Biodiversity accounting for Oslo:
Quantifying plant and ecosystem diversity

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UiO and NINA

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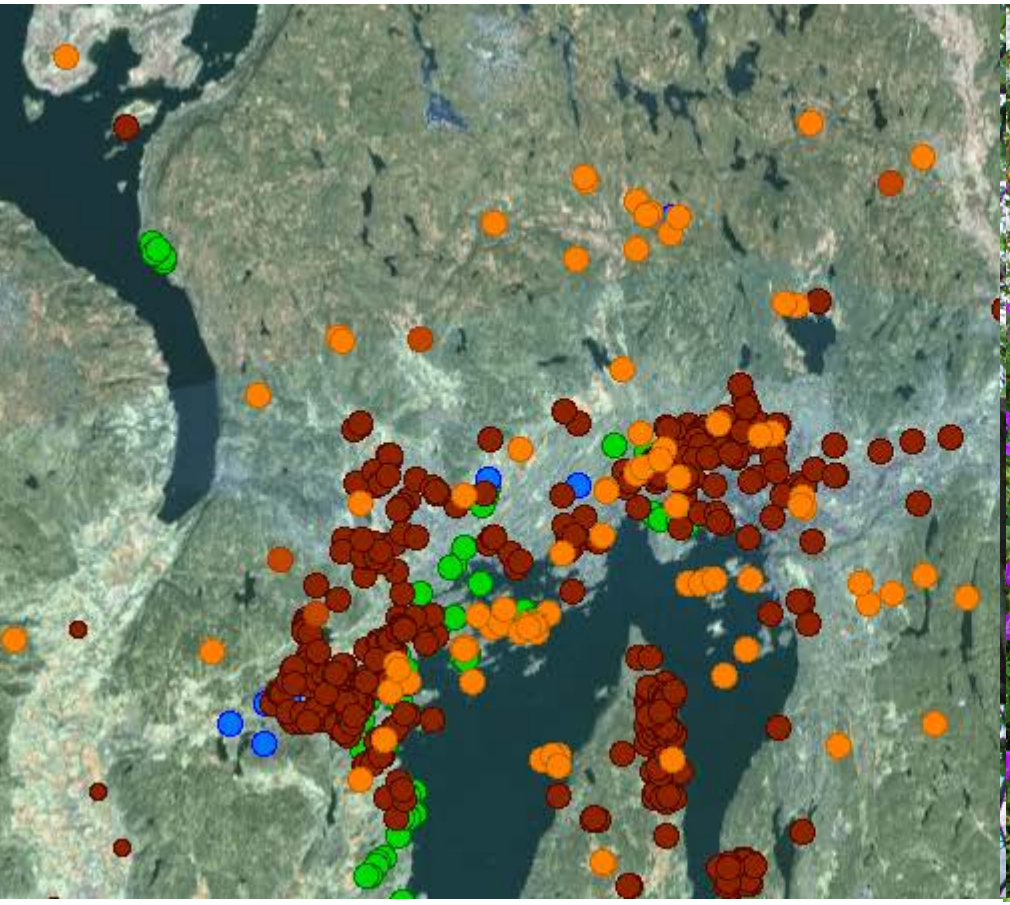
Overview

1) Measurements
   - Existing biodiversity data: (in)completeness, bias
   - URBAN EEA: stratified field surveys
2) Modeling
   - Current condition of species and ecosystems
   - Predictions for other conditions (past, future)
3) Accounts
   - Measured state & change
   - Modeled state & change

Existing ecosystem data: incomplete coverage

Selected ecosystems and habitats (‘utvalgte naturtyper’)

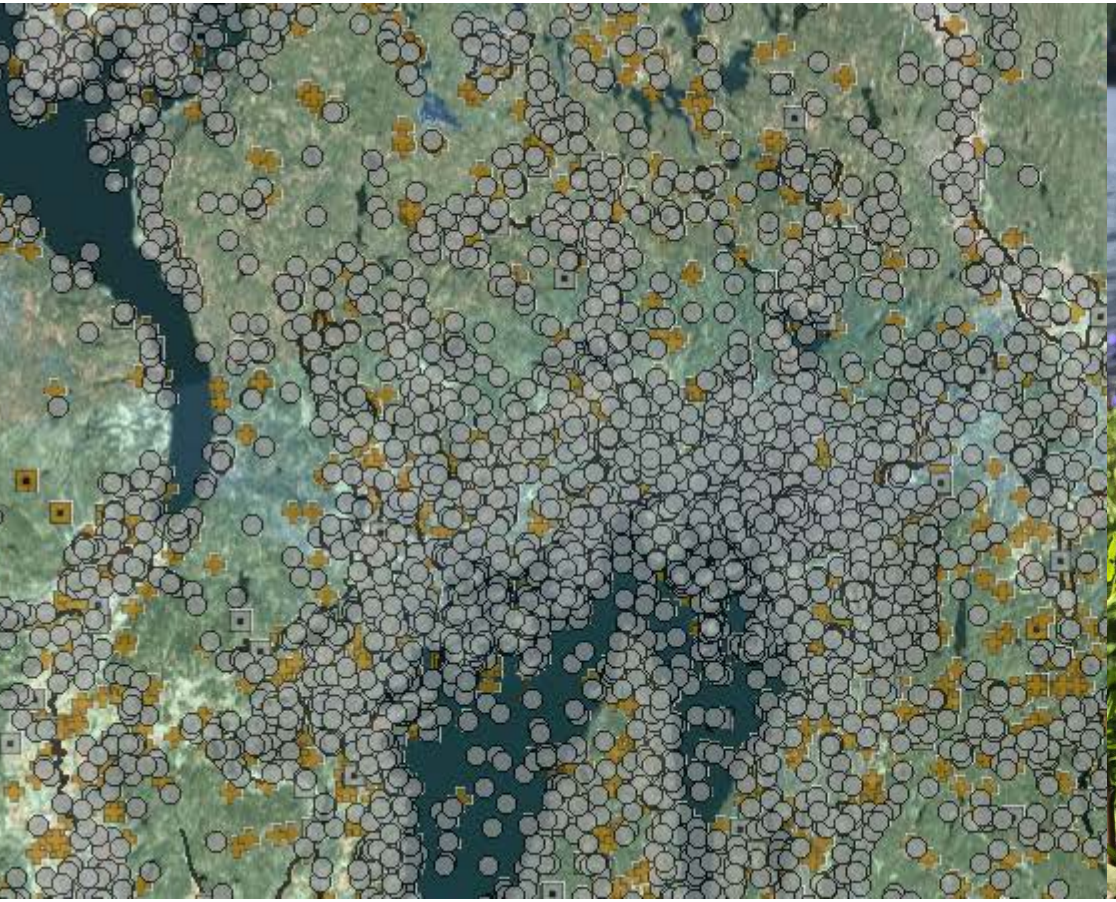


Calcareous grassland. Photo: Harald Bratli
http://www.nina.no/Overvåking/ARKO.aspx

Norwegian Environment Agency, Naturbase: http://kart.naturbase.no/

Existing species data: sampling bias

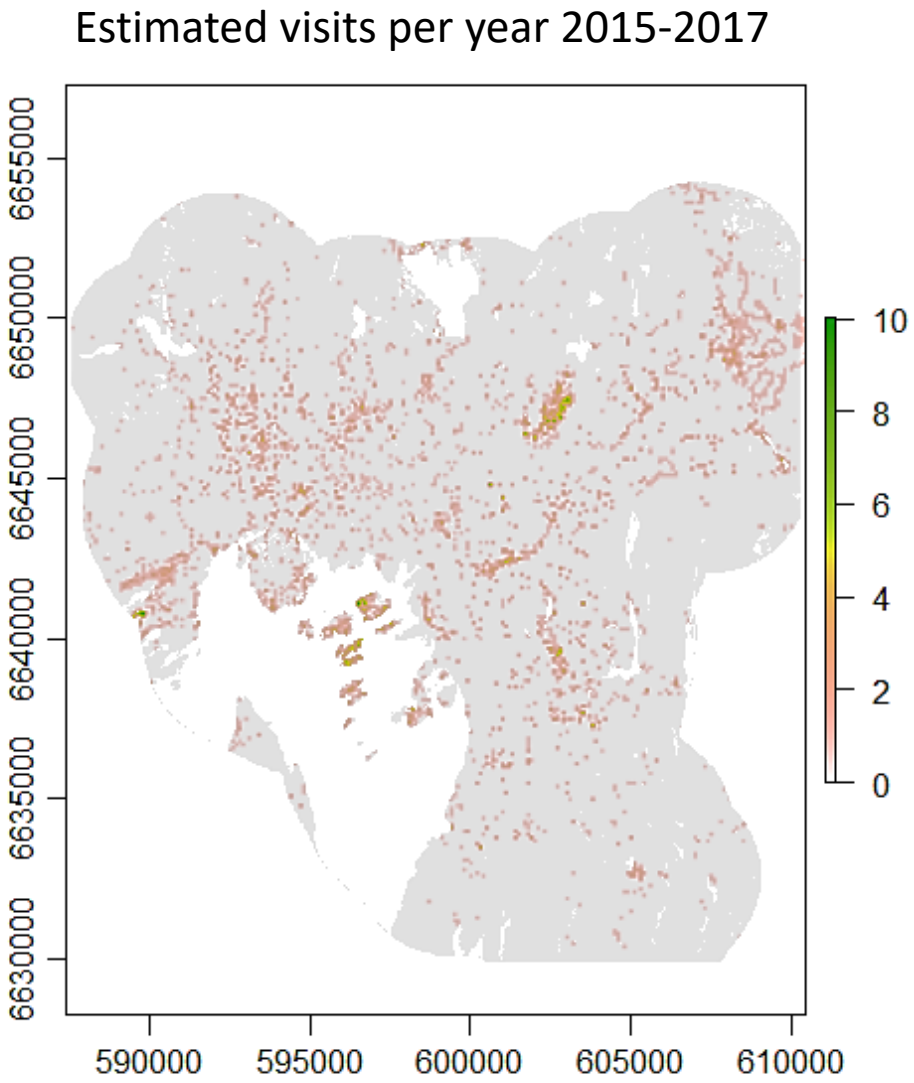
Species of interest to management (‘arter av stor forvaltningsinteresse’)



Northern dragonhead *Dracocephalum ruyschiana*. Photo: Olav Skarpaas.

Norwegian Environment Agency, Naturbase: http://kart.naturbase.no/

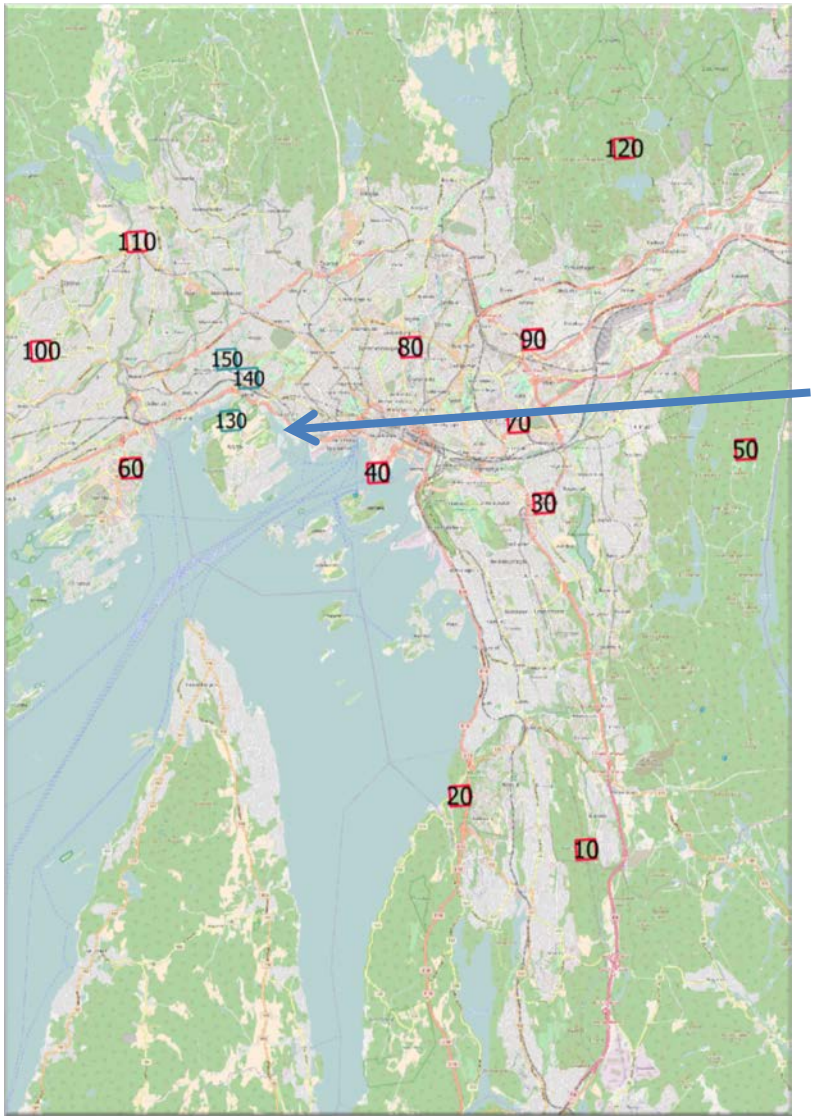
Existing species data: sampling bias



- **Observations:**
  20 000 plant occurrence records 2015-2017 (a selection of the data available at GBIF: www.gbif.org)

- **Sampling effort:**
  Number of unique visits (based on records of all plants)

New species and ecosystem surveys: Stratified sampling

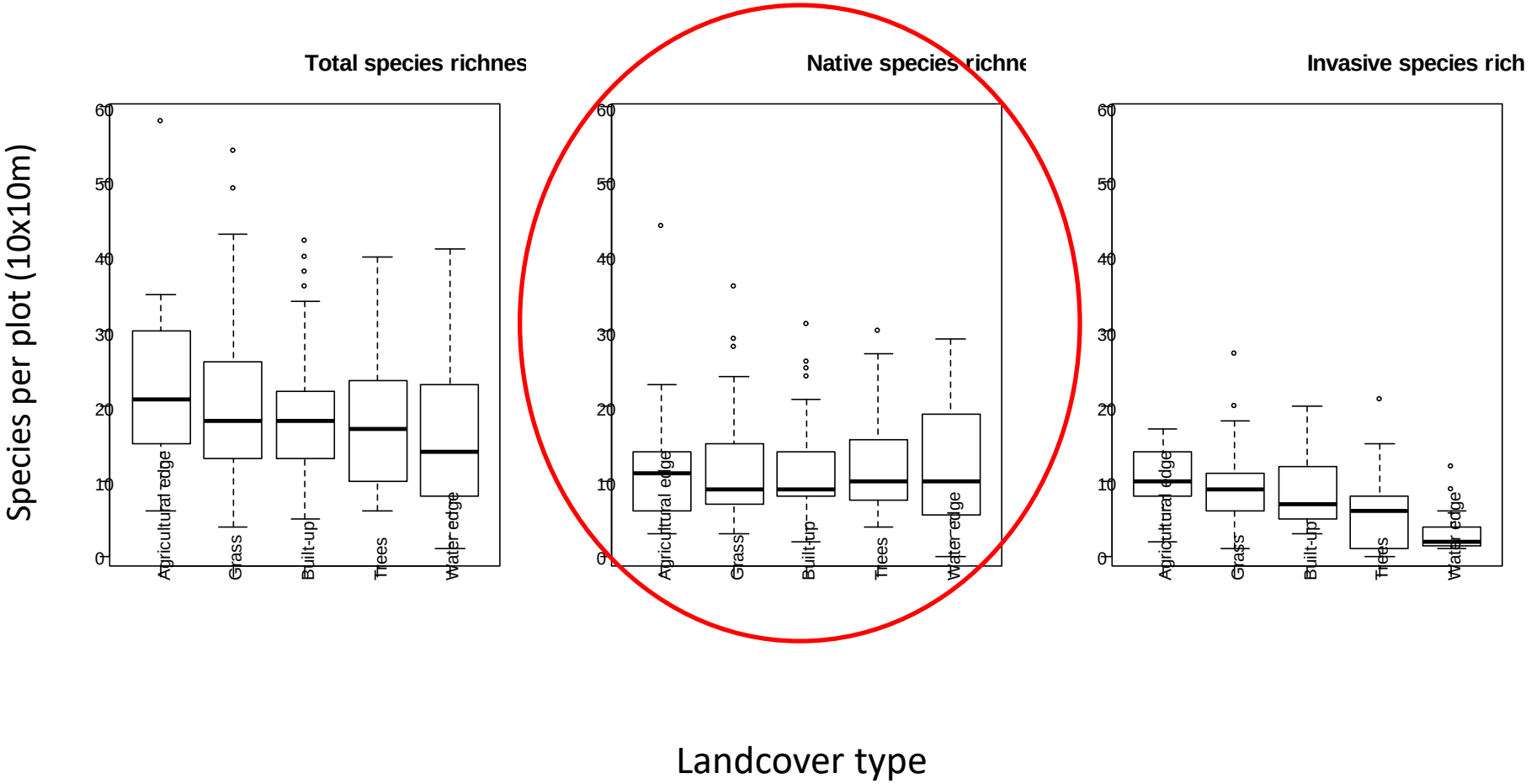



Pilot plot, 10x10m
70 plant species

Preliminary survey results (2017)

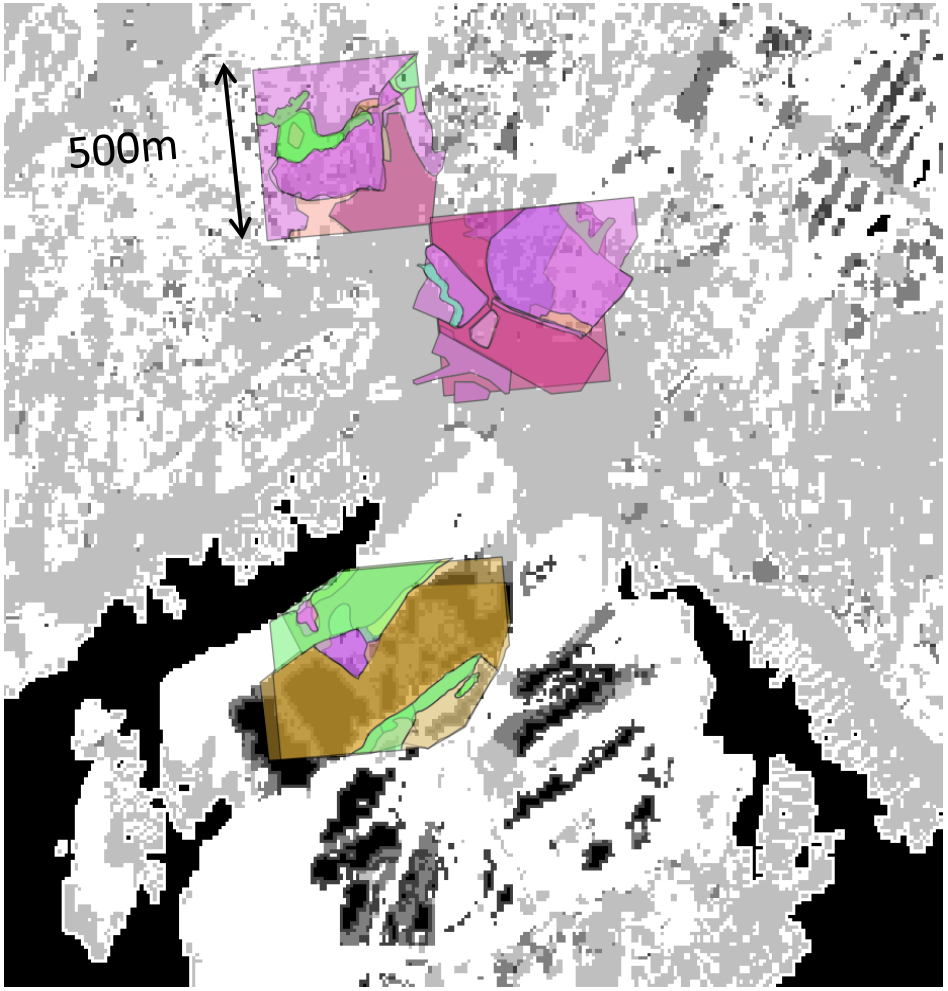
Observed species richness

- 201 plots, >400 species in total



Preliminary mapping results (2017)

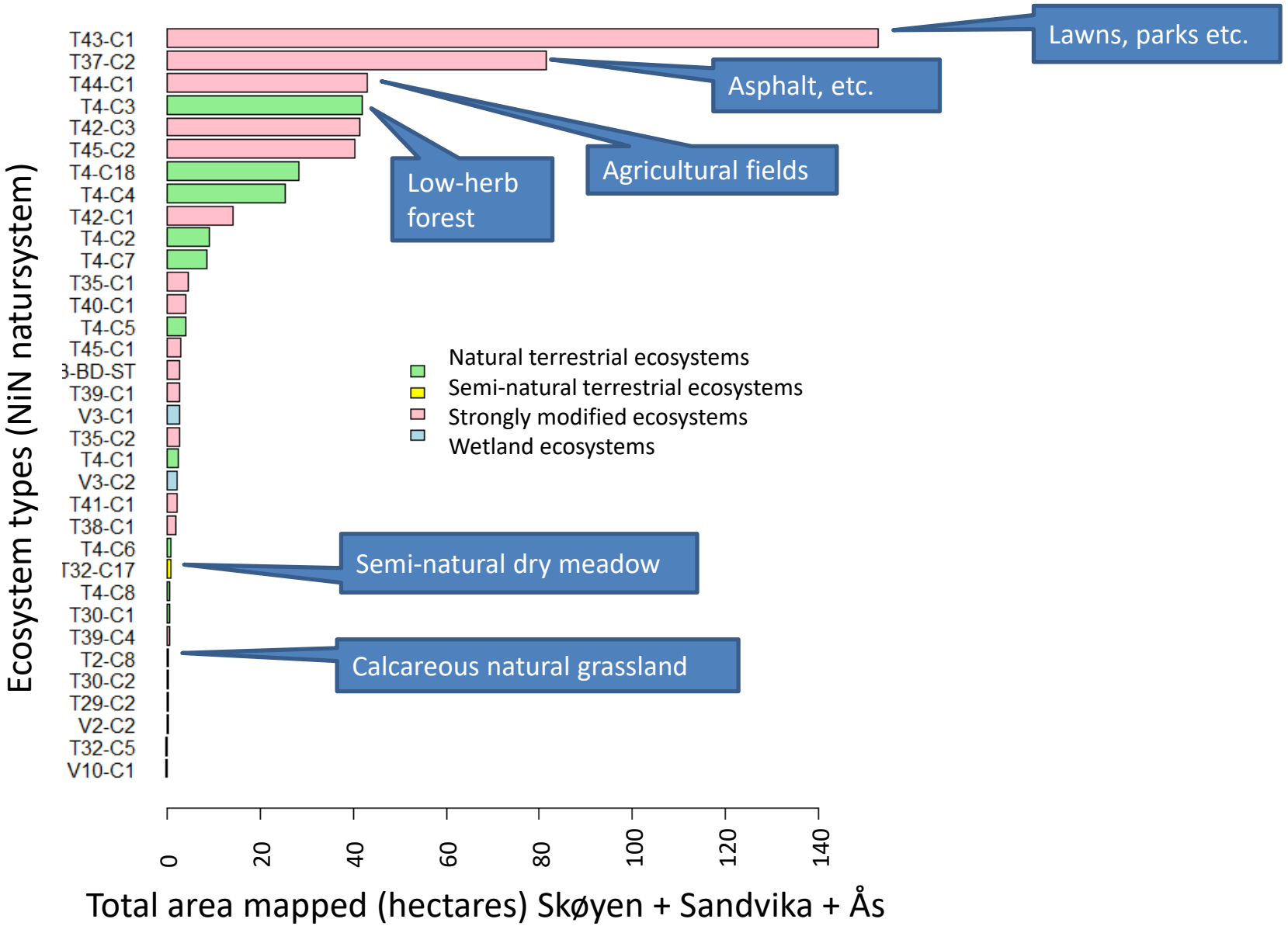
Observed ecosystem coverage



- Ecosystems mapped with NiN system (‘natursystemer’) by NMBU students
- Three blocks along urban-rural gradient
- Illustration from Skøyen: similar maps at Sandvika and Ås

Preliminary mapping results (2017)

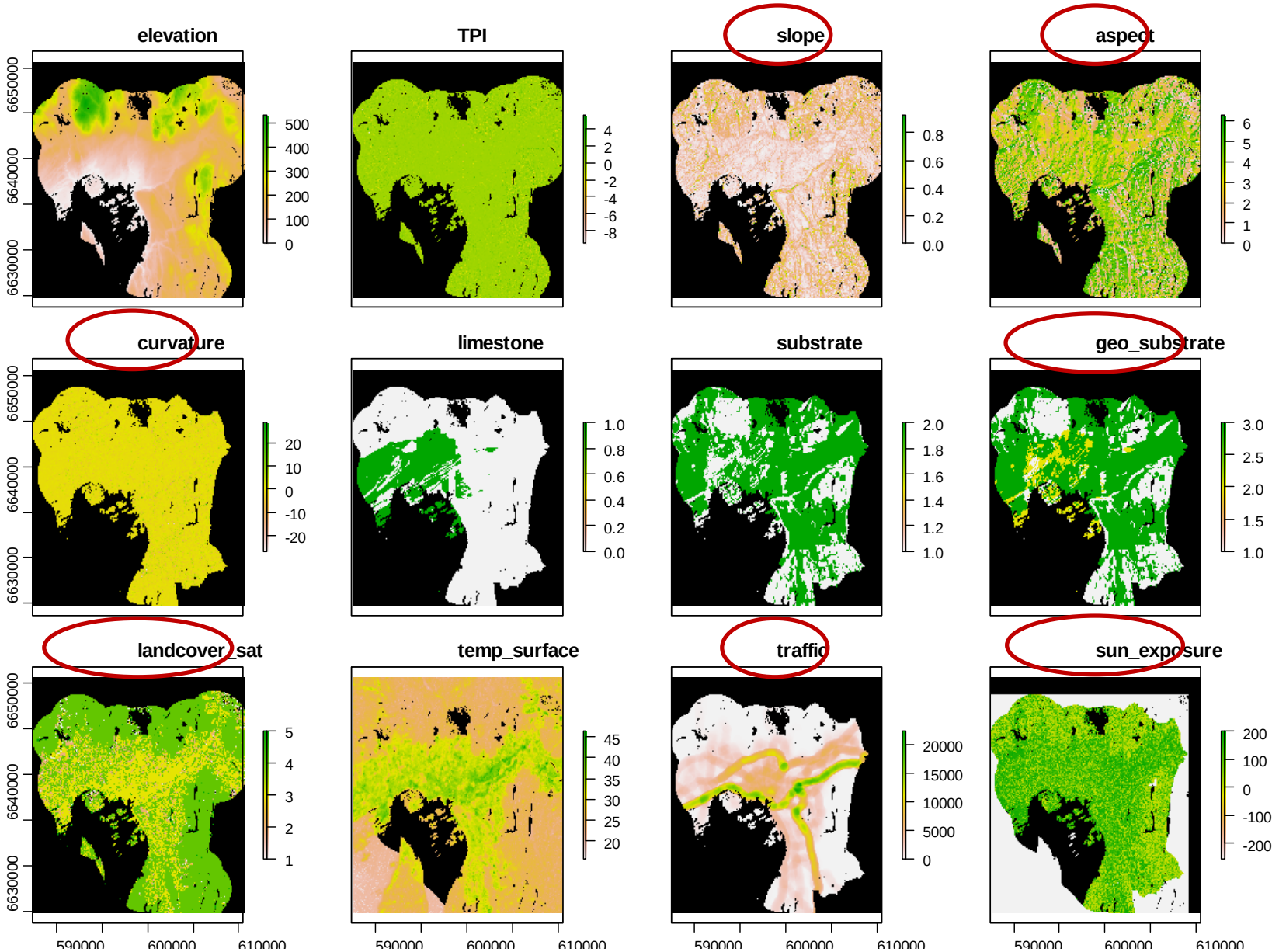
Observed ecosystem diversity



Modelling plant species richness: Approach for survey data

- Balanced systematic sample -> model species individually
- Logistic regression (binomial GLM), with backward model selection based on AIC
- Predicted richness = summed model predictions (probabilities) across single-species models

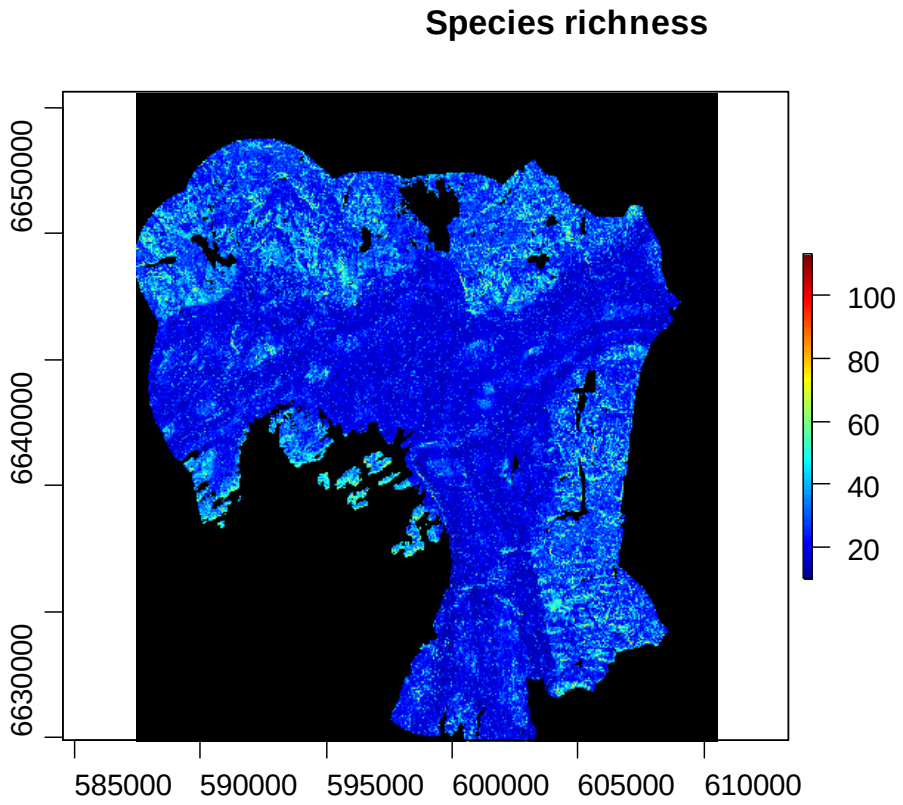
Environmental predictors (first round)

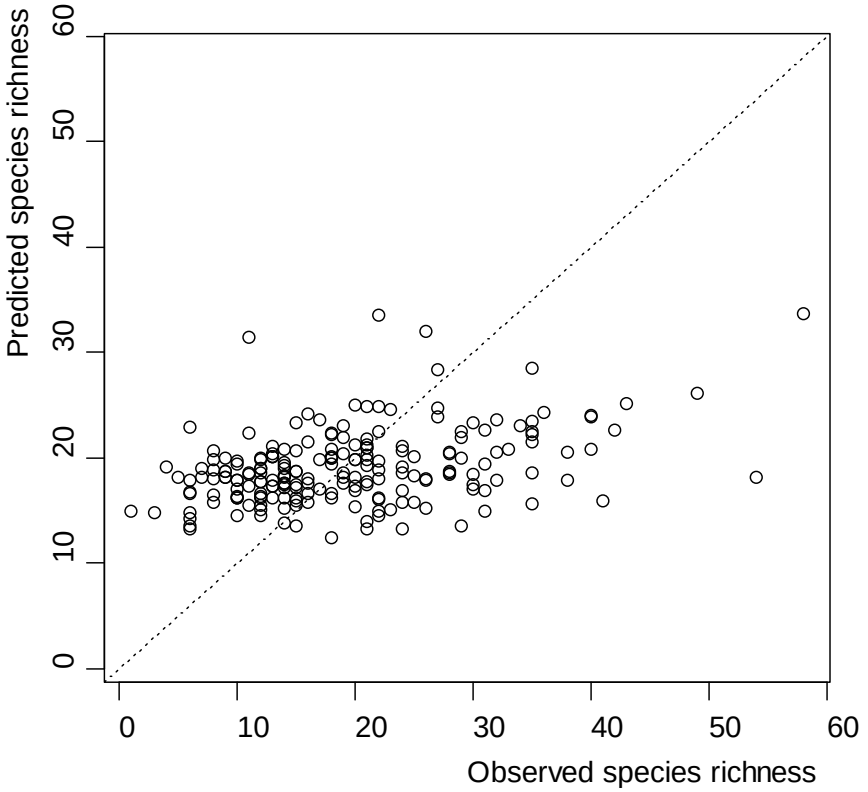


Preliminary results survey data 2017

Estimated species richness

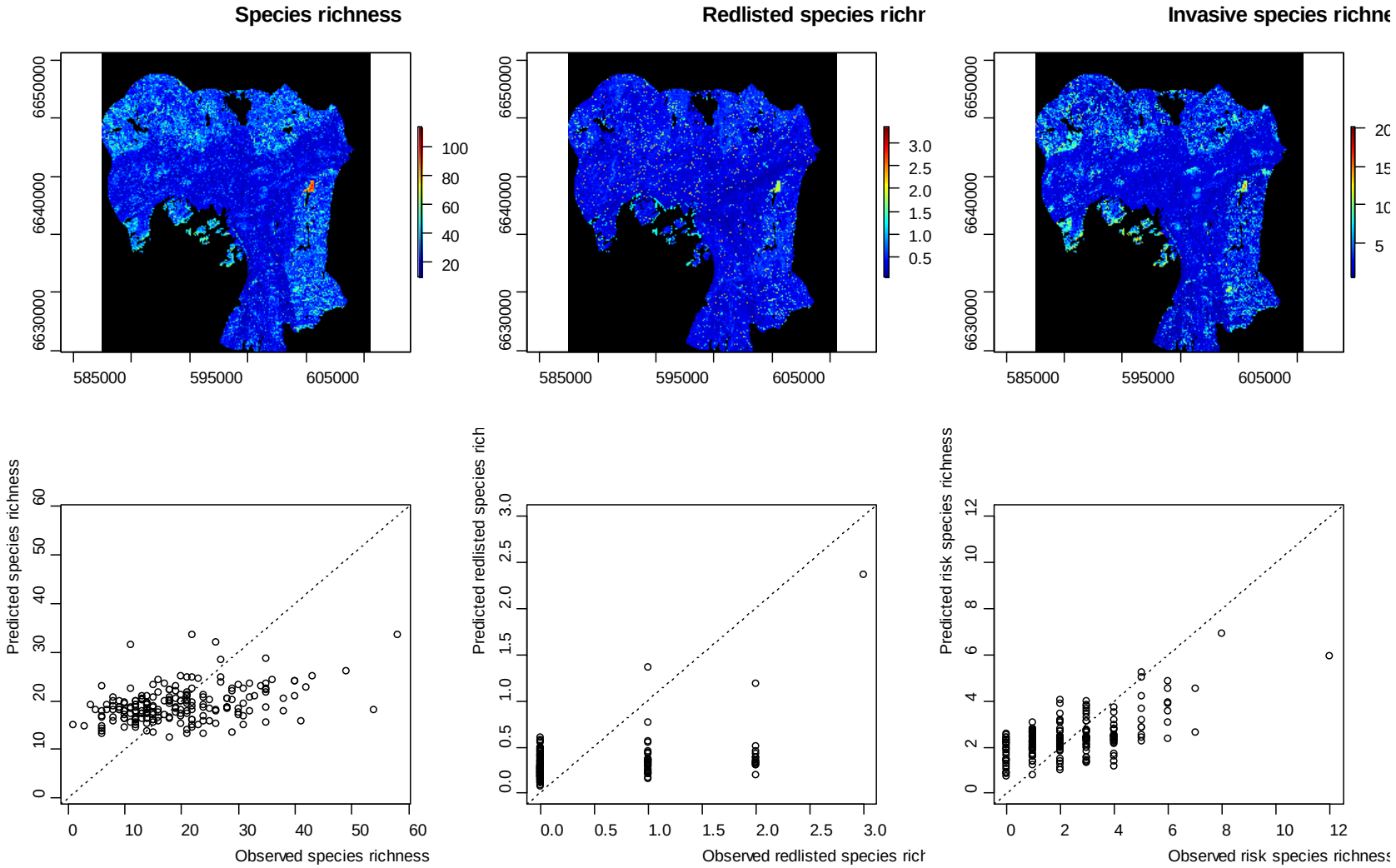
- All species, N = 430





Preliminary results survey data 2017

Estimated species richness



Modelling plant occurrence: Approach for GBIF data

- Few/imbalanced records per species -> model species ensemble (here: calcareous grassland specialists)

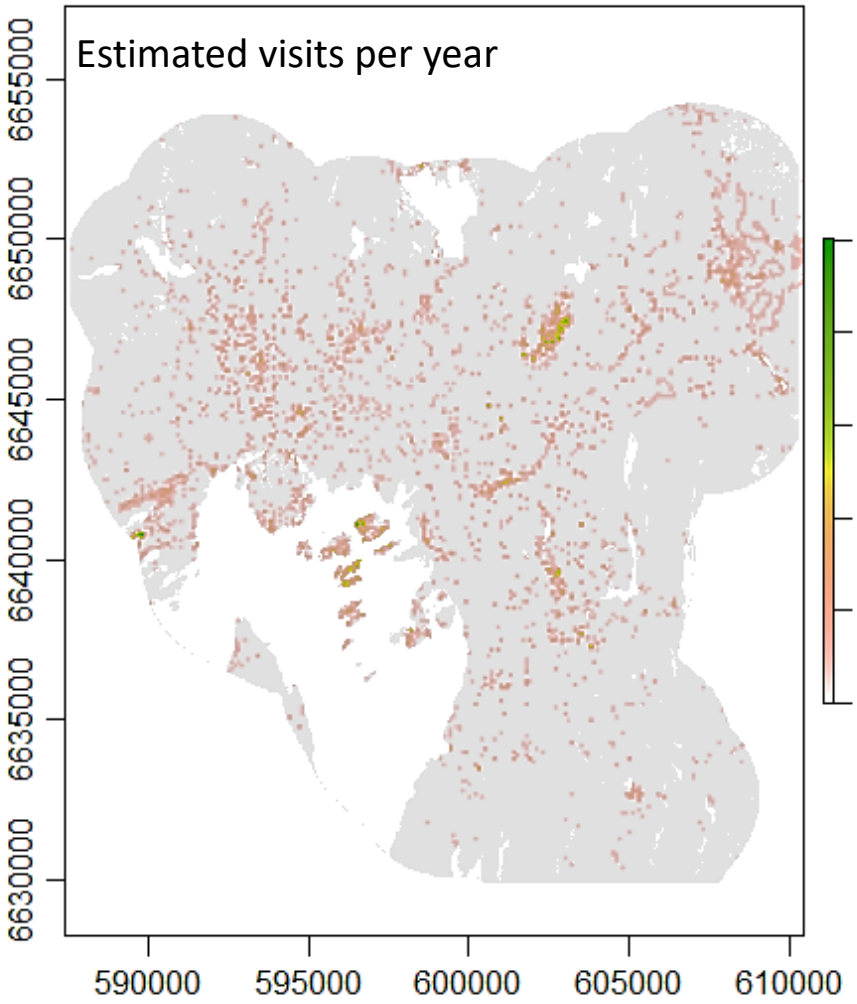
- Poisson regression (GLM) with sampling effort as offset, random species intercepts, and backward model selection based on AIC

- Model output: predicted probability of occurrence

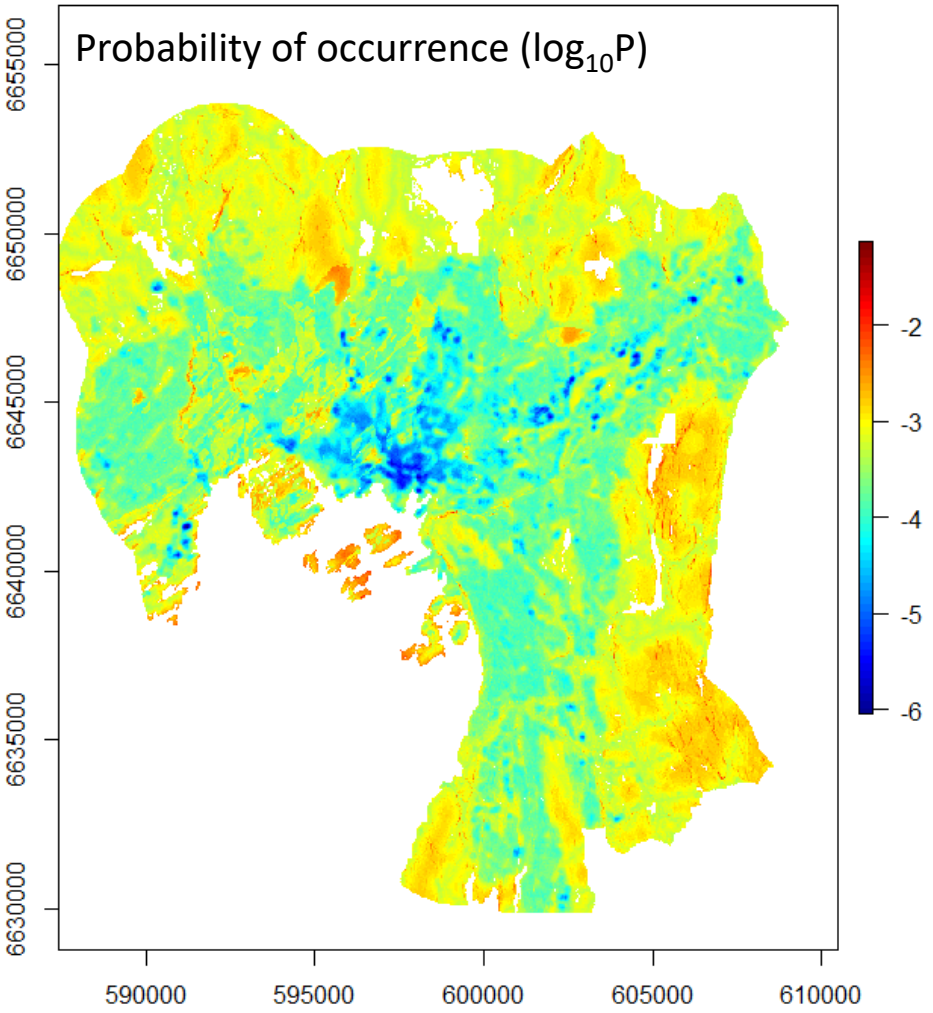
Preliminary results GBIF data

Multi-species model

Data 2015-2017



Model predictions calcareous specialists



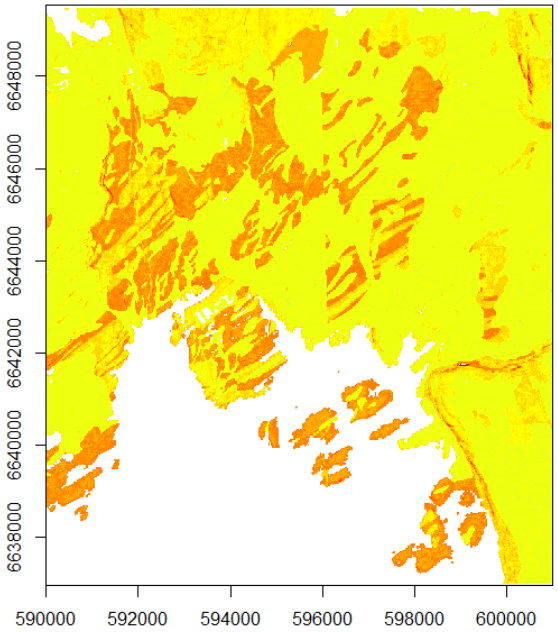
Preliminary results GBIF data
Multi-species models

Poisson regression model for calcareous grassland specialists

```
Fixed effects:
                    Estimate  Pr(>|z|)
(Intercept)         -7.87352   < 2e-16 ***
geo_soil            -0.29142    0.0433 *
geo_calcareous_rock 0.96592  3.75e-13 ***
slope               -0.02469    0.6494
slope^2              0.07305  5.86e-06 ***
curvature            0.04360    0.0103 *
landcover_built_up   0.06256    0.8890
landcover_trees      0.22514    0.6207
landcover_grass      0.45866    0.3241
landcover_water_edg 0.56396    0.2604
building_densityAW -0.83891   < 2e-16 ***
road_distance        0.39554  2.53e-05 ***
road_distance^2     -0.05463    0.0234 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05
‘.’ 0.1 ‘ ’ 1
```

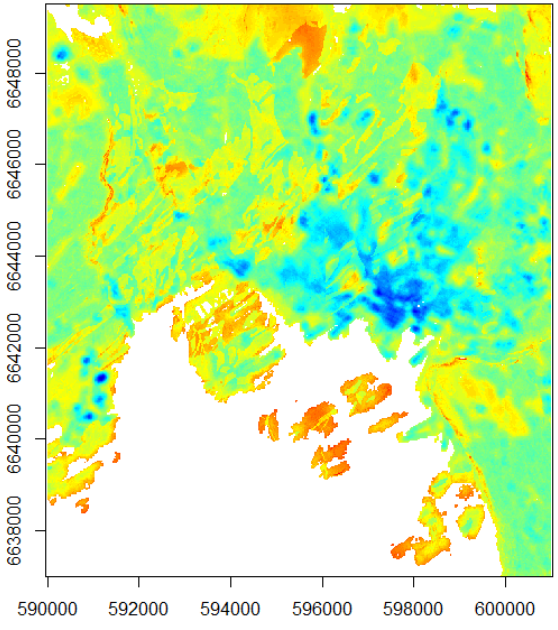
Model predictions for for land use scenarios

Nature scenario (‘past’)

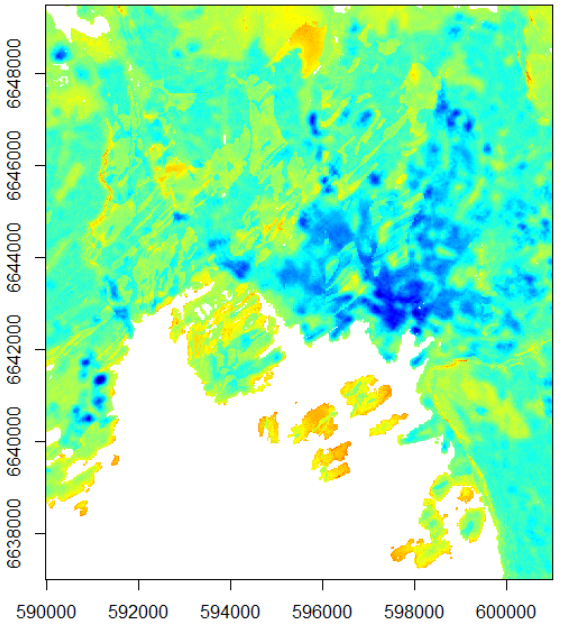


No buildings or roads, mostly forest, except on exposed bedrock

Present

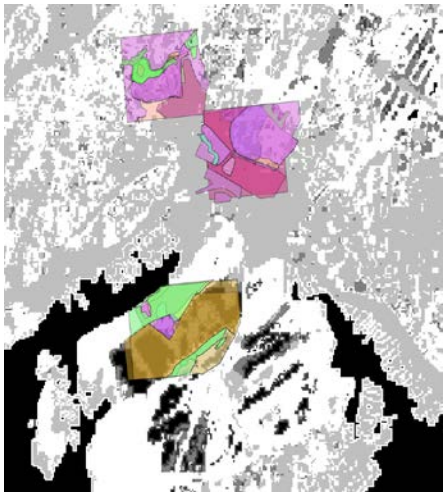


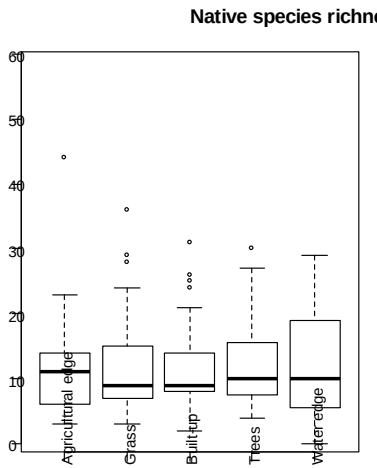
Urban scenario (‘future’)

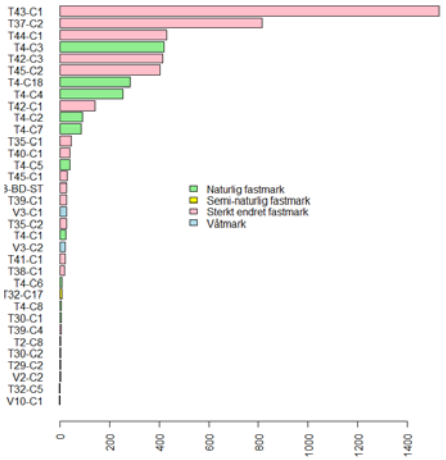


Building density increased everywhere with current mean density

Towards accounts
Measured state & change

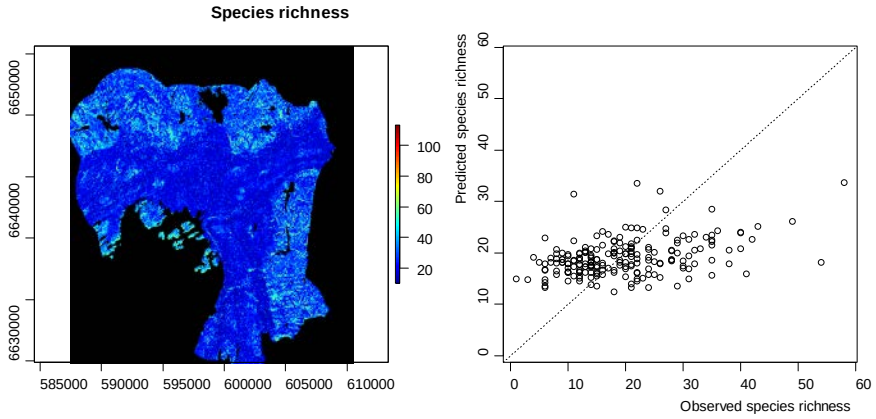


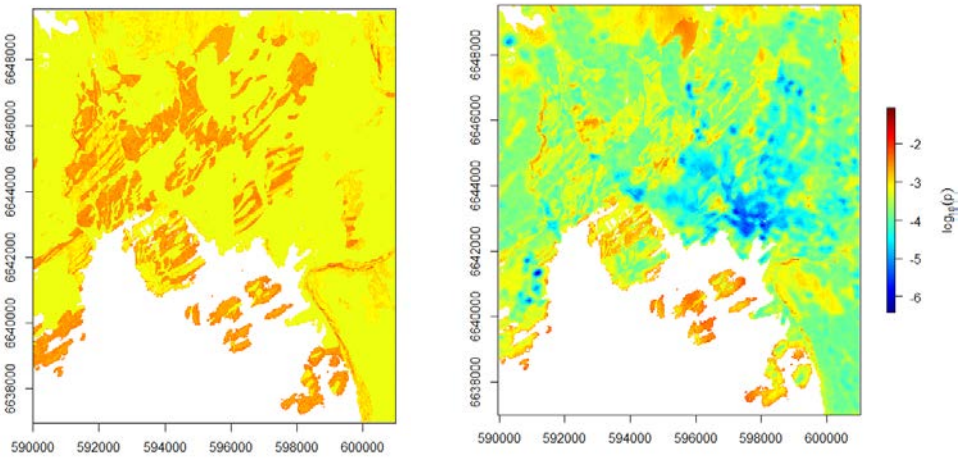




- State
  - 2017 surveys
  - 2018 extended surveys
    (4 MS: Halvorsen, Karlsen, Karijord and Lynne)
- Change
  2017 surveys repeated in 2018
  - species (MS Halvorsen)
  - ecosystems (NMBU students)
- Pros & cons
  - Pros: reliable, unbiased
  - Cons: costly, low coverage, rare species/ecosystems unobserved
- Suitable for (relatively) common species/ecosystems

Towards accounts
Modeled state & change





- State
  - modeled conditions based on surveys and other data (e.g. GBIF)
- Change
  - differences in model predictions between different times/scenarios
- Pros & cons
  - Pros: full coverage, (ideally) unbiased
  - Cons: many uncertainties, incl. predictor quality and coverage
- Suitable for selected species and ecosystems, incl. some rare

How to feed measurements and model outputs into accounts?

- Measures of ecosystem condition and extent:
  - Species richness?
  - (Mean) probability of occurrence?
  - (Mean) abundance?
  - Area of occupancy?
  - Aggregates (BGF, NI, NiN types)?
  - ES-oriented subsets (indicators)?
  - …
- Accounting unit:
  - Municipality?
  - District (bydel)?
  - Property?
  - …
- Baselines?

Depends on purpose: which accounts are useful?

Account example 1
Ecosystem extent: NiN types

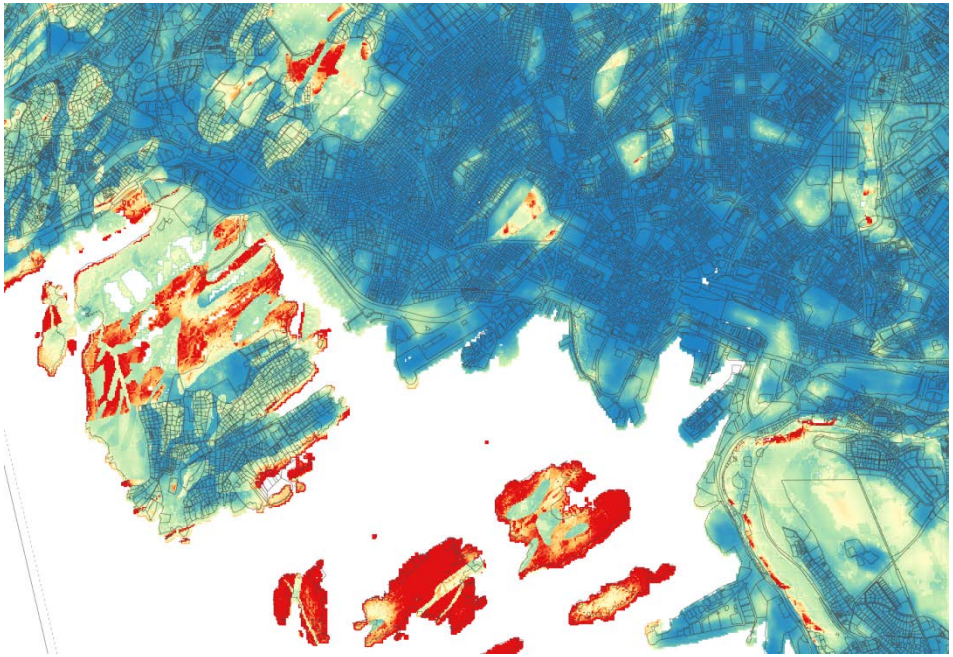
Percent of area covered by ecosystem types, in urban, suburban and rural areas.

	Major		2017				2018			
Ecosystem class	type	Description	Urban	Suburban	Rural	Overall	Urban	Suburban	Rural	Overall
Strongly modified	T43	Lawns, parks, etc.	51,4	63,4	3,0	39,3				
Strongly modified	T45	Agricultural field	0,0	0,0	67,7	22,6				
Strongly modified	T37	Asphalt, etc.	27,8	15,7	0,0	14,5				
Strongly modified	T35	Gravel, etc.	3,0	6,1	0,9	3,3				
Strongly modified	T42	Flowerbeds, etc.	7,0	0,0	2,2	3,1				
Strongly modified	T39	Concrete, boulders, etc.	3,0	0,0	0,0	1,0				
Strongly modified	T40	Road verges, etc.	0,7	0,5	0,1	0,5				
Semi-natural	T32	Semi-natural meadow	0,0	0,0	1,0	0,3				
Natural	T4	Forest	6,0	13,1	24,1	14,4				
Natural	T30	Flooded forest	1,1	1,1	0,0	0,7				
Natural	T2	Naturally open grassland	0,0	0,0	0,6	0,2				
Natural	T29	Gravel beach	0,0	0,0	0,3	0,1				
Sum			100,0	100,0	100,0	100,0				

Based on one subjectively placed block in each urban/subarban/rural stratum at Skøyen 2017.
2018: Revisits (NMBU students) + surveys of 12 tratified random blocks for all of Oslo are almost complete (Karlsen, Halvorsen, MS theses in prep.).

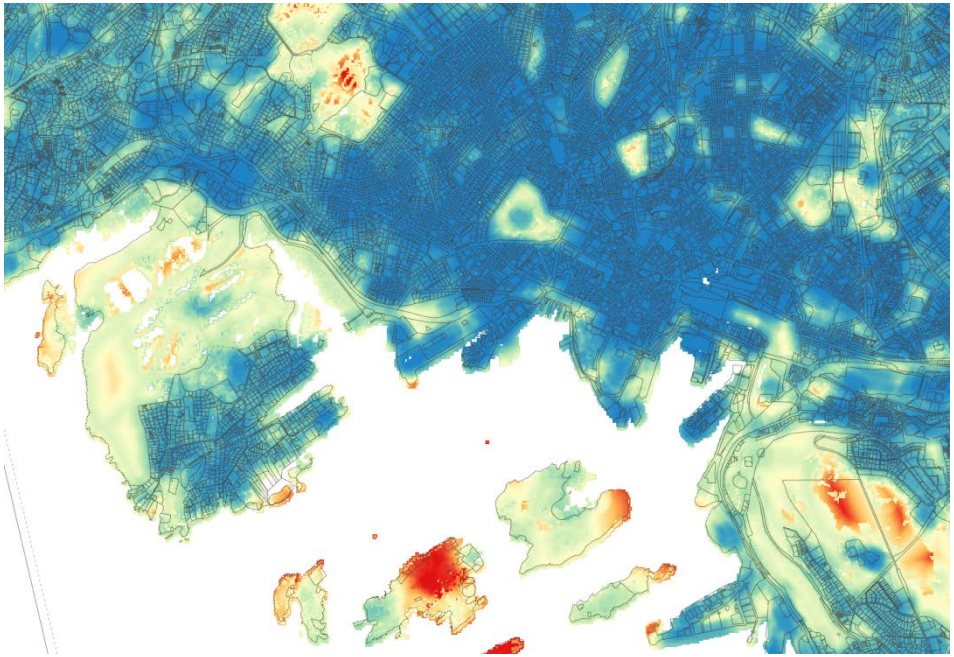
Account example 2
Ecosystem condition: calcareous species

Current modelled state, per property



blue: low, red: high

Relative loss/gain compared to estimated natural state, per property



blue: negative, red: positive

Based on preliminary model of probability of occurrence of calcareous specialist plants (Skarpaas et al. in prep.) and cadastre (Kartverket, geonorge.no).

Questions?

UiO : Natural History Museum
University of Oslo

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