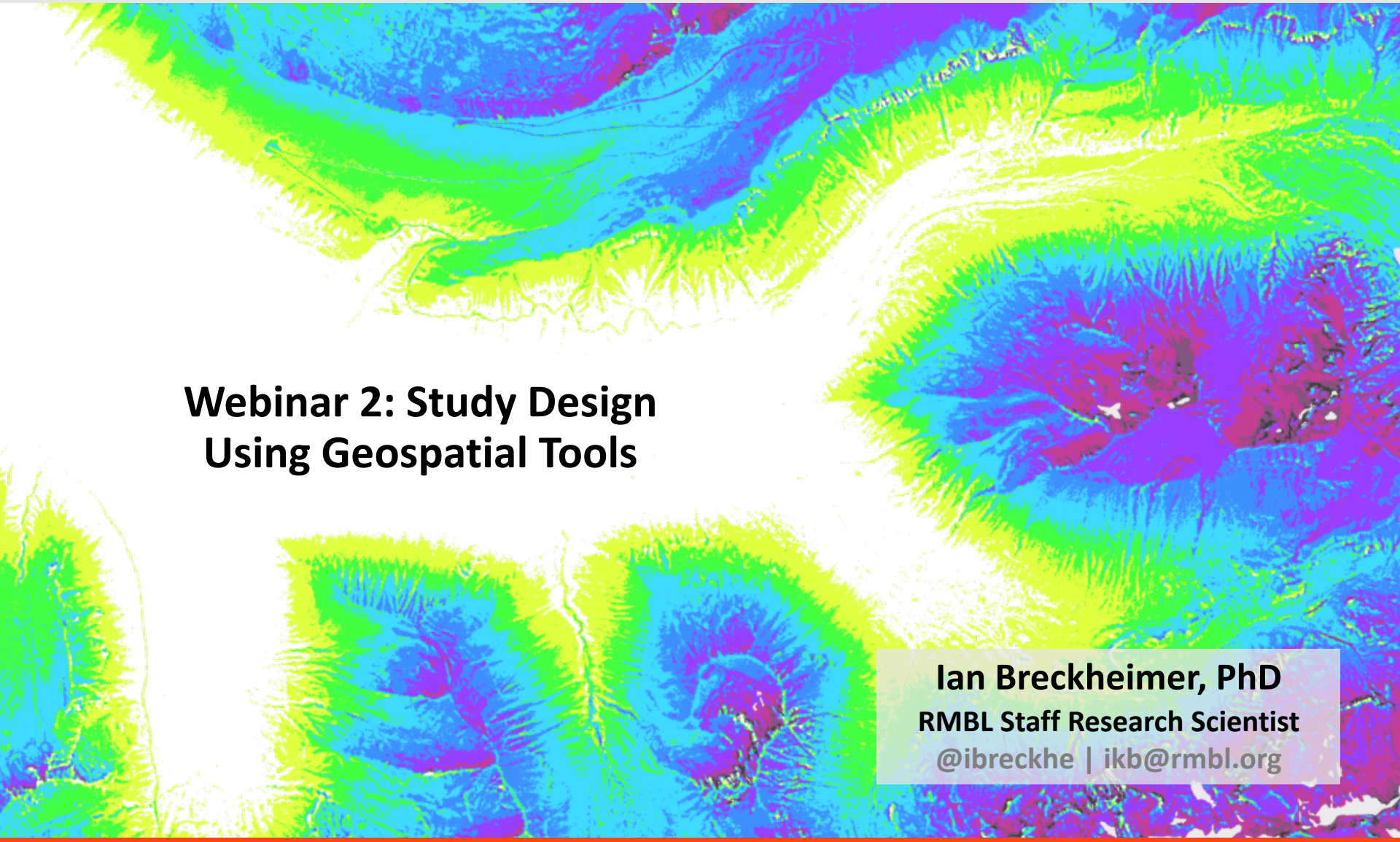


Webinar 2: Study Design Using Geospatial Tools

Ian Breckheimer, PhD
RMBL Staff Research Scientist
@ibreckhe | ikb@rmbl.org

Webinar Schedule

Tuesday September 22nd 2020
Introduction to the RMBL Spatial Data Platform,
How to access RMBL SDP data in GIS and programming environments, and where we are going with the platform.

Tuesday October 20th 2020 *Designing Robust Field Studies using Geospatial Tools*
How to optimize site selection using GIS and the RMBL SDP.

Tuesday January 26th, 2021 *Successful UAV Data Collection in Mountain Environments*
How to design and execute UAV flights for high-quality scientific data in challenging environments.

Tuesday February 23rd, 2021 *Leveraging Point Cloud Data from Lidar and UAV Photogrammetry*
Mapping vegetation structure and function using 3D data from lidar and drones.

Tuesday March 23rd, 2021 *Linking Field Data with Remote Sensing for Spatial Prediction*
How to leverage high-resolution remote sensing from imaging spectroscopy and lidar to map species, traits, and processes.

Tuesday April 20th, 2021 *What's New in the RMBL Spatial Data Platform*
Introduction to new snow and phenology datasets that form part of the SDP Release 2 and Release 3.

Outline

- **Why?**

Why use geospatial tools to design field studies?

- **What?**

What foundational concepts do I need to know to design good field surveys?

What are some useful basic design paradigms?

- **How?**

How to use QGIS and R to select research sites

Good design is hard

Scientific validity:

-Proper scope

-Appropriate data structure

-Adequate sample size

-Acceptable measurement error

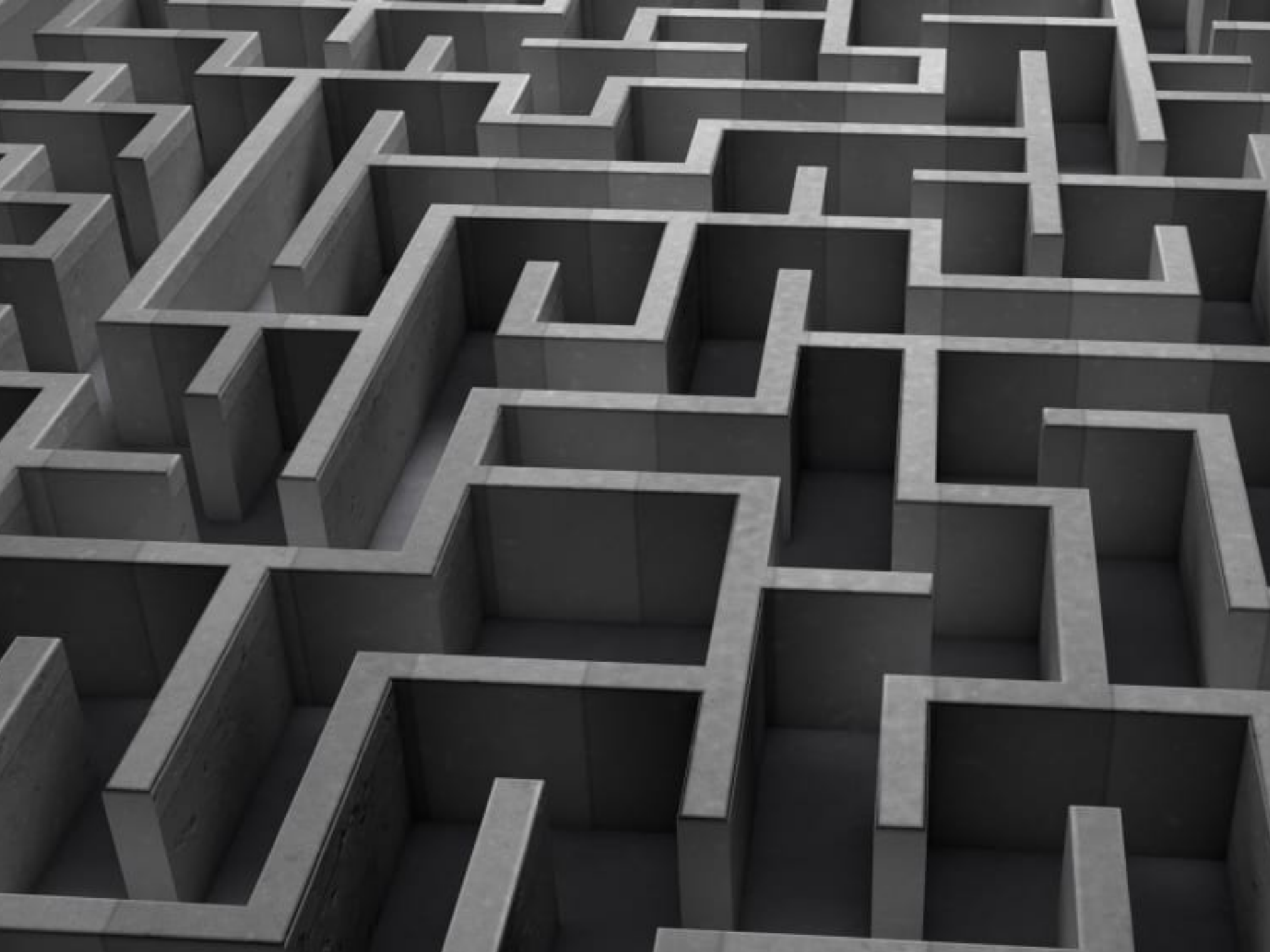
Logistical feasibility

-Adequate time and effort

-Safe and efficient access

-Good timing

-Few conflicting land uses



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Logistical feasibility

-Adequate time and effort

-Safe and efficient access

-Good timing

-Few conflicting land uses

Generalization - a sticky issue

Simulated rhizosphere deposits induce microbial N-mining that may accelerate shrubification in the subarctic

Lettice C. Hicks, Ainara Leizeaga, Kathrin Rousk, Anders Michelsen, Johannes Rousk

e03094 | First Published: 07 May 2020

Abstract | Full text | PDF | References | Request permissions

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Arctic and boreal paleofire records reveal drivers of fire activity and departures from Holocene variability

Tyler J. Hoecker, Philip E. Higuera, Ryan Kelly, Feng Sheng Hu

e03096 | First Published: 09 May 2020

Abstract | Full text | PDF | References | Request permissions

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Critical transition to woody plant dominance through microclimate feedbacks in North American coastal ecosystems

Heng Huang, Leander D. L. Anderegg, Todd E. Dawson, Safa Mote, Paolo D'Odorico

e03107 | First Published: 25 May 2020

Abstract | Full text | PDF | References | Request permissions

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Growing-season length and soil microbes influence the performance of a generalist bunchgrass beyond its current range

Clifton P. Bueno de Mesquita, Samuel A. Sartwell, Steven K. Schmidt, Katharine N. Suding

e03095 | First Published: 07 May 2020

Abstract | Full text | PDF | References | Request permissions

Outline

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4 Key Concepts for Study Design

- ***Study Area and Sampling Frame*** *– What is the population from which my samples are drawn?*

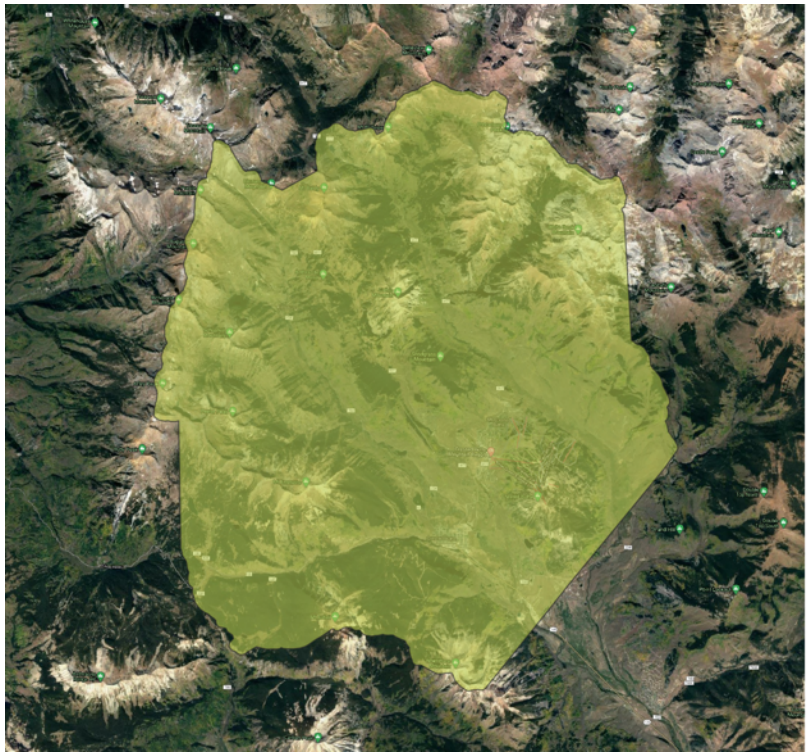
- ***Sample Size and Power*** *– How can I make sure my results are as precise as possible?*

- ***Representativeness and Coverage*** *– What are the most important features of a sample for inference?*

- ***Spatial Autocorrelation*** *– How important is it that my sites are independent?*

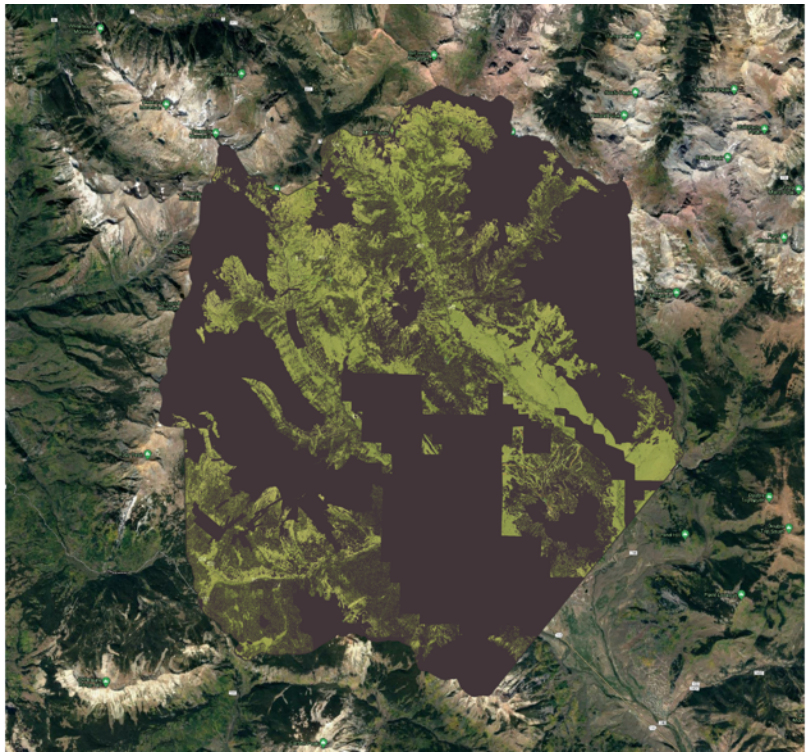
Study Area & Sampling Frame

Study Area



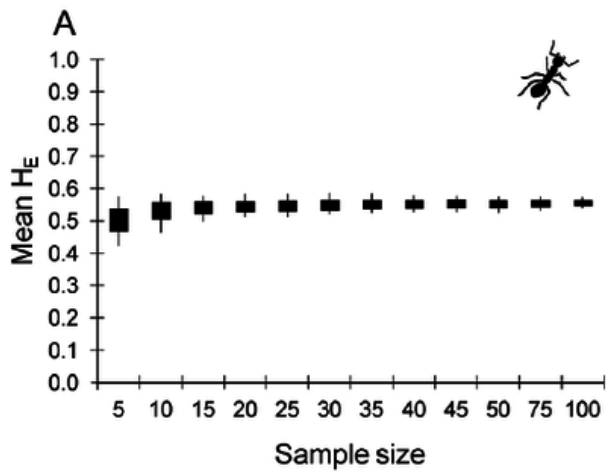
Where a study was done

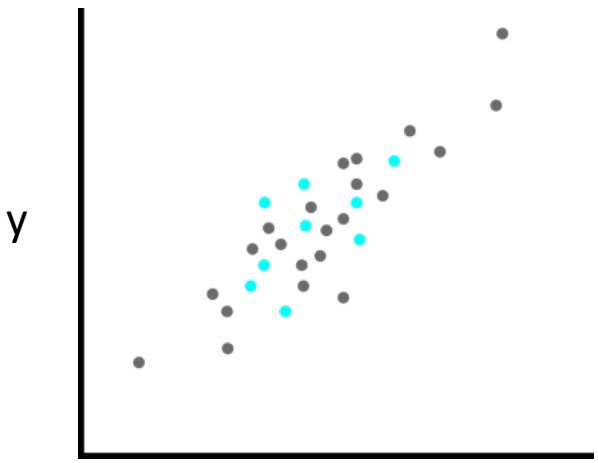
Sampling Frame

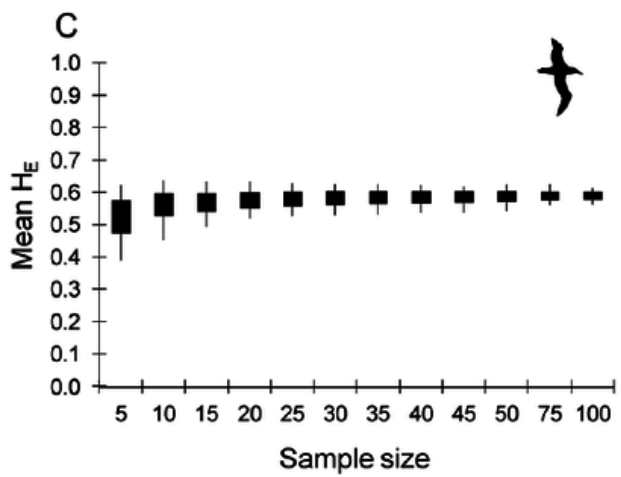


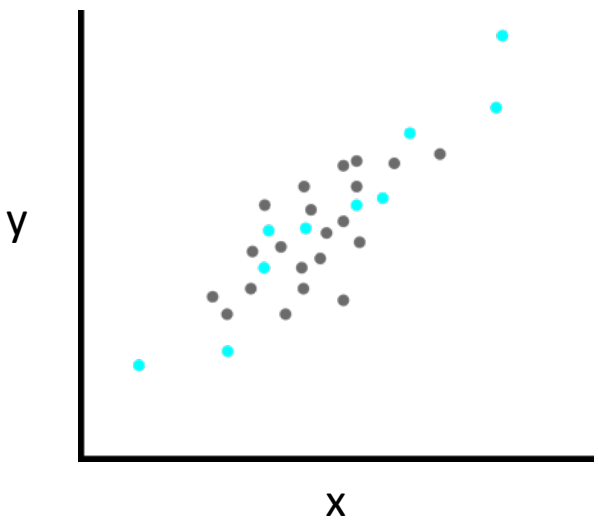
Collection of all sites
that could be sampled

Sample Size and Statistical Power







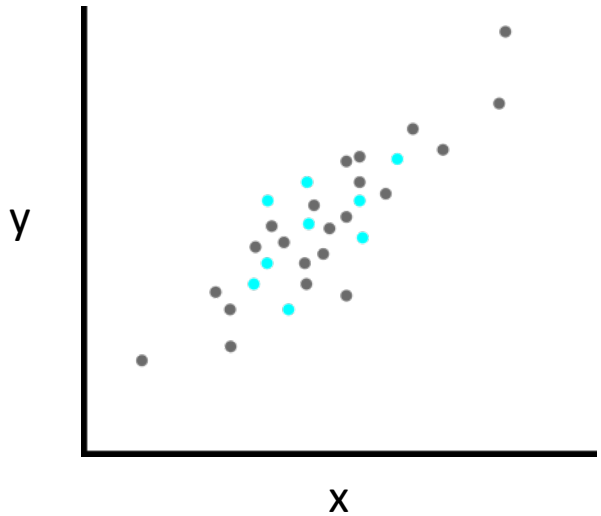


Hale et al. 2012 DOI: 10.1371/journal.pone.0045170

Representativeness and Feature Coverage

Representativeness

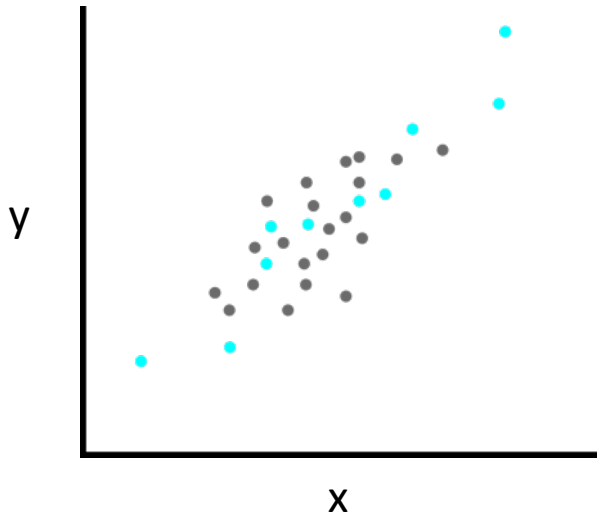
The degree to which the sample reflects the characteristics of the sampling frame or population.



Good representativeness, low coverage

Feature Coverage

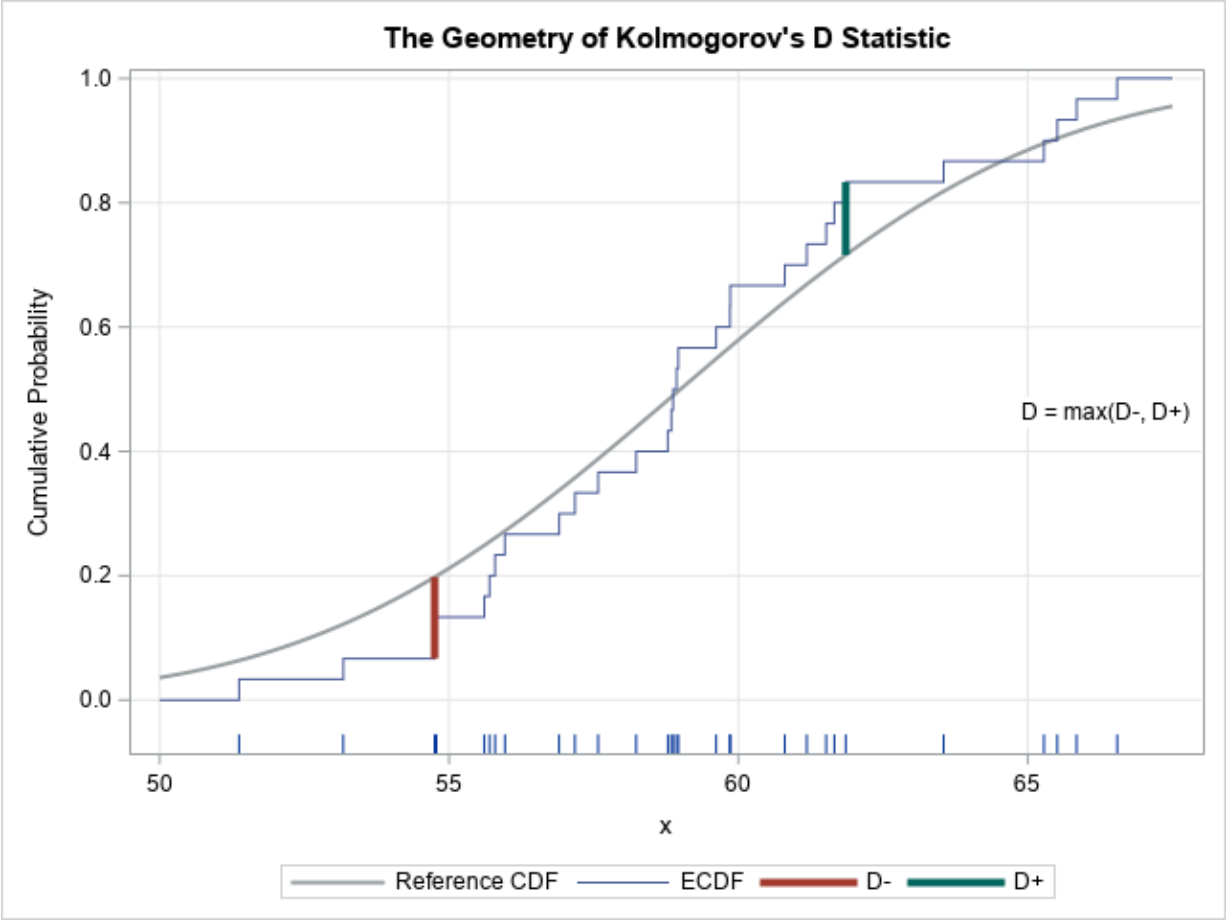
The degree to which the sample reflects the full range of variability in the sampling frame.



Good coverage, poor representativeness

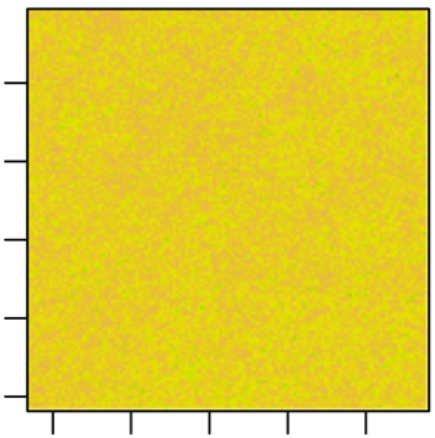
Measuring Representativeness

Kolmogorov's D

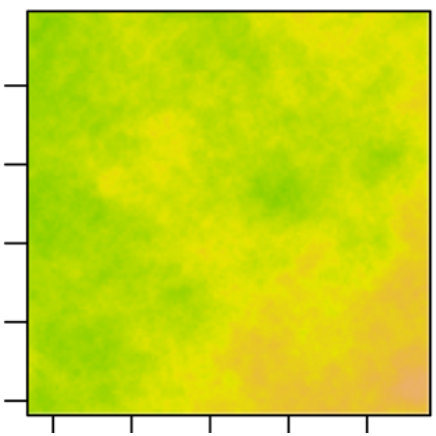


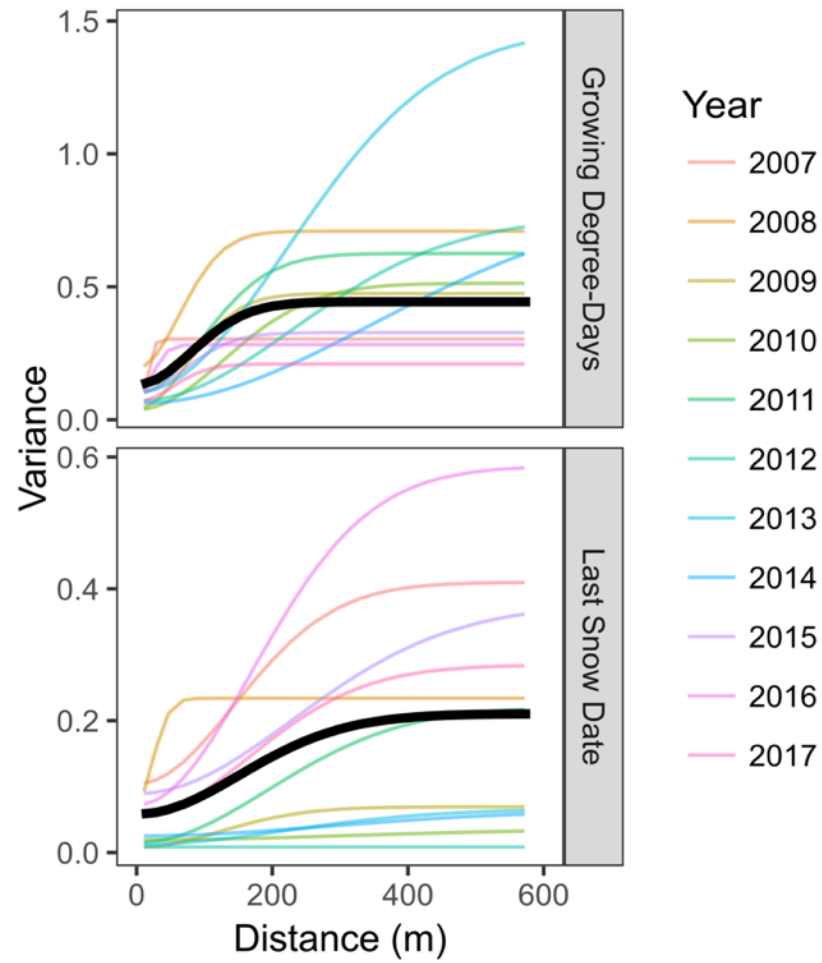
Spatial Autocorrelation (smoothness)

Growing Degree-Days



Last Snow Date



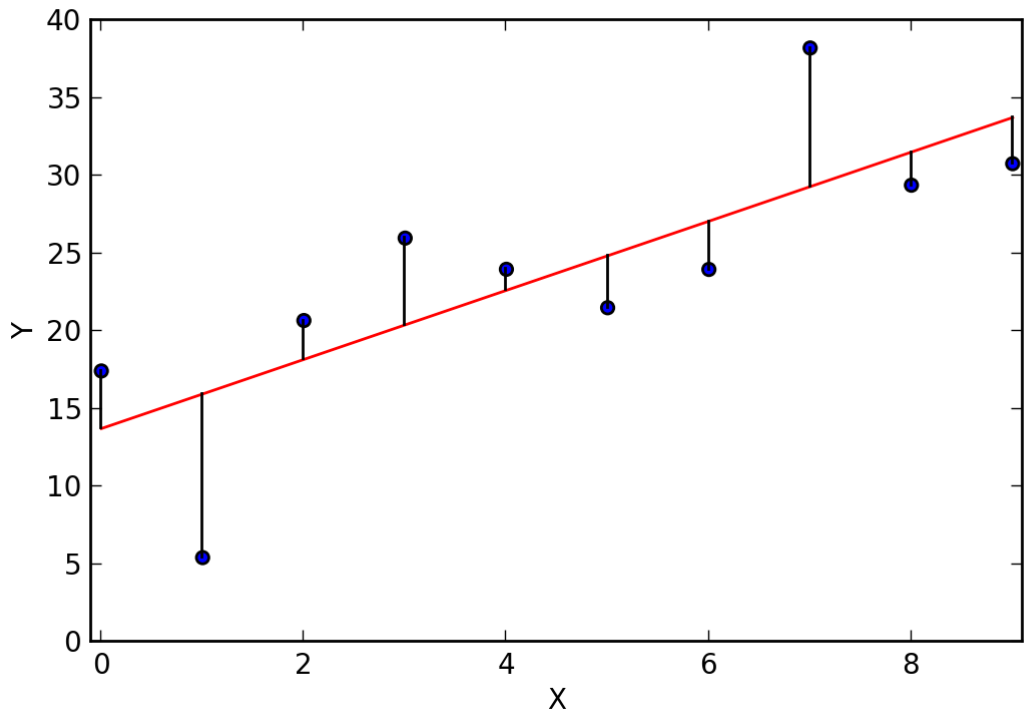


When is spatial autocorrelation a problem?

Generally, this is only a problem for inference when there is autocorrelation in the **residuals** from a statistical model.

Residuals:

$y_i - \widehat{y_i}$



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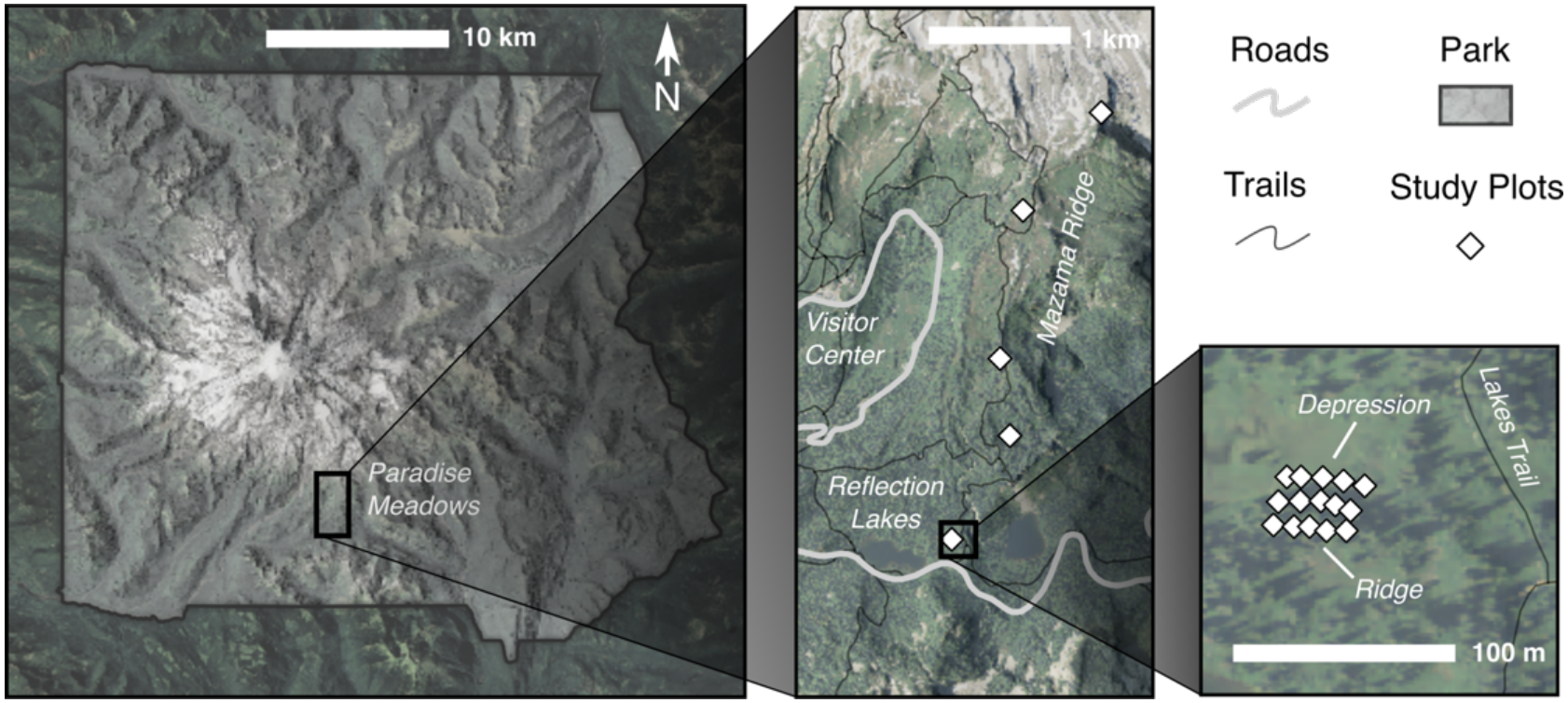
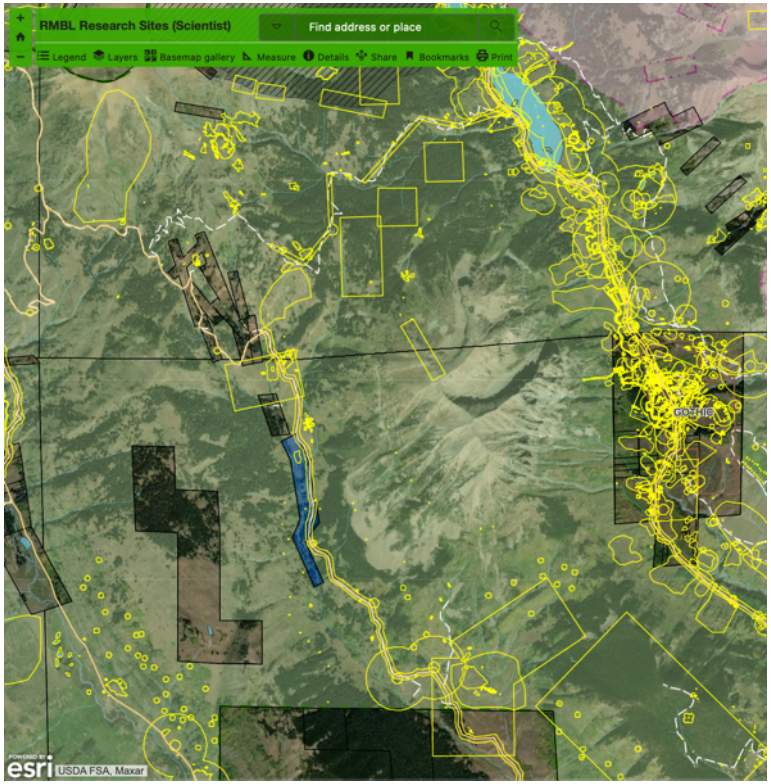
Manual vs semi-automated site selection

An Example of Manual Site Selection



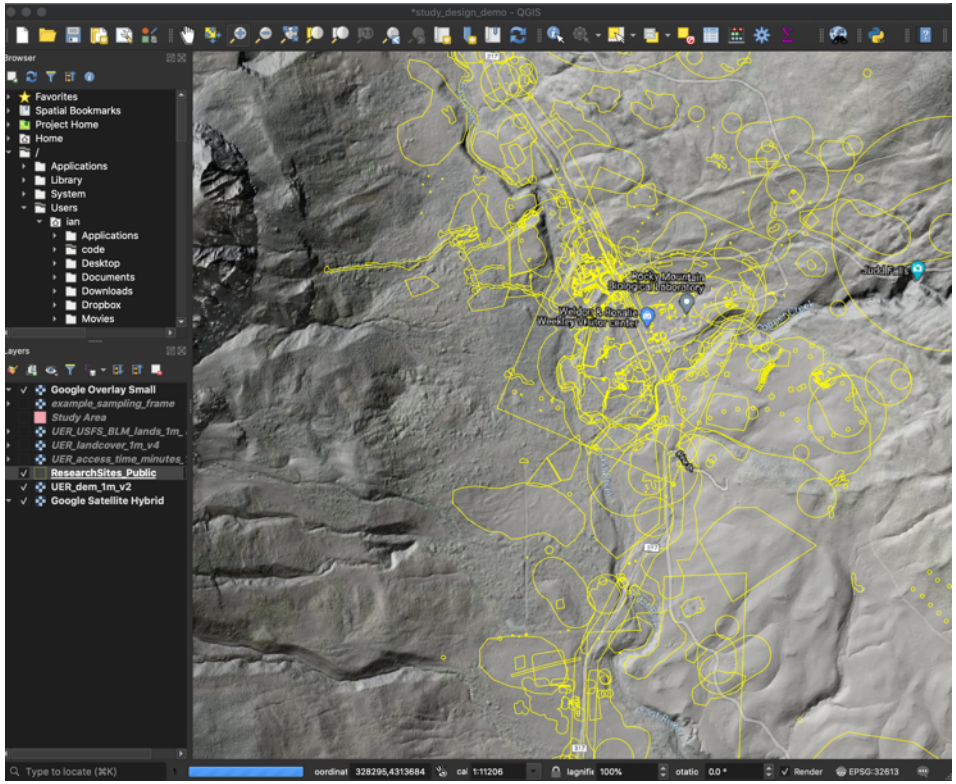
Tools for manual site selection

RMBL Online Research Map



https://rmbl.maps.arcgis.com/apps/View/index.html?appid=f79d76dbeec144518cc46dddd3bf95ac

Desktop GIS



RMBL Research sites
URI: https://services8.arcgis.com/jOS5YDdMN6EQxI1b/arcgis/rest/services/RMBLResearchSites_Public/FeatureServer

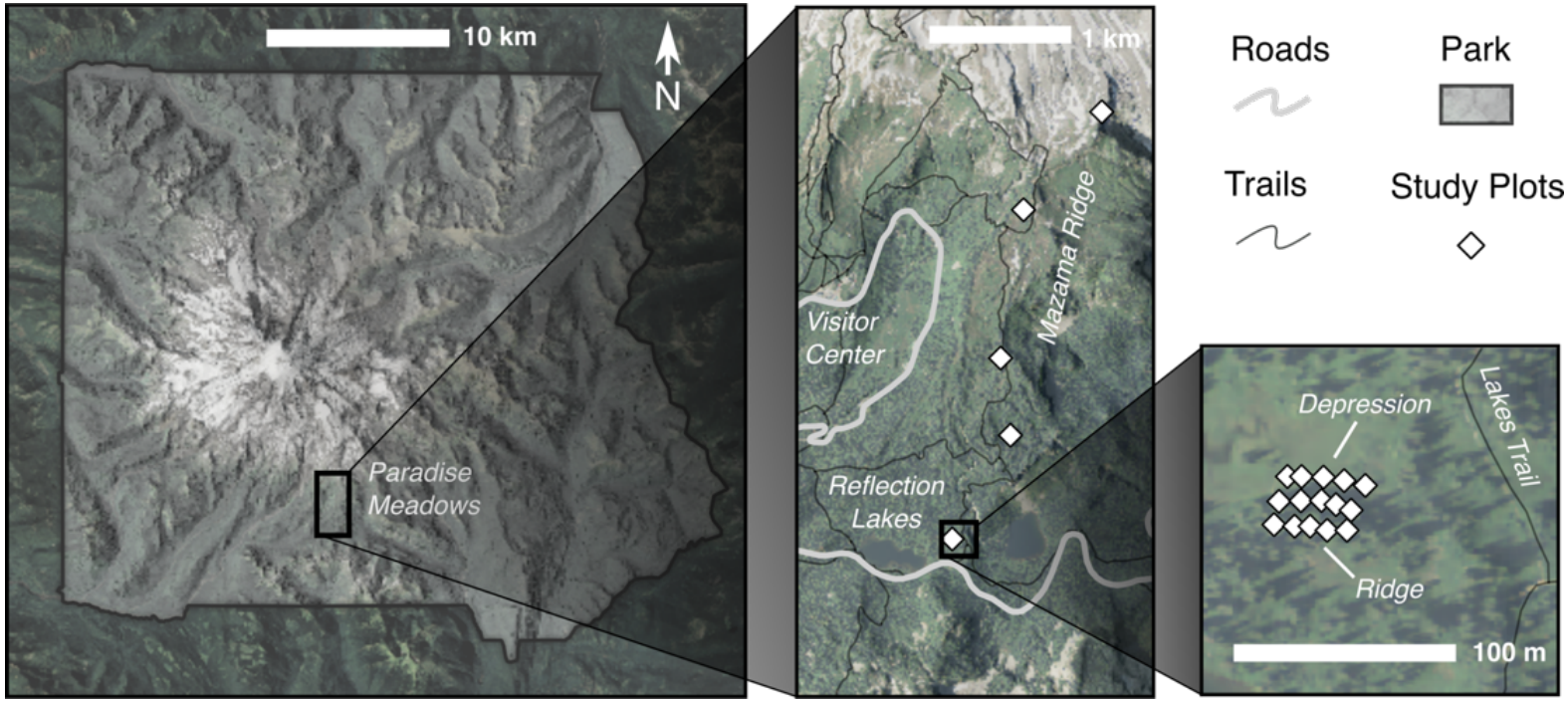
Drawbacks of manual site selection

Our brains are not set up to select representative samples.

…especially in 3+ dimensions.

Drawbacks of manual site selection

The sampling frame is ambiguous.



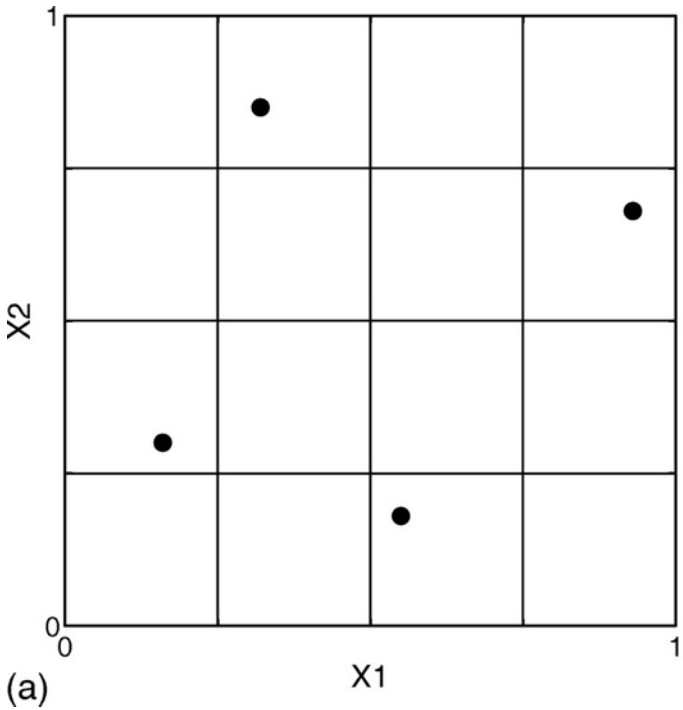
(semi)automated Site Selection

- Simple random sampling.
- Stratified random sampling.
- Latin hypercube sampling.

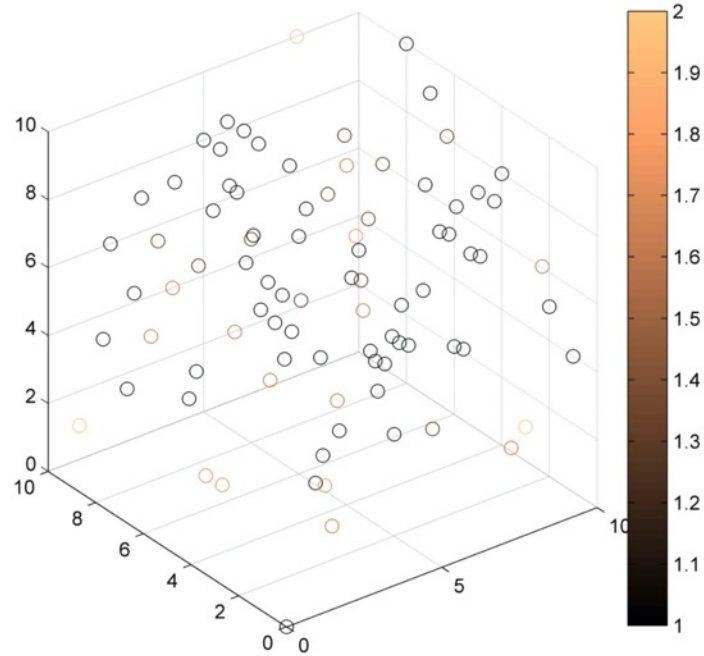
- Others: Geographic tessellations, faceted clusters.

Latin Hypercube Sampling

Latin Square, 2d

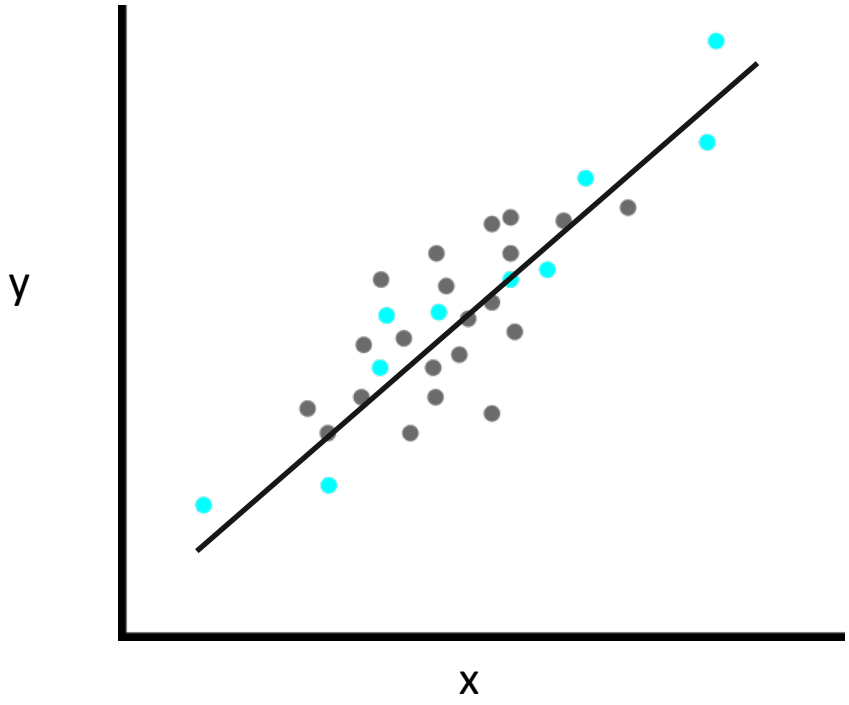


Latin Cube, 3d



Vamvatsikos et al. 2014 https://doi.org/10.1061/(ASCE)ST.1943-541X.0001030

Latin Hypercube Sampling



Maximizes **coverage**, at the cost of representativeness

Demo: Exploring sampling designs in R

Thanks!

Contact Me:

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