Tree species discrimination by aid of Template Matching Applied to Digital Air Photos

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Swedish National Land Survey
Z/I DMC camera

2003: test flights

2004: camera acquisition

2005: large areas photographed, radiometry issues

2006: first year new policy

2007: only digital production line

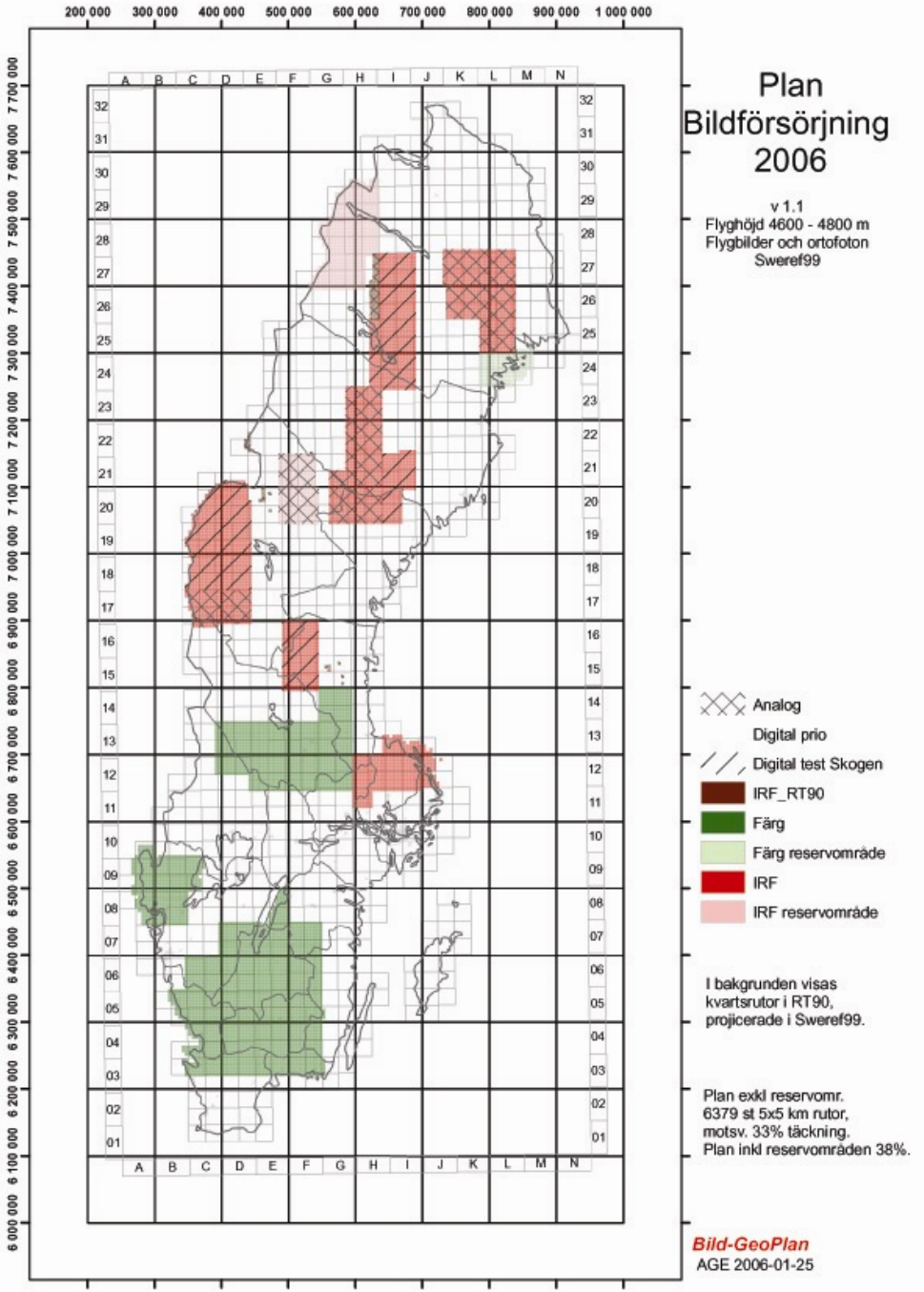
Swedish National Land Survey
New policy for air photgraphy

adopted 2005

1/3 of Sweden to be
photographed yearly from 2006,
No commercial tasks
Normally: 4800 m
Special areas: 3000 m

From 2007,
only digital photos and
only digital production

No similar policy yet for
other sensors
(e.g. satellite data, laser data)

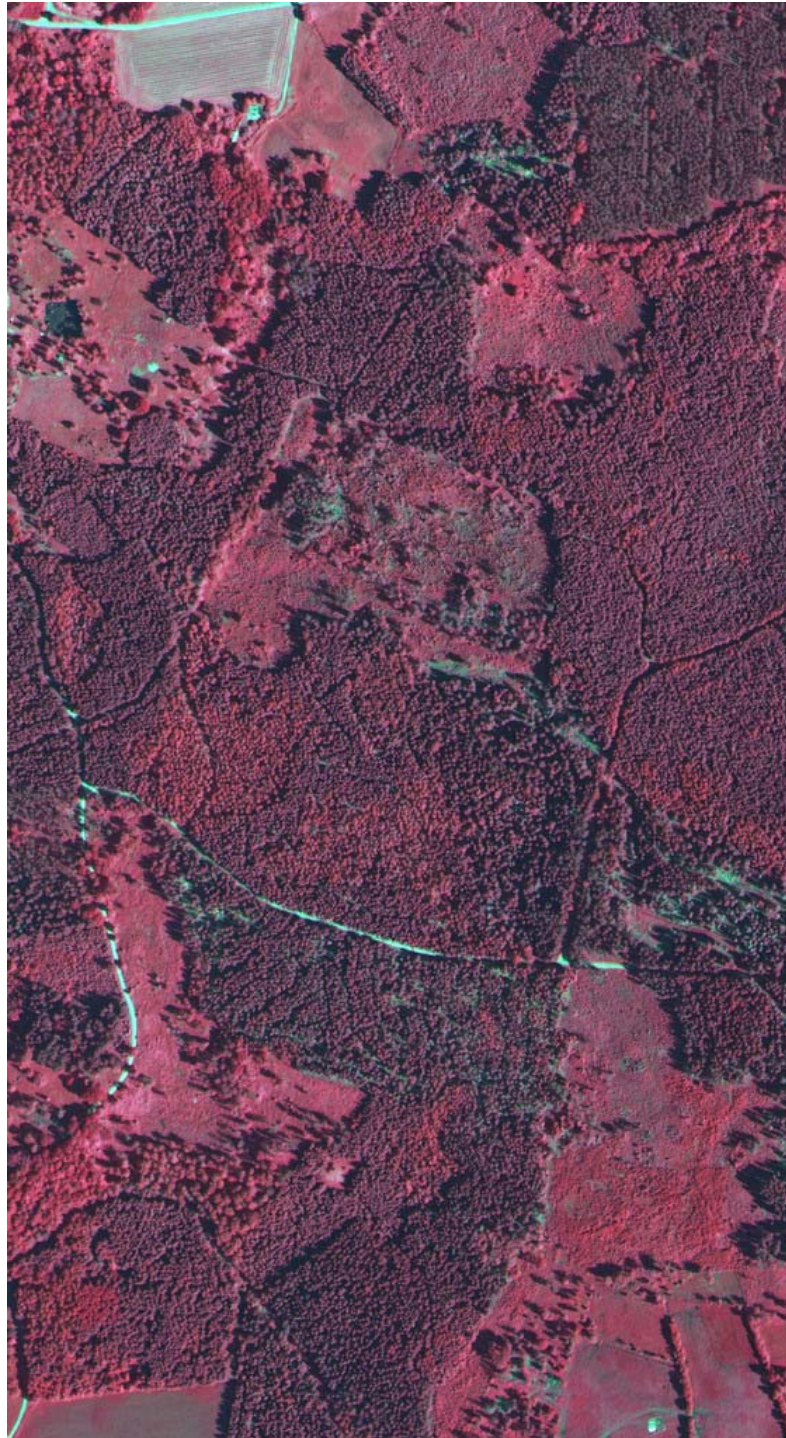


Thus, there will be large amounts of aerial photos available yearly which are:
- digitally recorded
- of high radiometric quality,
- multispectral (blue – NIR),
- affordable

<u>Specific question in this study:</u>
can we separate
spruce / pine / deciduous ?

<u>Motivation:</u>
Swedish forests are dominated by 3 species:
- 43% spruce
- 40% pine
- 12% birch (+ 5 % other deciduous)

Encouraging first results from Oct 2003

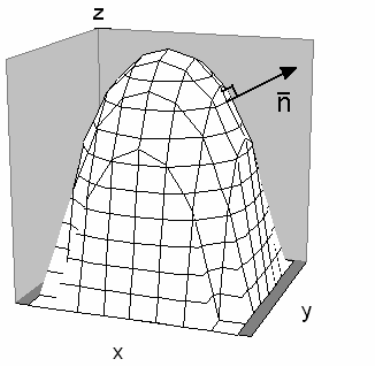


Common approaches to single tree detection:

- Local maxima (e.g. Pinz, 1989) 2D
- Segmentation (e.g.Gougeon) 2D
- Template matching (R. Pollock, 1996) 2.5D
- DSM 3D

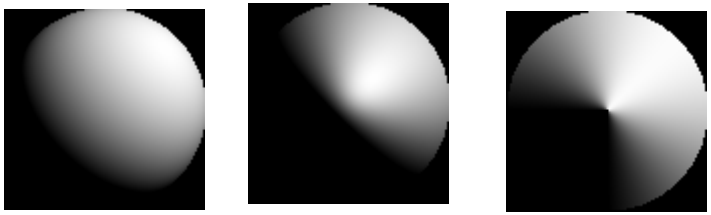
The template matching idea

1. Several synthetic 3D model trees are generated,

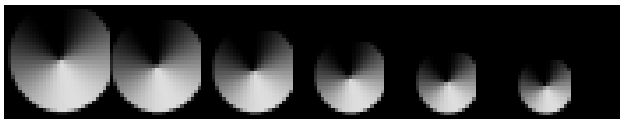


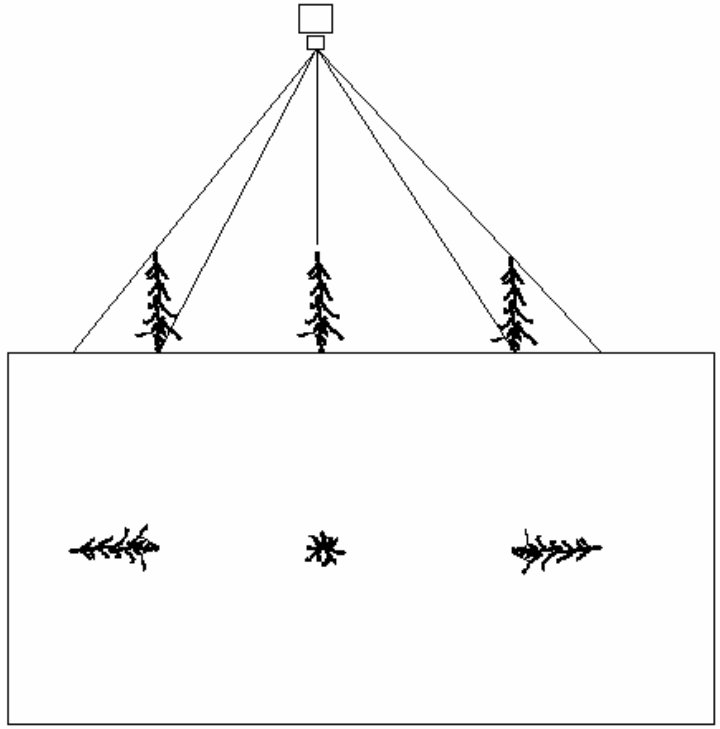
$$\frac{z^n}{a^n} + \frac{\left(x^2 + y^2\right)^{n/2}}{b^n} = 1$$

for different crown shapes:



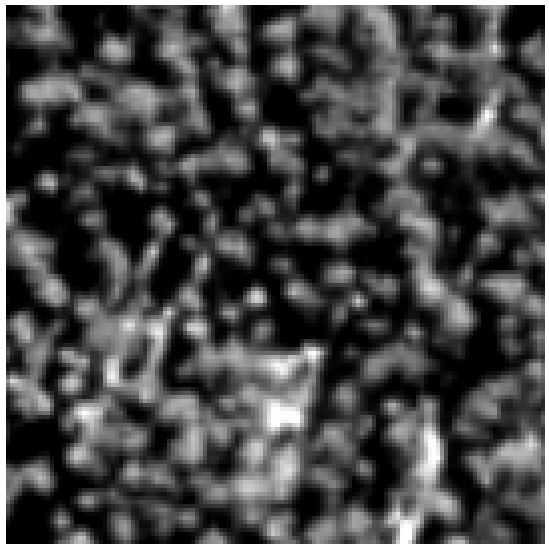
and crown sizes:

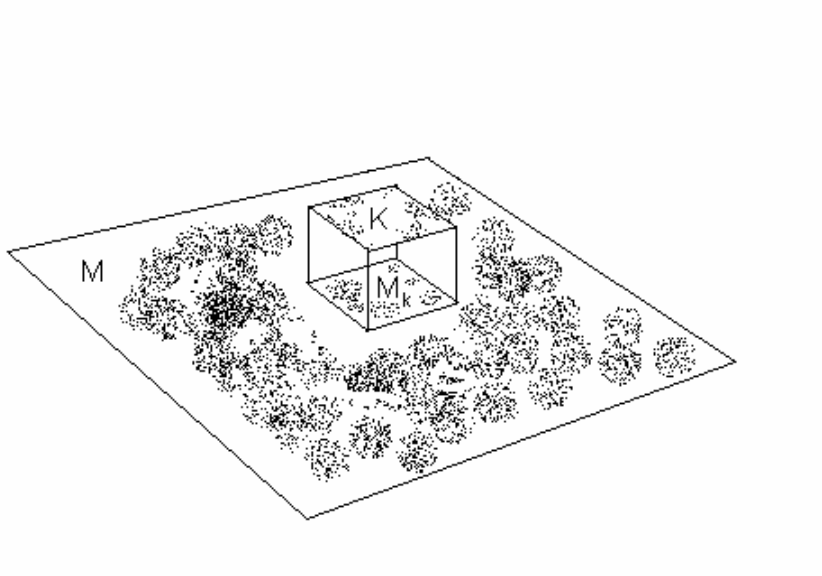




2. The templates are rendered with appropriate 2D projection and illumination for each position in the image

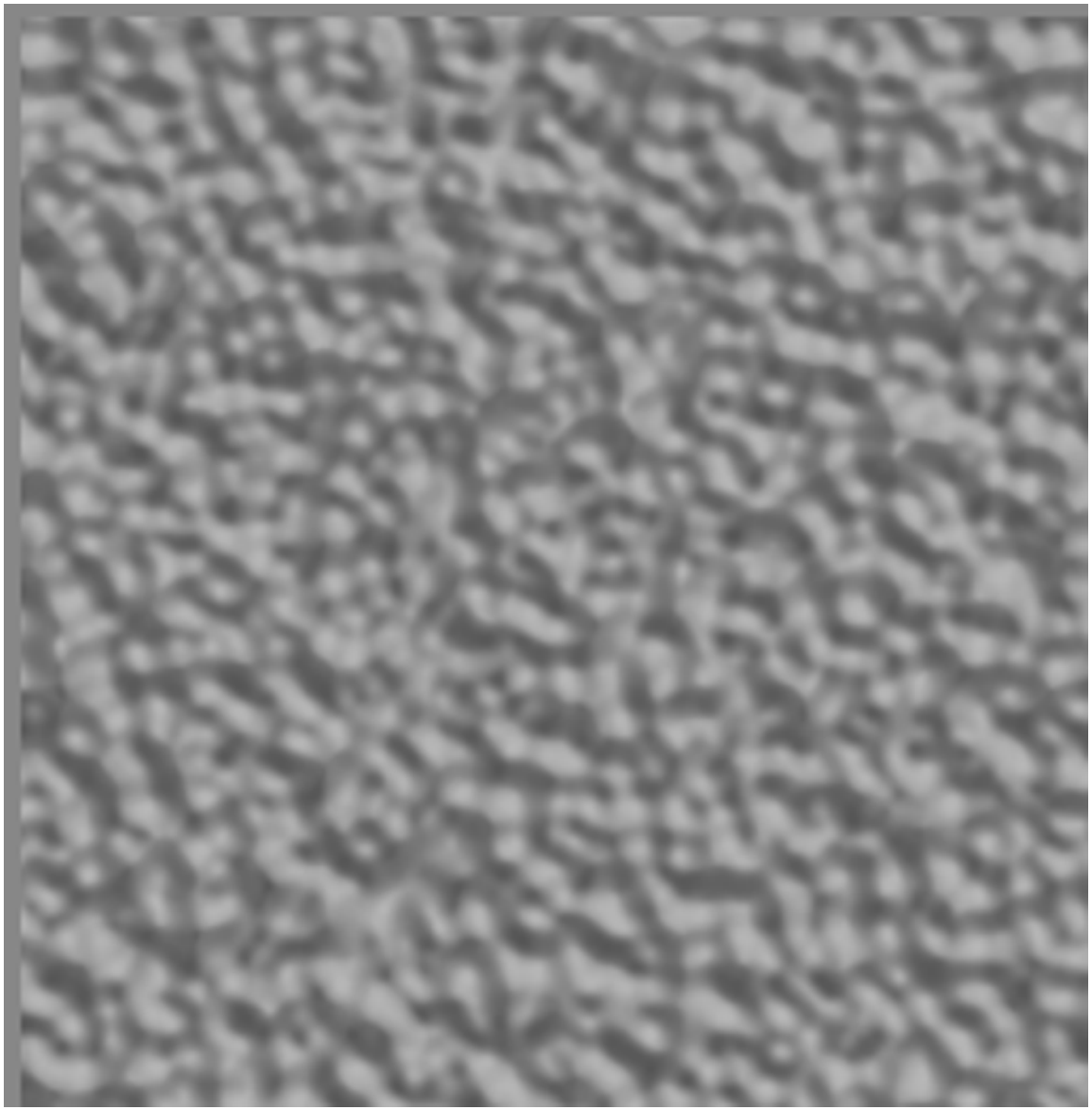
3. The templates are cross corellated with the image



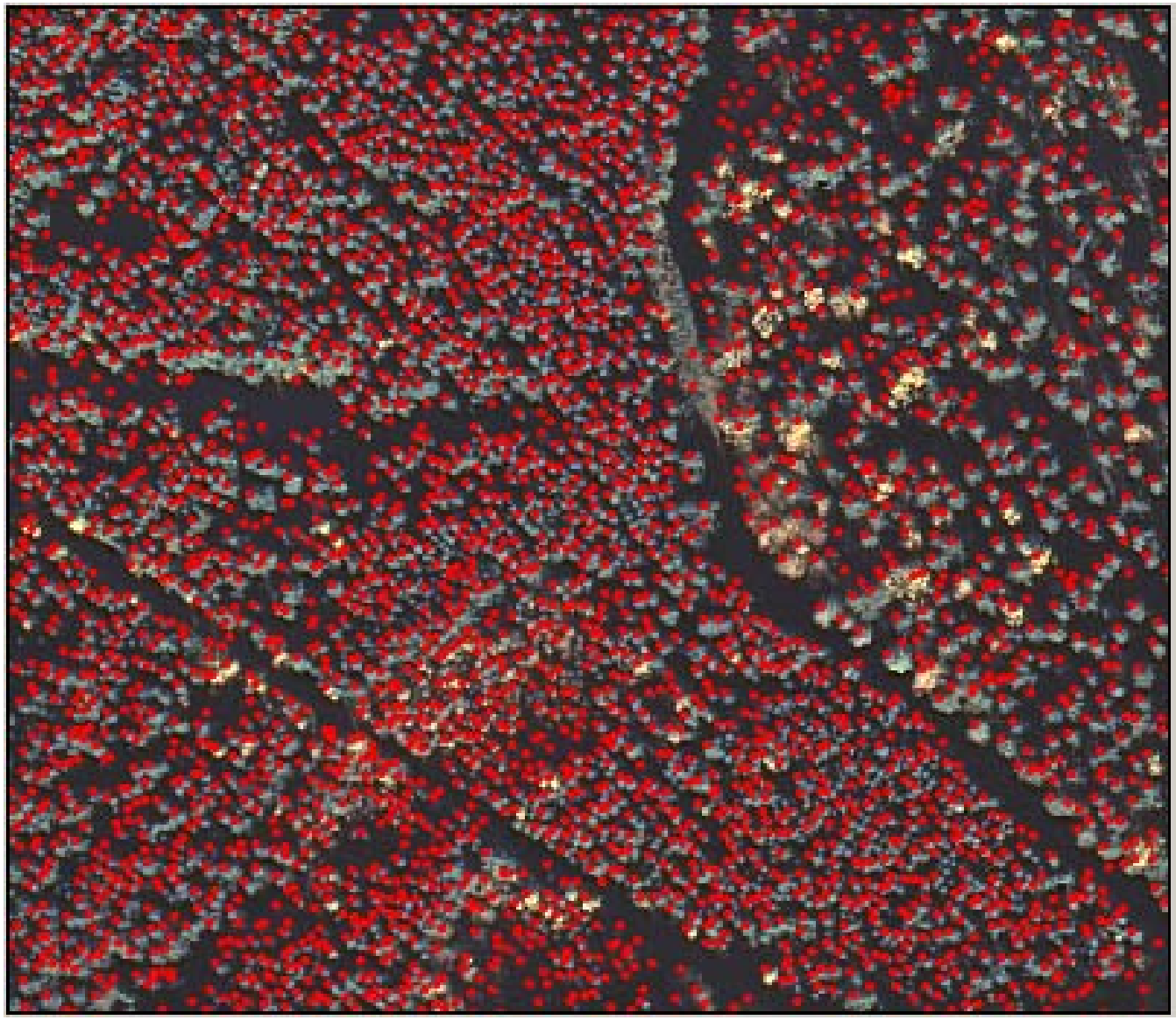


$$\rho = \frac{\sum_x \sum_y \left(K_{xy} - K_{average}\right)\left(M_{kxy} - M_{k\,average}\right)}{\sqrt{\sum_x \sum_y \left(K_{xy} - K_{average}\right)^2}\sqrt{\sum_x \sum_y \left(M_{kxy} - M_{k\,average}\right)^2}}$$

4. Local maxima in corellation images are selected



5. Example of pattern of found trees



Typical results from template matching in coniferous forest[1]

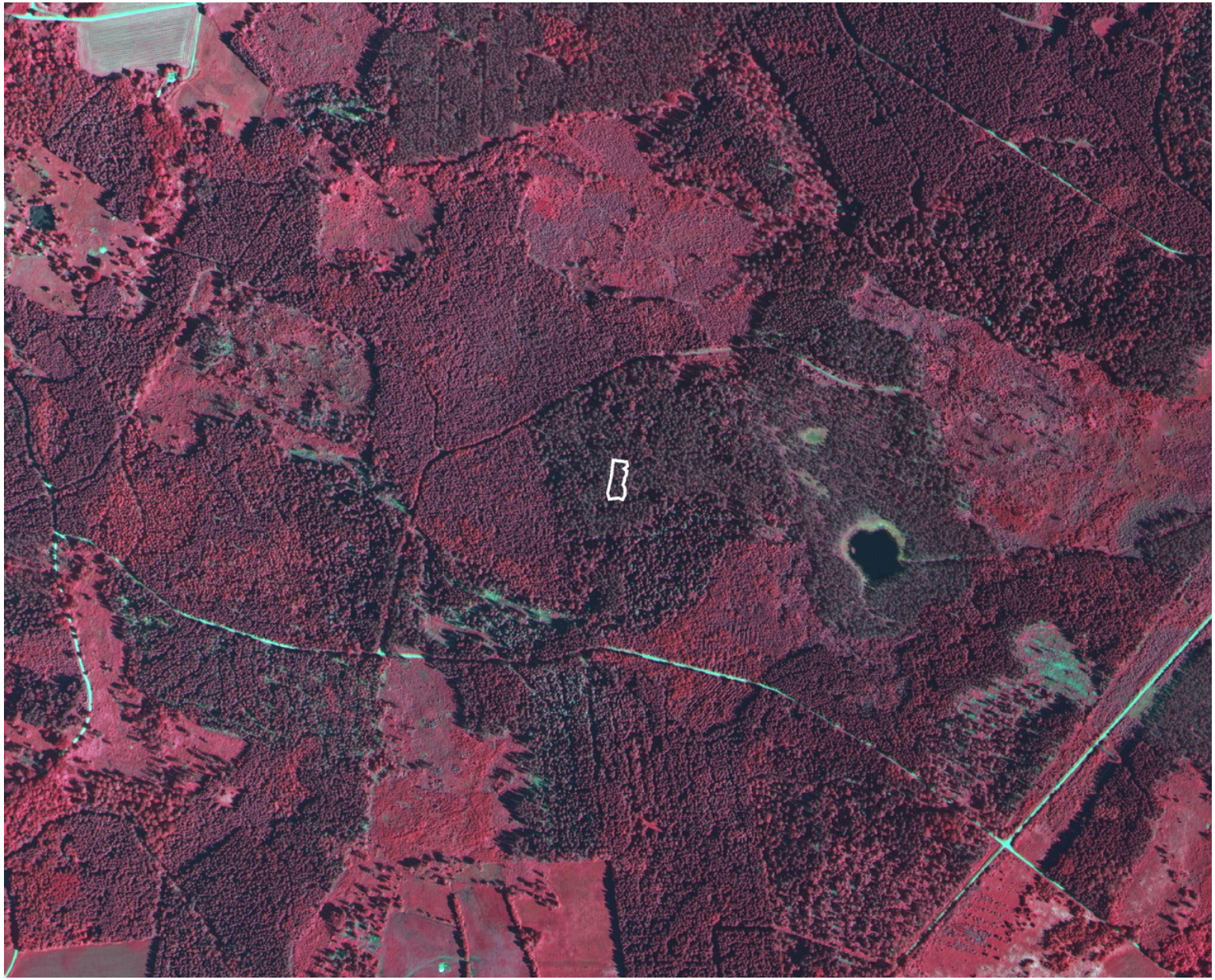
- Found trees 67 %
- Missed trees 33 %
- False positives: 10 %

More difficult in deciduous forests

1) Erikson, M & Olofsson, K. 2005. Comparision of three individual tree crown detection methods. Machine Vision and Applications. Vol. 16, no 4, 258-265.

Two tests of tree species discrimination, using pan sharpened Z/I DMC, green, red, NIR bands

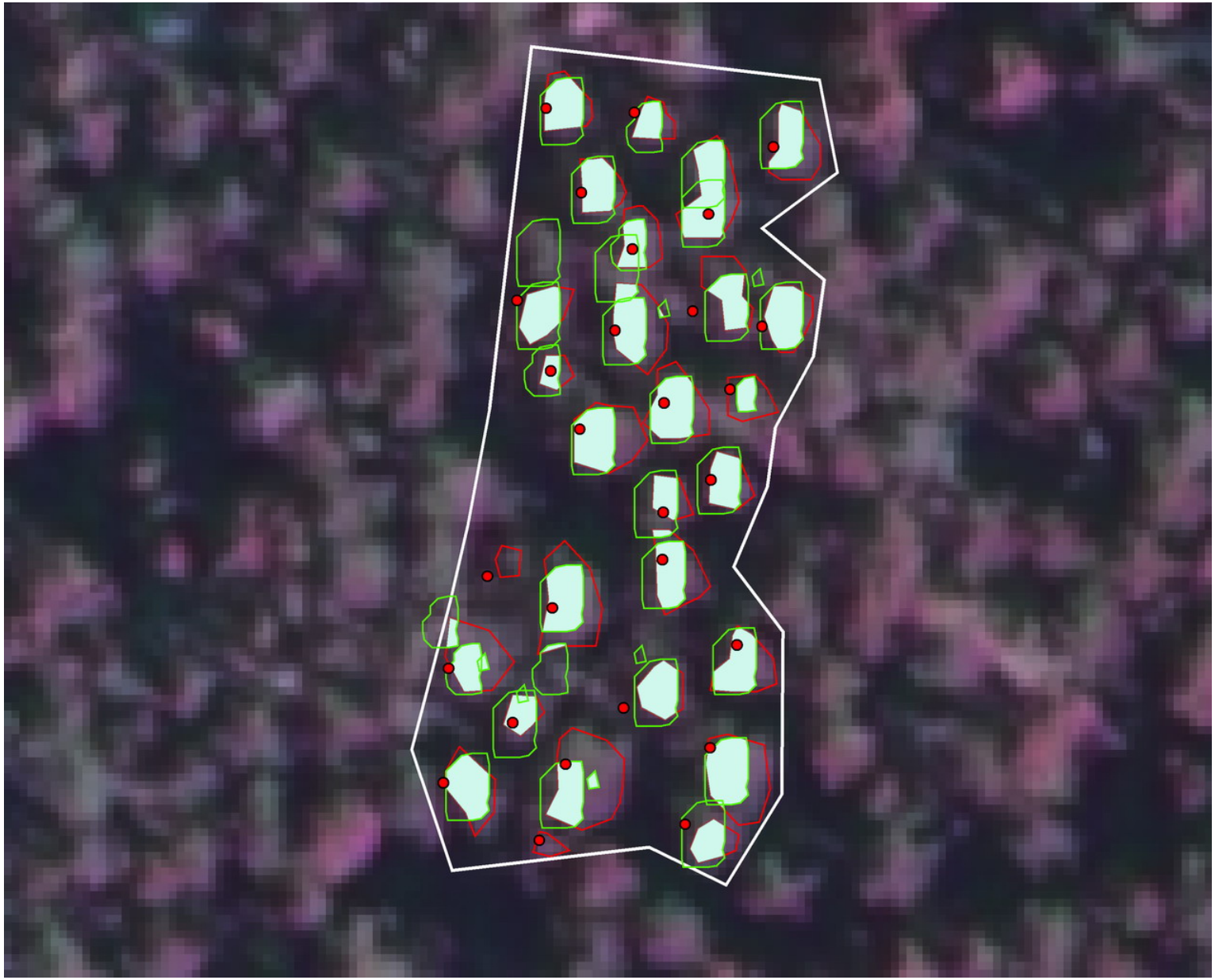
	Test A	Test B
Date	13 Oct 2003	28 June 2005
Flying altitude	3000 m	4800 m
No of trees	256	170



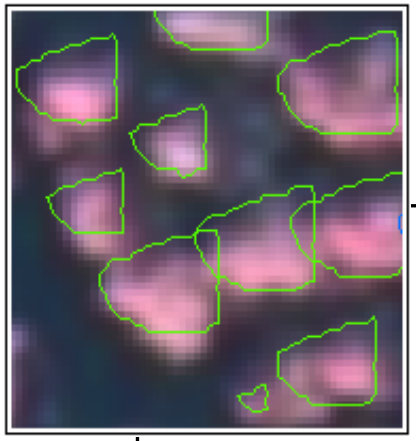
Subset of Z/I DMC image, from 4800 m altitude, with one of five plots

Plot with true tree positions and manually digitized visible canopies for validation

Green = sunlit part of template hits

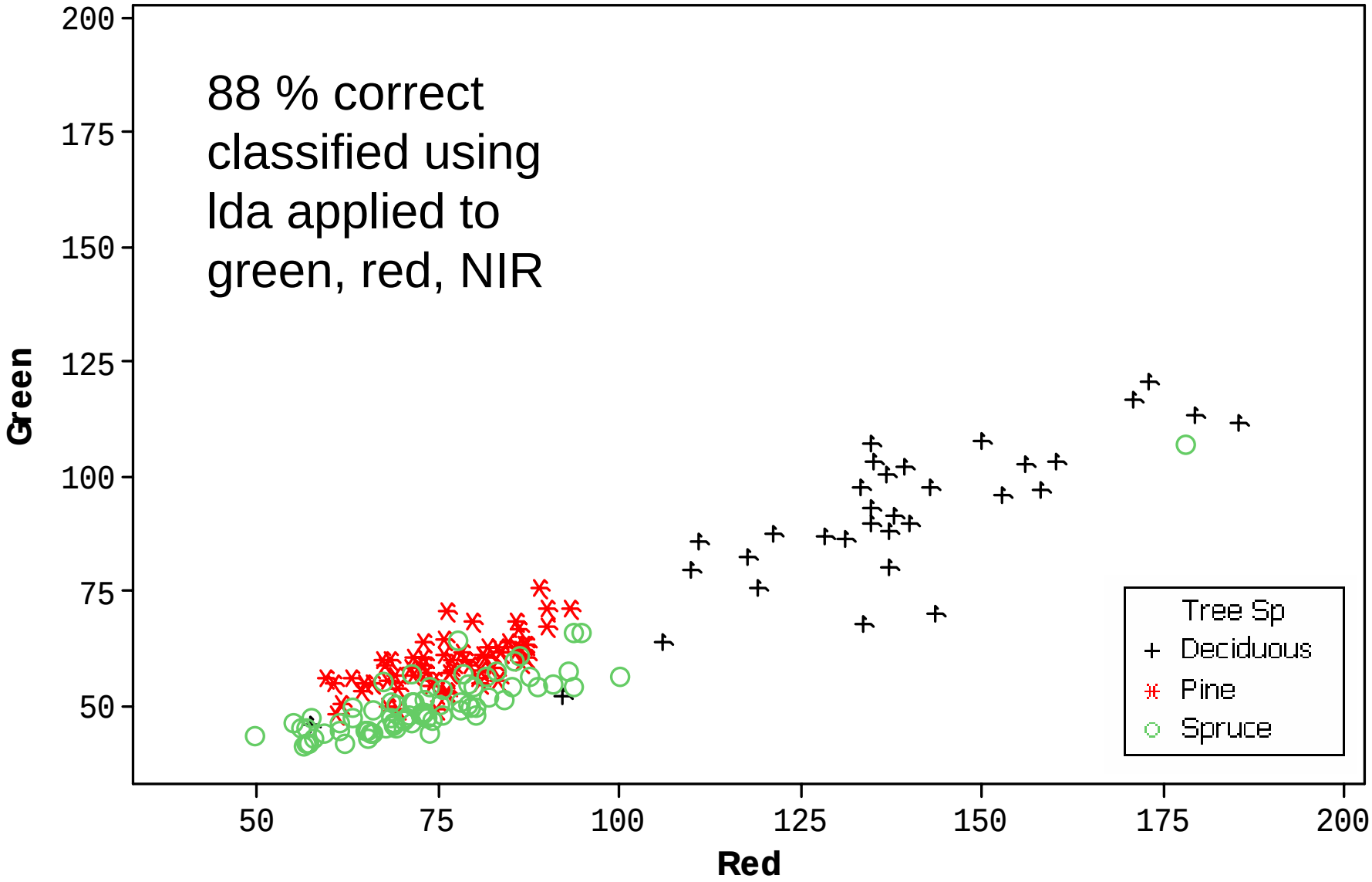


Pixel values where selected for the templates (green) that had a sufficient intersection with the manually identified crowns (red)

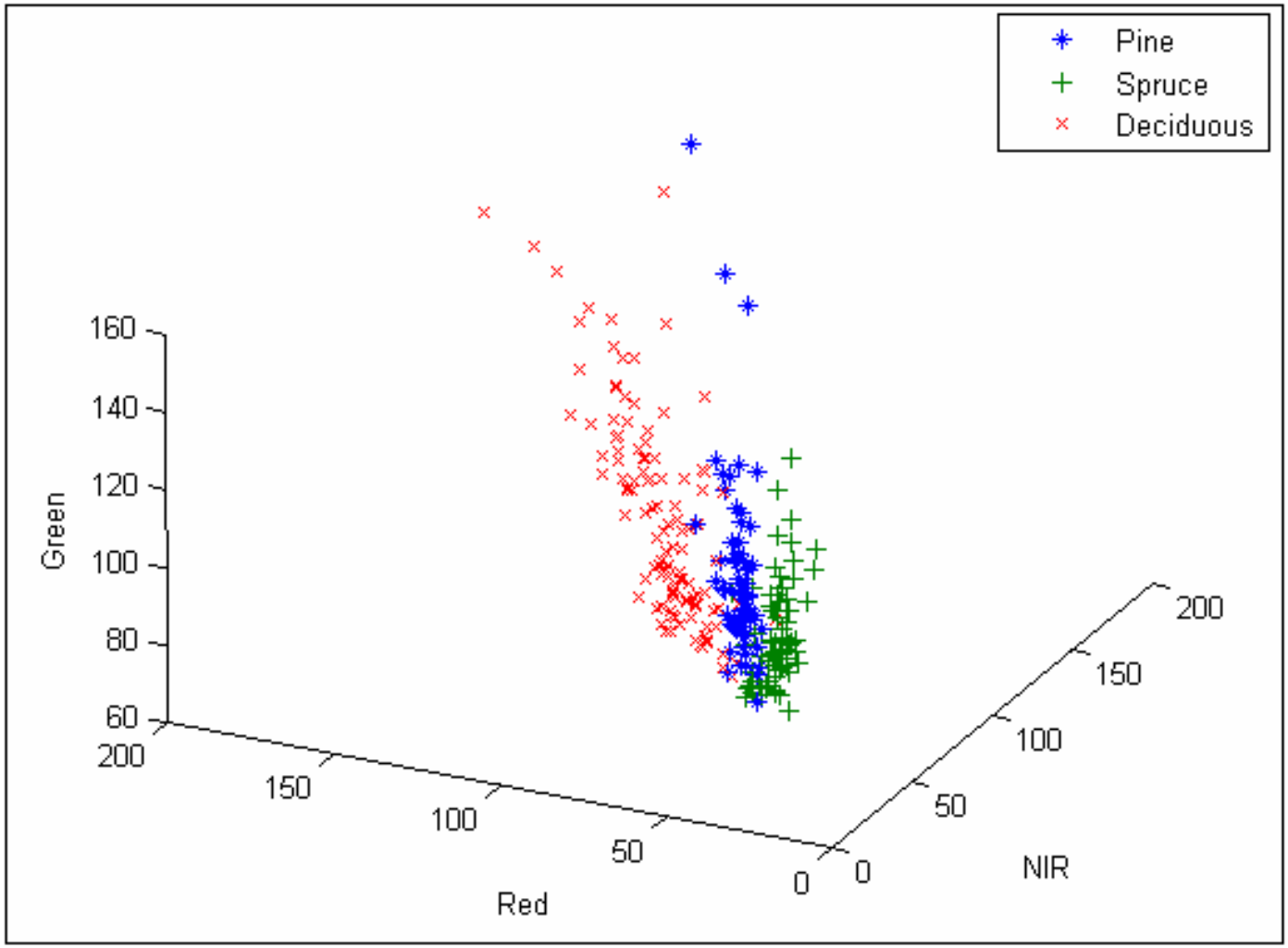


Z/I DMC October 13, 2003

Z/I DMC June 28, 2005



Z/I DMC October 13, 2003 in G, R, NIR colour space



Conclusions

- Considerable potential for tree species discrimination using CIR digital air photos

- The relative spectral development among tree species over the season needs to be a re-discovered research topic

- Radiometry is still an issue after 2 season of DMC operations at the Swedish National Land Survey, larger studies are motivated when this is solved

How do we more easily capture a large material with trees with known species and connect it to the Z/I DMC images?


5 cm pixel images can be used for validation of tree species


UAV with digital camera developed
by Steve Joyce, SLU, Umeå
mc-12
Thank you for your attention