Hyperspectral imaging of boreal peatland biotopes along soil moisture and fertility gradients

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Introduction (1)

- Spatial information on biotopes would be an asset for boreal peatland inventories. It may be helpful for protection and monitoring changes in species diversity caused by artificial regulation of hydrology, atmospheric deposition, and global change.
- Remote sensing methods have proven potential in interpolating the vegetation structure between field plots through image interpretation at local scales.
- The success in classification of peatlands with remote sensing is mainly determined by the level of class detail (number of classes and their ecological description)

site type: fen

Introduction (2)

- Each RS dataset, based on their spectral, spatial, and temporal resolution has an optimal class level.
- For supervised classification approach, the process of combining them into ecologically meaningful higher level classes with the traditional spectral separability approach from remotely-sensed data might be a tedious task.

- **Objective**

  Develop a methodology to determine an optimal number of ecologically meaningful peatland classes which can be reliably spatially mapped with airborne hyperspectral data.

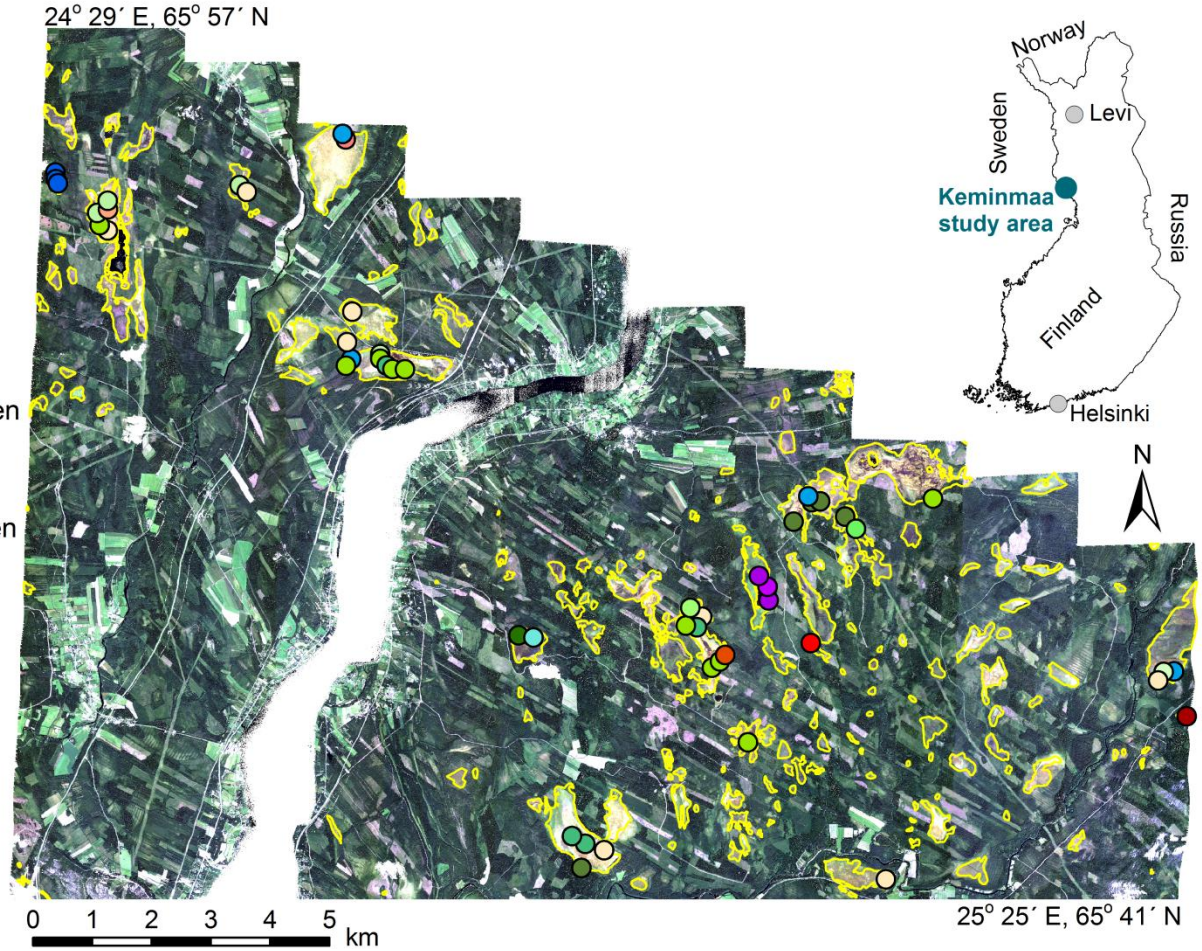
site type: swamp

Keminmaa study area

Site type

- Mesotrophic Betula nana Pine Bog
- Mesotrophic Low-Sedge Pine Bog
- Oligotrophic Empetrum Bog
- Oligotrophic Low-Sedge Pine Bog
- Oligotrophic Tall-Sedge Pine Bog
- Ombrotrophic Empetrum Bog
- Eutrophic Low-Sedge Fen
- Eutrophic Pine Fen
- Mesotrophic Low-Sedge Fen
- Mesotrophic Papillosum Tall-Sedge Fen
- Oligotrophic Eriophorum Fen
- Oligotrophic Low-Sedge Fen
- Oligotrophic Papillosum Tall-Sedge Fen
- Oligotrophic Tall-Sedge Fen
- Eutrophic Scorpidium Flark Fen
- Eutrophic Warnstorfii Fen
- Mesotrophic Tall-Sedge Fen
- Mesotrophic Tall-Sedge Swamp
- Mesotrophic Willow Swamp

Treeless peatlands



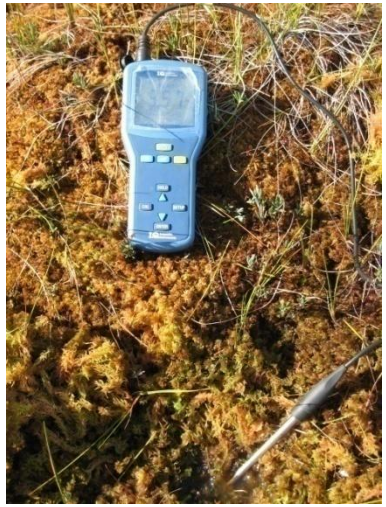
True colour RGB of airborne HyMap™

Field data

Soil dielectric Permittivity (ε)

Soil electrical conductivity (σ)

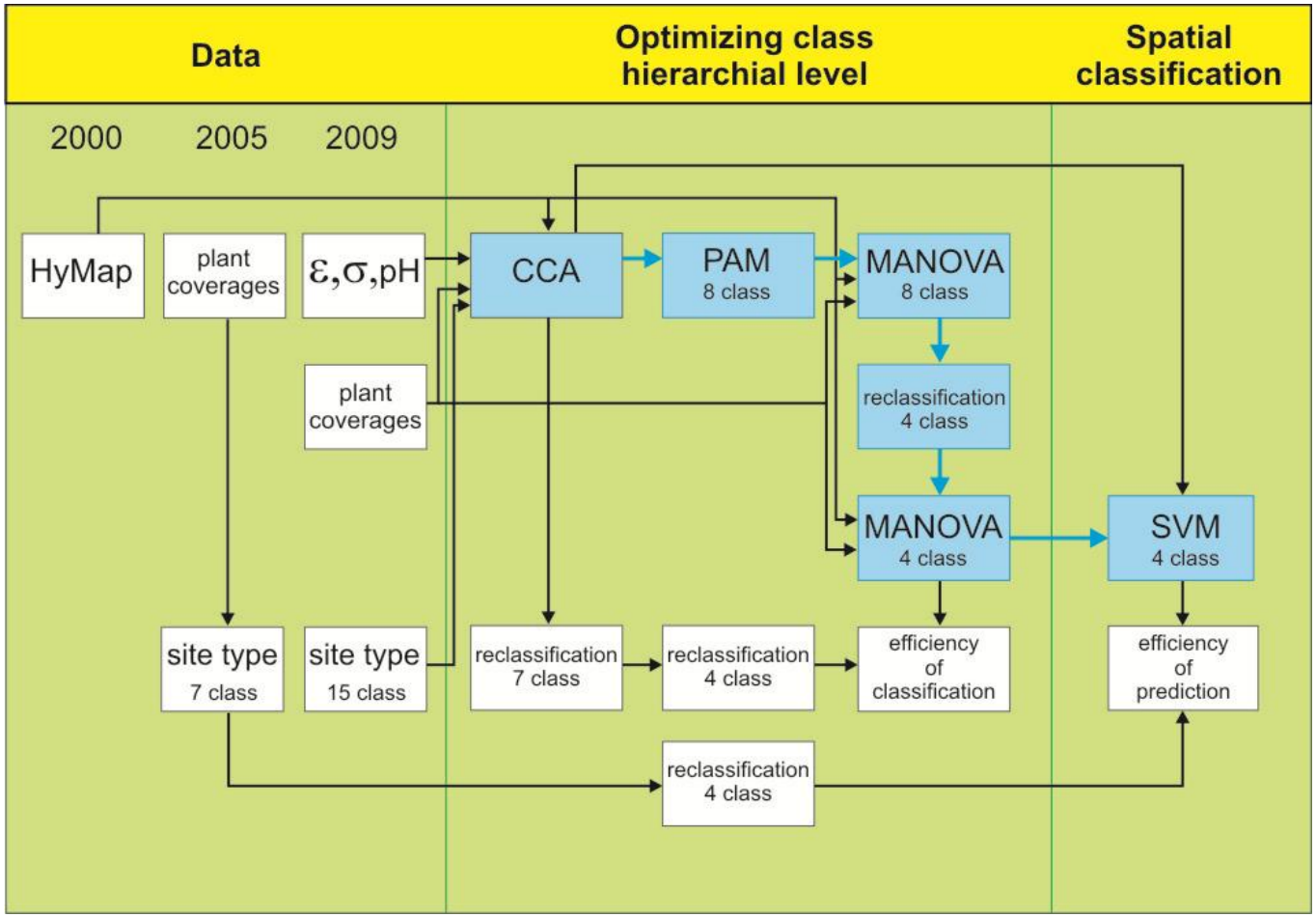
Soil pH



Plant species coverages (%)

Site type (Eurola et al. 1984)

Methods



ε Soil dielectric permittivity

σ Soil electrical conductivity

CCA Canonical correspondence analysis

PAM partitioning around medoids, unsupervised clustering

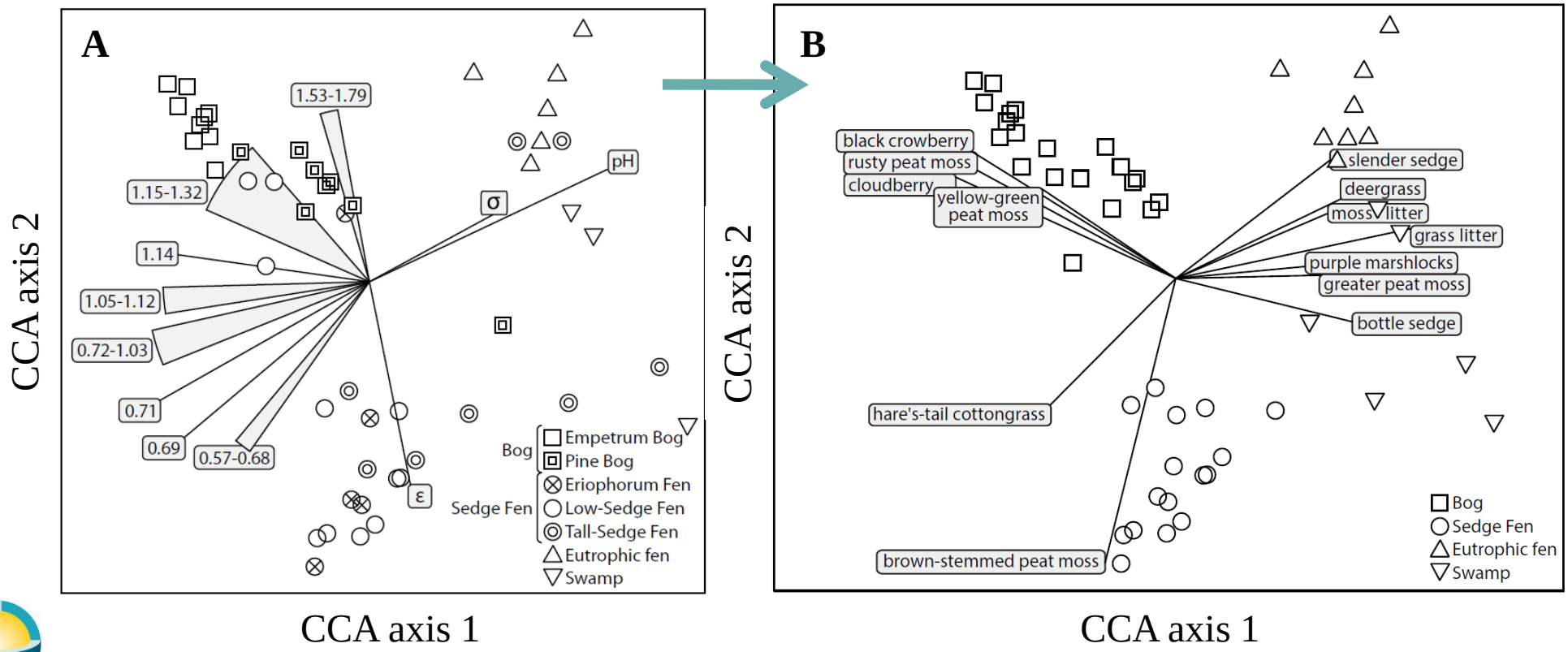
MANOVA multivariate analysis of variance

SVM Support vector machines, supervised fuzzy classifier

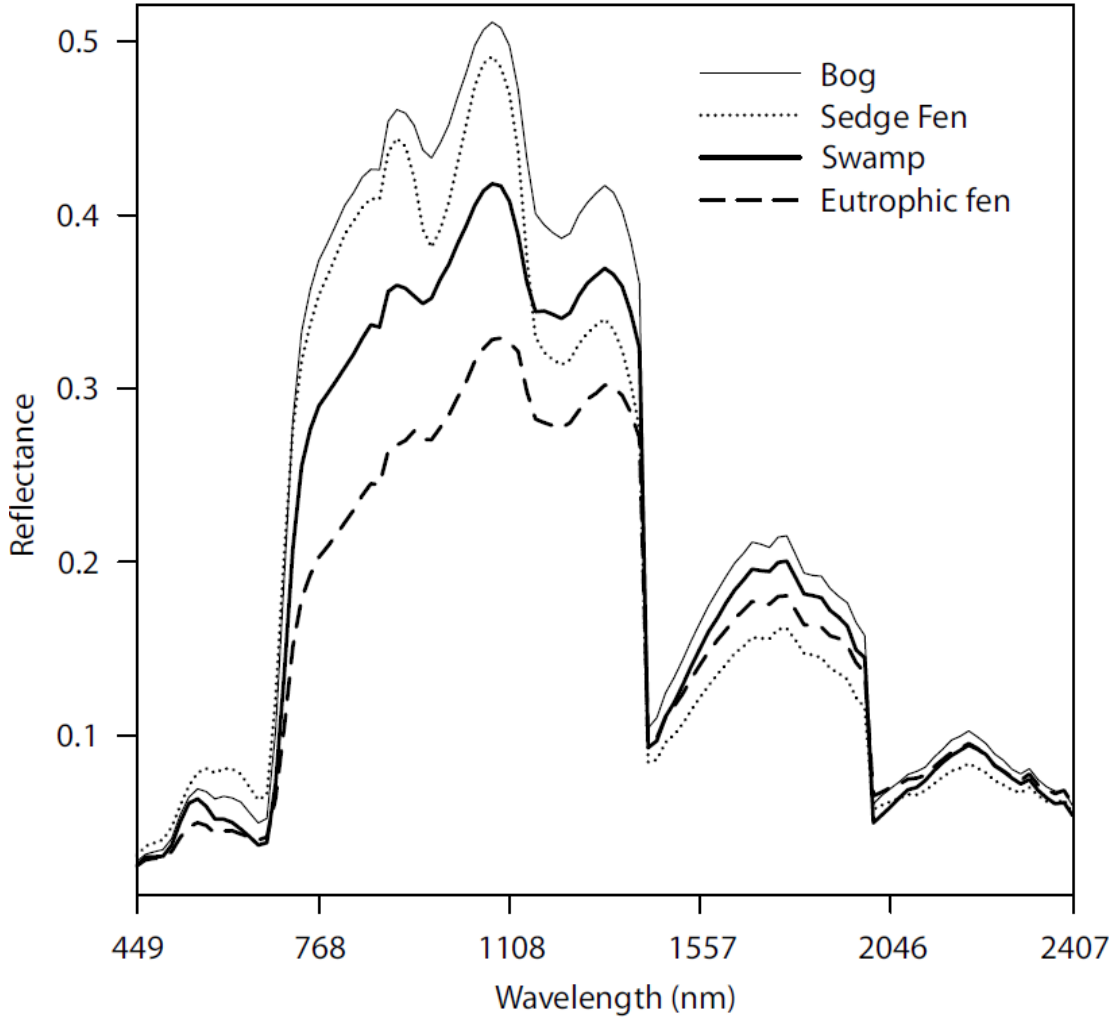
Optimizing class hierarchial level with canonical correspondence analysis

CCA and 1st PAM clustering (7 classes)
HyMap channels overlaid

CCA and 2nd PAM clustering (4 classes)
Plant species overlaid



Spectral properties of peatland site types



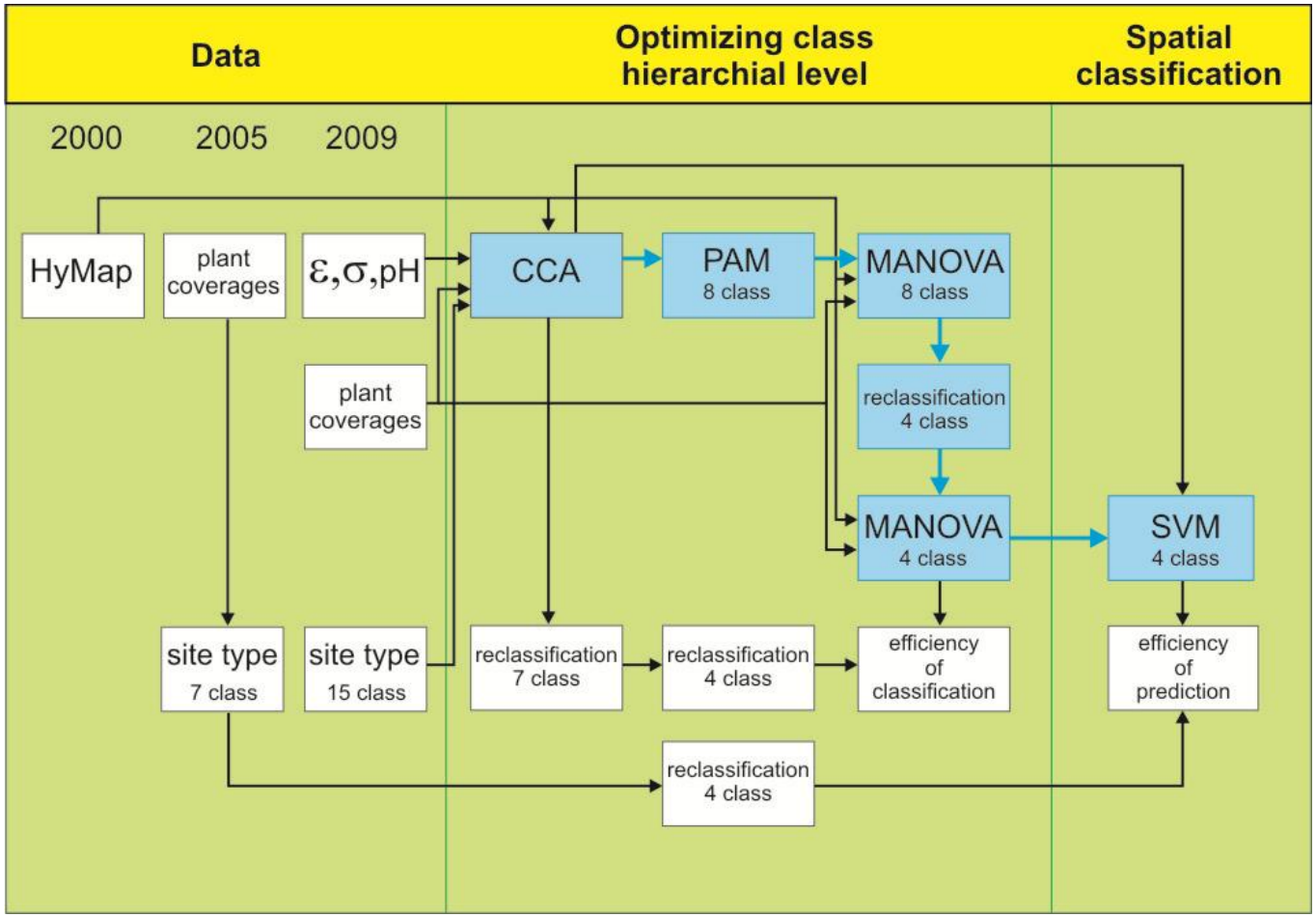
Bog

Sedge fen

Swamp

Eutrophic fen

Methods



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MANOVA multivariate analysis of variance

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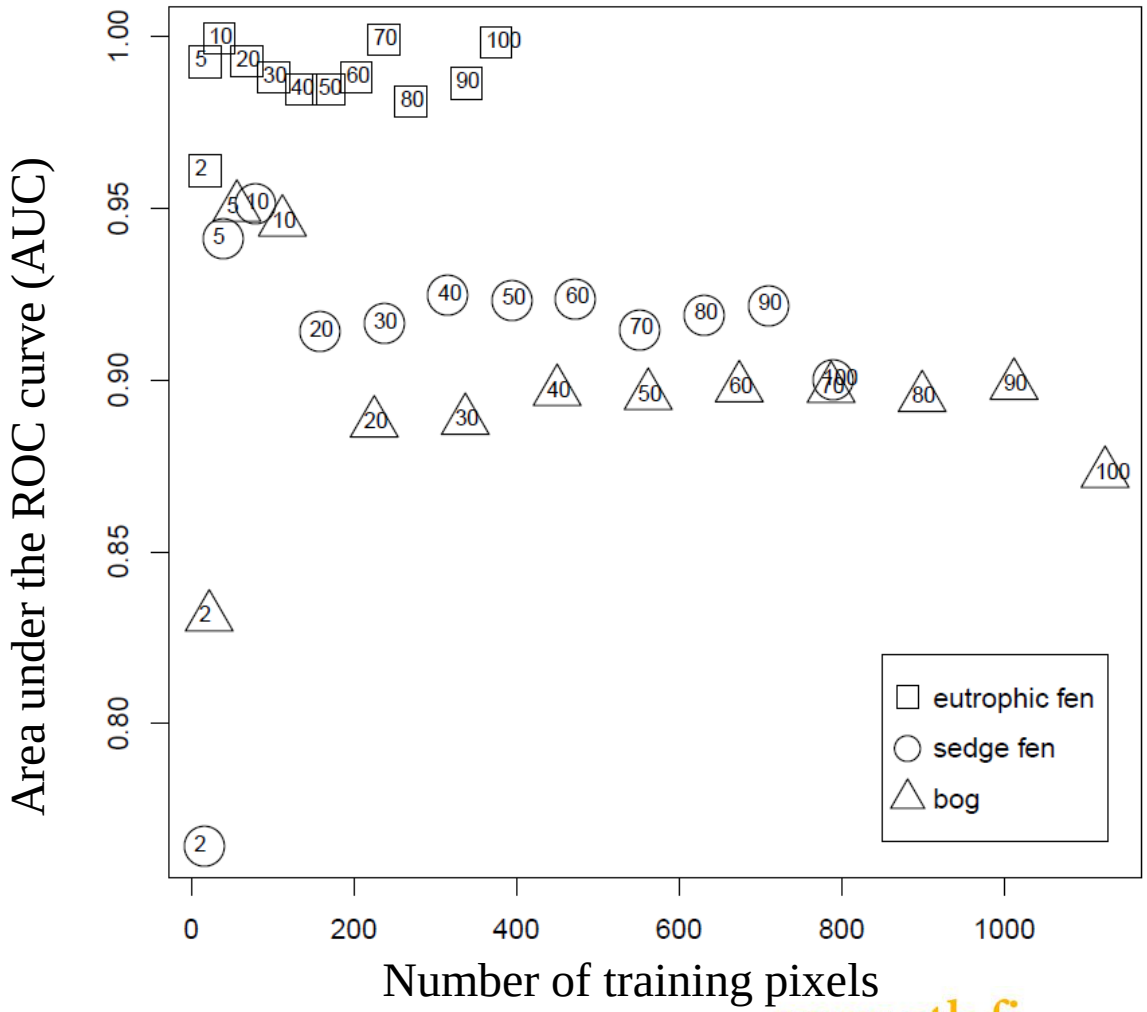
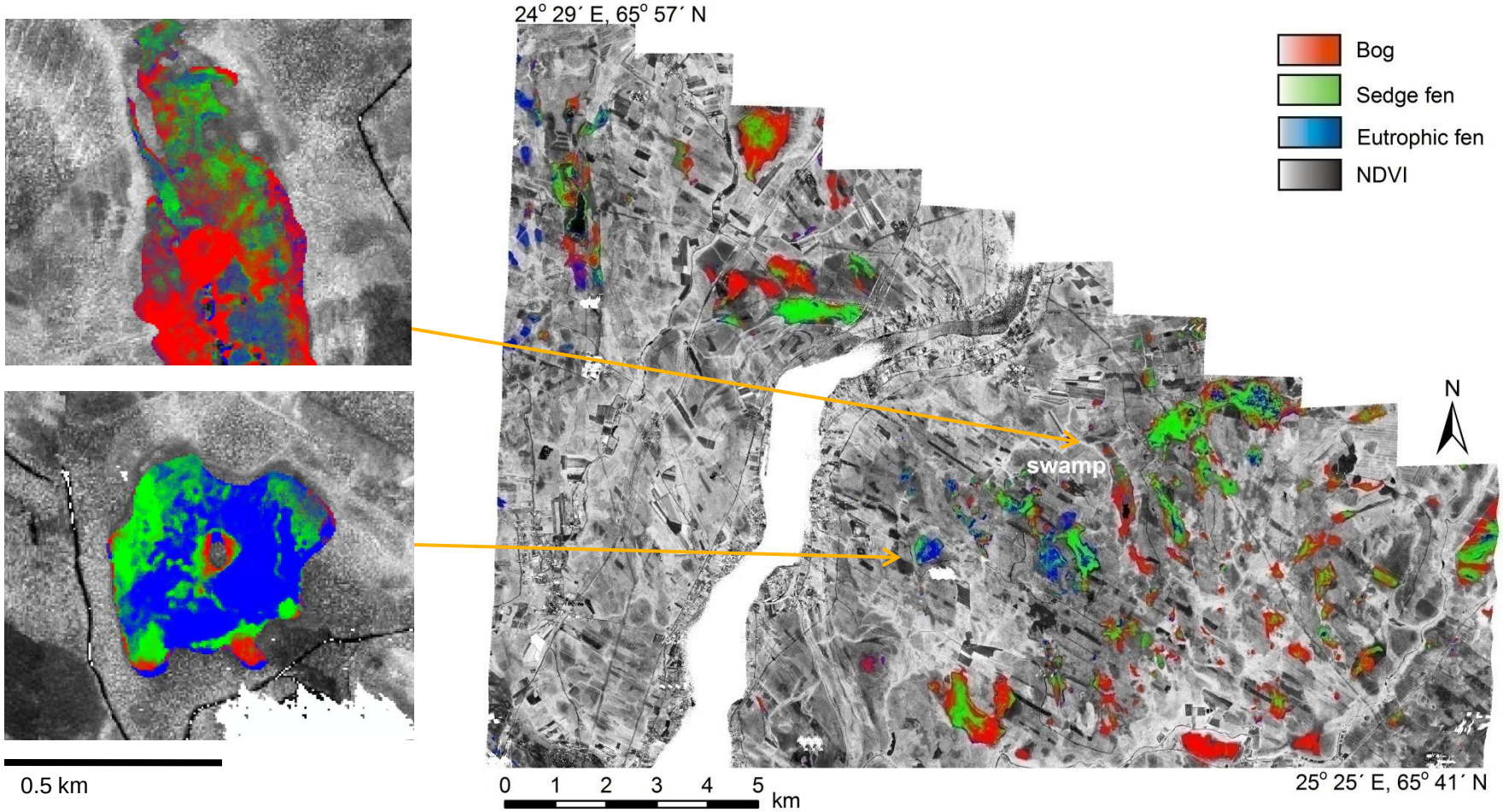
Validation of support vector machine classification with receiver operating characteristics curves

Number inside the shape = % of training pixels used for training a SVM model



Mapping peatland biotopes with fuzzy support vector machine classification



Conclusions (1)

- The CCA-PAM-MANOVA preprocessing produced a four class high-level peatland biotope classification: bog, sedge fen, eutrophic fen and swamp.

- Fuzzy mapping of these peatland biotopes with SVMs showed considerably higher accuracies (0.946−0.999 AUC values, overall accuracy 87.8 %, kappa 0.781) than previous studies.

- Eutrophic fens which are the most species rich and underrepresented in conservation areas could be spatially mapped with hyperspectral data.

site type: eutrophic fen

Conclusions (2)

- Future research could include prolonging the ecological gradient to include the entire variability of peatlands by including drained peatlands and peatlands with tree cover.
- Considering the number of potential improvements, this research provides a basis for movement towards a spatially continuous national wetland inventory based on remotely-sensed data.
- The introduced methodology could also be applied to reveal spectrally separable plant communities in treeless arctic environments such as suggested e.g. by Atkinson and Treitz, 2007, on Melville Island, Nunavut.

Site type: bog

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Thank you!

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