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Supporting scientific research @ INBO

Master of Statistical Data Analysis Day, Coupure Campus, UGent

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Research Institute for Nature and Forest (INBO)

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- Instituut voor Natuur- en Bosonderzoek / Research Institute for Nature and Forest
- Flemish research and knowledge centre for nature and its sustainable management and use
- conducts research and supplies knowledge to policy makers and stakeholders
- supports
  - agencies of Flemish government related with countryside or nature within urban areas
  - organisations involved in nature conservation, forestry, agriculture, hunting and fishery

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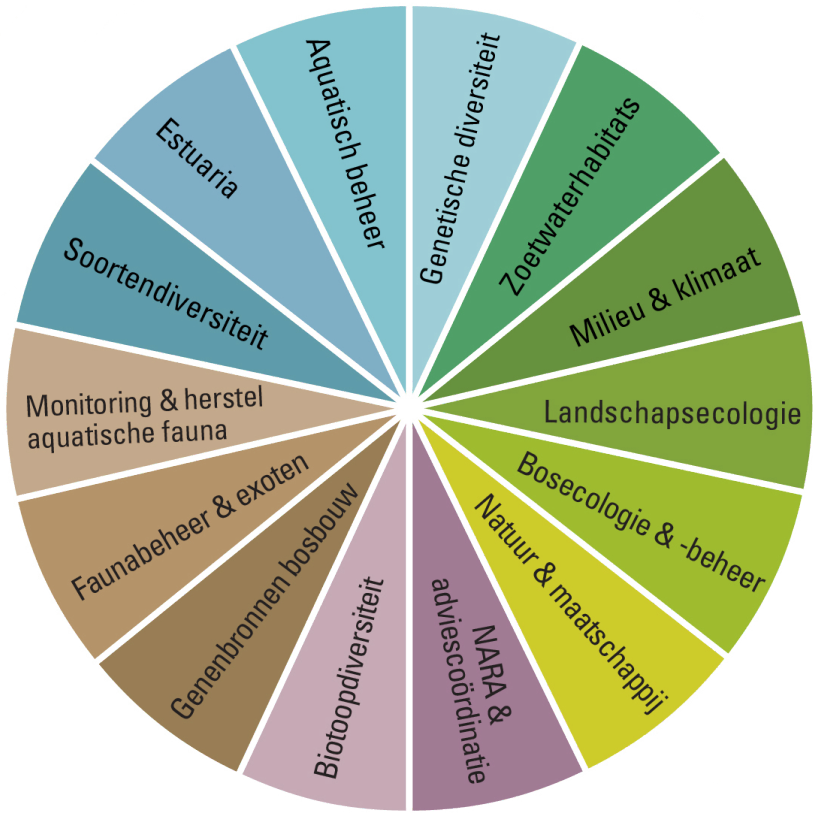
Data collection and provision

- INBO collects and provides data for international reporting
- Participates in (inter)national research networks
  - LTER: the Long Term Ecological Research network
  - LifeWatch: e-Science and Technology European Infrastructure for Biodiversity and Ecosystem Research
  - ALTER-Net: A Long-Term Biodiversity, Ecosystem and Awareness Research Network
  - …

Organigram



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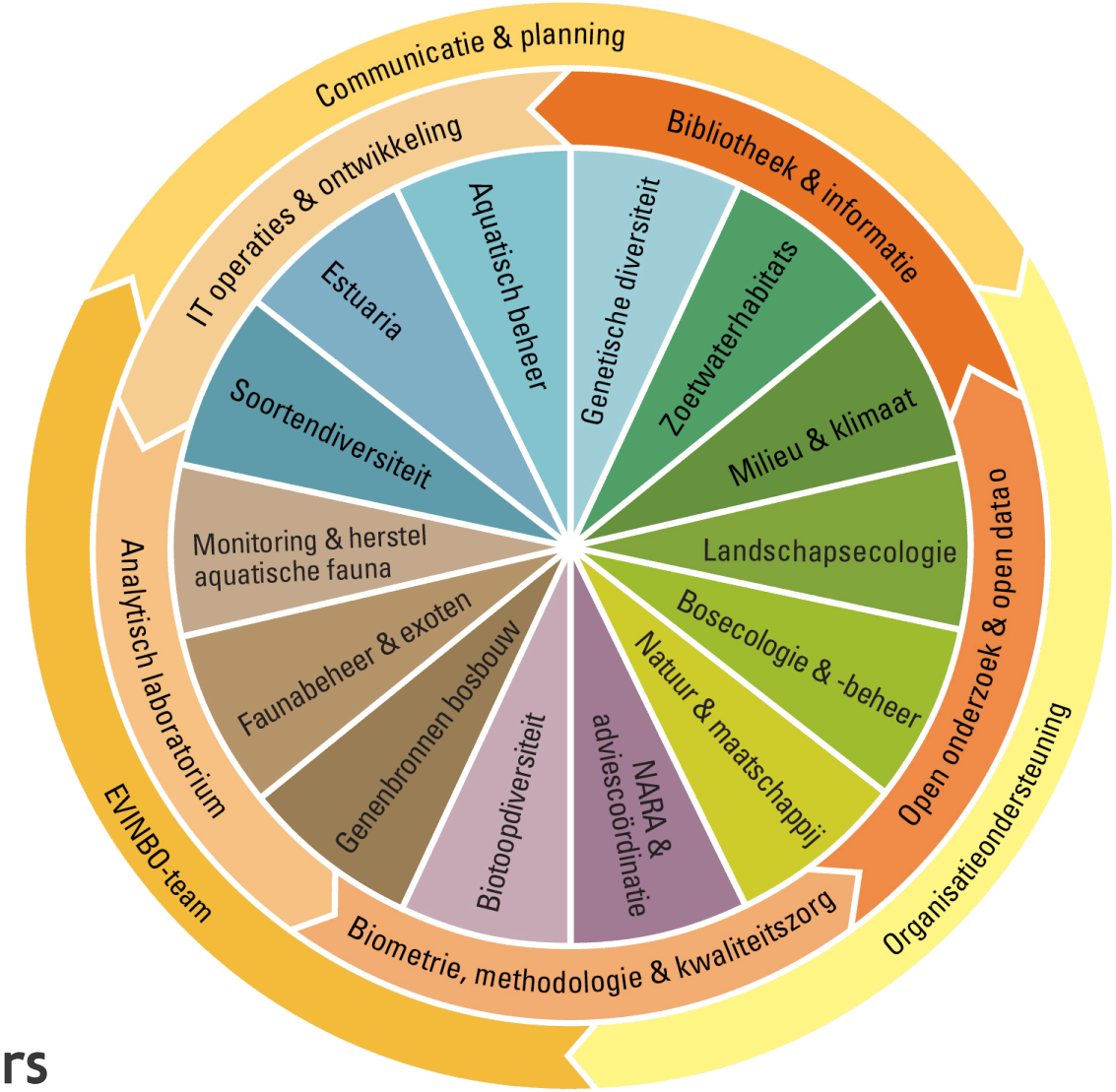

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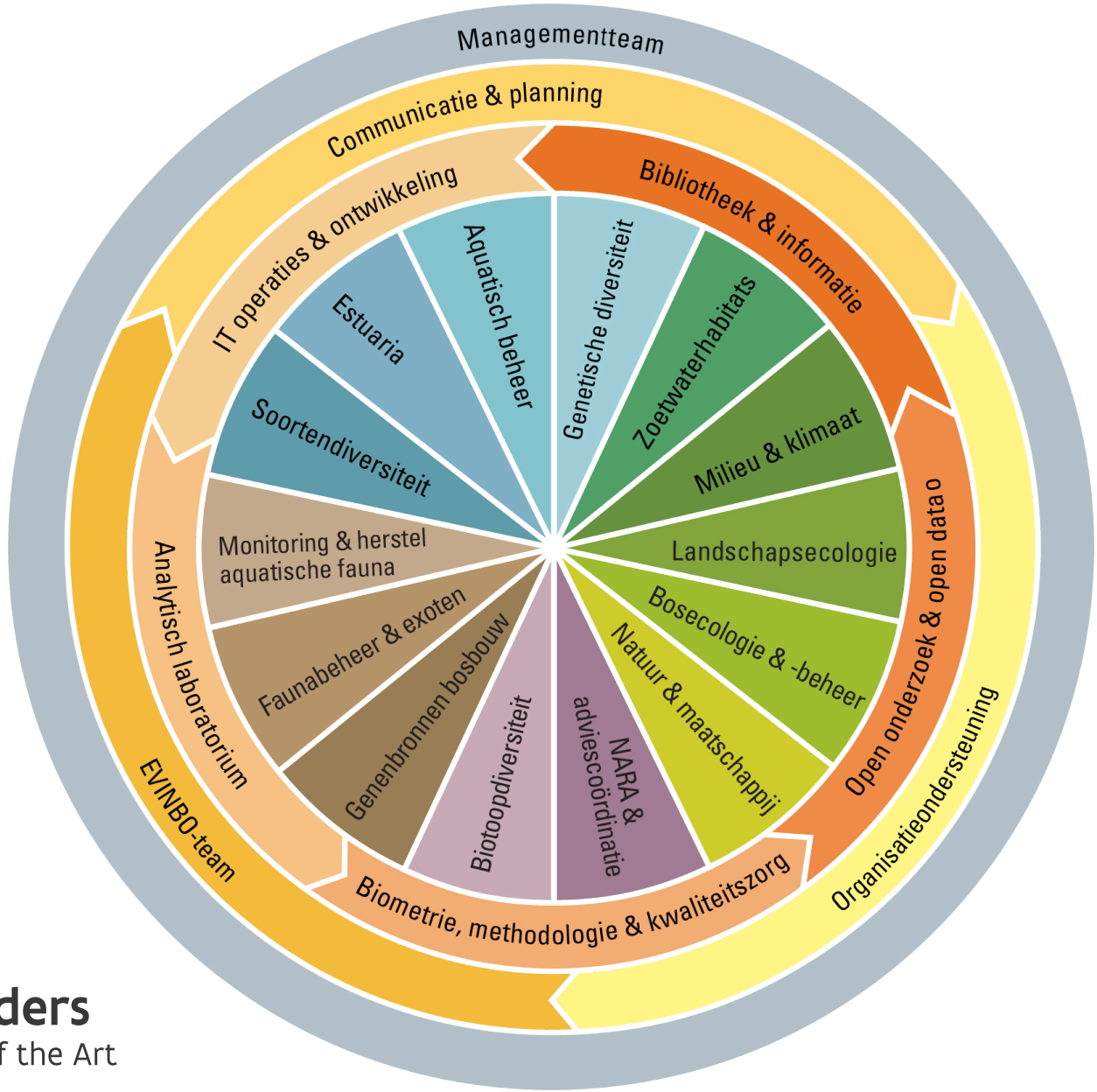

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Staff

- 262 staff
  - 191 scientific staff (scientists + technicians)
  - 40 support for scientific staff
  - 22 administrative staff
  - 9 management
- 5 specialised teams dedicated to support the scientific staff
  1. Biometry, Methodology & Quality assurance (8)
  2. Open data & open research (8)
  3. Laboratory (10)
  4. IT operations & development (6)
  5. Library (8)

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Biometry, Methodology & Quality assurance

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A scientific corporate identity and quality assurance

- involvement from design phase up to implementation phase
- creating, evaluating and adjusting procedures
  - harmonising protocols for data collection
  - validation of data through statistical modelling
- improving reproducibility
  - scripted analysis (R)
  - dynamic documents (RMarkdown)
  - version control (git)
- gradual change!
  - focus on early adopters and early majority
  - stimulation and support is vital
  - new procedures should lower the burden in the long run
  - allow for a long transition period before enforcing change

Creating a methodological platform

- implementing methodologies
  - standardise methods and analyses with focus on long term monitoring and common experiments
  - testing new methods and analysis techniques
  - developing new methods and analysis techniques
- improving self-reliance of scientists
  - internal statistics courses ranging from “stats 101” to generalised linear mixed models and multivariate analysis
  - offer scientists tools to help themselves and each other: websites, webinars, books, …
- maintaining tools
  - software, manuals, documentation, books, …
  - templates for basic analyses
  - corporate identity styles for graphics (ggplot2) and dynamic documents (markdown, LaTeX, HTML)

Leading specific projects

Some projects are led by the team, in collaboration with scientists. These projects typically:

- have more statistical or technological challenges
- strive towards achieving higher quality and standardization levels at INBO
- have a longer term

Examples:

- design and implementation of monitoring networks to support and evaluate Natura 2000 objectives
- design and implementation of monitoring of nature management plans
- elaboration of population modelling methods

Support and services

- teaching
  - statistical courses (sampling theory, GLMM, multivariate data analysis, …)
  - R and RStudio
- consultancy
  - help desk: ad hoc questions on statistical techniques and R
  - sounding board: critical reflection on research goals, experimental design, statistical analysis, …
- expertise assignments
  - experimental design: spatio-temporal resolution, sample size calculation, financial impact, …
  - complex analyses requiring a full-fledged statistician
- quality control
  - scientists can ask for a review of their code

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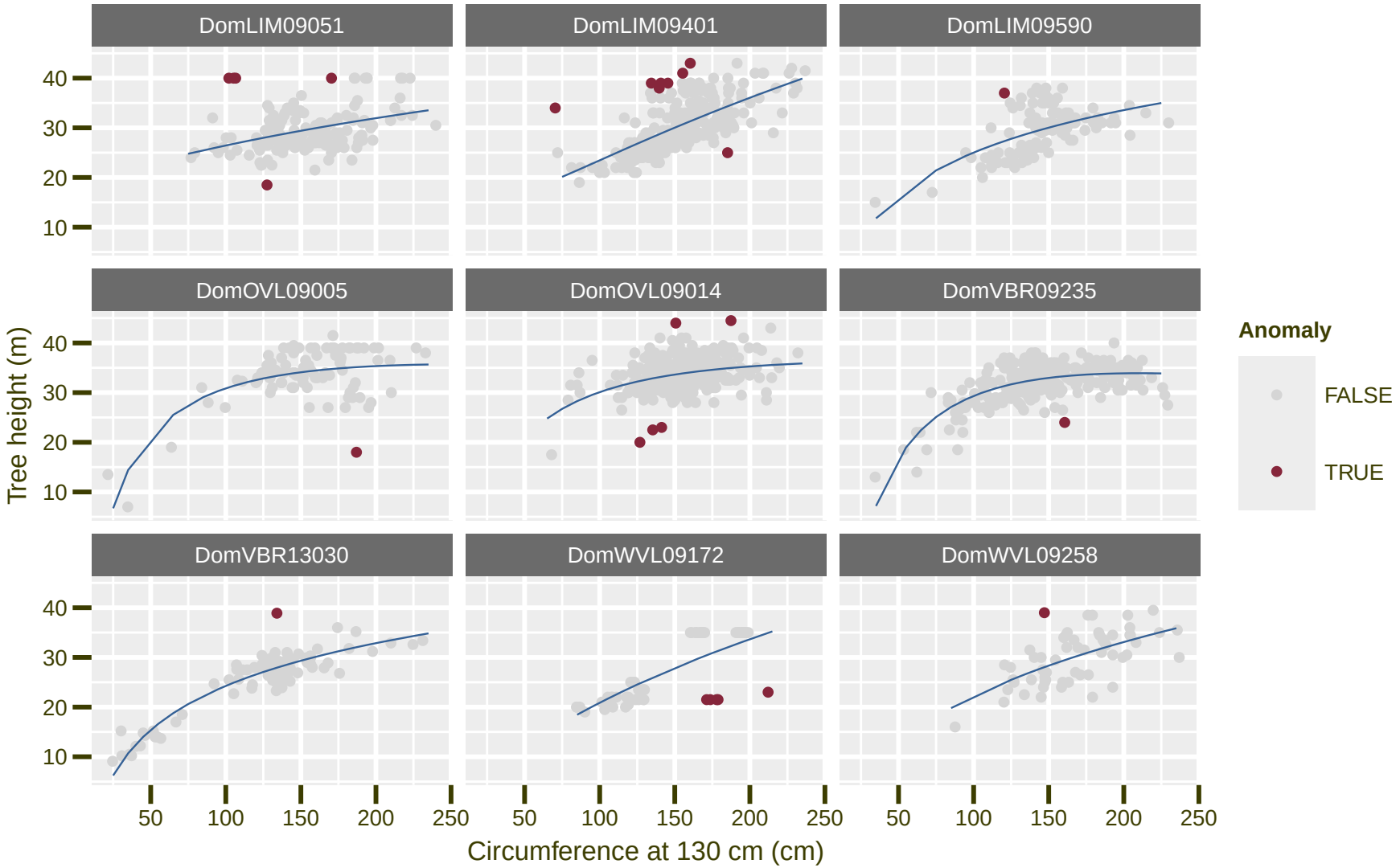
Examples

Validation of data through statistical modelling

- inspecting each data point in a large dataset is impractical
- observed value is the result of an (unknown) data generating process
- try to model the data generating process
- look for extreme values given the model
  - strong residuals
  - strong (hyper)parameters
  - “anomalies”: *n* strongest values
- thoroughly inspect all observations linked to an anomaly
  - something wrong with the observation?
  - something wrong with the model?
- remove irrelevant observations, fix typos, adjust model
- repeat until
  - model makes sense
  - all anomalies are relevant and correct observations

Example: height-diameter curves for trees



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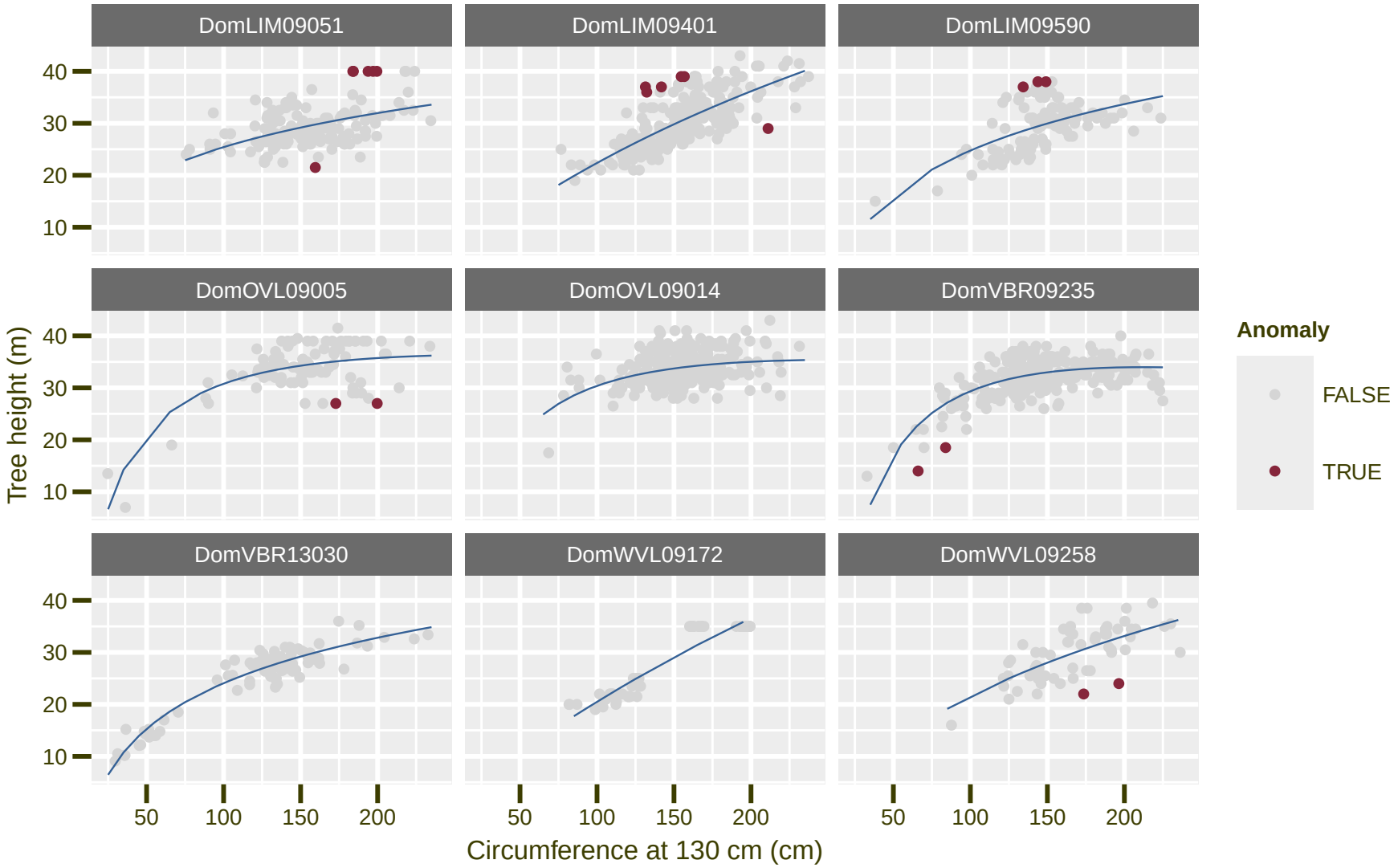
Example: updated height-diameter curves for trees



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Visual estimates of plant cover

- vertical projection of stems and leafs onto ground
- fraction of projected area per plant species
  - does not sum to 1
- estimated in classes with different binwidth
- ordinal data but often treated as continuous data
- survey quadrant size ranges from 1 m² to 256 m²

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Alternative: integral occurrence probability

- measure the shortest distance r_{ij} from sampling point i to nearest plant part of species j
  - $r_{ij} = 0$ when species j covers the sampling point
  - $r_{ij} = r_{max}$ when species j is not found within r_{max} around the sampling point
- requires several sampling points per location
- measured continuous data instead of visually estimated ordinal data
- $r^2/r^2_{max} \sim BI(p_0, p_1, \mu, \phi)$
  - p_0: cover estimated by point sampling
  - $1 - p_1$: presence within a circle of r_{max}
- integral occurrence probability
  - $1 - \mathrm{E}(r^2/r^2_{max}) = 1 - (p_1 + (1 - p_0 - p_1)\mu)$
  - $\frac{\sum_{i=1}^{n}(1-r_i^2/r^2_{max})}{n}$