Is forest a pharmacy?

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forest ecology

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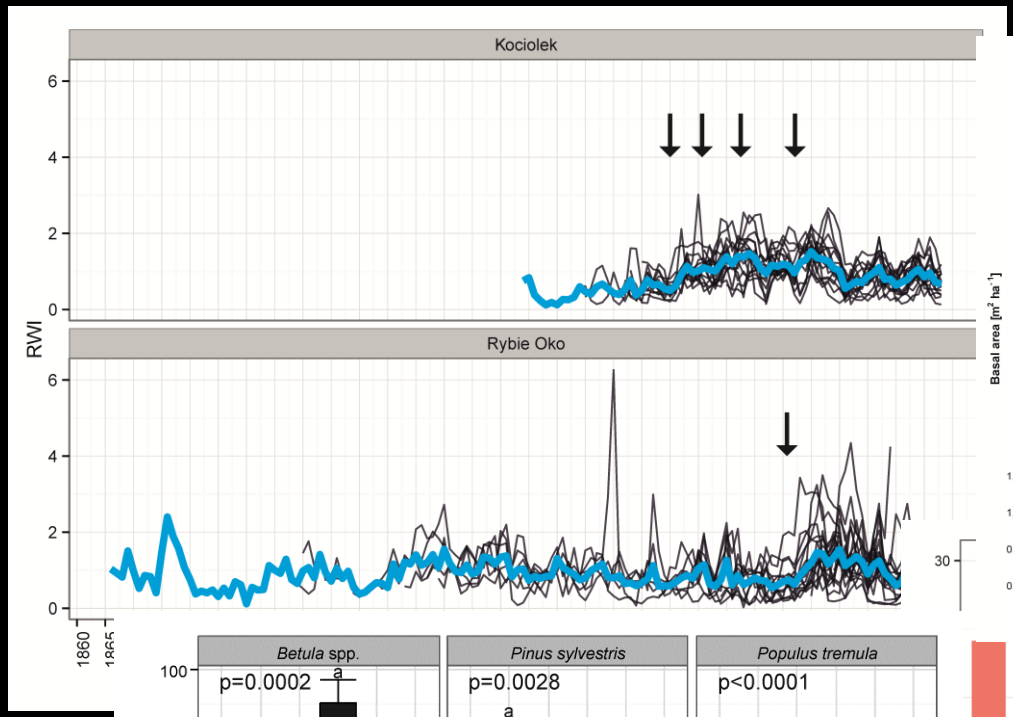
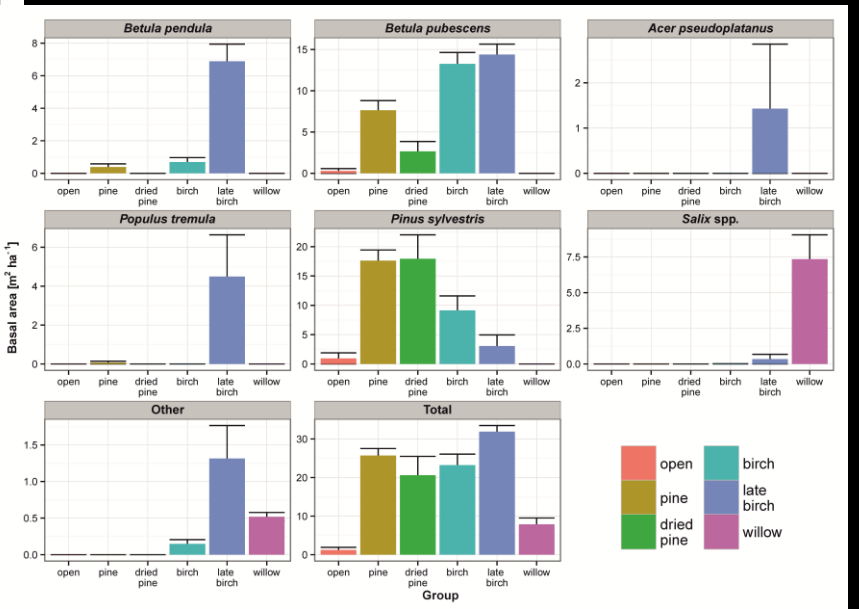
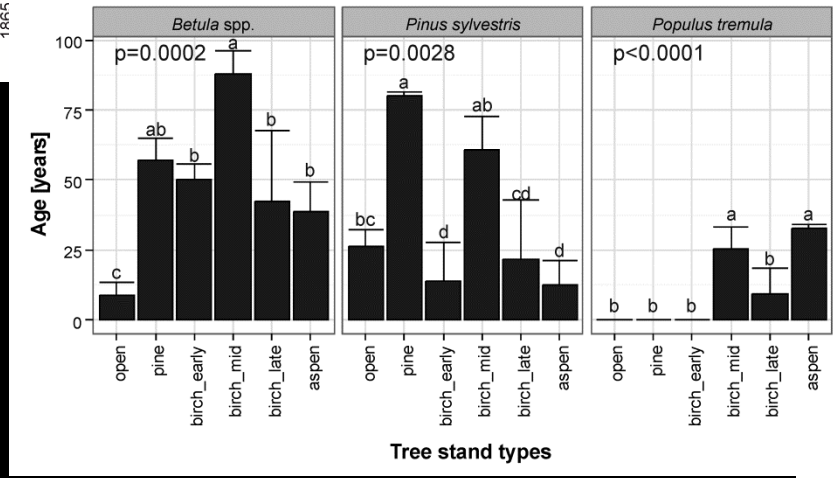
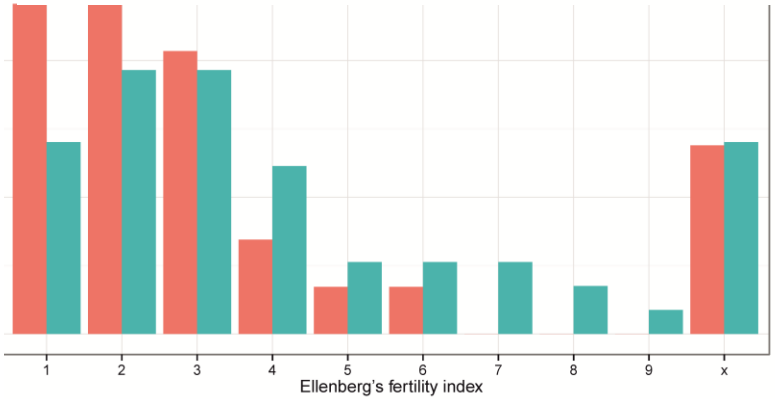








Aims of the presentation

- to show analytical problems typical to forest ecology and its solutions in **R**
- to consider place for data science in forest ecology

Primary production patterns

- plants are producing biomass
  - how much?
  - how long?
  - when?
  - why?
  - …

Why biomass?

- carbon retention
- best measure of plant's success
- utilisation (e.g. wood or food)

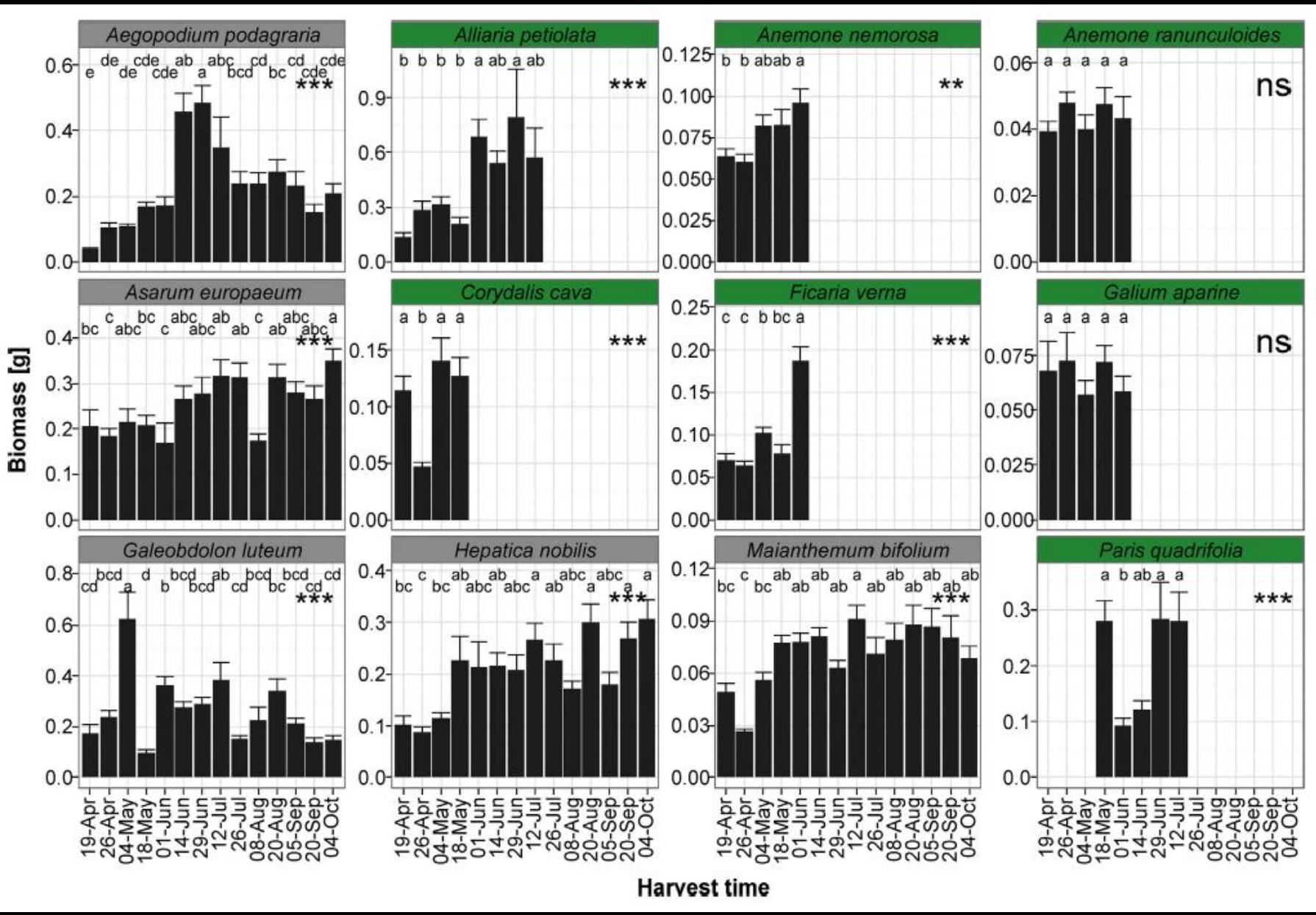
Data analyzes

- 12 understory herb species
- 14 dates of harvest
- three parameters:
  - Specific Leaf Area
  - Total leaf area
  - Biomass of individual
- uneven time of emergence:
  - spring ephemerals
  - species present during the whole growing season
- unknown variablity

in total: 2429 plants

Possible approaches

- linear model
- data mining, e.g. SVM
- two-way ANOVA:
  e.g. SLA ~ harvest time * species
- exploratory data analyzes + one-way ANOVA – species case studies and looking for patterns



Jagodziński et al. 2016; Forest Ecology and Management 374

Multiple comparisons?

- each species is a separate story
- due to different life strategies

Caution needed

- always plot your data **before** cleaning
- knowledge about range of variables
  - come from field and lab work
  - and lead to answer whether it is a mistake or natural variability
  - thus we need to caution and put effort into proper measurements

Natural regeneration – zero problem?

Case study – Rogów Arboretum

- invasive black cherry
- 20,843 counted plants
- few explanatory variables:
  - distance from the seed source
  - type of tree stand

Problem

- how type of tree stand modifies relationship between distance from seed source and density of black cherry

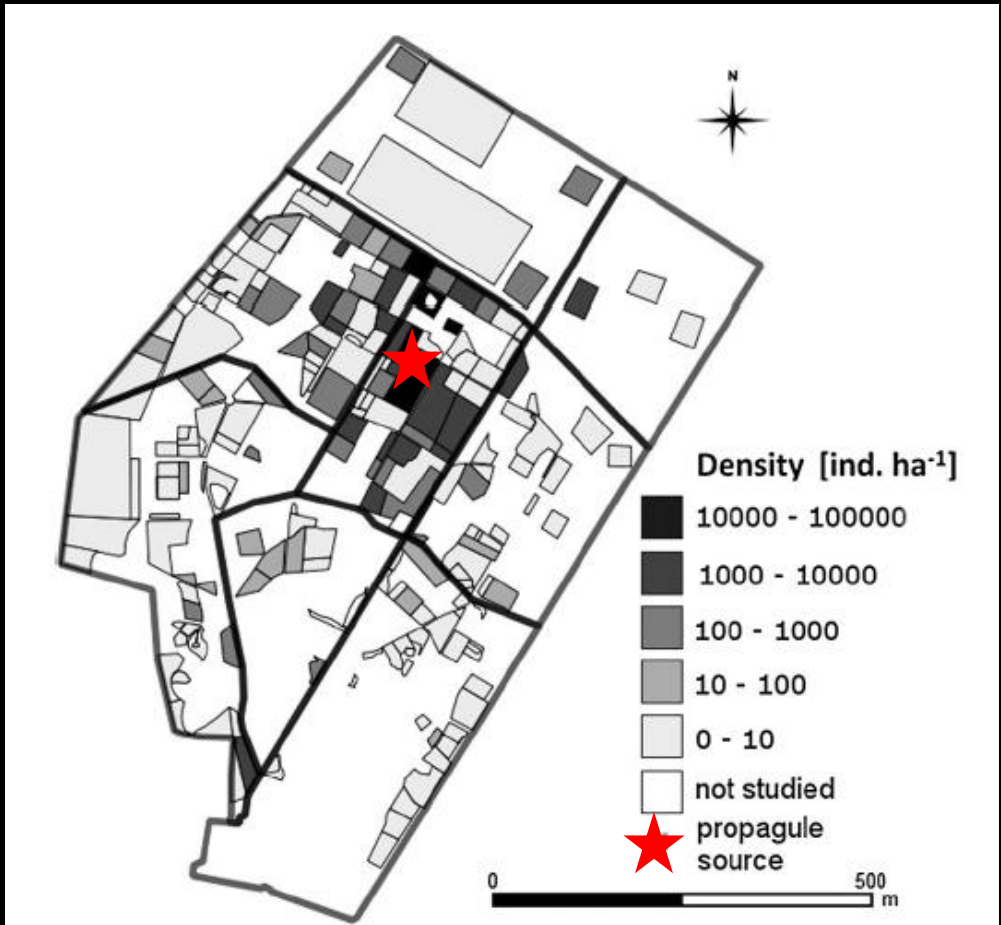


Fig. 1. Spatial distribution of natural black cherry regeneration density (all height classes) in Rogów Arboretum.

Jagodziński et al. 2015; Forest Ecology and Management 357

It sounds easy, but...

- how it is meaningful?
- what is more important – density or presence?
- how to model it?
- what is an outlier in this case?

Caution needed – outliers

- suitable microhabitat
- density of adult (fruiting) trees
- clustered group of seedlings conncected with random clustering
  - dispersion by birds – faces full of seeds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Effect size and interaction

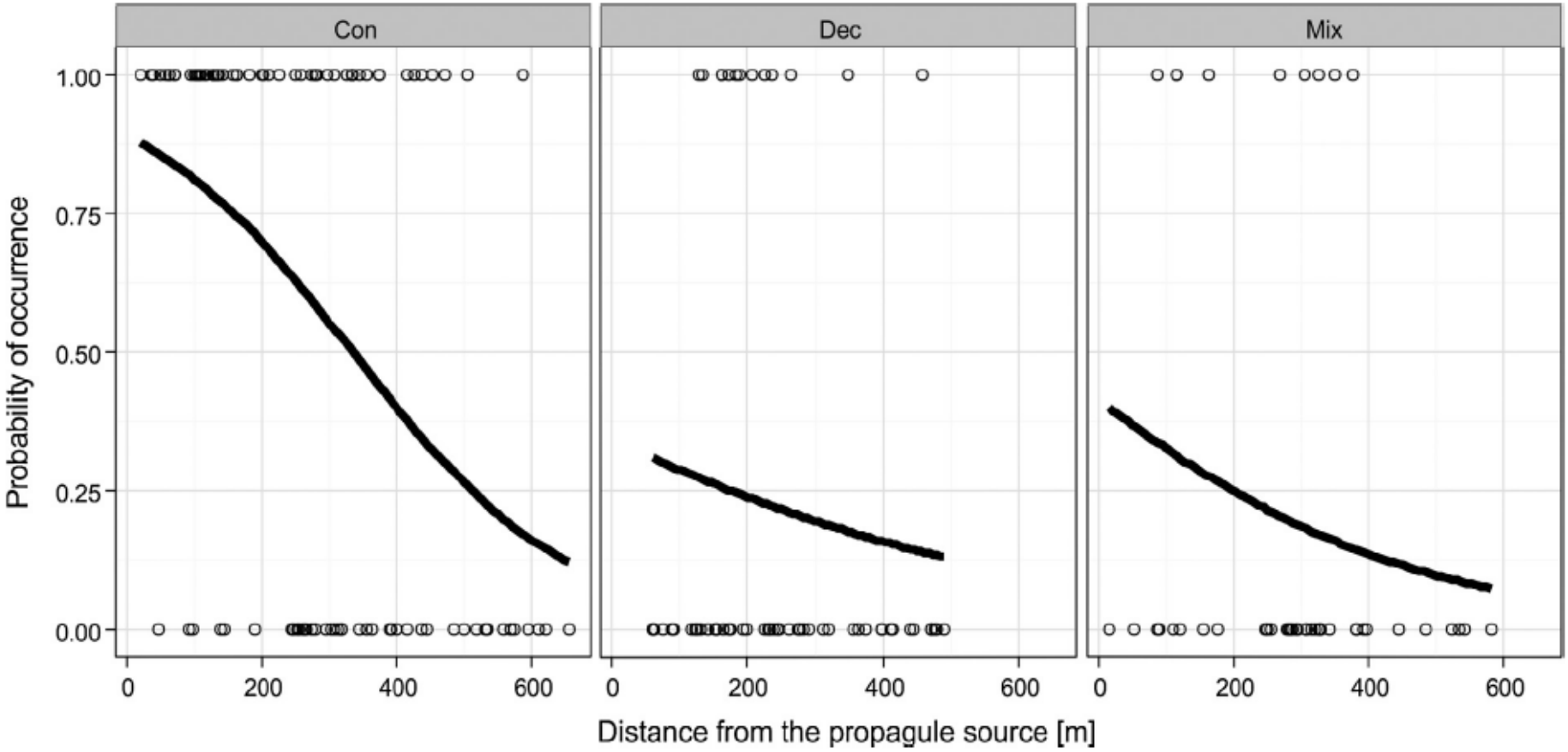


Fig. 4. Effect of coniferous (Con), deciduous (Dec) and mixed (Mix) tree stands on the probability of colonisation by black cherry ($p < 0.001$).

Jagodziński et al. 2015; Forest Ecology and Management 357

Effect size and interaction

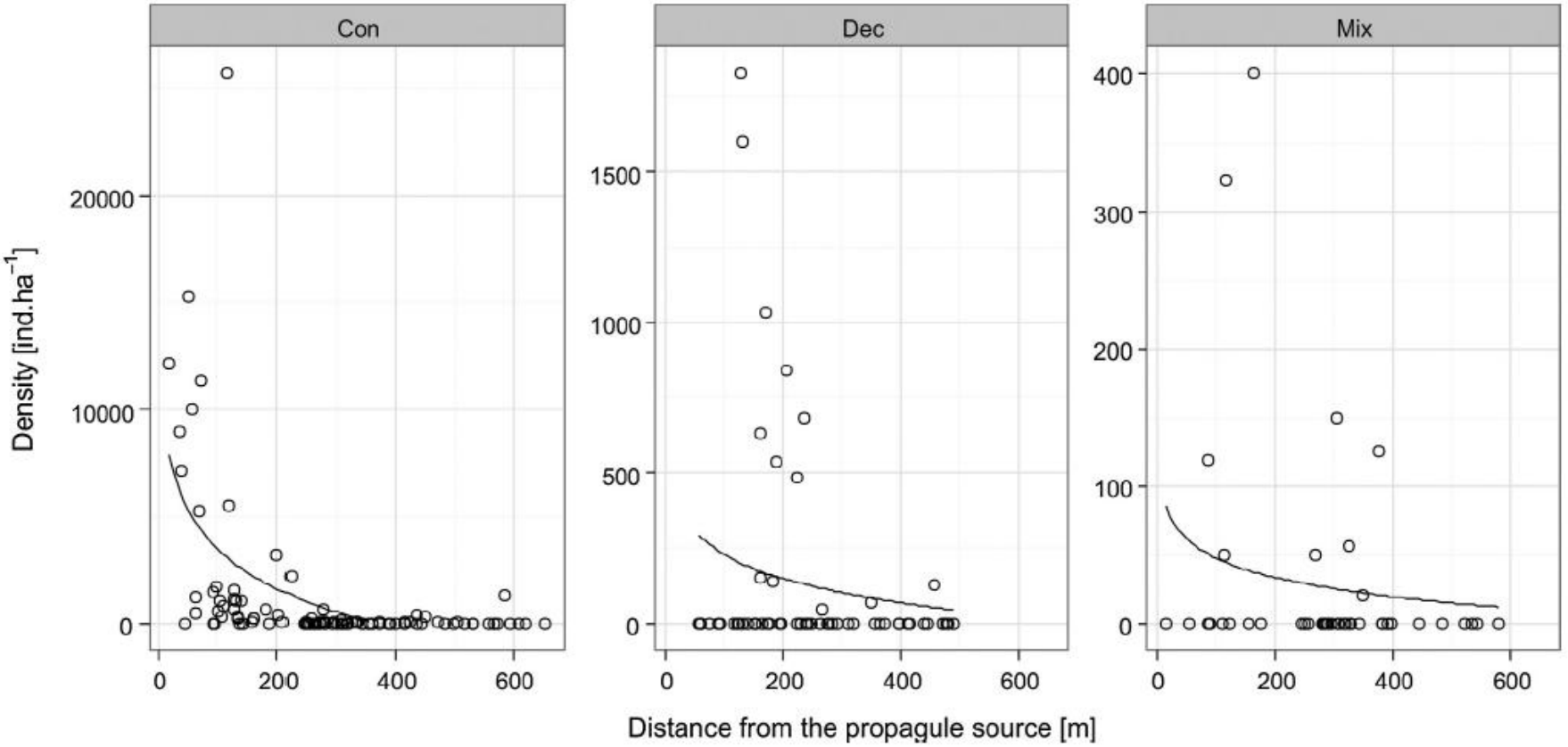


Fig. 5. Effect of coniferous (Con), deciduous (Dec) and mixed (Mix) tree stands and distance from the propagule source on the density of natural black cherry regeneration ($p < 0.001$).

Jagodziński et al. 2015; Forest Ecology and Management 357

Impact of urbanization on flora

- Ancient Woodland Indicator Species (AWIS)
- statistically significantly more frequent in old forests
- but… are they good bioindicators?



Why AWIS are doubt?

- AWIS enter cities, dumps, spoil heaps and other „new forests"



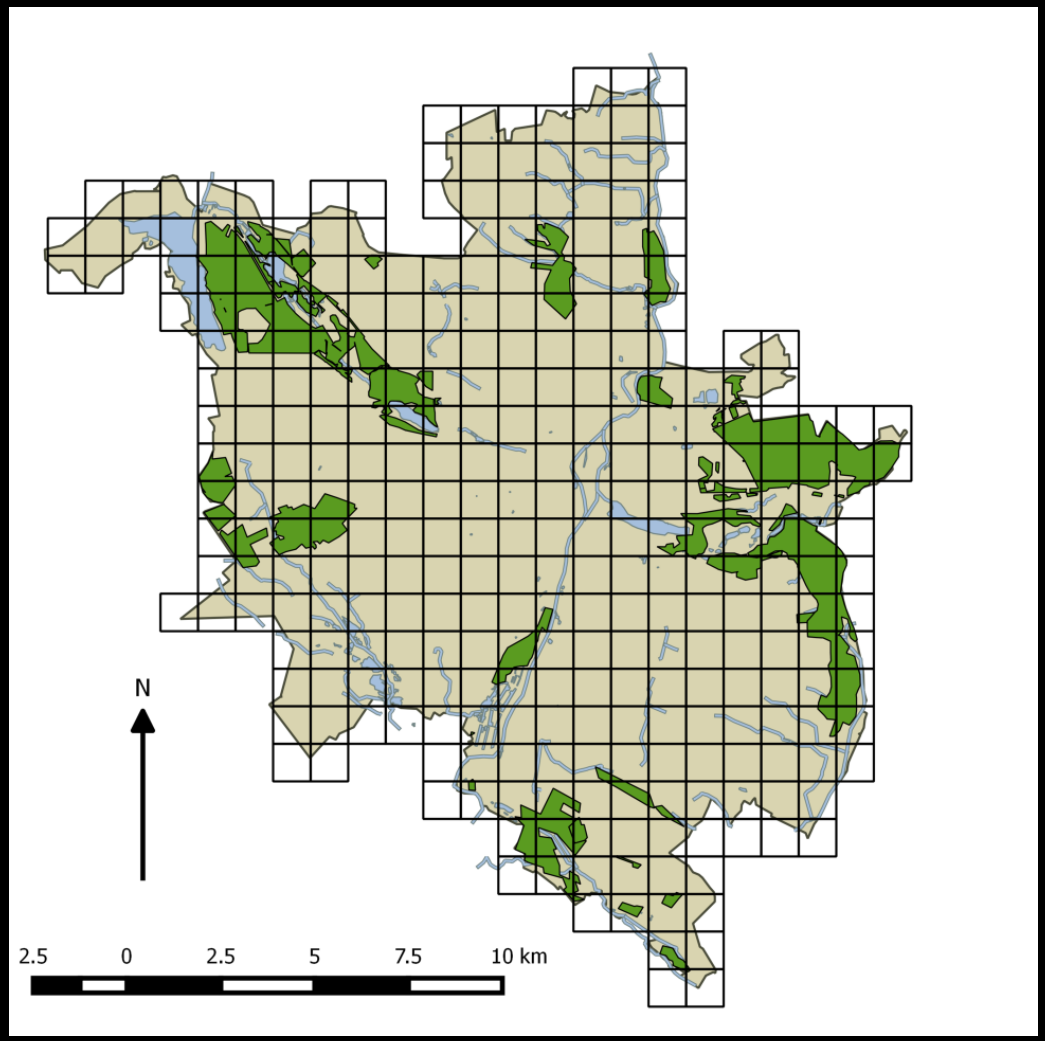
- even these seriously threatened may be found in the 'rubbish forests'

Questions

- are AWIS really connected with old forests in urban areas?
- if yes, how they respond to land-use forms (CORINE Land Cover)?



Data



- mainly published data on AWIS occurences (n=1589)
- grid squares 1 km^2
- time extent of database: 35 y

Dyderski et al.; submitted to Diversity and Distributions

Analyzes

- how to check every species fidelity?
- most of them – confirmed fidelity

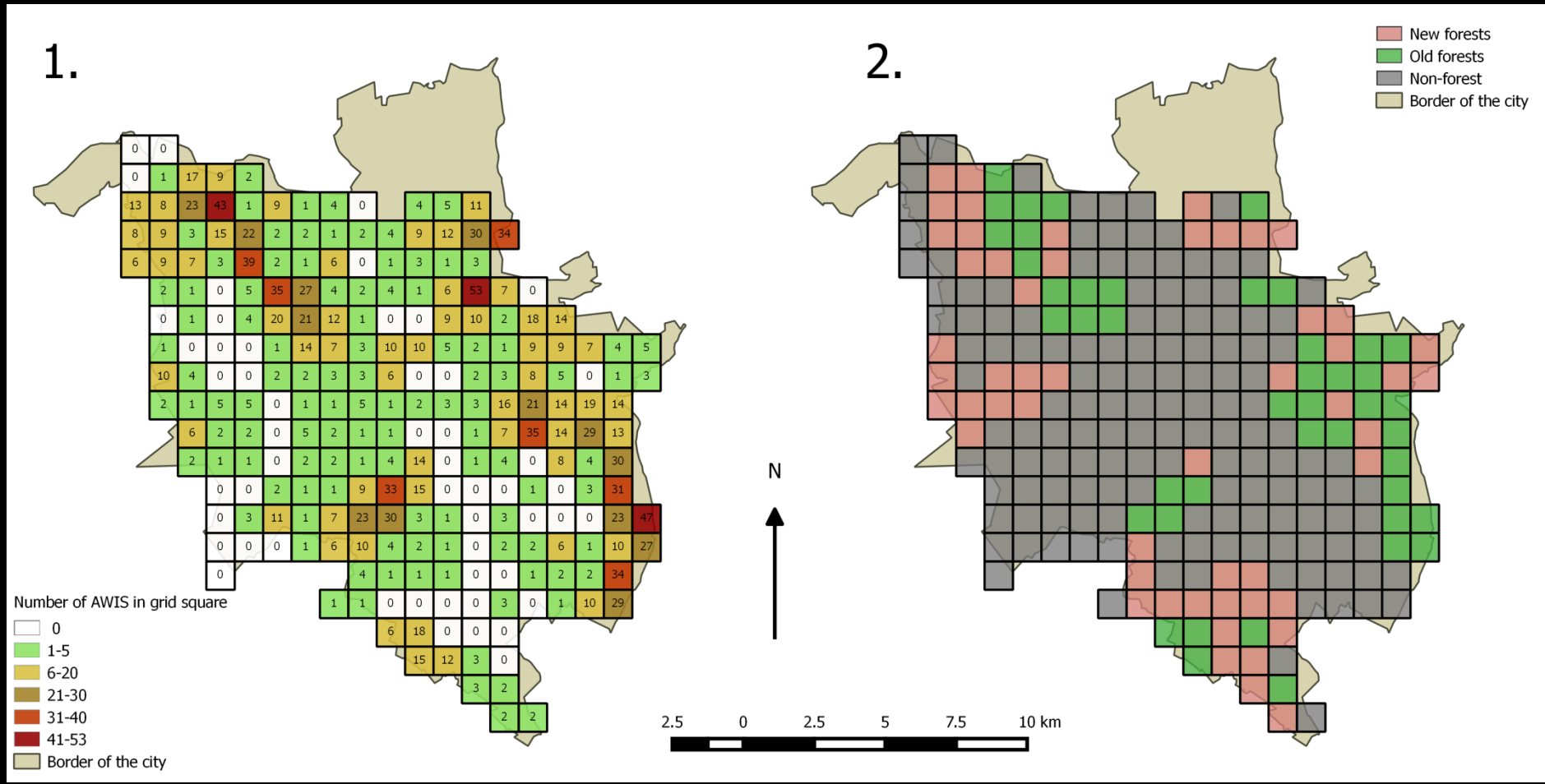
Presence	Old forests	New forests	Without forests
YES	**21**	14	20
NO	23	39	125

$X^2 = 22.66$; $p<0.001$ – pattern confirmed





Visualisation



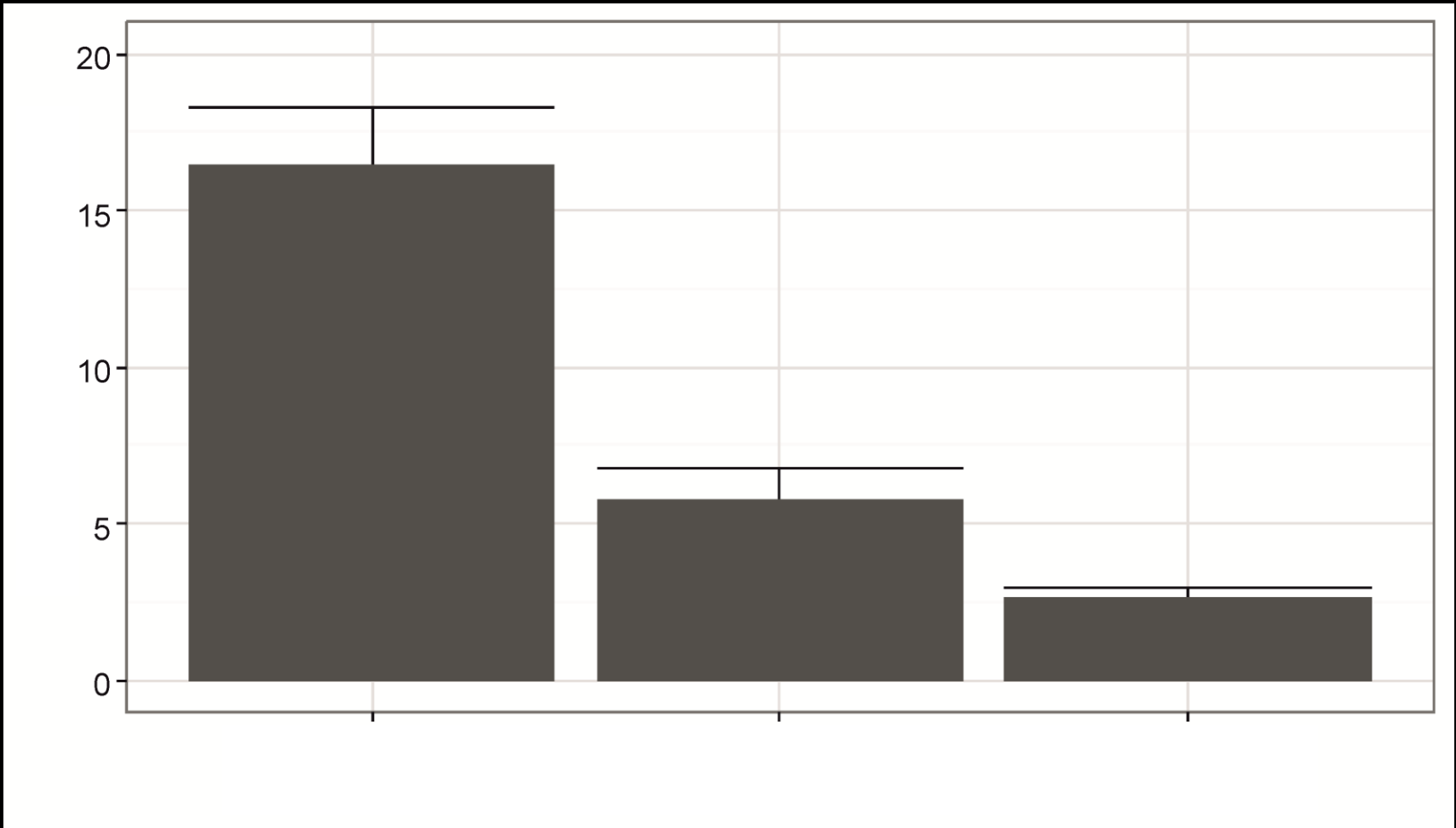
Dyderski et al.; submitted to Diversity and Distributions

How to check whether differences between old and new forests are important?

- **simple:**
- one-way ANOVA
- *base* package

- **sophisticated:**
- spatially-explicit Poisson GLM
- *hglm* package
- + *spdep* – for neighbourhood matrix

Result: the same or not?



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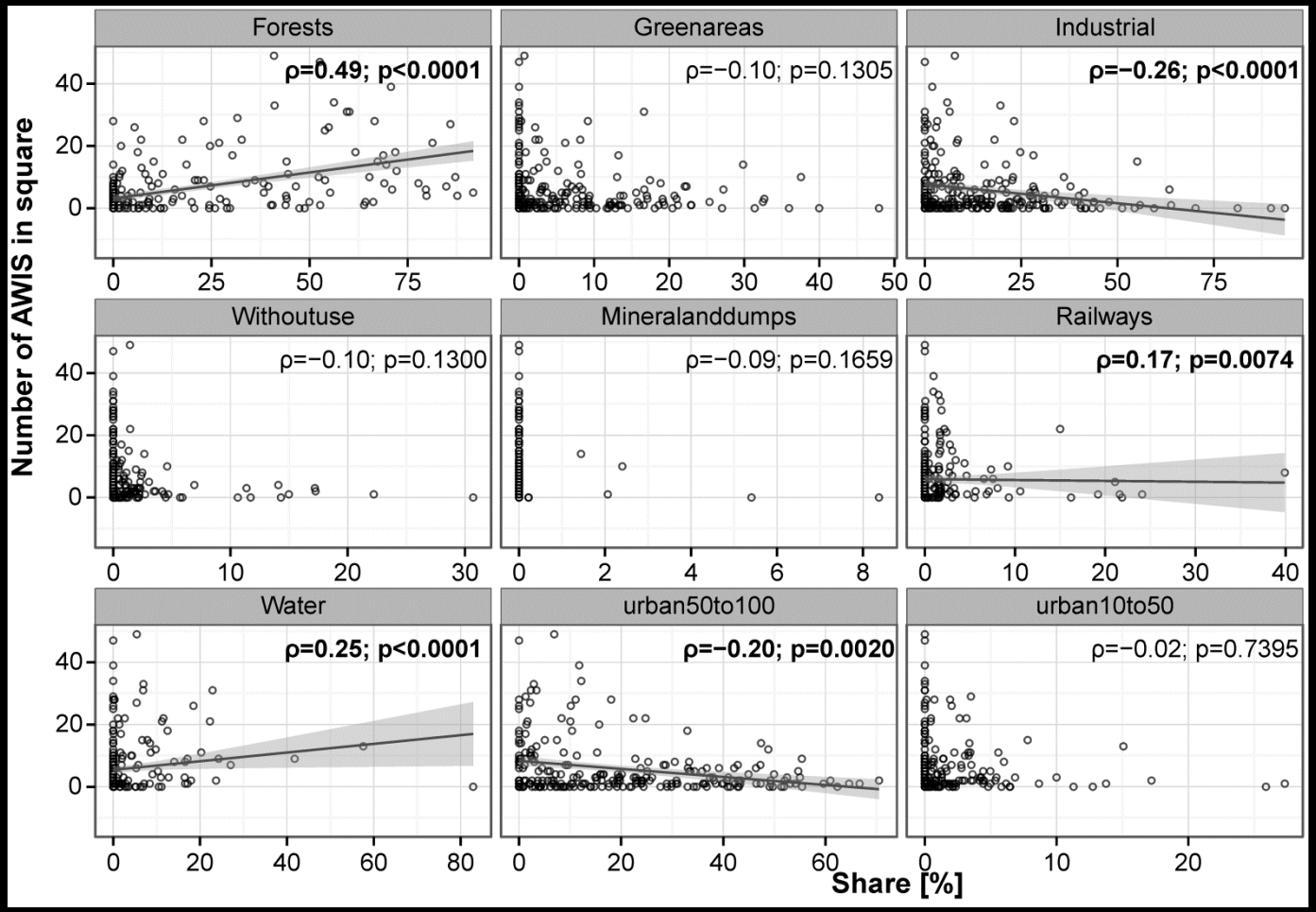
Land-use forms



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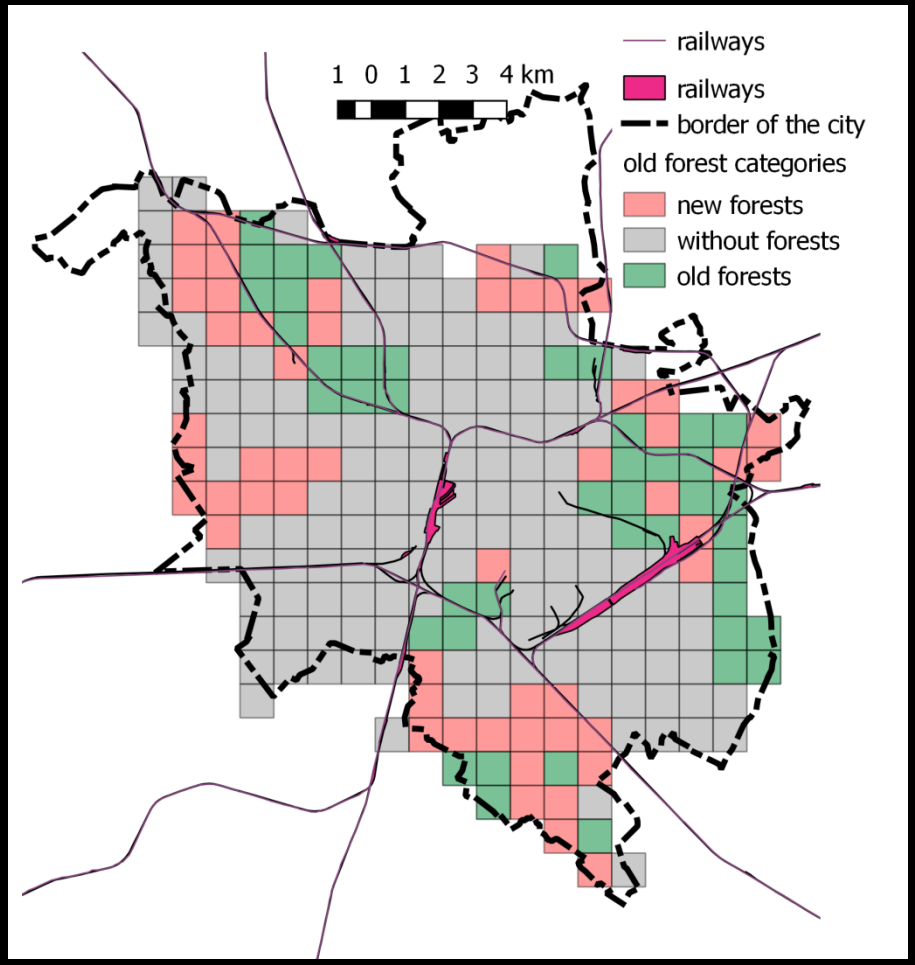
Are railways really nice for AWIS?

- Prussian stronghold
- railways from XIX century
- forests planted for forts protection

= coincidence



Conclusions

- forest ecology needs data science
- 'expert knowledge' about species and ecosystems is required to distinguish computation artifacts from biological phenomena
- many problems are solvable by easy methods, but require lot of data
- many problems don't require hard-to-collect data, but require analytical skills

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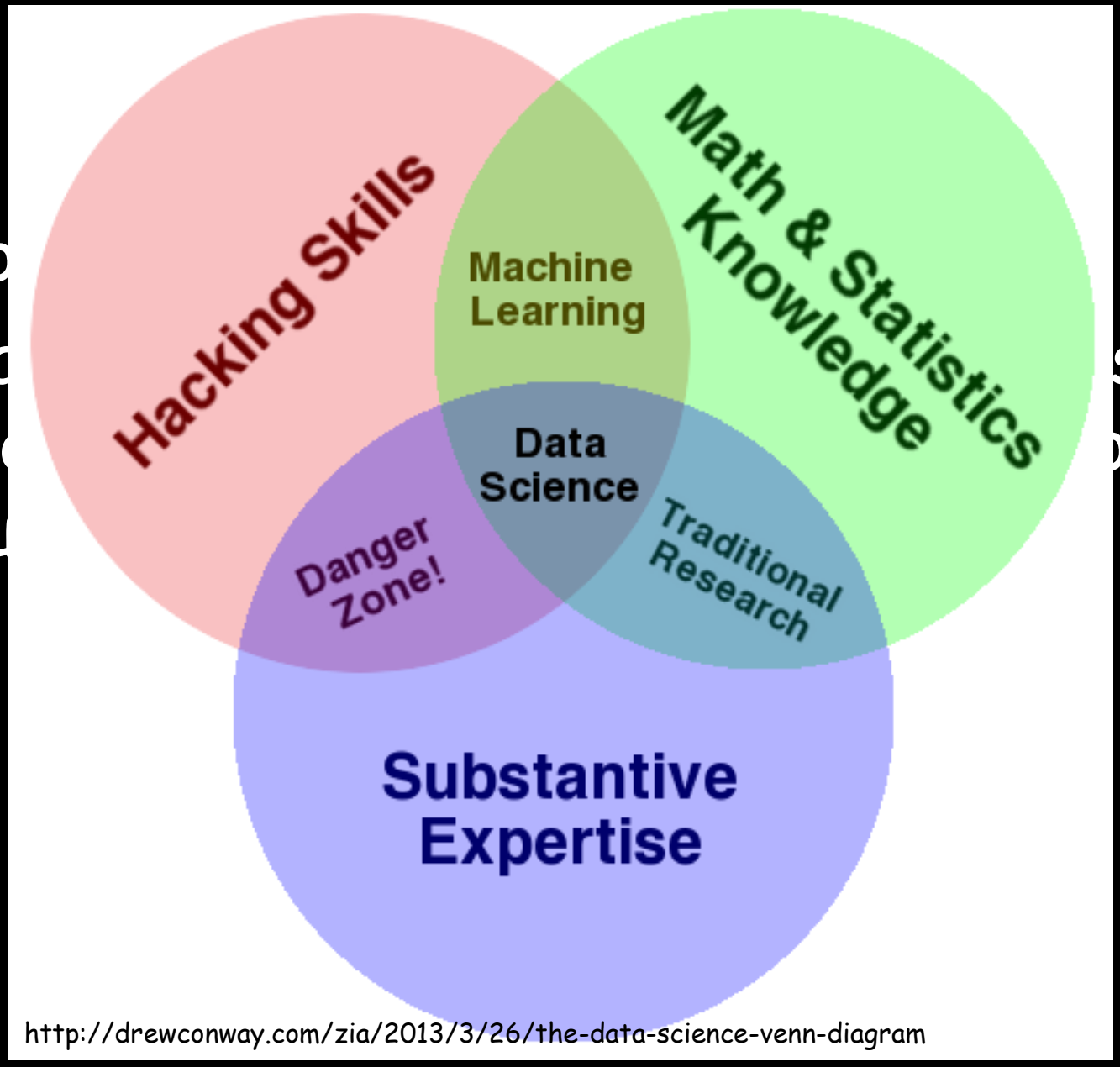

http://drewconway.com/zia/2013/3/26/the-data-science-venn-diagram

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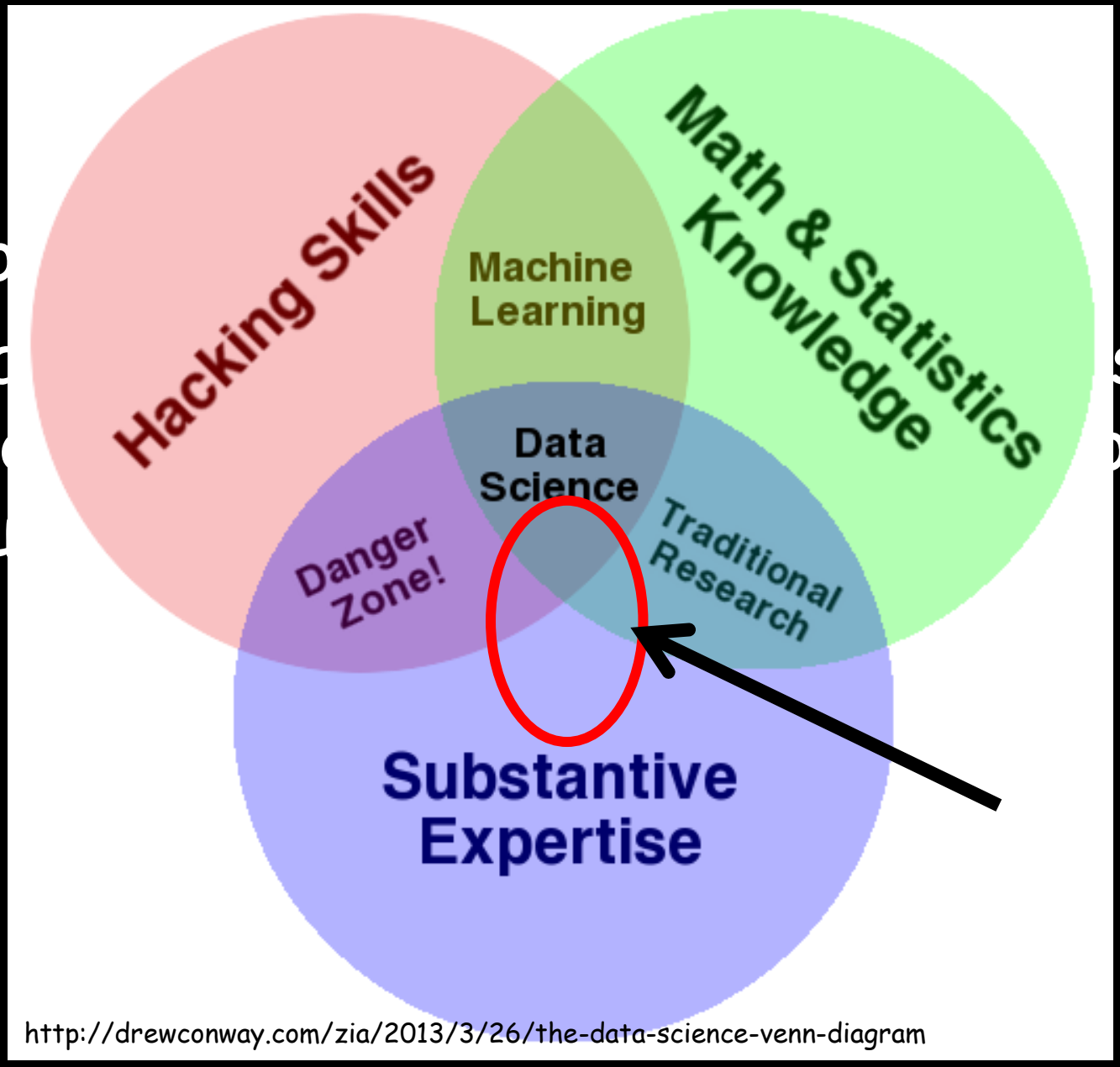

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