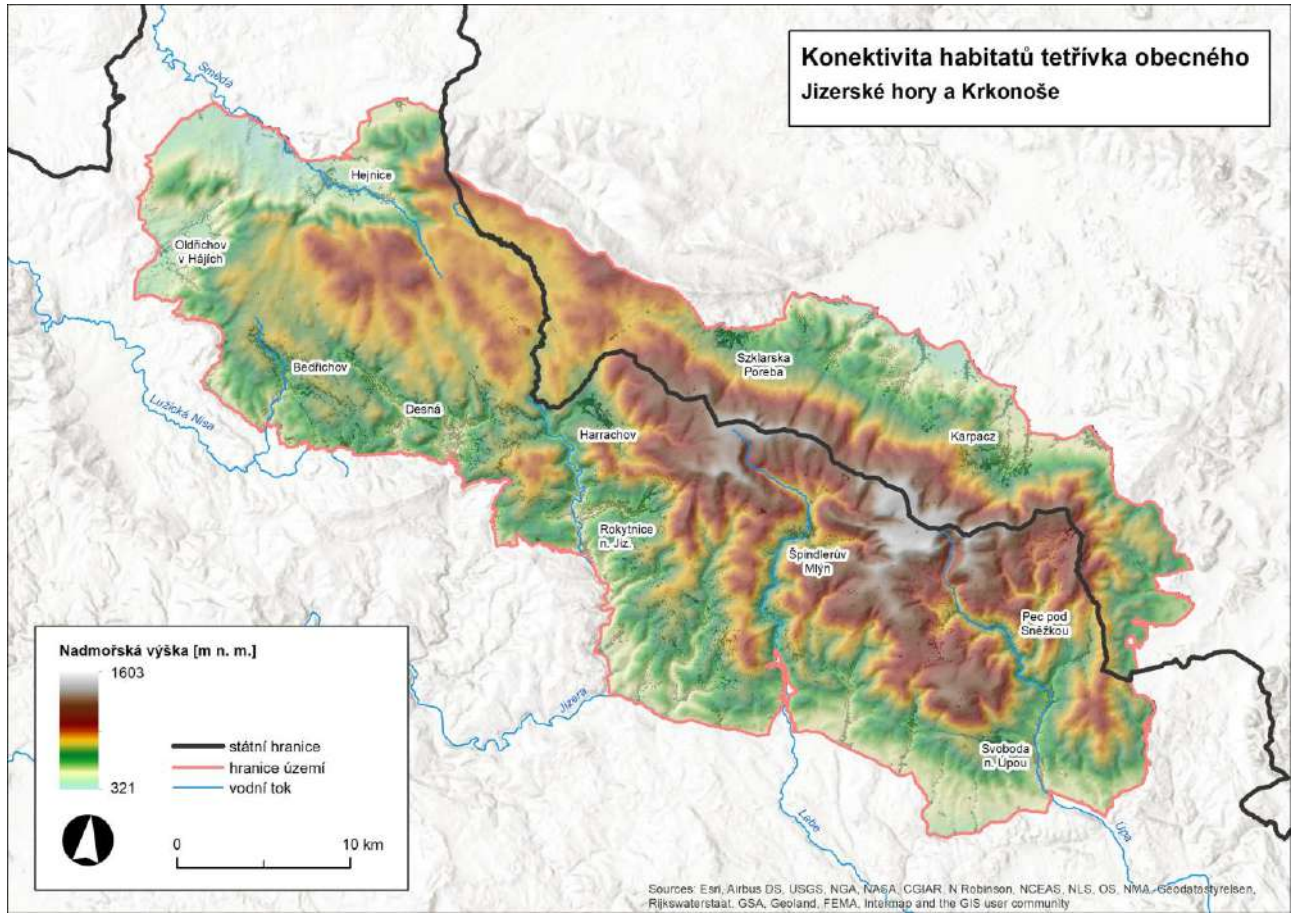
1. **Occurence data**
   - data from regular spring monitoring 2010 – 2020 (J. Flousek – KRNAP)



Data inputs

2. Abiotic factors

- topography & climate – basic gradients



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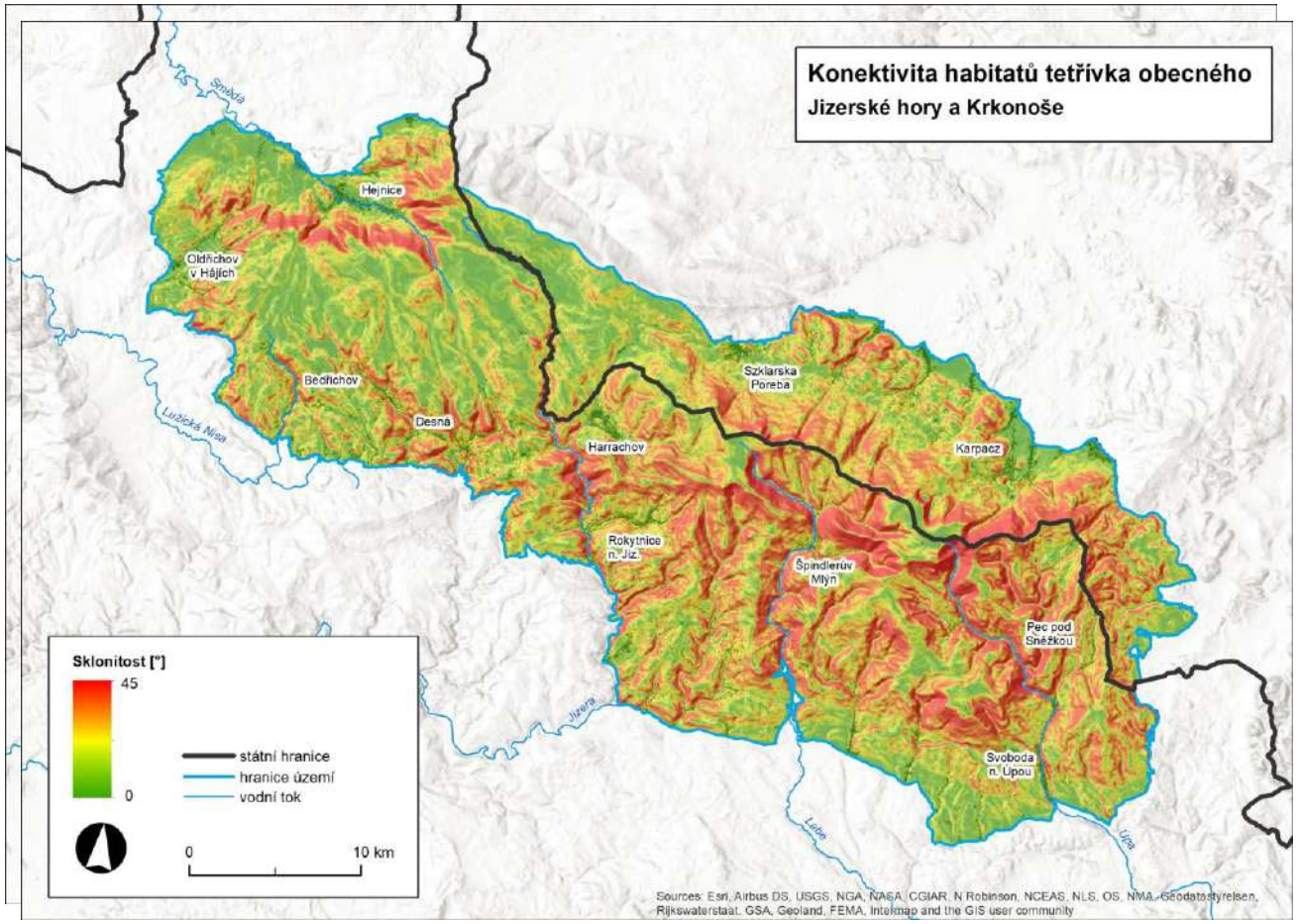

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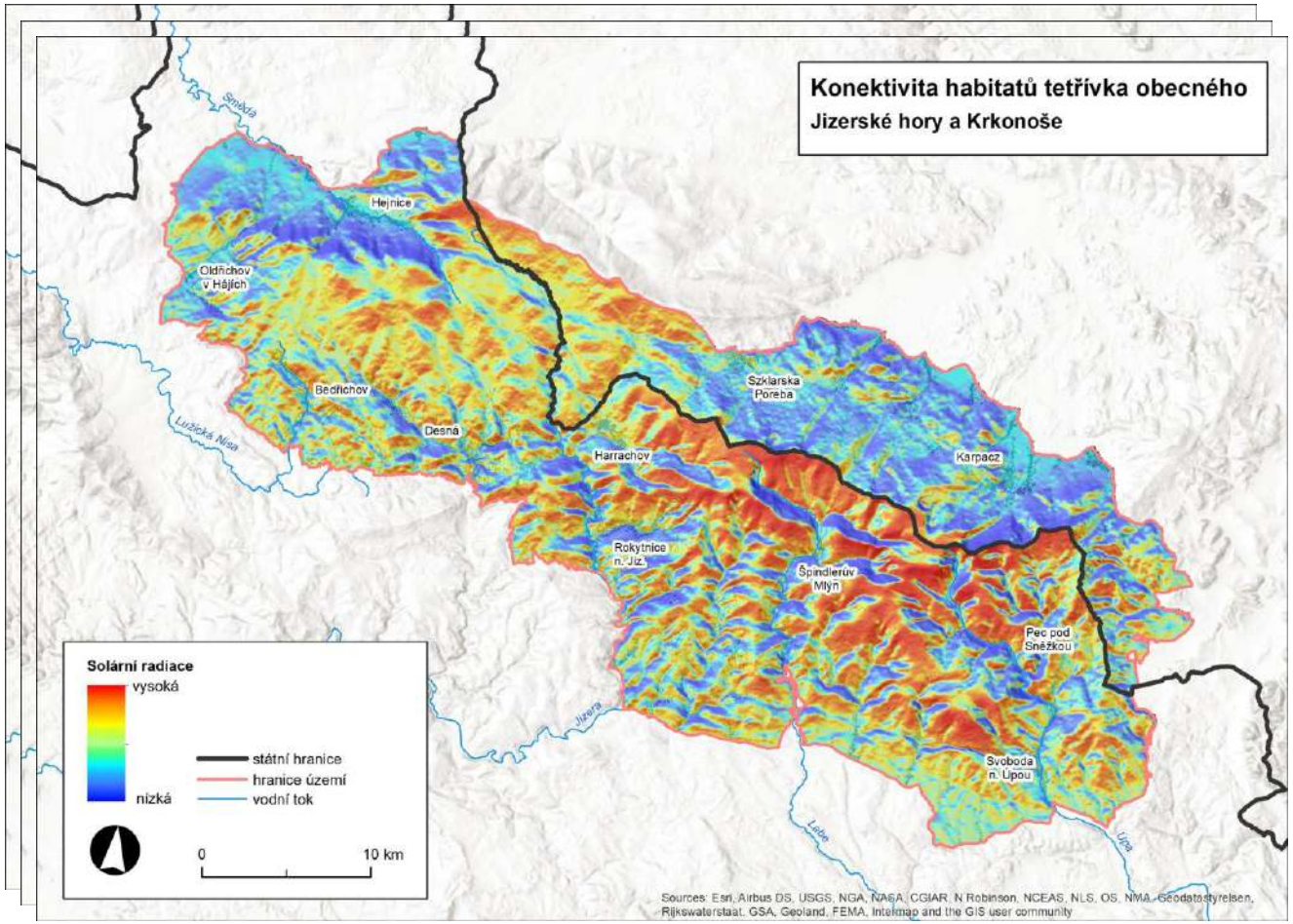
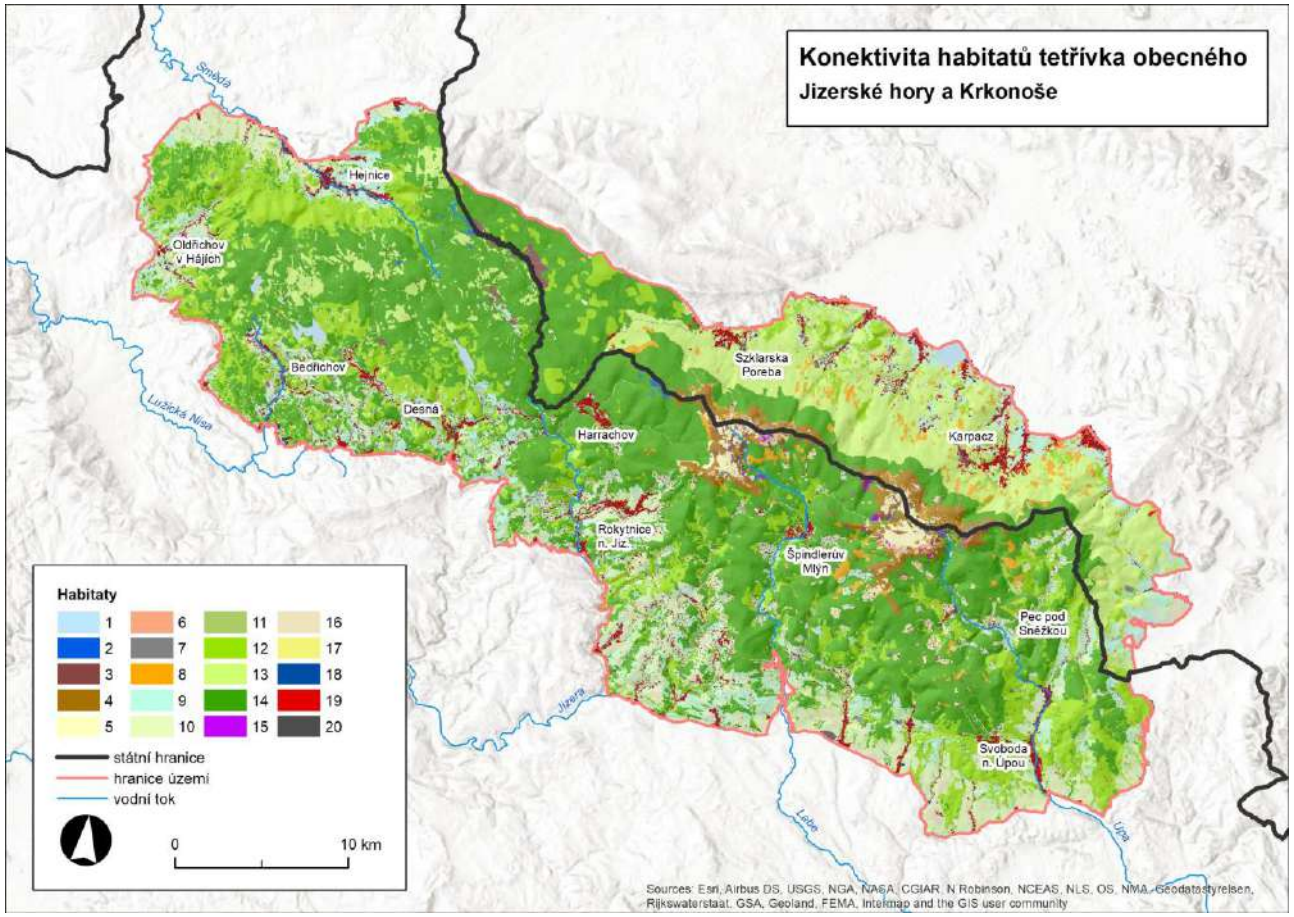


Data inputs

3. Habitat factors

- biotopes according to NATURA 2000 habitat mapping & KVES & Sentinel satellite images



Data inputs

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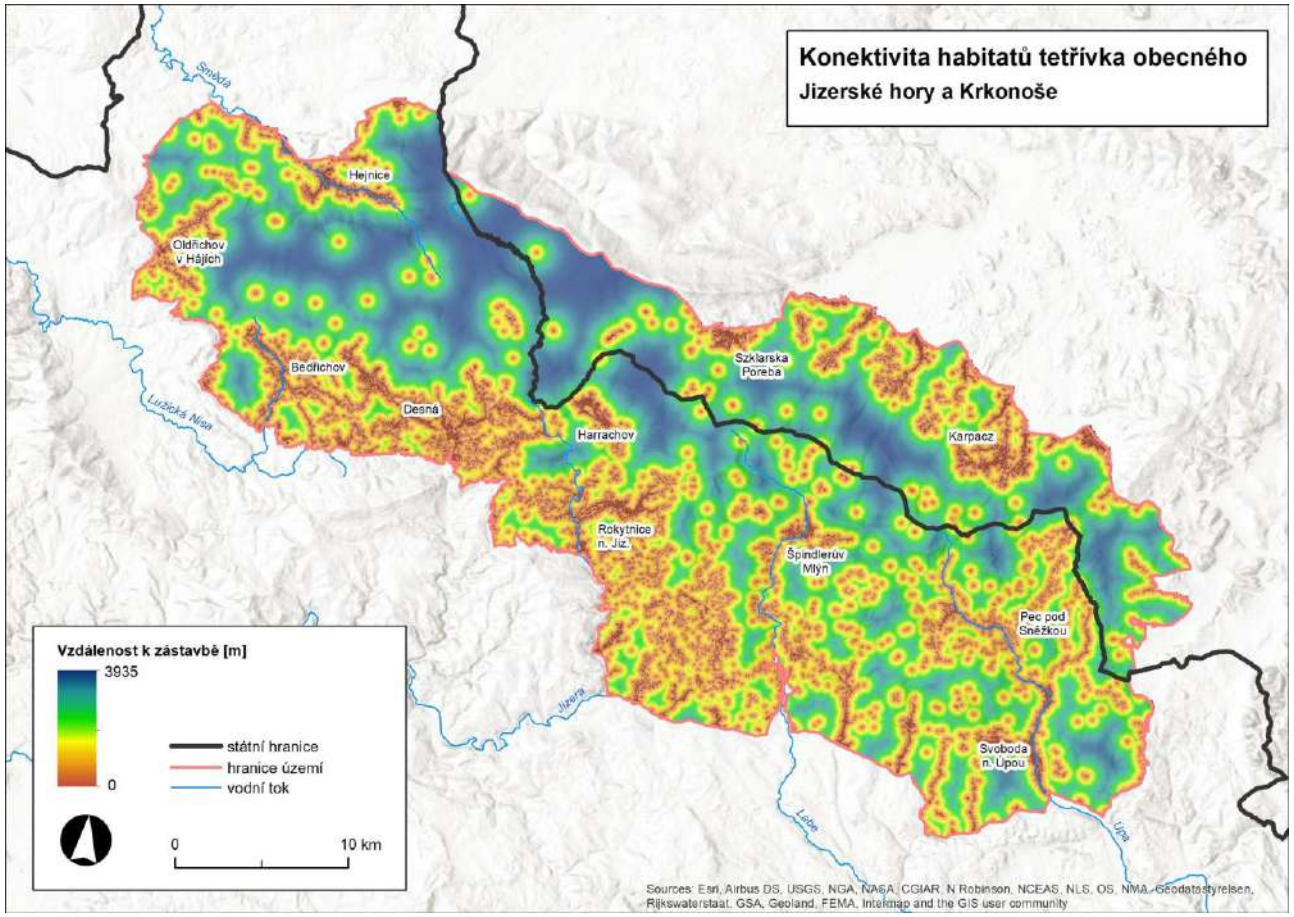
4. Anthropogenic factors

- distances to anthropogenic structures / cummulative impact assessment



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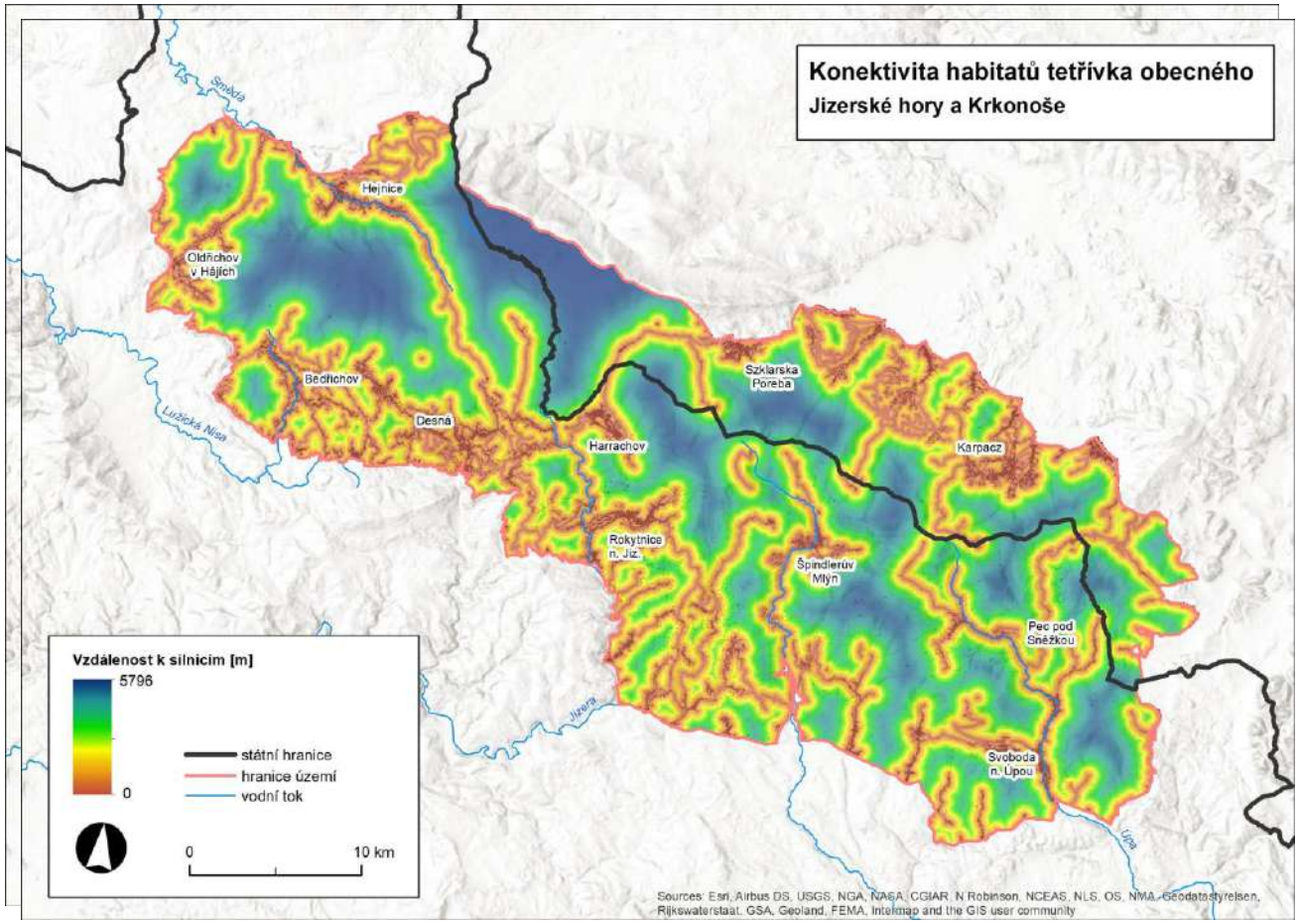

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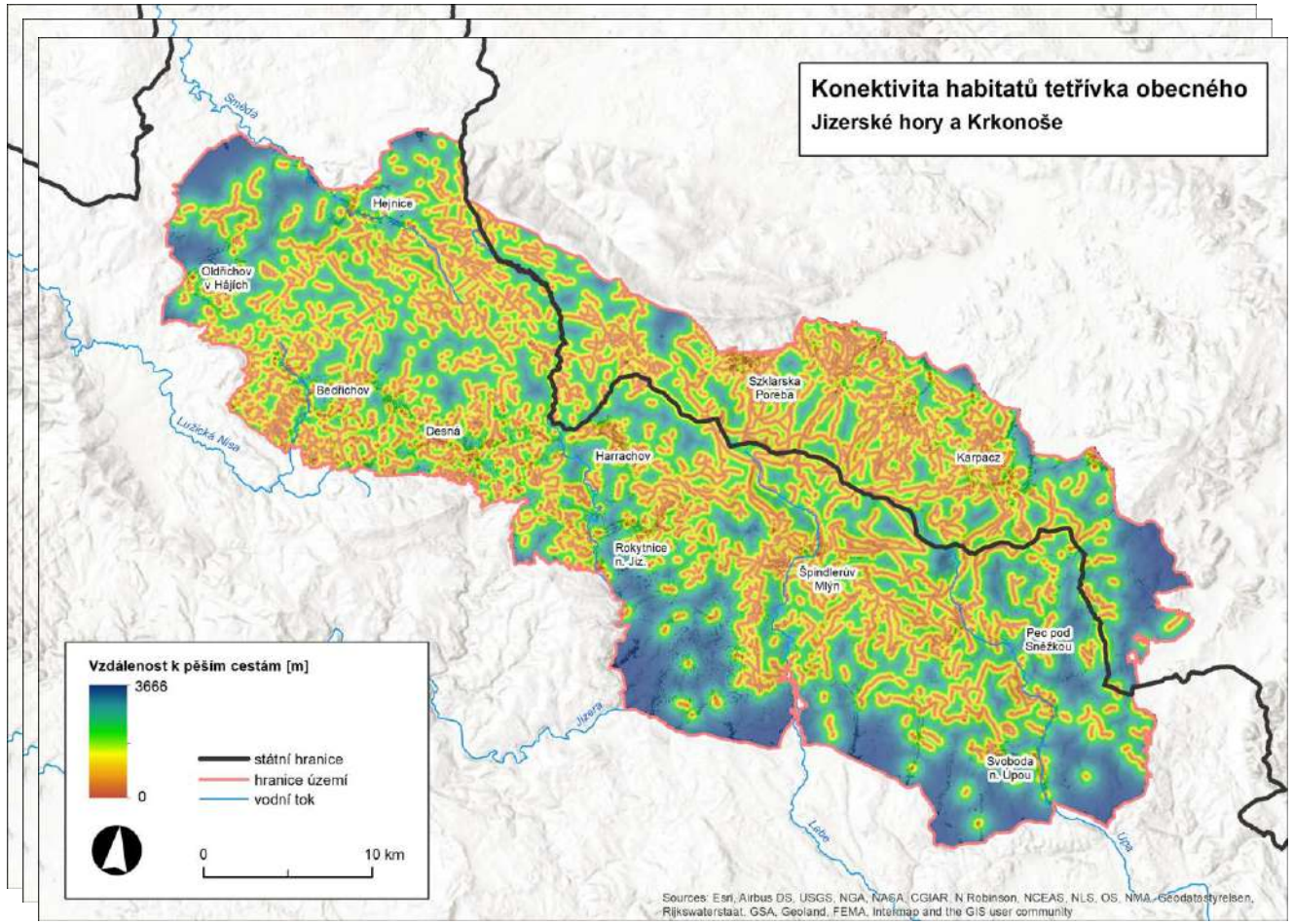

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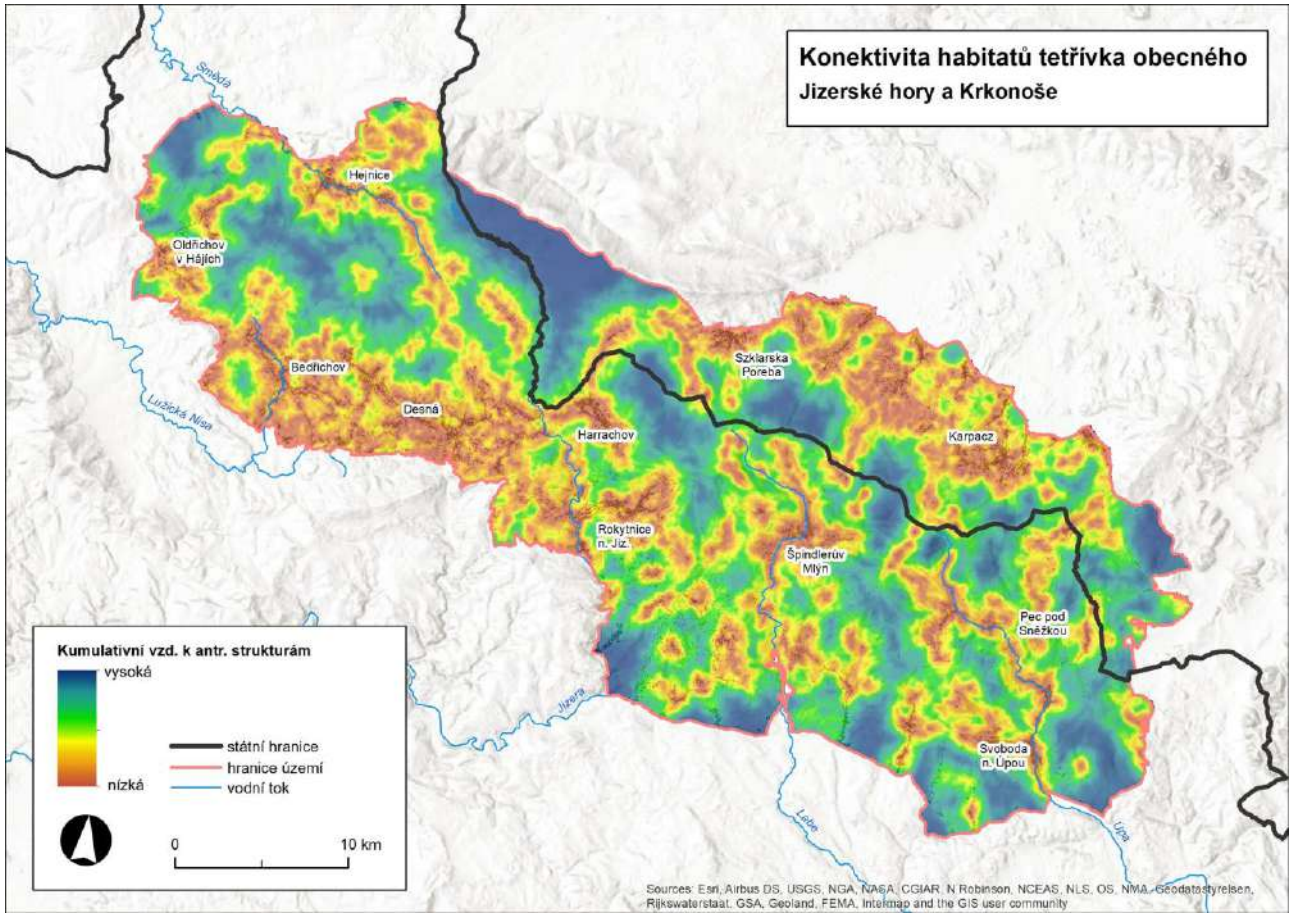
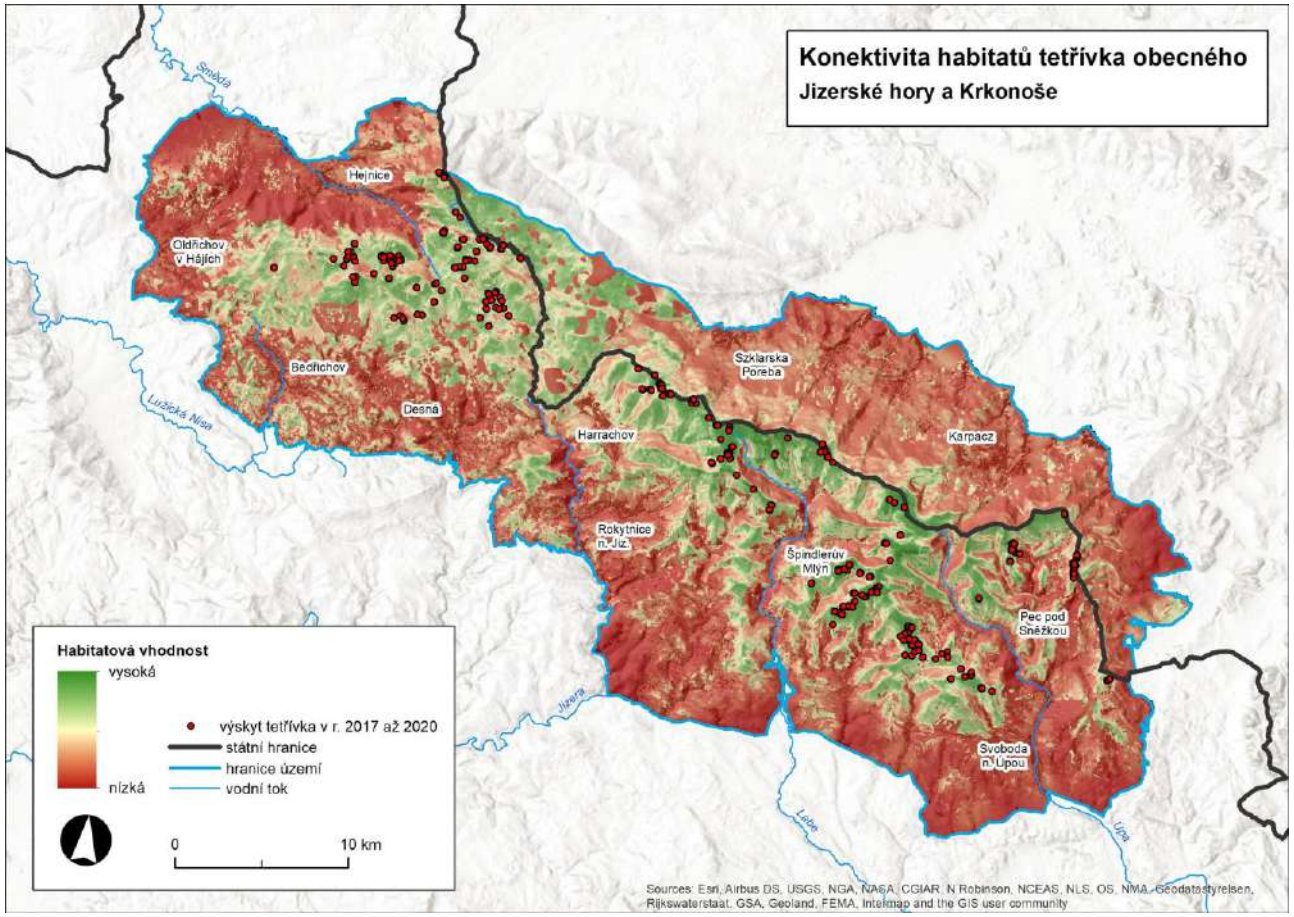


Outputs

1. **Habitat suitability model**
   - showing continuous potential species distribution with the focus area (gradient 0 – 100 %)



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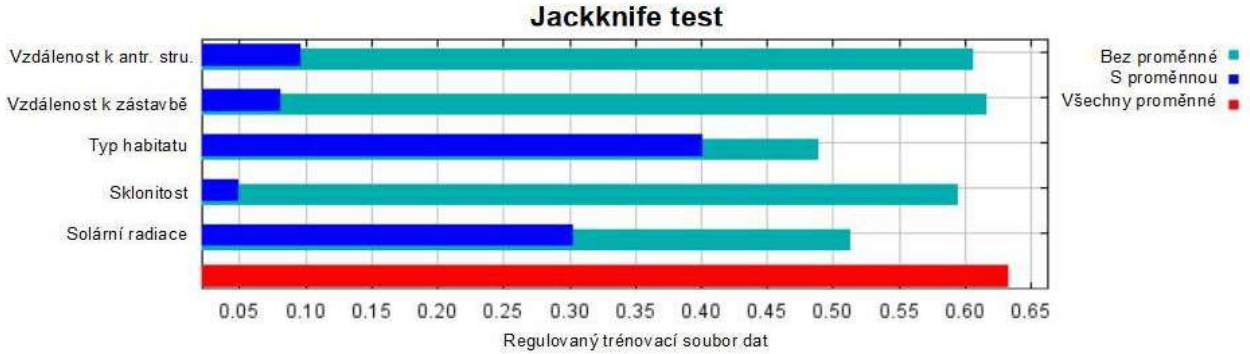

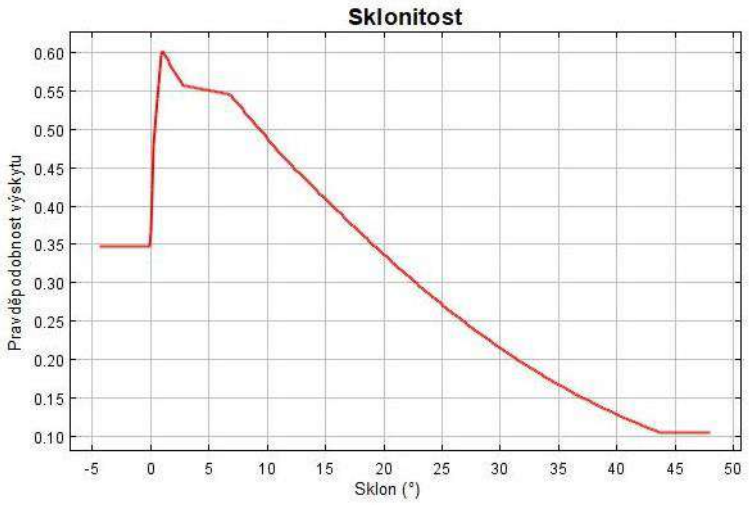

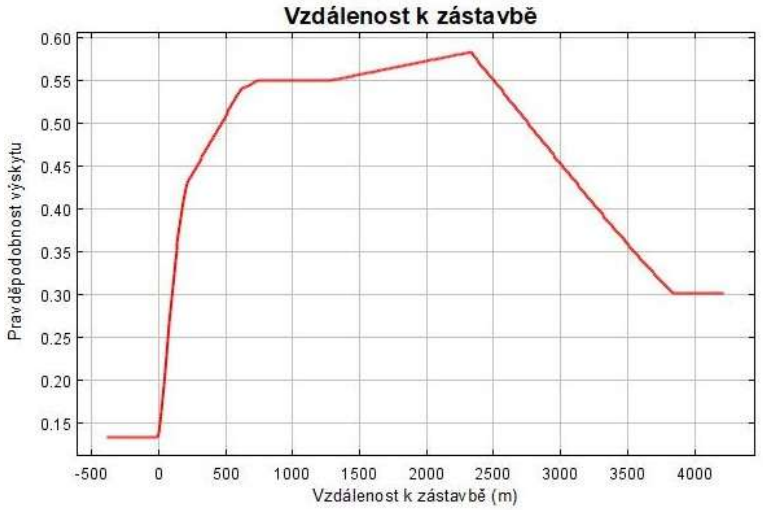

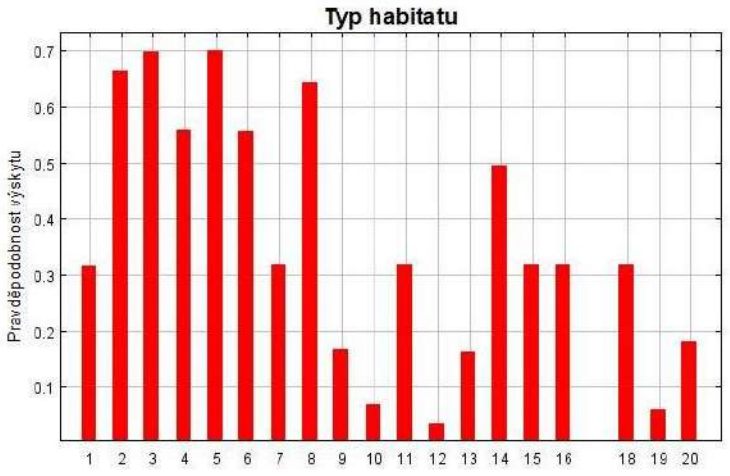

Outputs

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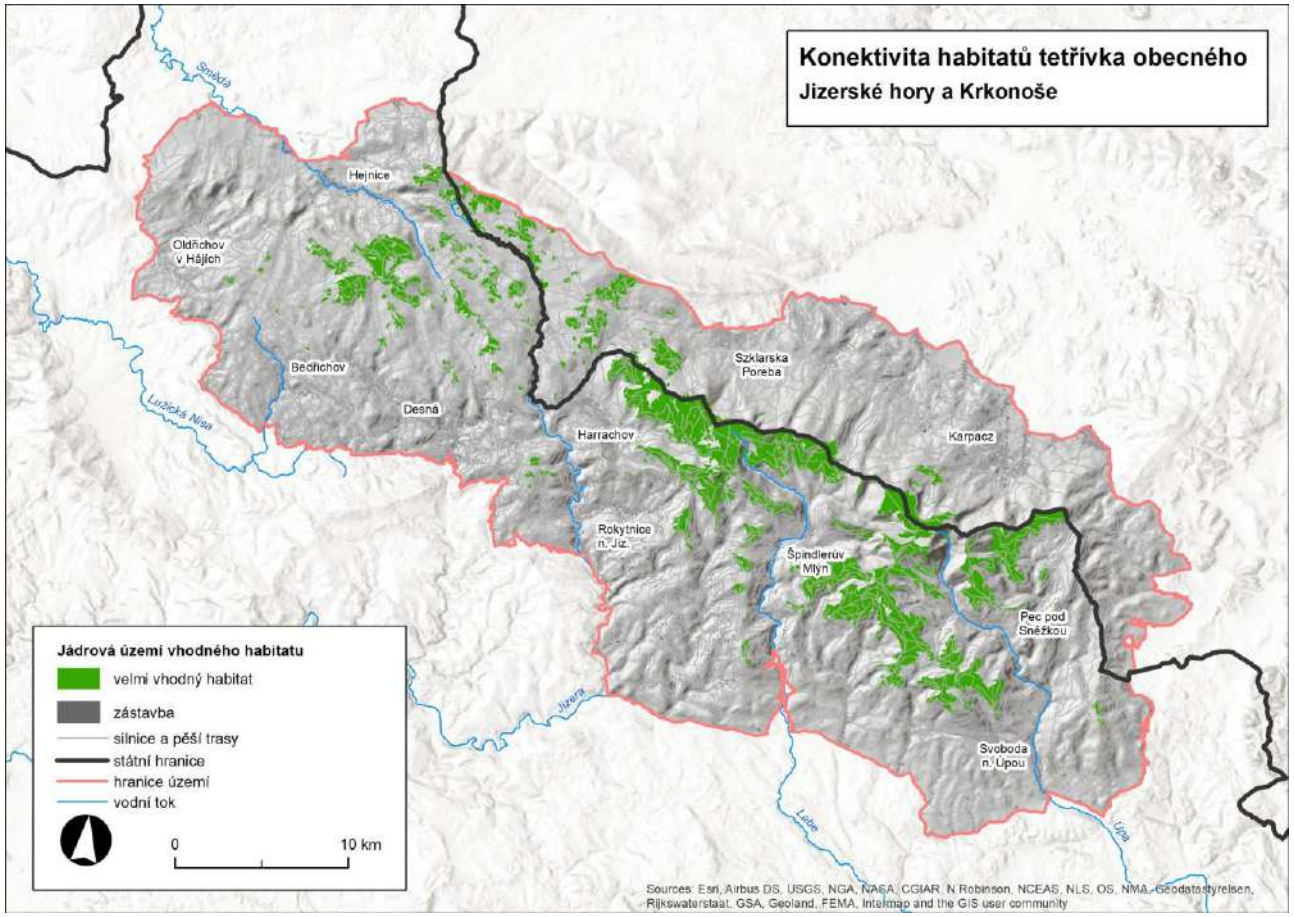
1. Habitat suitability model

- definition of core areas of suitable habitats or stepping stones *(binary model)*

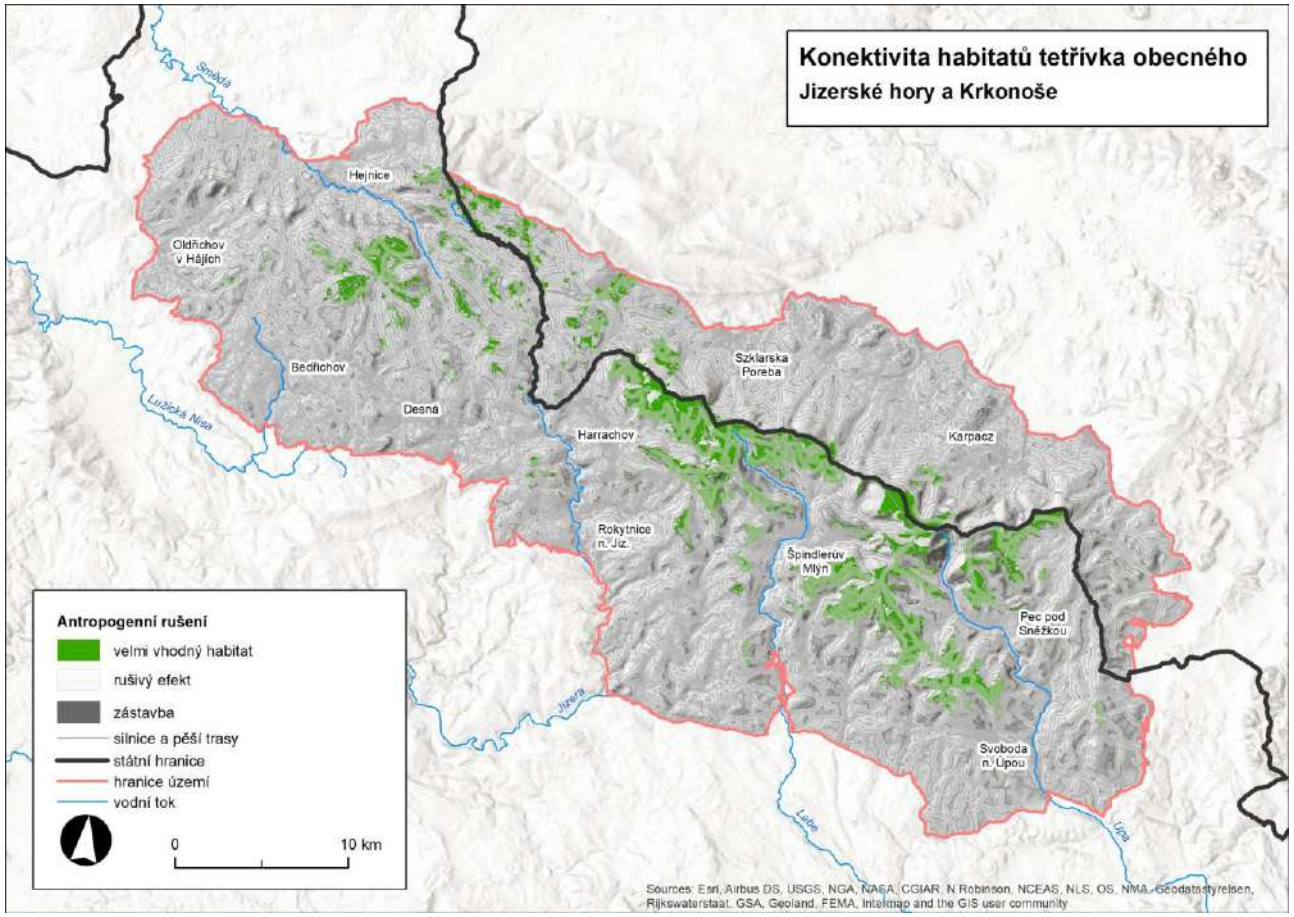


Jádrová území vhodnosti	Počet plošek	Celková plocha (km²)
Bez antropogenního rušení	163	122,19
S antropogenním rušením	193	22,54

POTENTIAL

Outputs

1. **Habitat suitability model**
   - definition of core areas of suitable habitats or stepping stones *(binary model)*

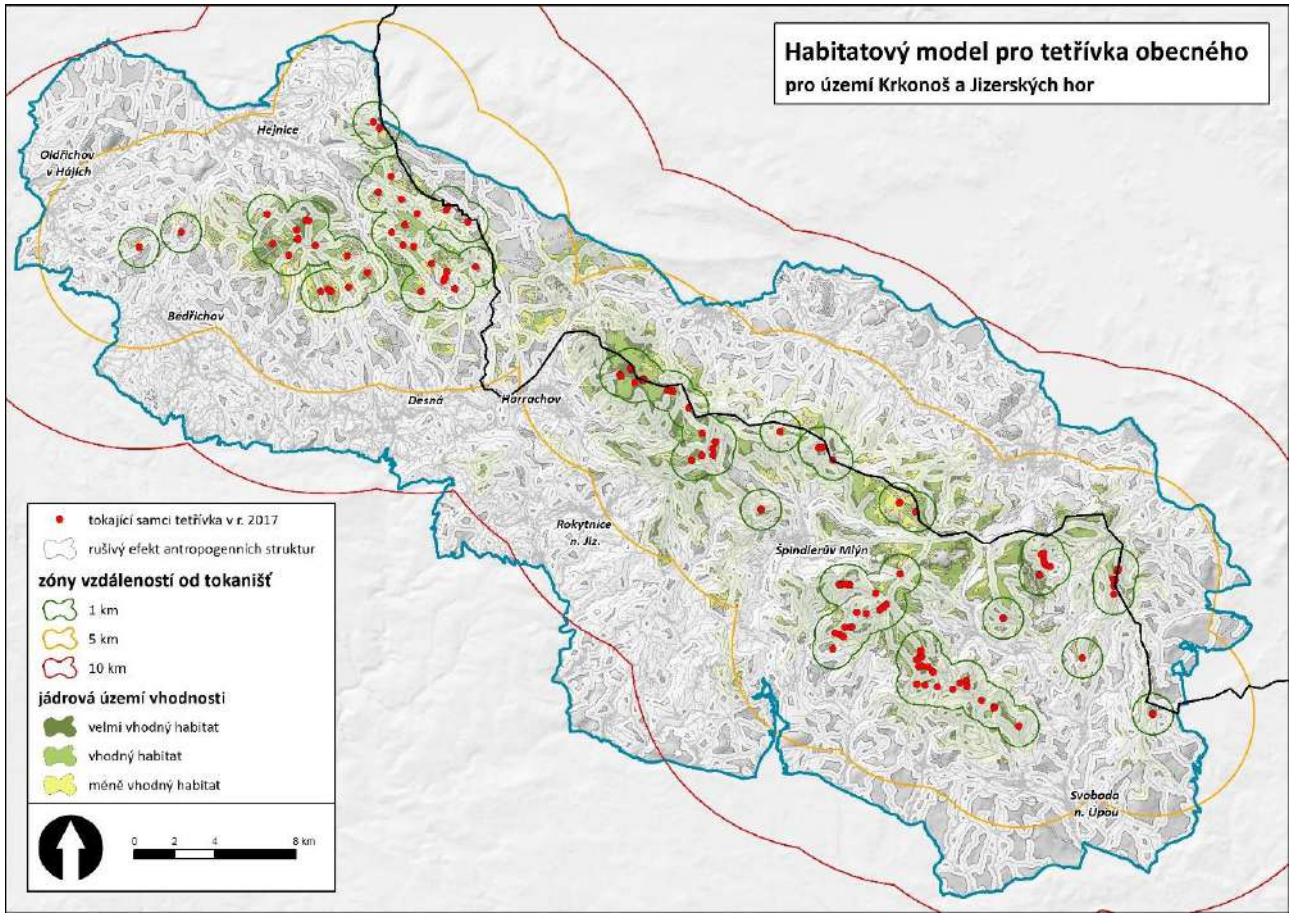


Jádrová území vhodnosti	Počet plošek	Celková plocha (km²)
Bez antropogenního rušení	163	122,19
S antropogenním rušením	193	22,54

REALITY

Outputs

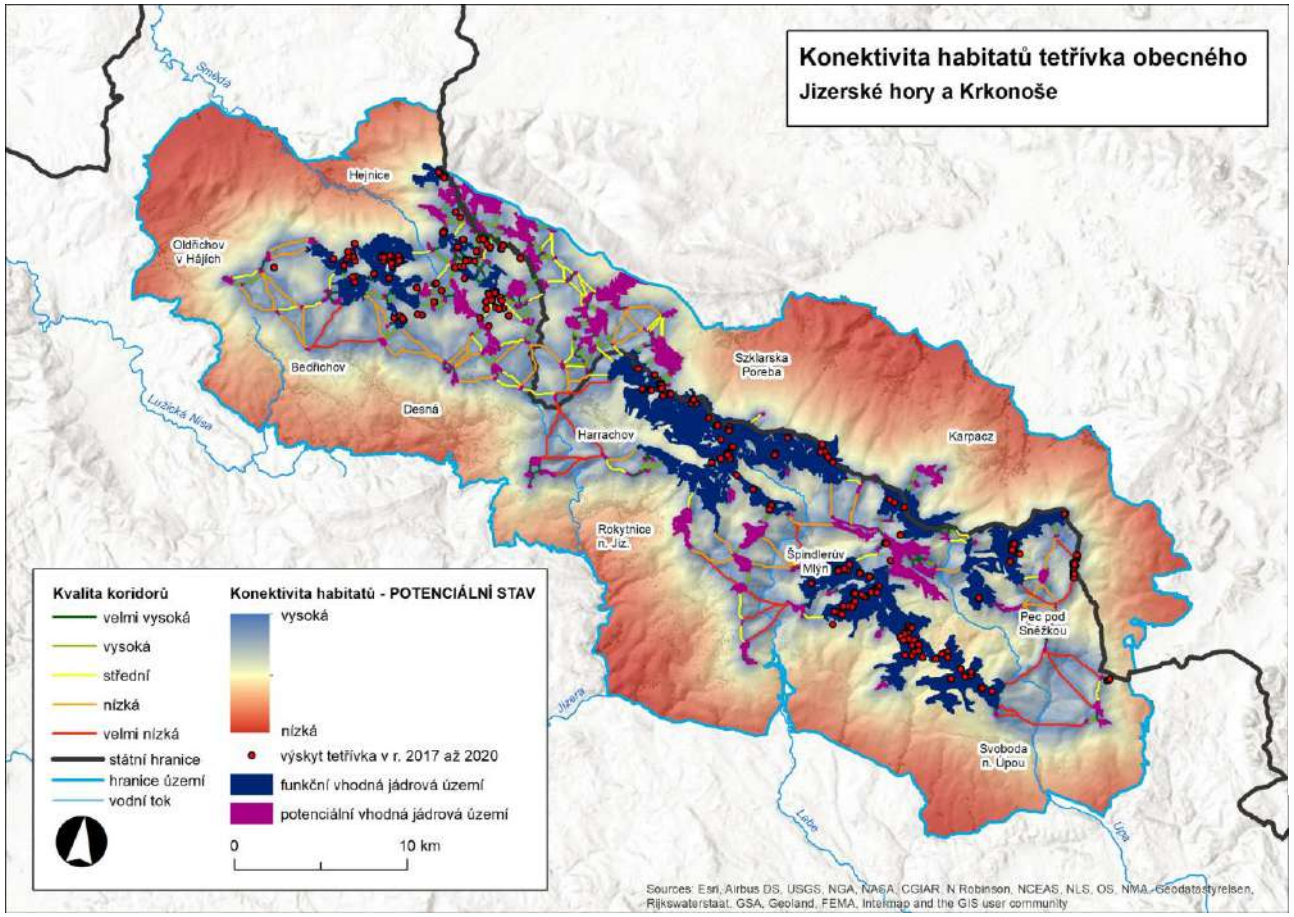
1. **Habitat suitability model**
   - adding information about dispersal possibilities



Outputs

2. Model of population connectivity

- connectivity modeling based on *„resistance surface“* (inverted habitat suitability)



POTENTIAL

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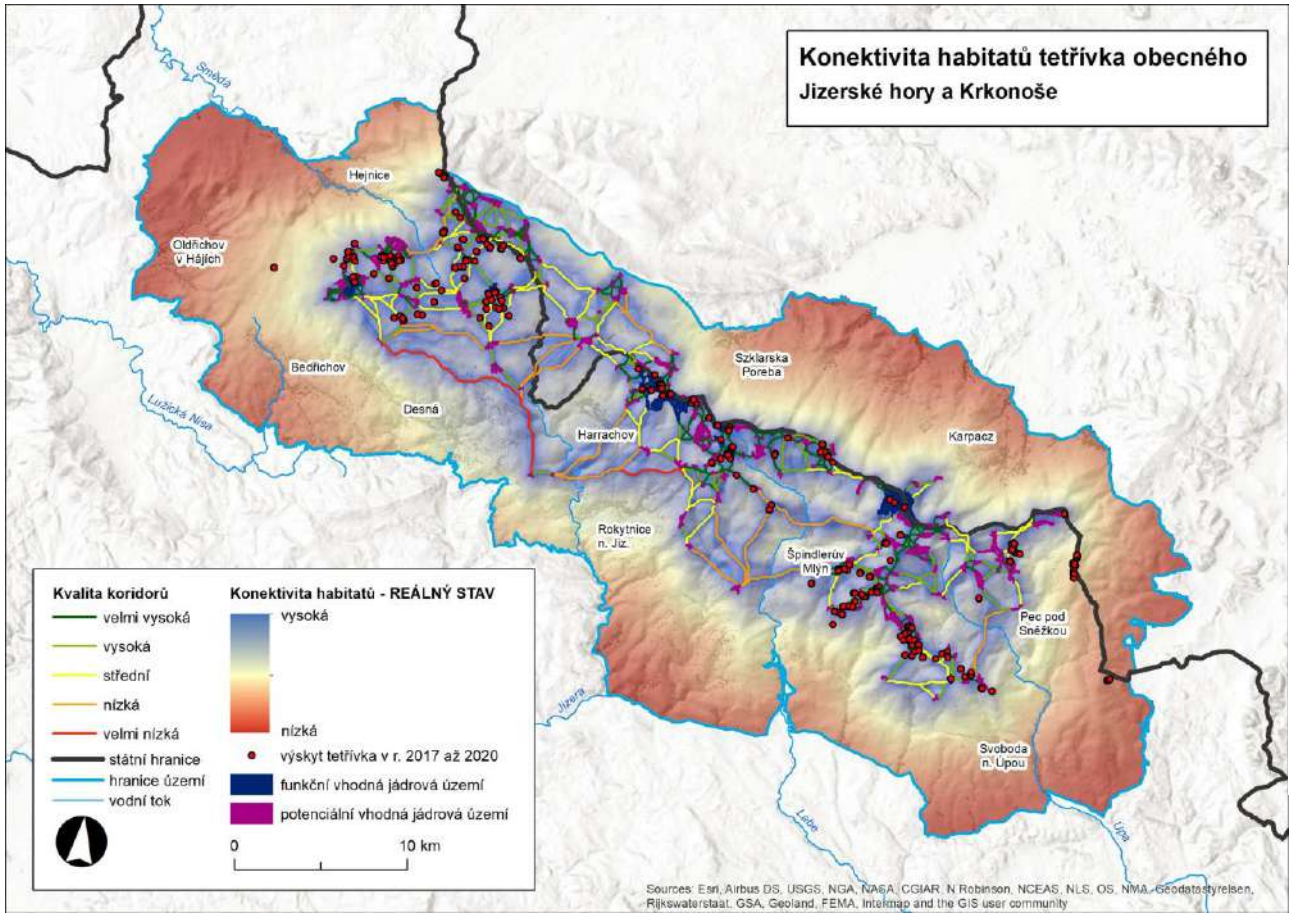

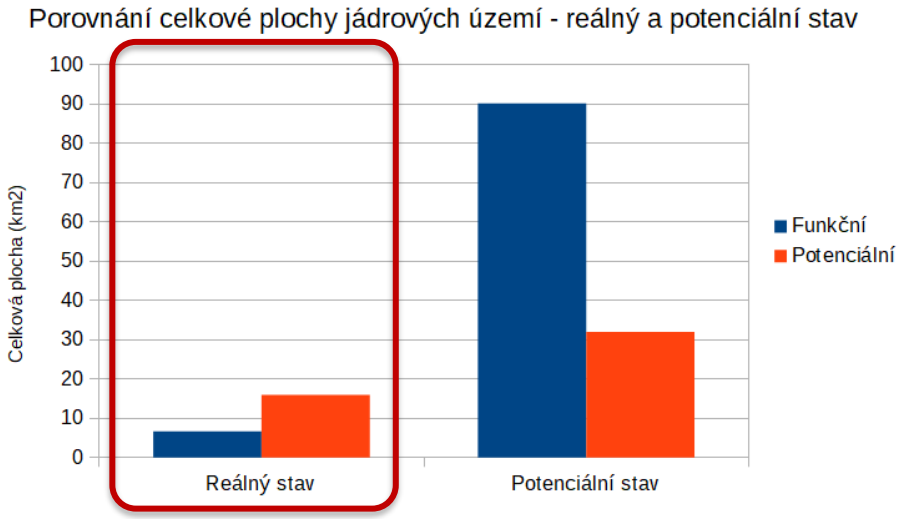

REALITY

Summary

- **Core areas of suitable habitat**
  - reduction of area, degradation & fragmentation – increasing isolation
  - intensity of the recreation - the most important factor

- **Population connectivity**
  - very low probability of dispersal of individuals / sub-populations
  - low quality of corridors & long distances, many migration barriers, loss of „stepping stones“
  - unlikely interconnection between Krkonoše & Jizerské hory

- **Black Grouse‘ Future in the Giant & Jizerské Mts.**
  - steady decline in abundance
  - gradual disappearance of individual sub-populations
  - inevitable (?) extinction of the entire population

- **Possible solution**
  - much more strict restrictions of the visitors & regulation of traffic
  - habitat supporting measures

Summary

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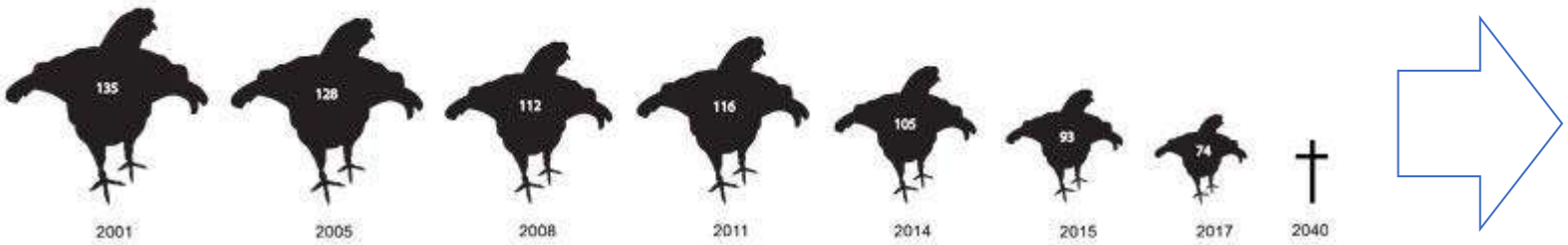
Početnost tetřívka obecného v Krkonoších

(sčítané stavy kohoutků)



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Environmental impacts of overturism

Multispecies approach - Development of stacked habitat suitability models (sSDM)

- preparation and standardization of available **occurence data**
- development of **predictive habitat models** (using MIAmaxent method) for 23 species of animals *(molluscs,amphibians, repitiles, **birds** and mammals)*

Druh	České jméno	skupina	funkční skupina
Cochlodina dubiosa corcontica	vřetenovka krkonošská	měkkýši	Lesní druh
Semilimax kotulae	slimáčník horský	měkkýši	Lesní druh
Ichthyosaura alpestris	čolek horský	obojživelníci	lesní mokřady & tůně
Salamandra salamandra	mlok skvrnitý	obojživelníci	lesní mokřady & tůně
Vipera berus	zmije obecná	plazi	lesní
Zootoca vivipara	ještěrka živorodá	plazi	lesní
Aegolius funereus	sýc rousný	ptáci	horský (lesní)
Anthus spinoletta	linduška horská	ptáci	horský
Bubo bubo	výr velký	ptáci	lesní
Crex crex	chrástal polní	ptáci	luční
Ficedula parva	lejsek malý	ptáci	lesní
Glaucidium passerinum	kulíšek nejmenší	ptáci	lesní
Luscinia svecica svecica	slavík modráček tundrový	ptáci	horský
Picoides tridactylus	datlík tříprstý	ptáci	horský (lesní)
Picus canus	žluna šedá	ptáci	lesní
Prunella collaris	pěvuška podhorní	ptáci	horský
Scolopax rusticola	sluka lesní	ptáci	lesní (mokřadní)
Turdus torquatus	kos horský	ptáci	horský (lesní)
Canis lupus	vlk obecný	savci	lesní
Dryomys nitedula	plch lesní	savci	lesní
Glis glis	plch velký	savci	lesní
Lynx lynx	rys ostrovid	savci	lesní
Sorex alpinus	rejsek horský	savci	lesní

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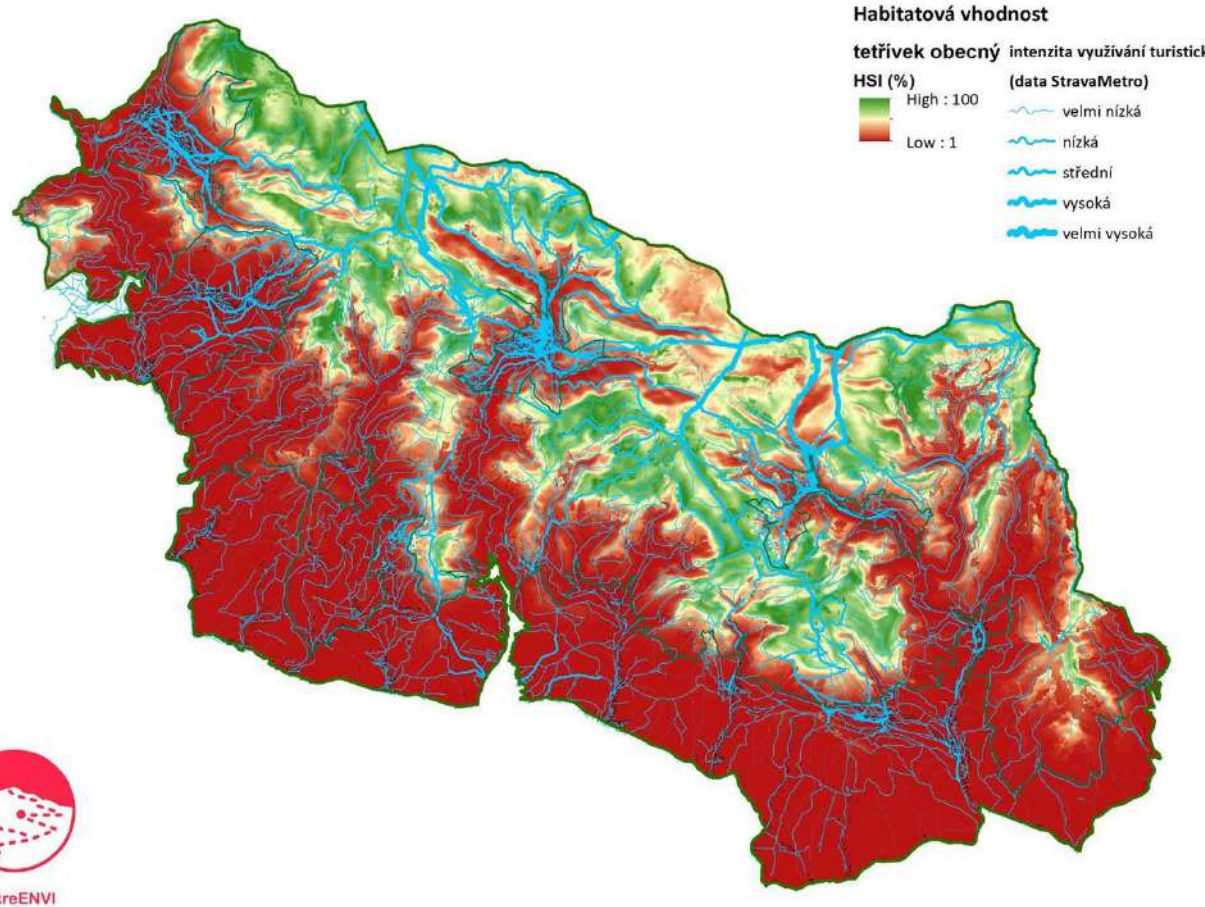
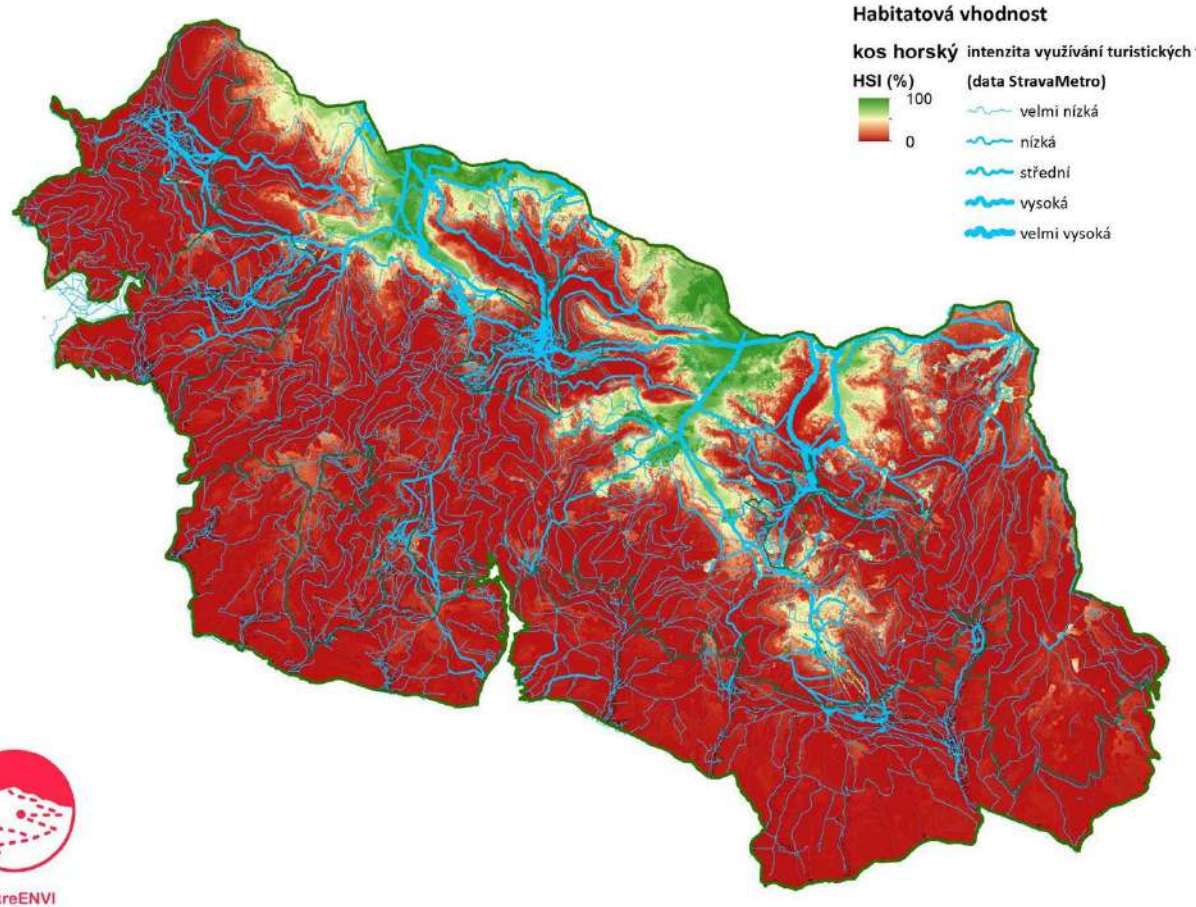
Environmental impacts of overturism

Development of habitat suitability models (SDM)





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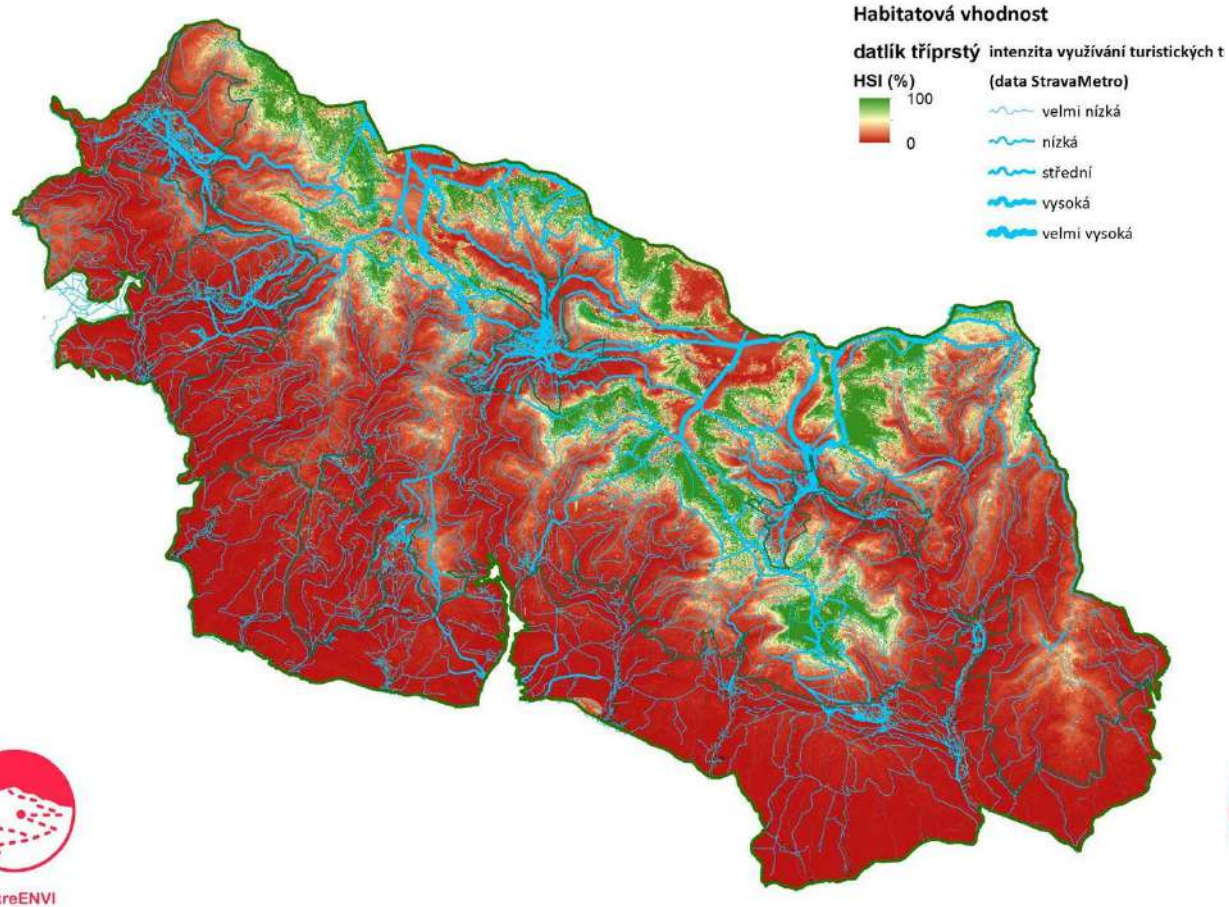
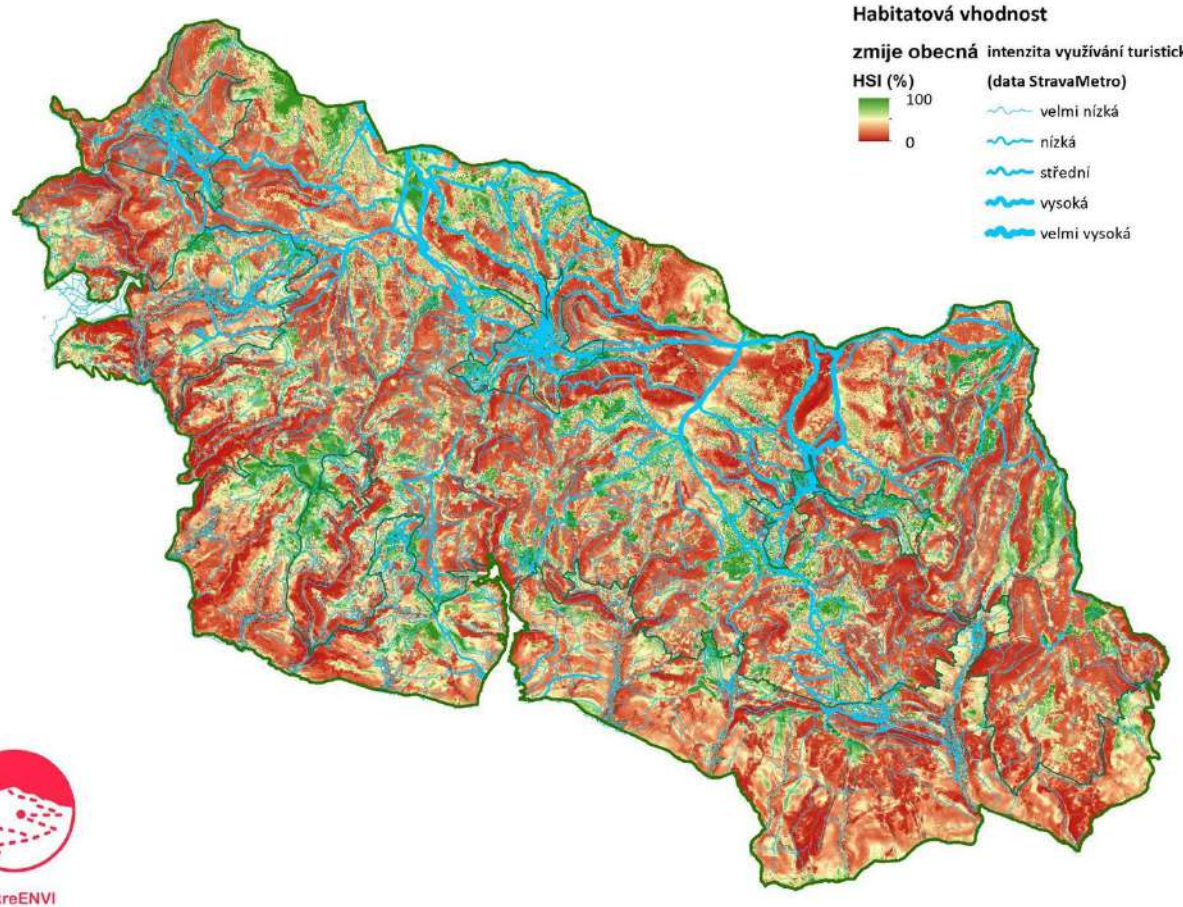
Environmental impacts of overturism

Development of habitat suitability models (SDM)





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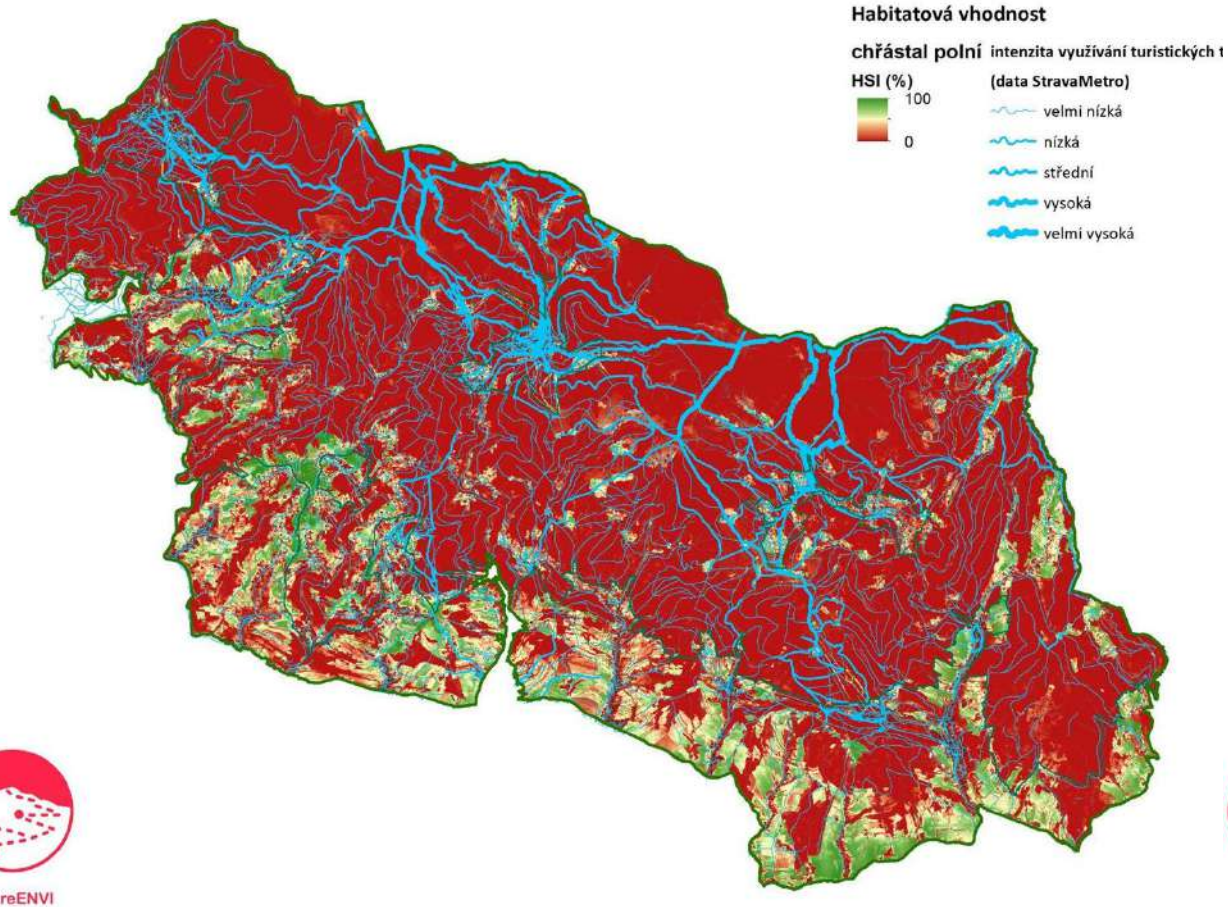
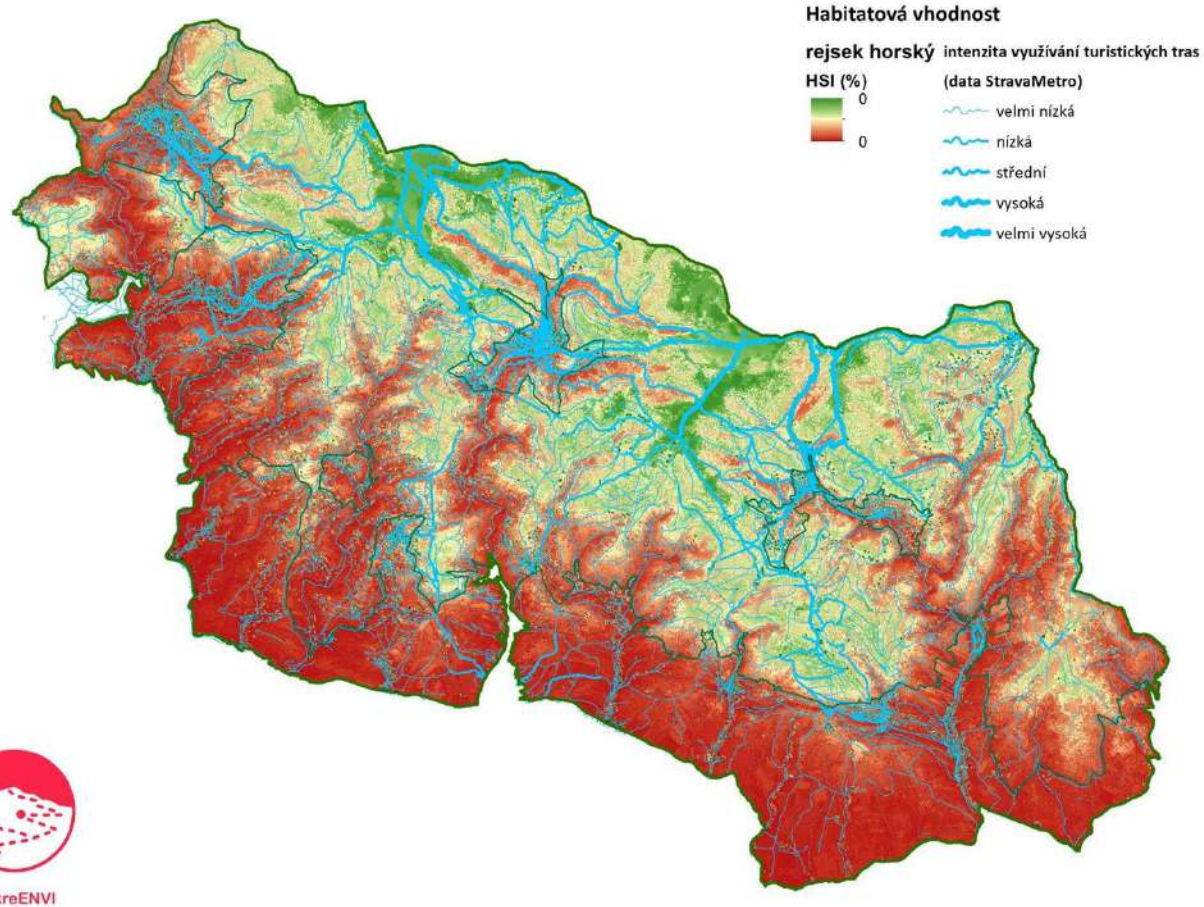
Environmental impacts of overturism

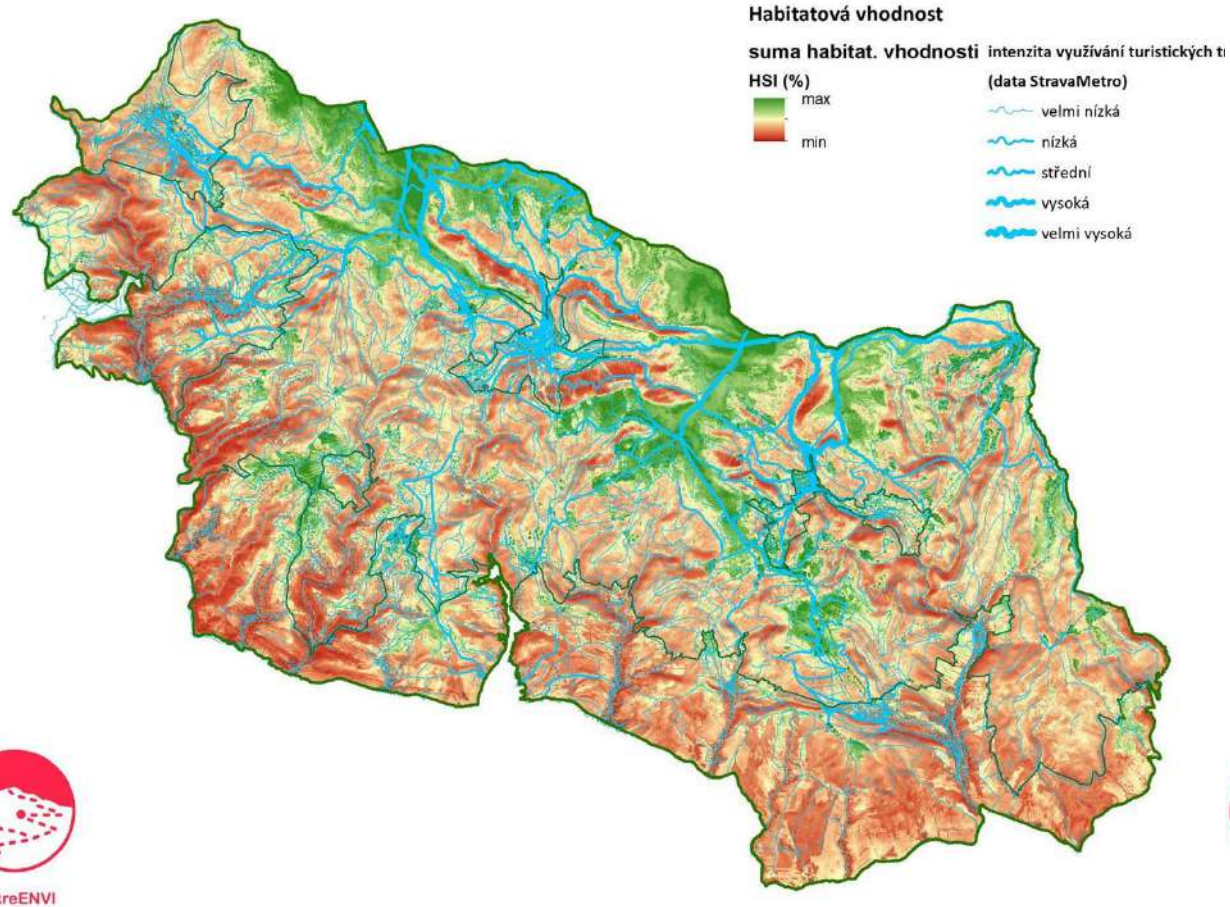
Development of habitat suitability models (SDM)

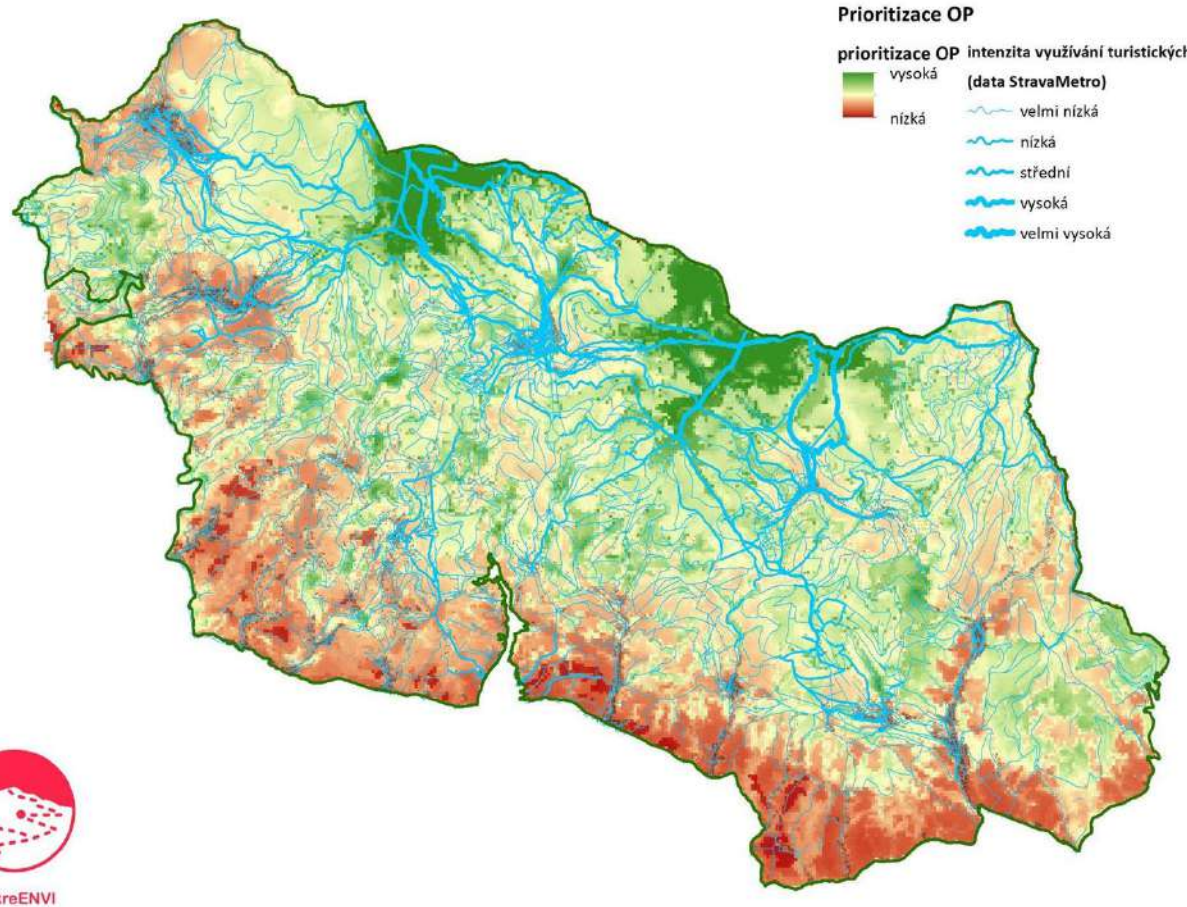




Environmental impacts of overturism

Habitat model synthesis & prioritization (ZONATION)





Program **Prostředí pro život**

Thank you for your attention

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Výzkumný ústav pro krajinu, v. v. i.

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