Aerial photograph time series as a proxy of vegetation change in boreal peatlands

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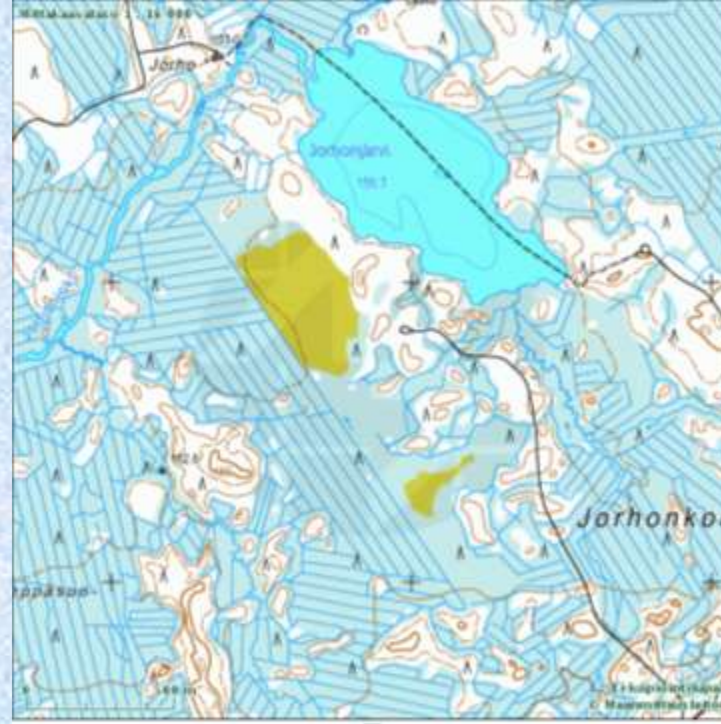
Introduction

- Peatlands have undergone significant changes due to intensive drainage campaigns since 1960's in Finland.

- Drainage in the surrounding areas has affected hydrology also of many peatlands that have remained undrained.

- We investigated changes of a typical aapa mire belonging to the Valkeassuo mire complex in Eastern Finland


Jorhonkor

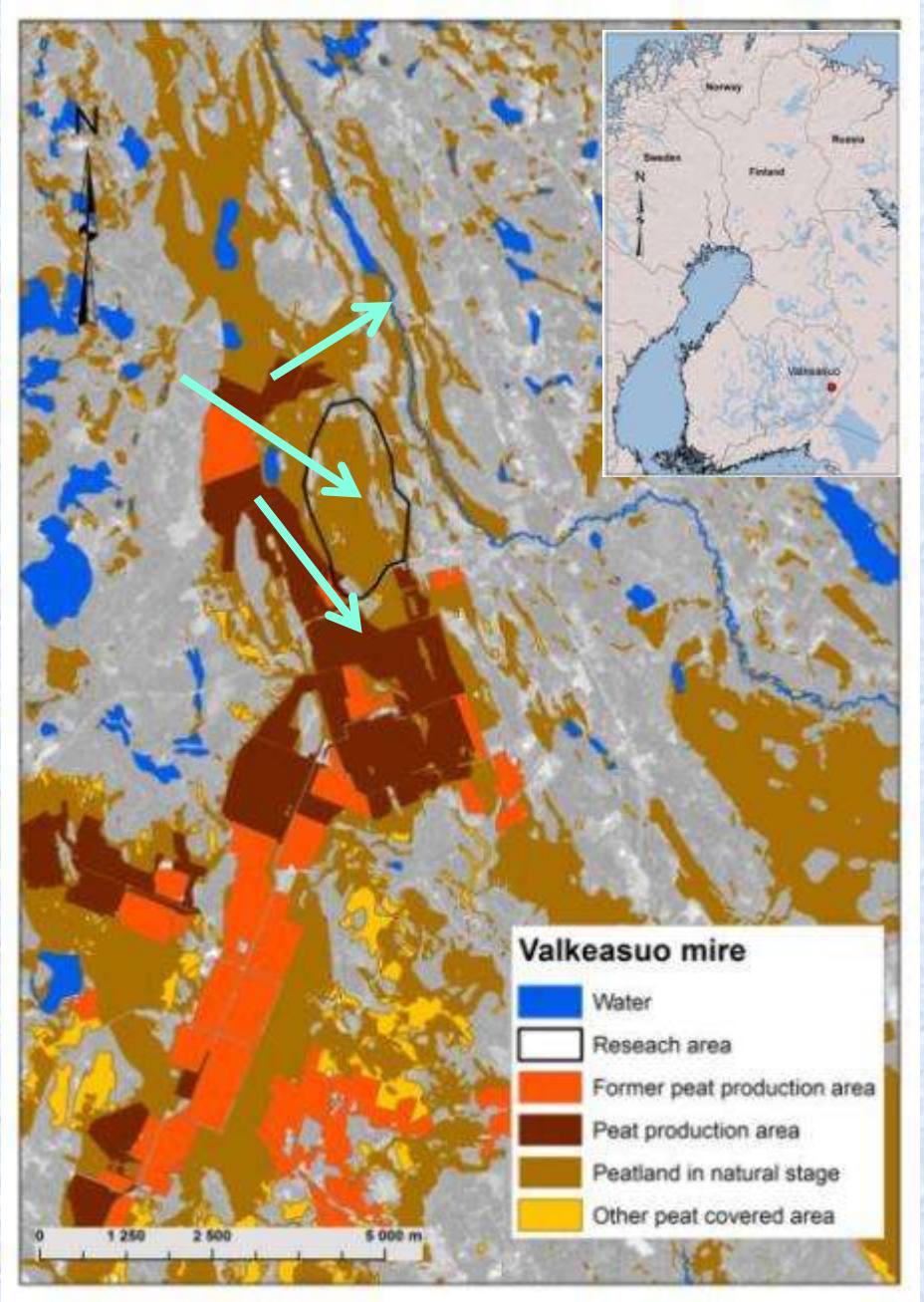

Valkeasuo

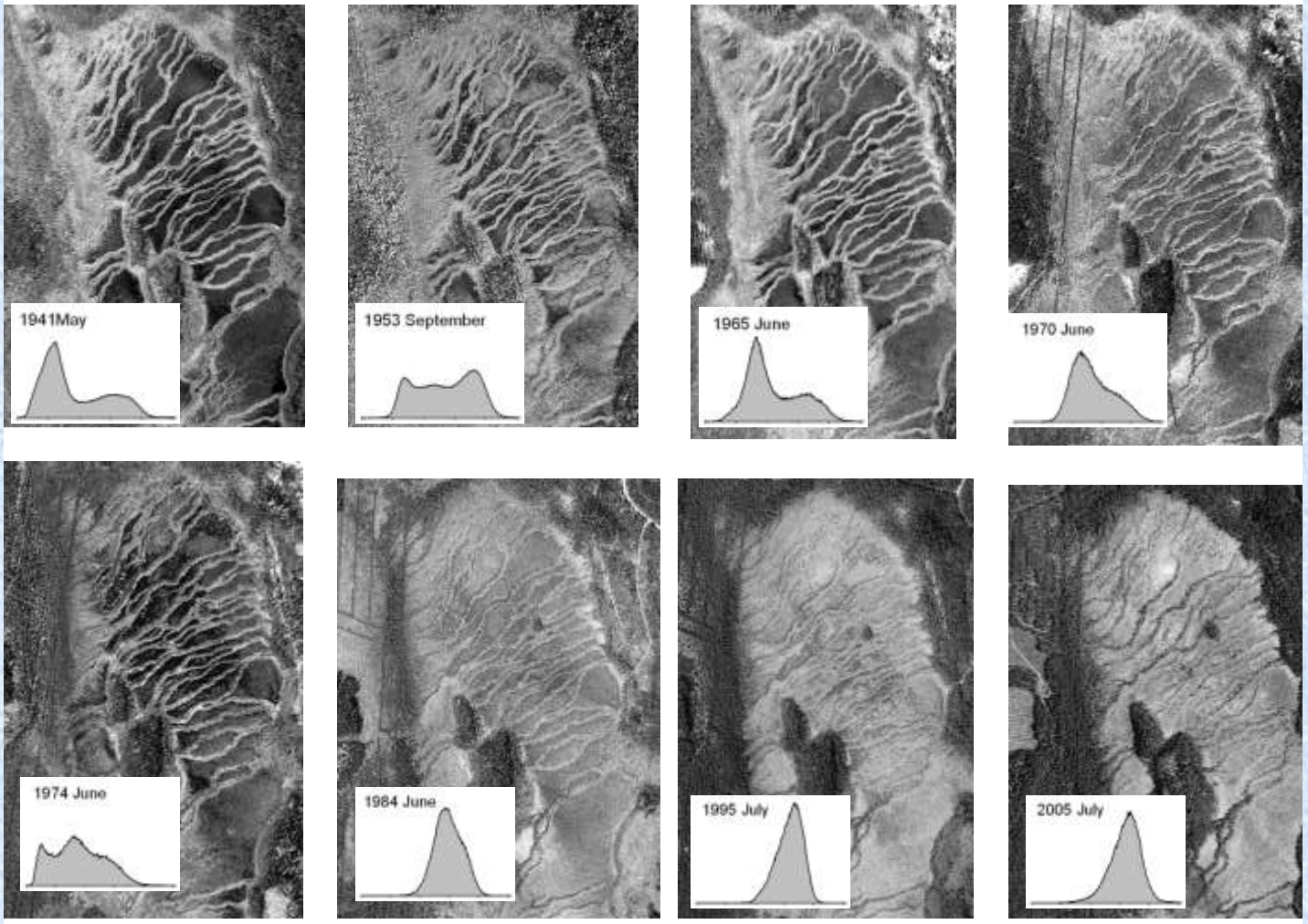
Research area:
Valkeasuo was one of the largest mire complexes in southern Finland.

Drainage process in the catchment area surrounding the aapa mire began in 1968 and led to major changes in the mire ecosystem

Now only the Northern parts of the mire are out of peat production.

Water flow in the peatland watershed is from North West to South East, also current research area have been affected by the changed drainage system.





Grayscale histograms of the central area of the aapa mire summarize the dramatic shift from fen vegetation to dominance of *Sphagnum* mosses (dark to bright). Disturbance of catchment triggered the change from fen to bog within few decades (Tahvanainen 2011).

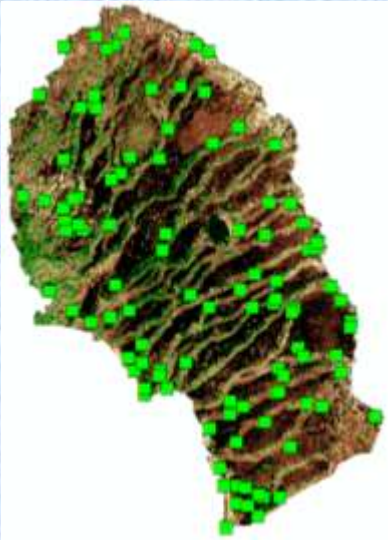
Tahvanainen, T (2011). Abrupt ombrotrophication of a boreal aapa mire triggered by hydrological disturbance in the catchment. *Journal of Ecology* 2011, 99, 404–415

Material and methods

- In the first part of our study, we utilize a false-color image from the year **2009** and second we investigate black and white image series from the years 1941, 1953, 1965, 1974, 1984, 1995 and 2005.

- We test if the image classification can be created on basis of plant community composition, analyzed from vegetation plot (103 plots) data collected in the field in summer 2011

- Plant community composition was analyzed using non-metric multidimensional (NMS) scaling.
- The aerial false-color photograph was then classified. Accuracy of the different classifications will be tested using field data and results are compared post hoc.



- Second aim of the research is to investigate how the aapa mire has changed since the drainage of the surrounding areas started in 1968.

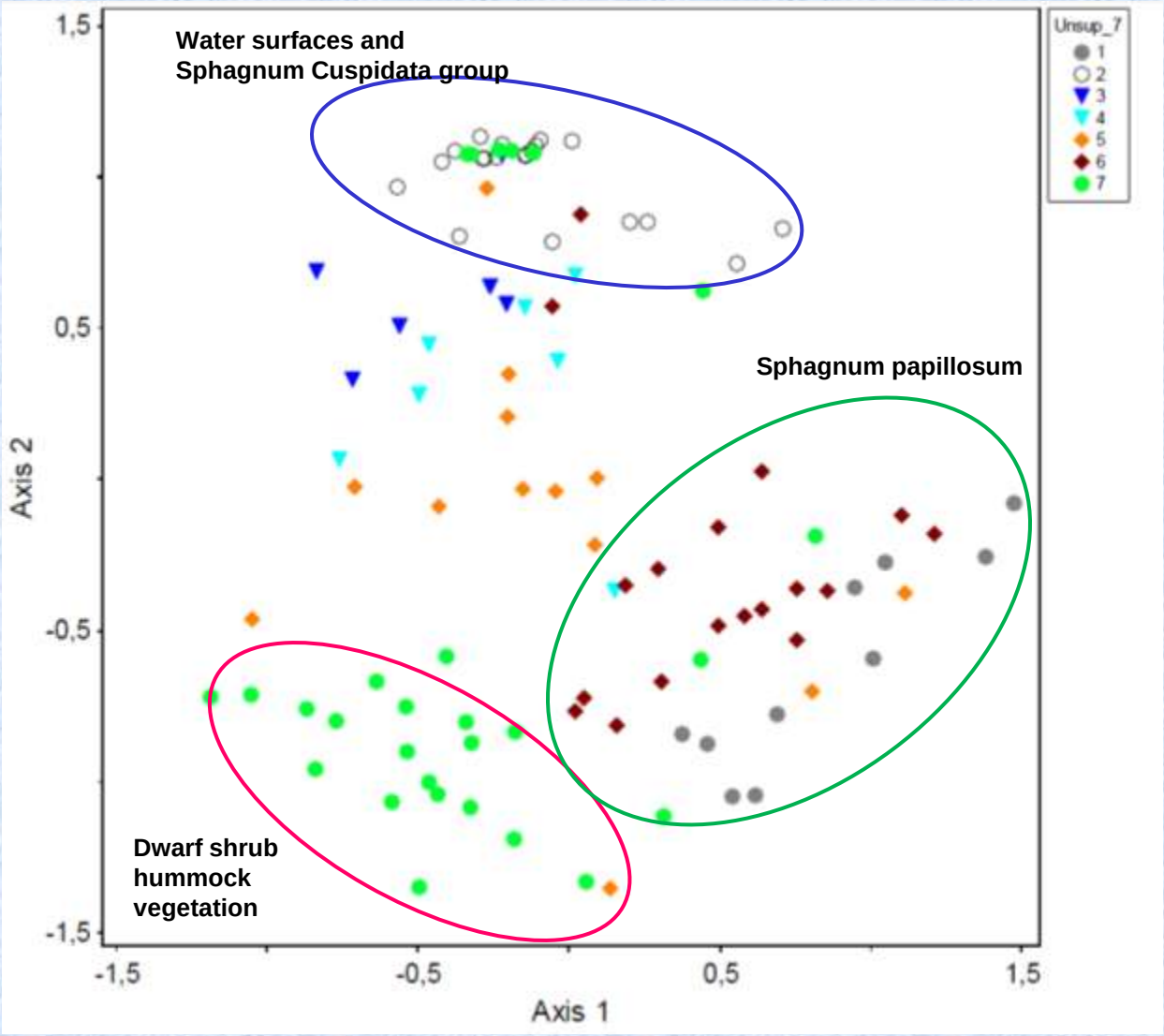
- Here, we are using both paleobotanical data (peat samples) and aerial photographs. Old aerial photographs are homogenized and classified into five classes representing the main vegetation types.

- We are detecting the changes comparing the classification results and by visual interpretation.

- Preliminary results revealed a dramatic shift from fen vegetation to the nearly complete dominance of peat mosses (*Sphagnum*) within three decades after the catchment disturbance.

Field work in Valkeasuo summer 2011. This site represents typical *Intermediate flark-Sphagnum* type. Flark has become significantly dryer and Sphagnum species has become more dominant.

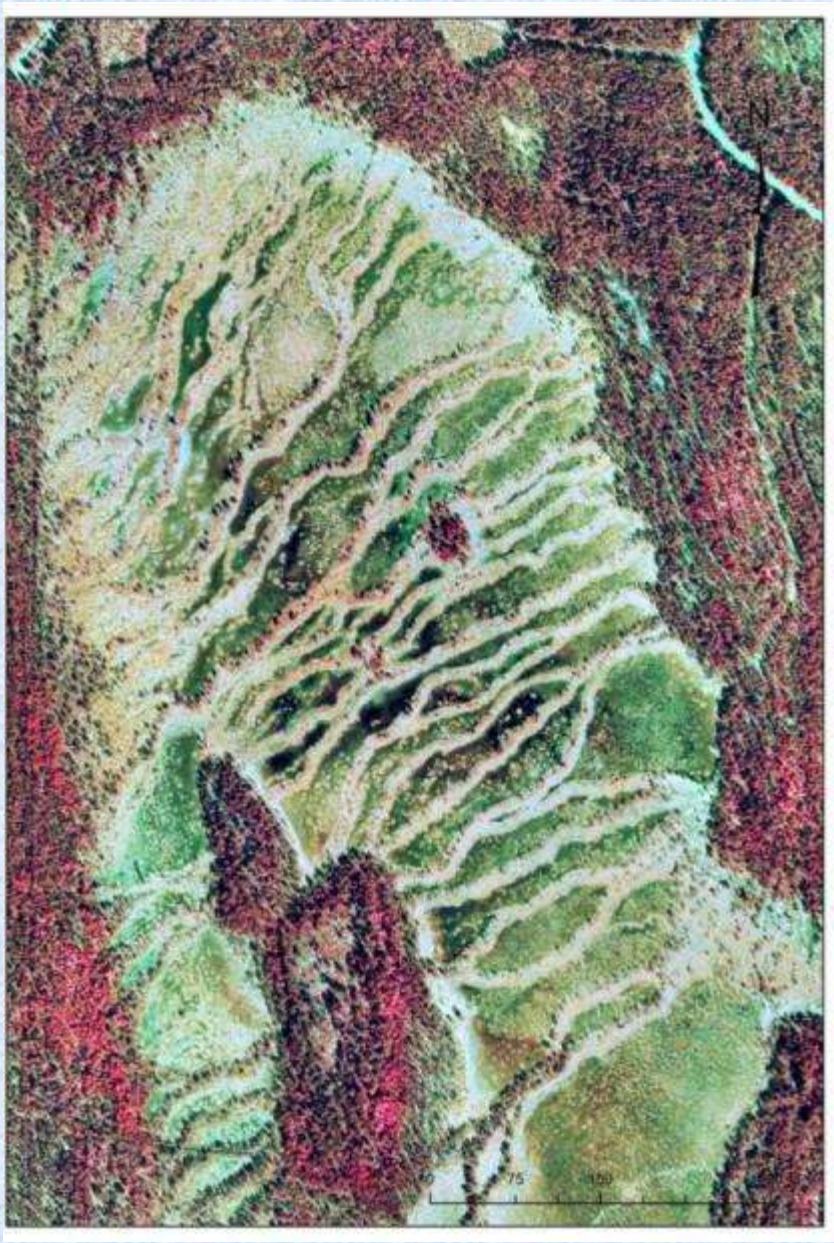
Hummock strings form patterns perpendicular to slope. Intermediate *sphagnum* dominated zone between the flarks and hummock strings have become wider and this can be detected by comparing old and new aerial photographs.

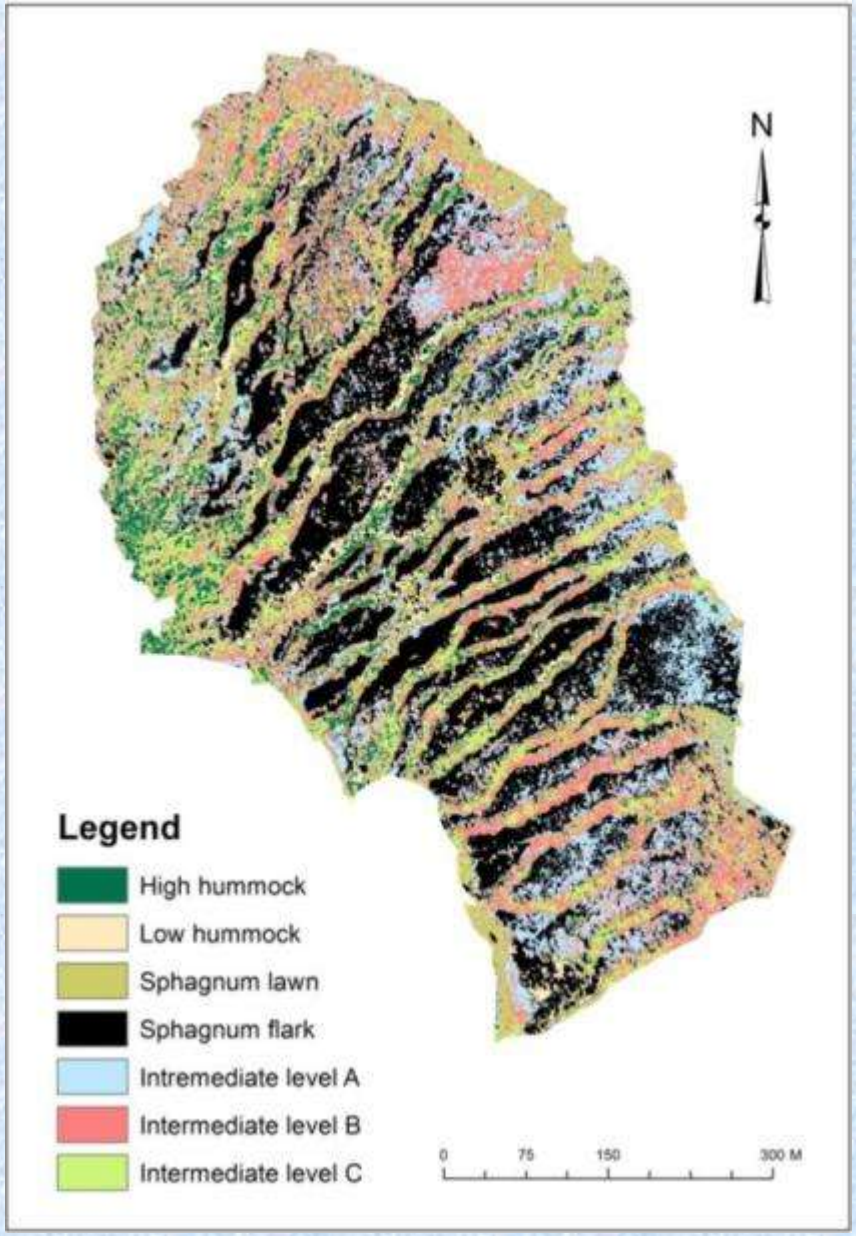


2-dimensional ordination of vegetation plots created by non-metric multidimensional scaling (NMS). Unsupervised test classification using 7 classes is overlayed in the ordination. (74 % of original distances explained).

Species	Class	p	
Molinia caerulea	1	0,001	
Trichophorum cespitosum	1	0,014	Wet flark
Rhynchospora alba	2	0,000	species
Carex limosa	2	0,010	
Sphagnum fuscum	3	0,013	
Carex lasiocarpa	3	0,024	Intermediate
Scheuchzeria palustris	4	0,014	surface
Andromeda polifolia	5	0,026	species
Sphagnum papillosum	6	0,012	
Rubus chamaemorus	7	0,000	
Empetrum nigrum	7	0,000	
Vaccinium uliginosum	7	0,000	Hummock
Chamaedaphne calyculata	7	0,015	species
Pleurozium schreberi	7	0,020	
Polytrichum strictum	7	0,033	

- Each 7 airphoto classes seems to have indicator species that are statistically significant. (Monte Carlo test, 5000 permutations)


N
0
75
150


N
Legend
High hummock
Low hummock
Sphagnum lawn
Sphagnum flark
Intremediate level A
Intermediate level B
Intermediate level C
0
75
150
300 M

Difficulties in aerial photograph interpretation

- Image related, BRDF, shadow etc.

Peatlands variations due climatic conditions:

- Water level
- Spectral differences of sphagnum species
  - Sphagnum (papillosum)

Other data options:

- VHR satellite imagery: Pleiades, Worldview, etc.
- Hyperspectral data?

Discussion:

- Aerial photographs comprise a valuable proxy data for the investigation of changes of peatland ecosystems over the past 50-70 years.

- False colour aerial photographs have been considered relatively difficult to classify for the needs of botanical based peatland inventories.

- We are trying to create accurate vegetation type classification to compare with ordination analysis of field data plots (species data)

- Preliminary classification with **7 classes** seems to fit well with field vegetation and species composition classes, while there were problems e.g. with class mixtures and shadows of tall tree canopy. There is a great need for further utilization of aerial image archives to study changes in peatland landscapes.

Impacts of changes in water regime in peatlands:

- Ombtrofication increases sphagnum growth→ carbon sequestration

- Methane emission decreases as change from minerotropfy to ombrotrophy
- Is there some good way to connect old aerial photographs to NIR photos, maybe define the structure of changes peatland surface → which could be then used more larger scale and faster….