Exaktní vylišení vývojových stadií prirozeného smrko-jedlo-bukového lesa na modelovém území Žofínský prales

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VÚKOZ, v.v.i. **oddelení ekologie lesa**

Theory assumption

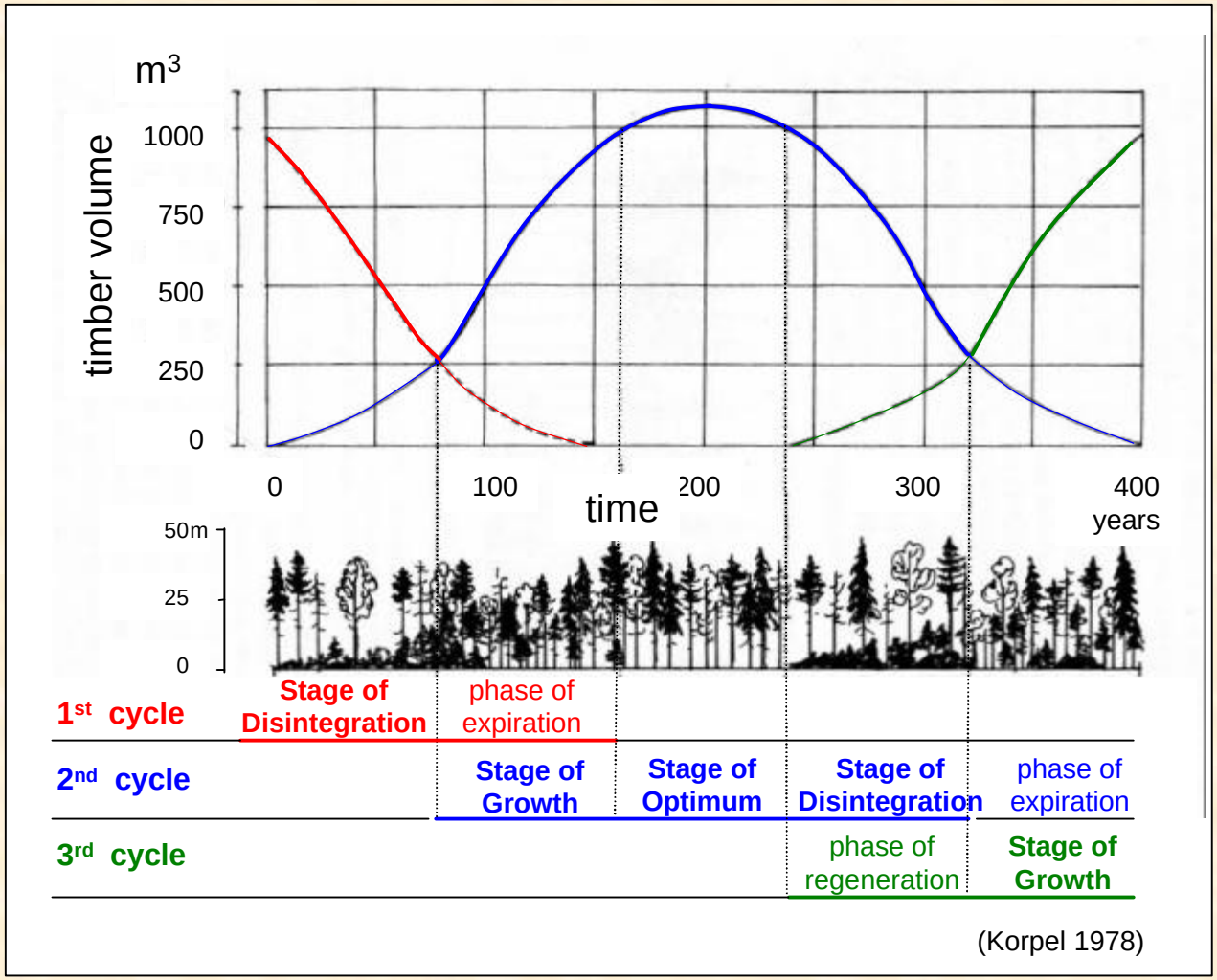
The natural stand dynamics of the climax temperate mixed forests may be described by the concept of **forest cycle**, which is characterized by the sequentially shifting fine-scale mosaic of patches in different phase of forest development. Particular developmental stages markedly differ in live-dead wood volumes and their proportions; they also differentiate by its specific stand structure.

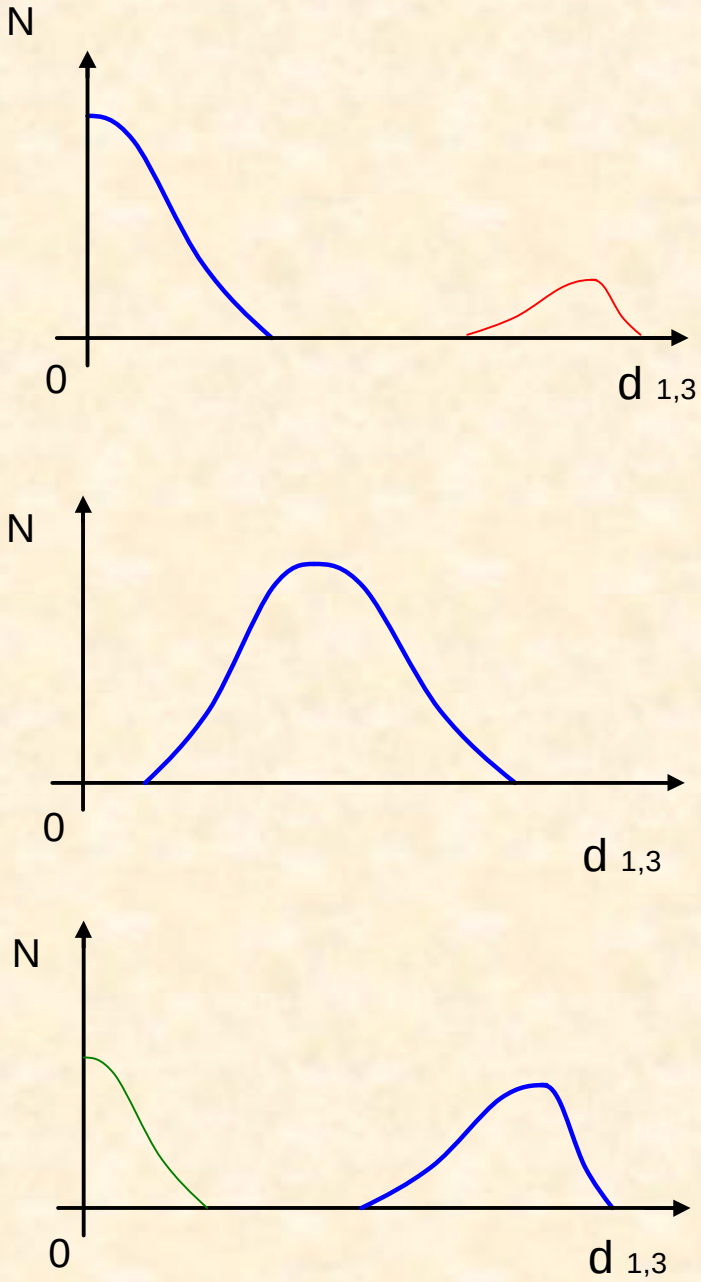
Theory development

- Leibundgut 1959 (only phases)
- Zukrigl 1963 (only phases)
- Mayer et al. 1987 (only phases)
- Koop (1989)
- Korpel 1978,1995 (3 stages, every stage incl. 1-3 phases)
- Drössler 2006 (mosaic)
- and others !!!

Model of the forest cycle

(Korpel 1978, 1995)





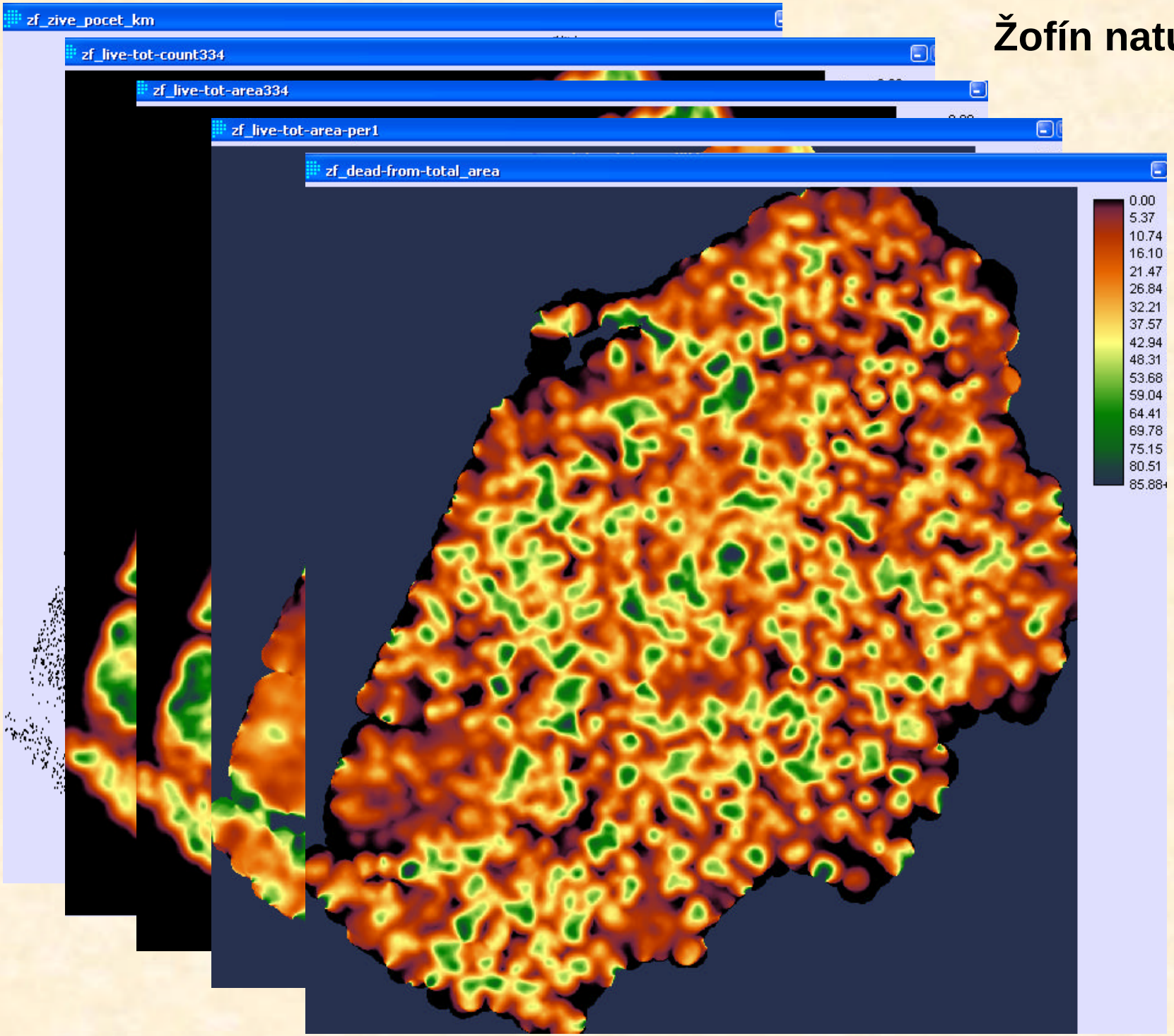
Determination and mapping to date:

- subjective approach – categories are loosely defined => „guesstimate“ methods (observer – dependent)
- determination on research plots – one plot = one stage and phase
- mapping on the net of points or in a grid (e.g. 50x50m; 12,5x12,5m)
- mapping into the maps of trees (Czech approach)

Challenges for new approach:

- to use data from large area of natural mixed forest
- to find the optimal spatial scale
- to use the exact parameters of trees
- to use the spatial analysis
- repeatability of mapping

Žofín natural forest



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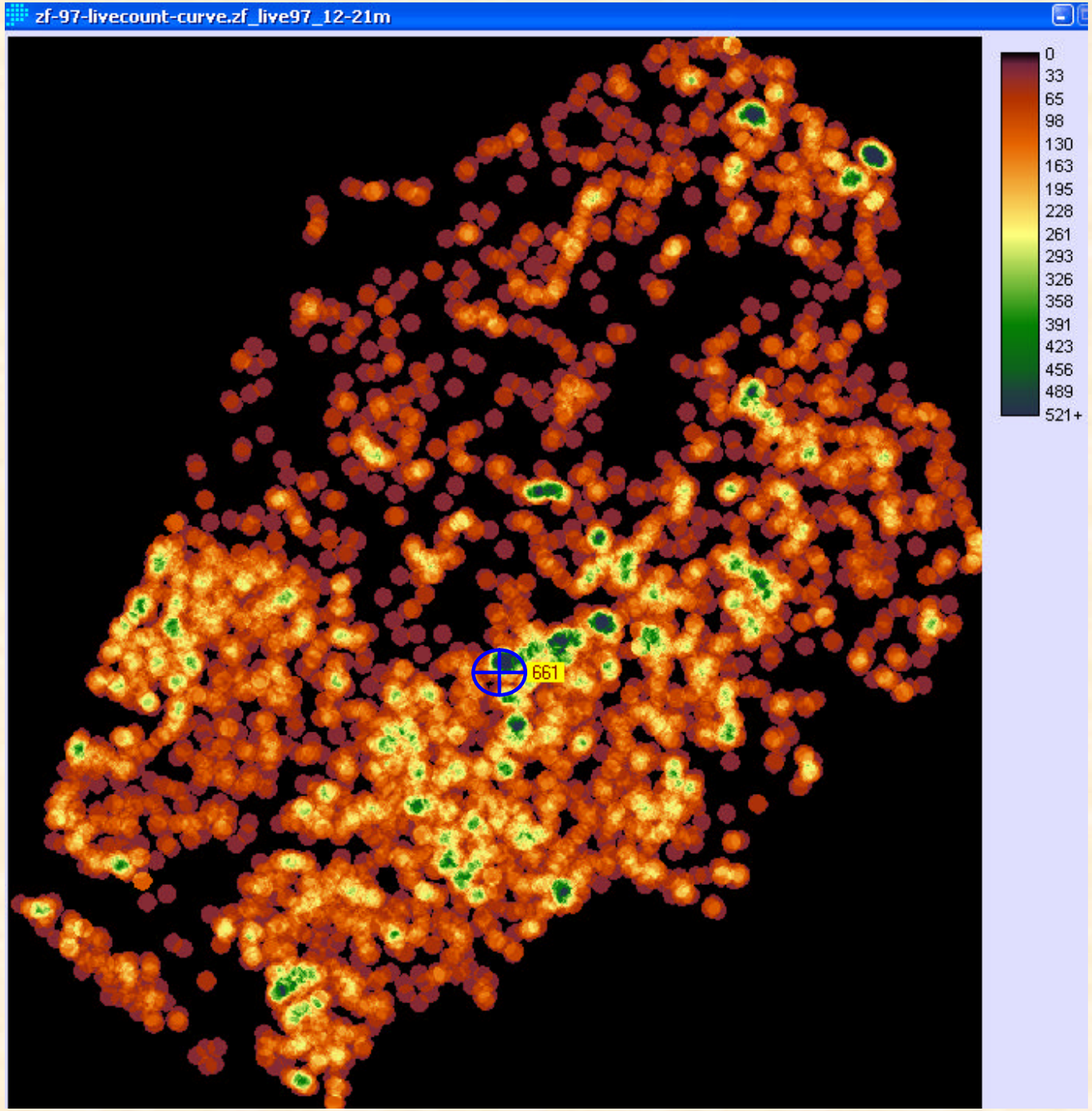

Feature Properties

Attribute	Value
zf_live97_12-21m	661
zf_live97_34-21m	90
zf_live97_56-21m	30
zf_live97_78-21m	0
zf_live97_916-21m	0

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zf_live97_12-21m	
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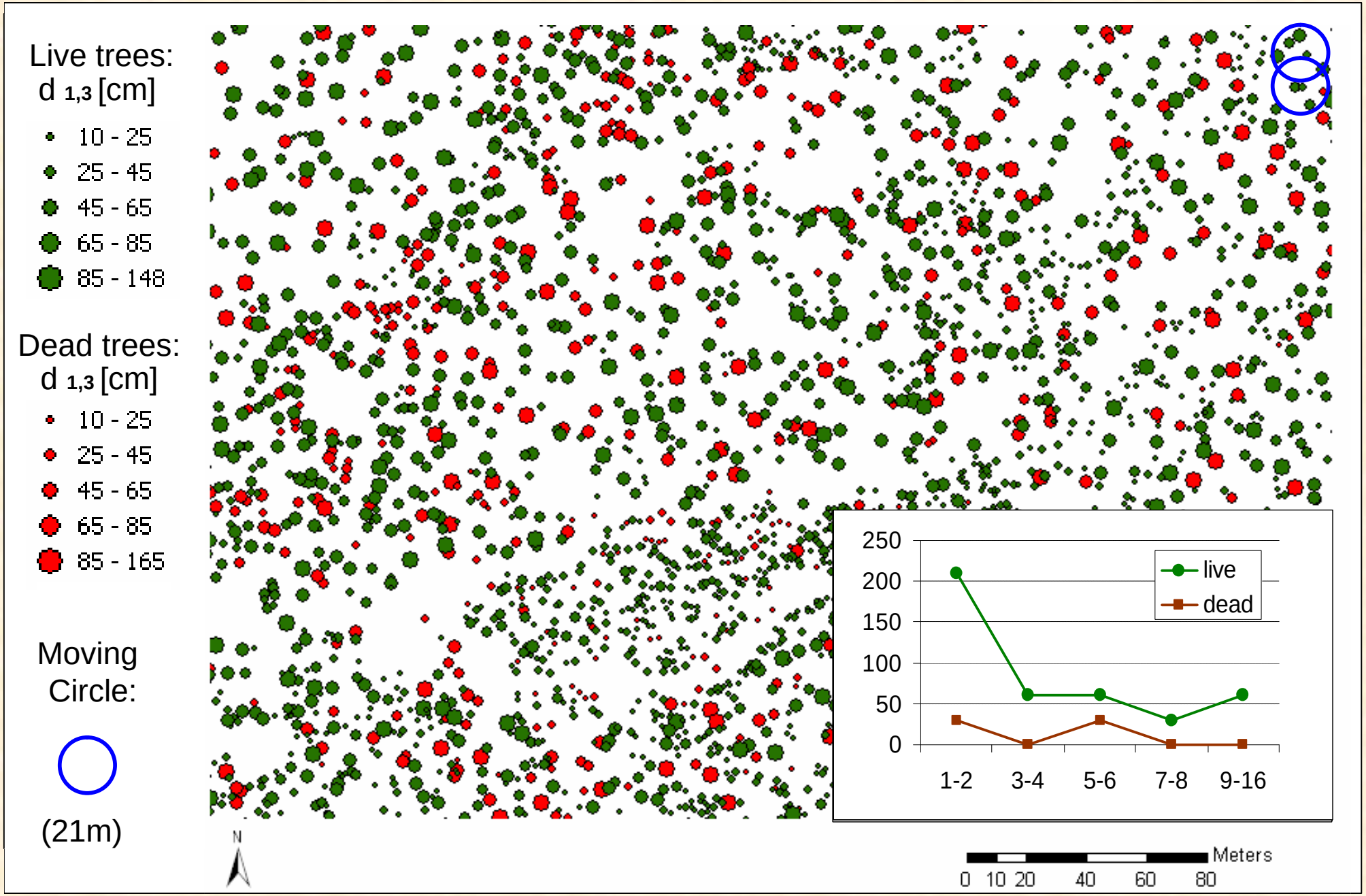
Method of the moving filter



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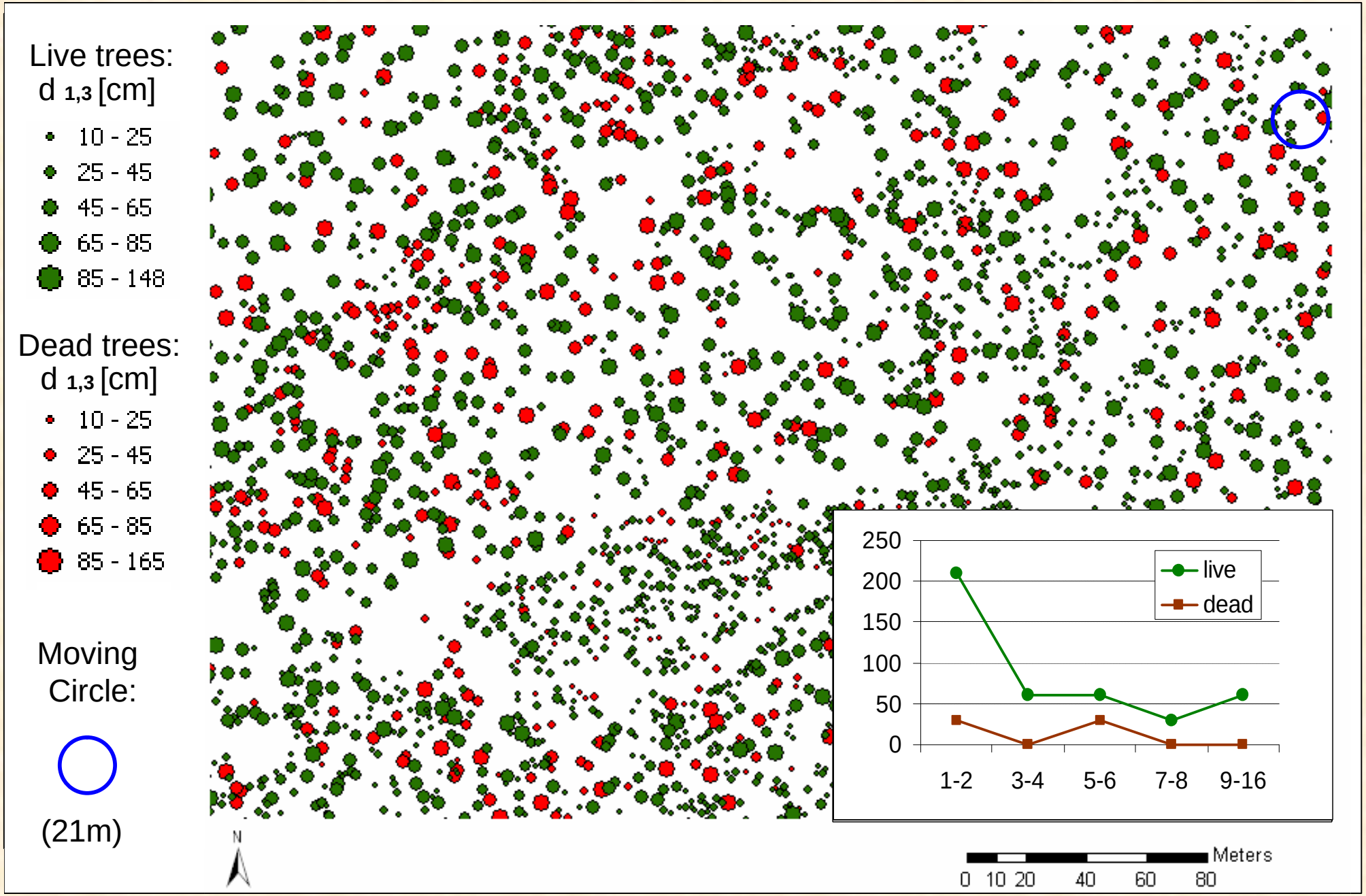

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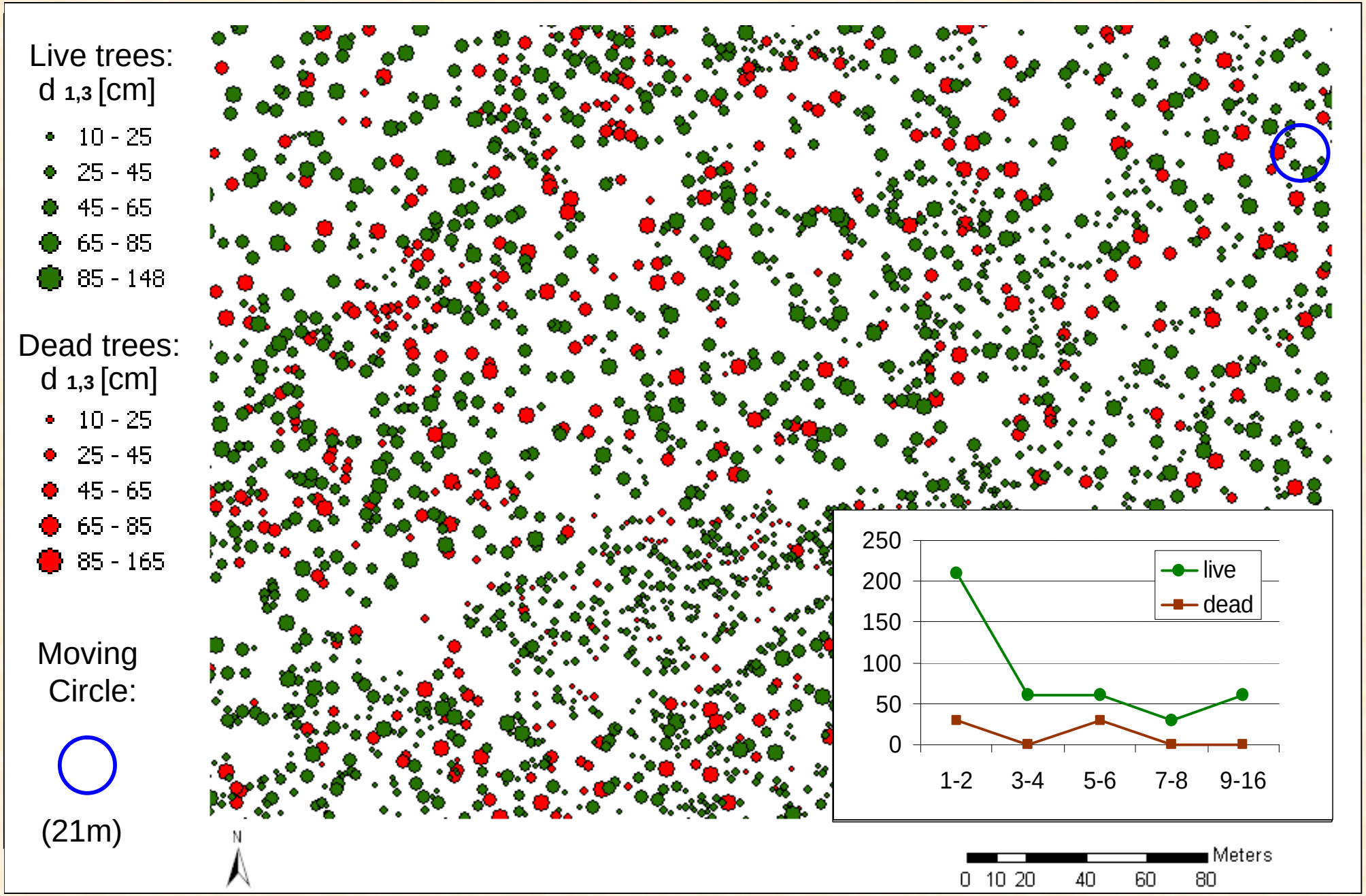
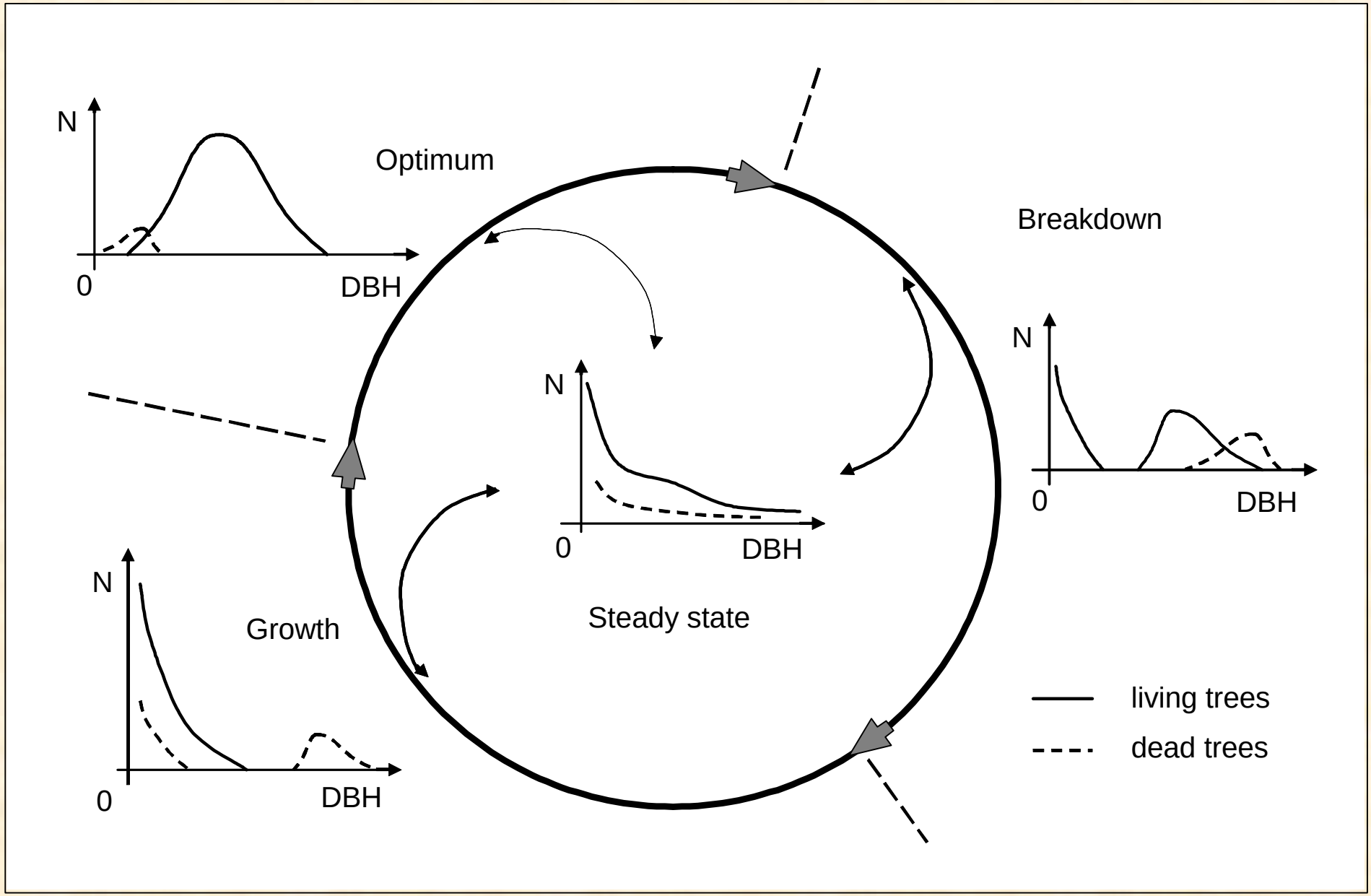
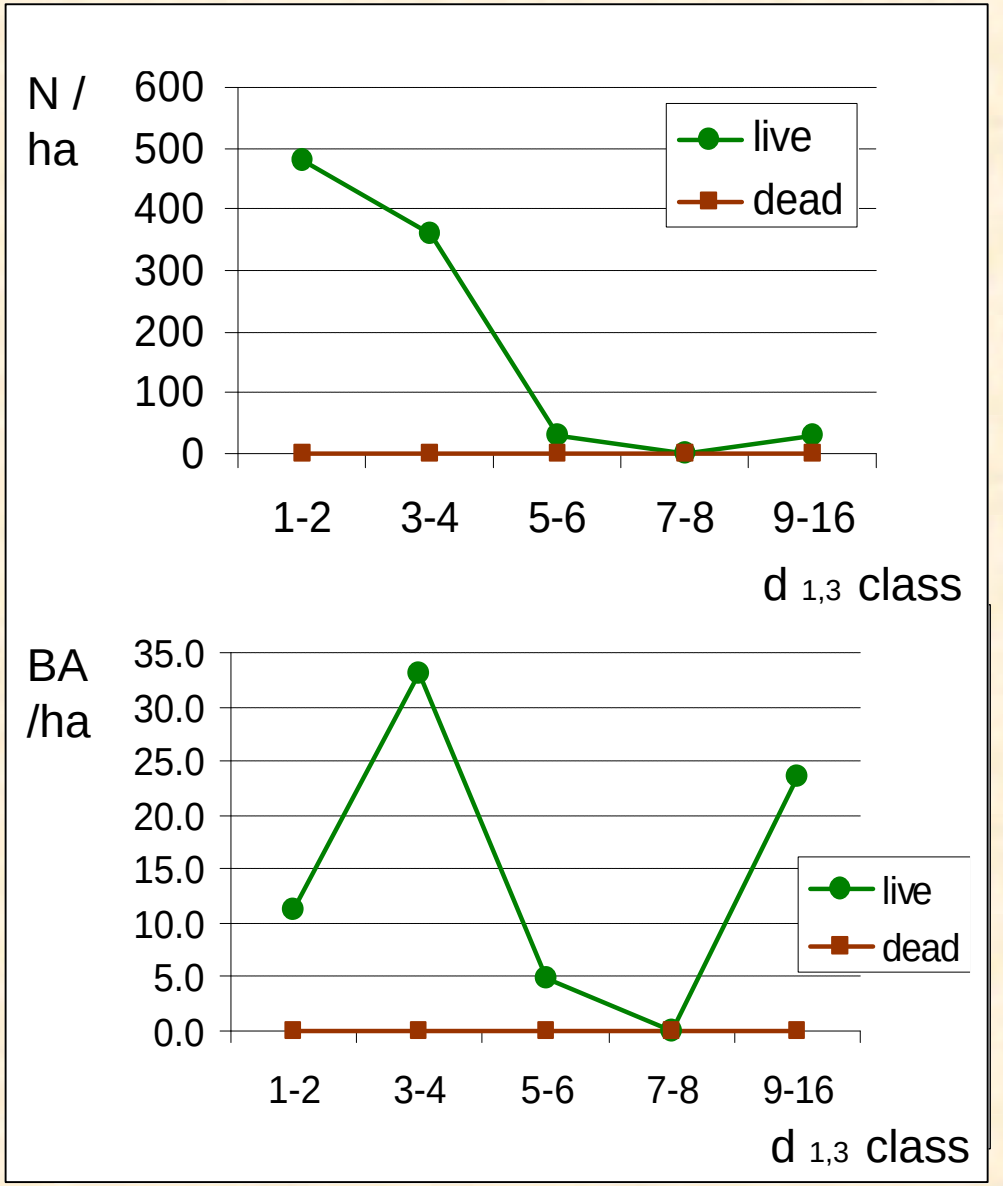


- **700 000 diameter distribution curves (as a result of filtering)**
  - ➢ how to classify them ?



Determination of classes

- **Stage of growth, phase of expiration**
- Stage of growth
- Stage of optimum
- Stage of optimum, terminal phase
- Stage of disintegration
- Stage of disintegration, phase of regeneration
- Stage of “Maximum Stability”



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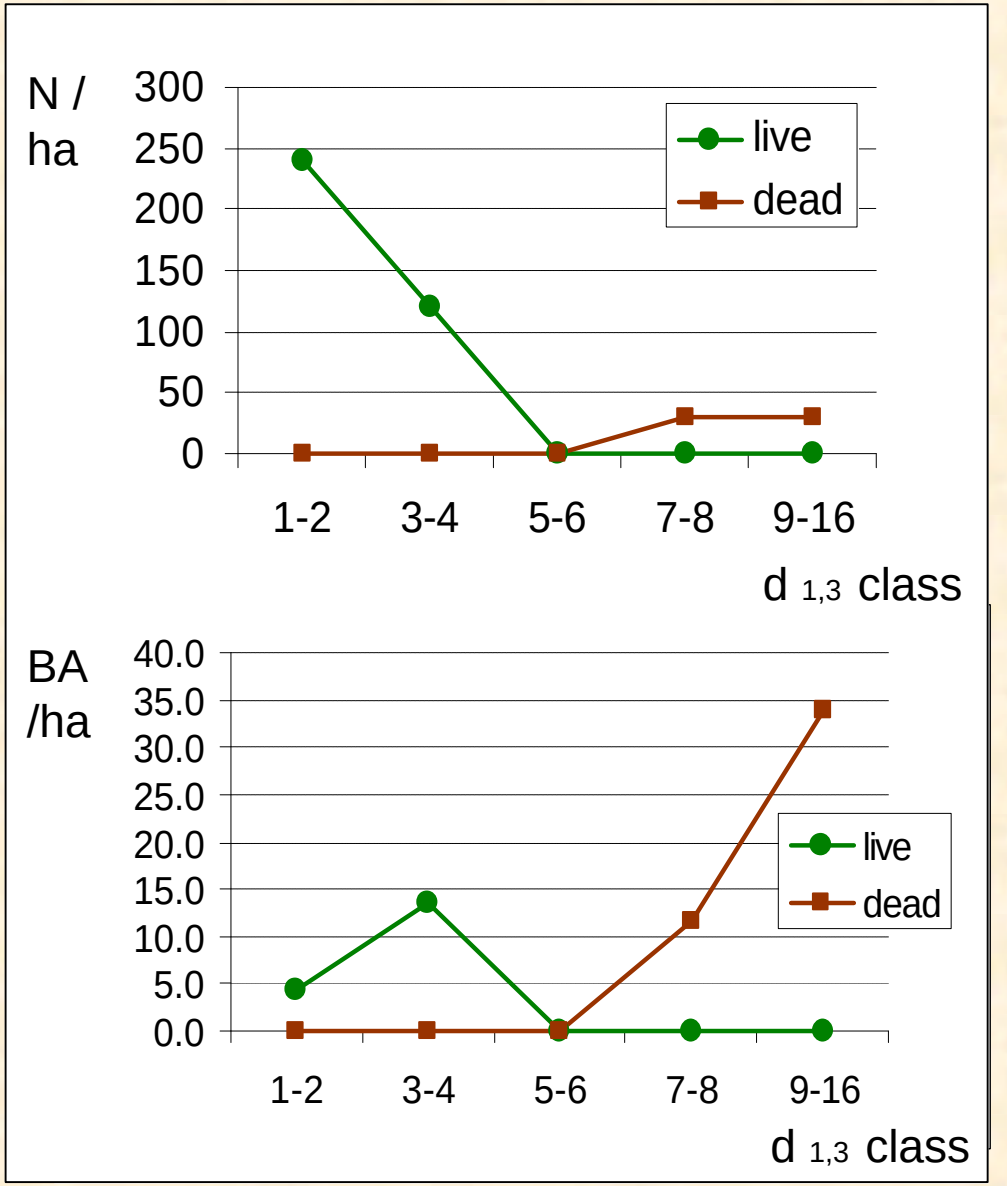

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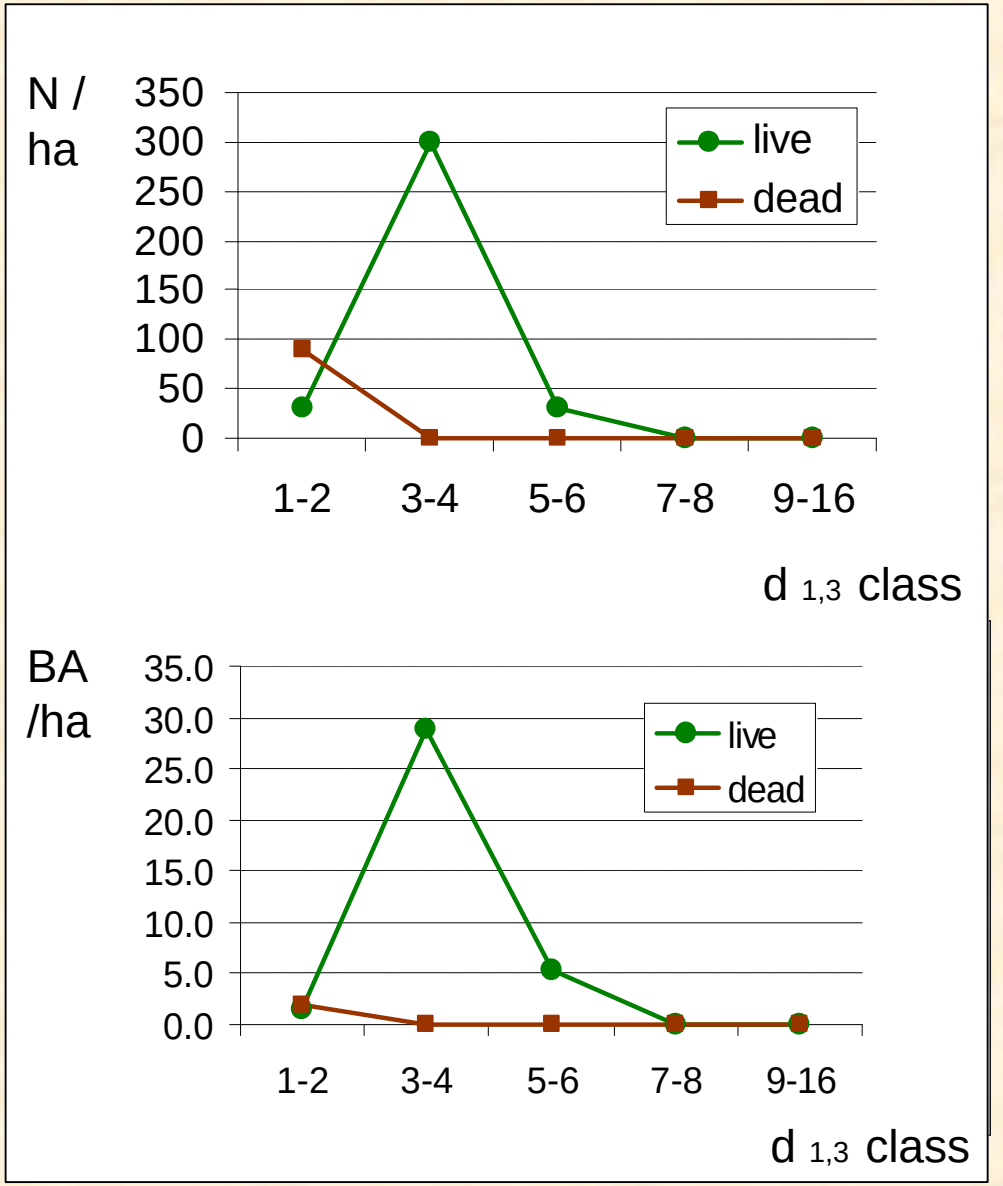

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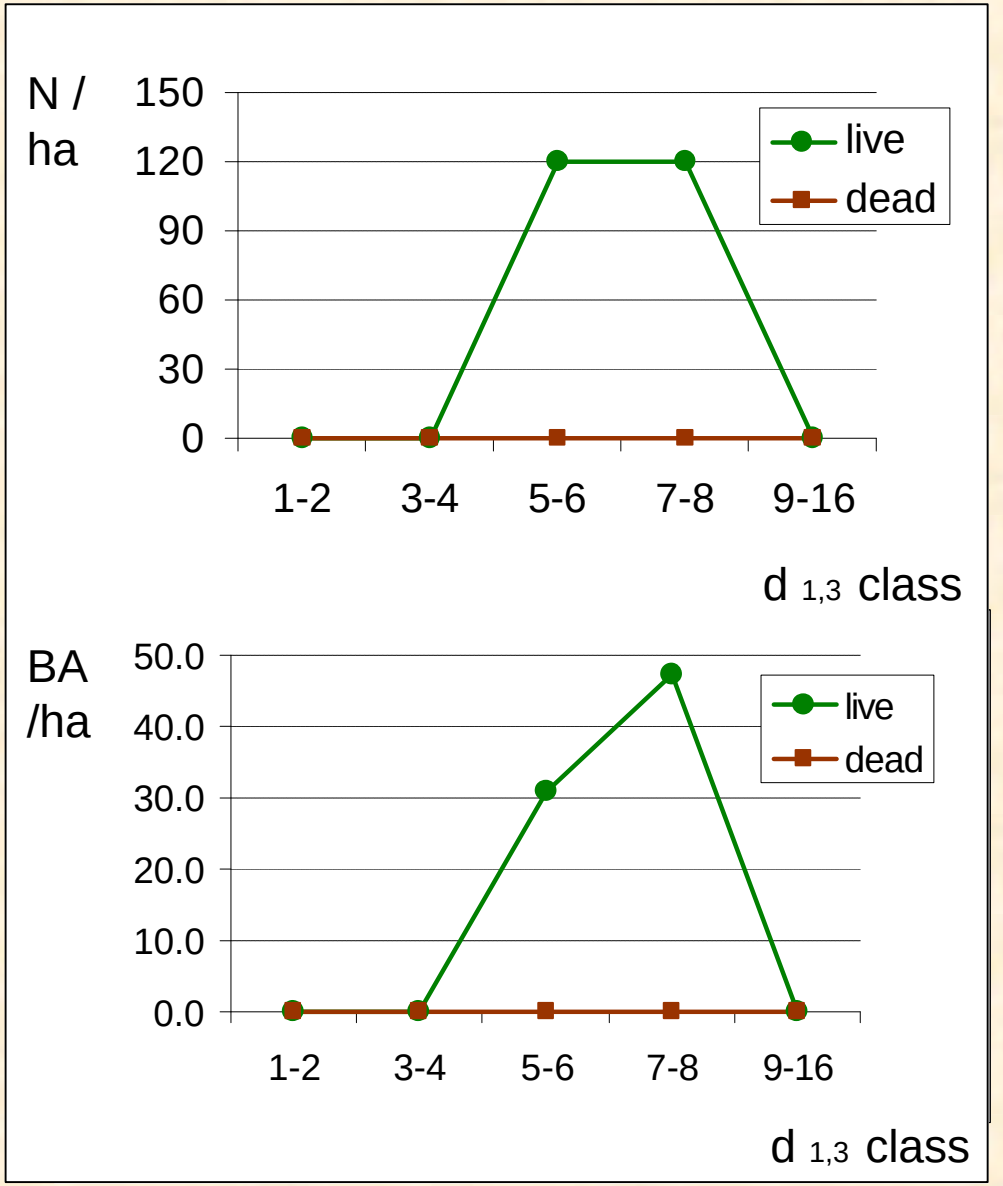

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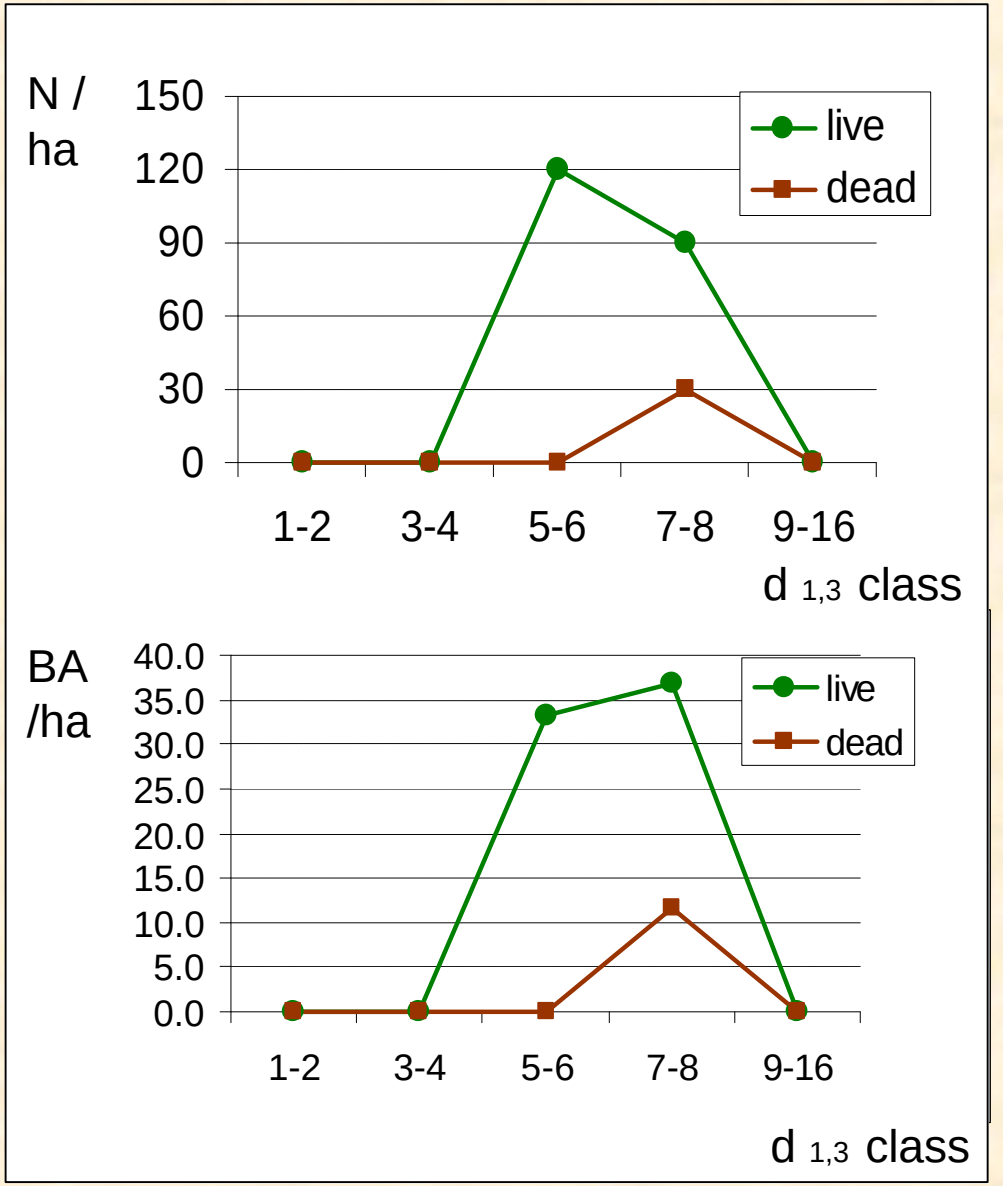

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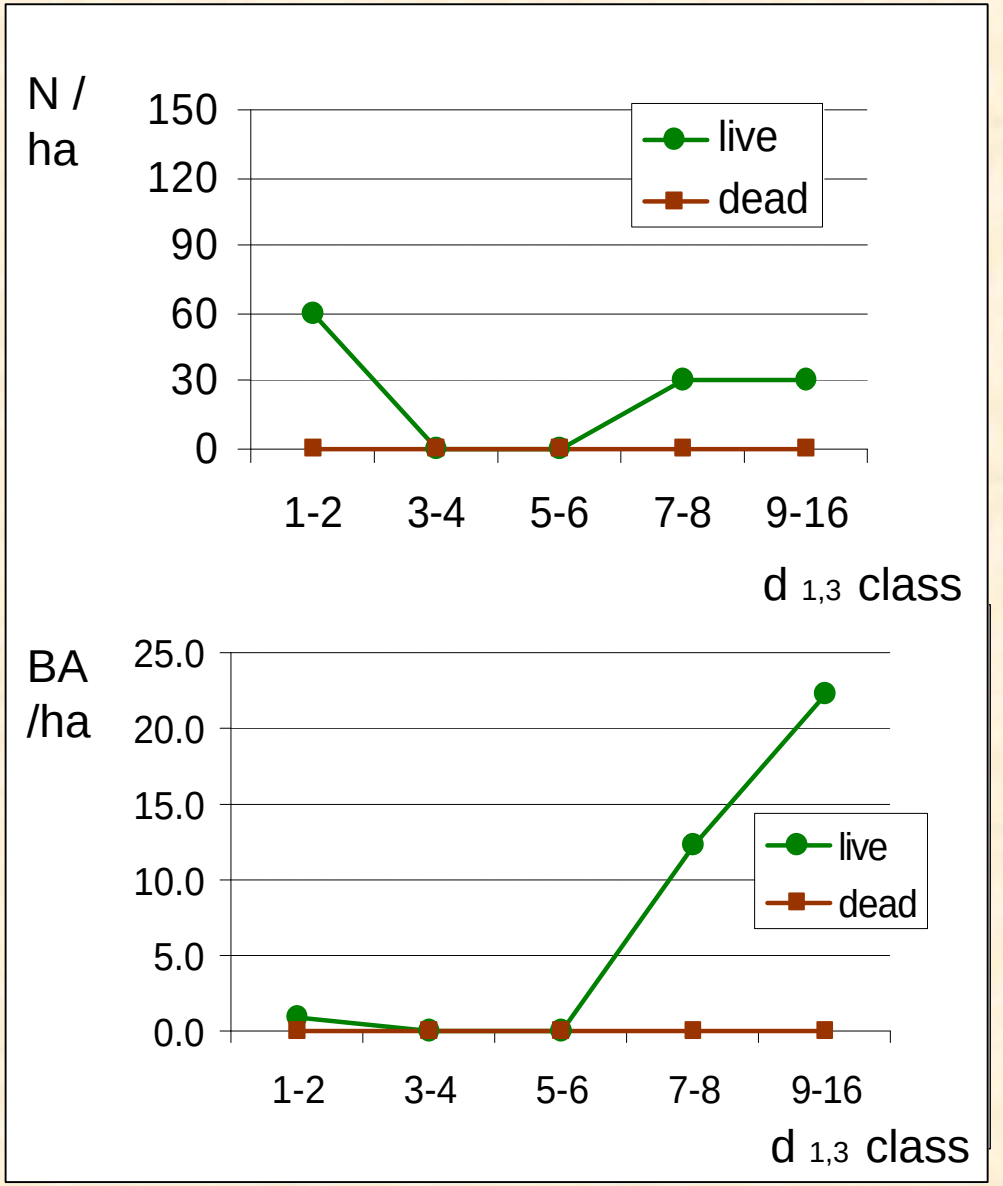

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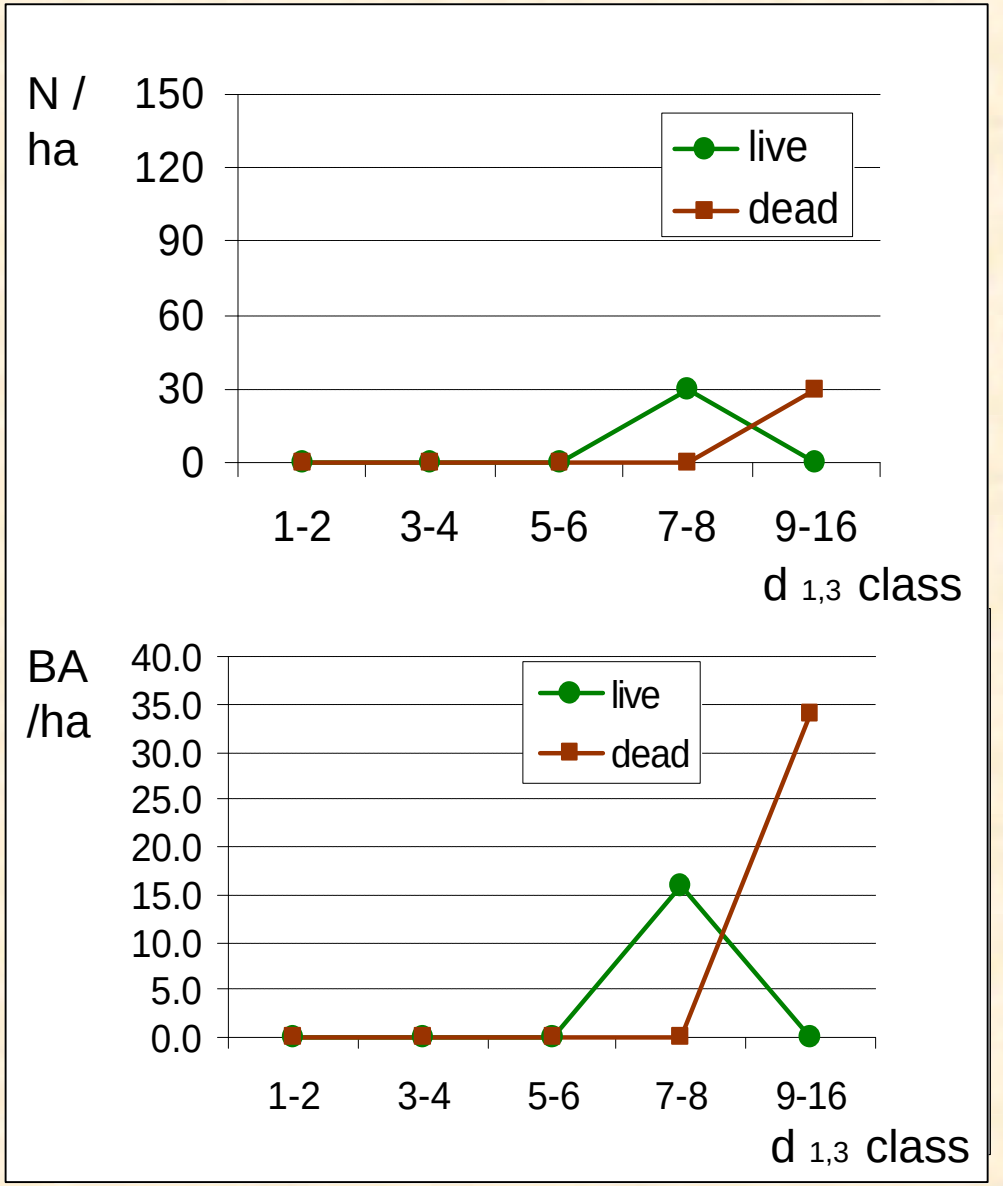

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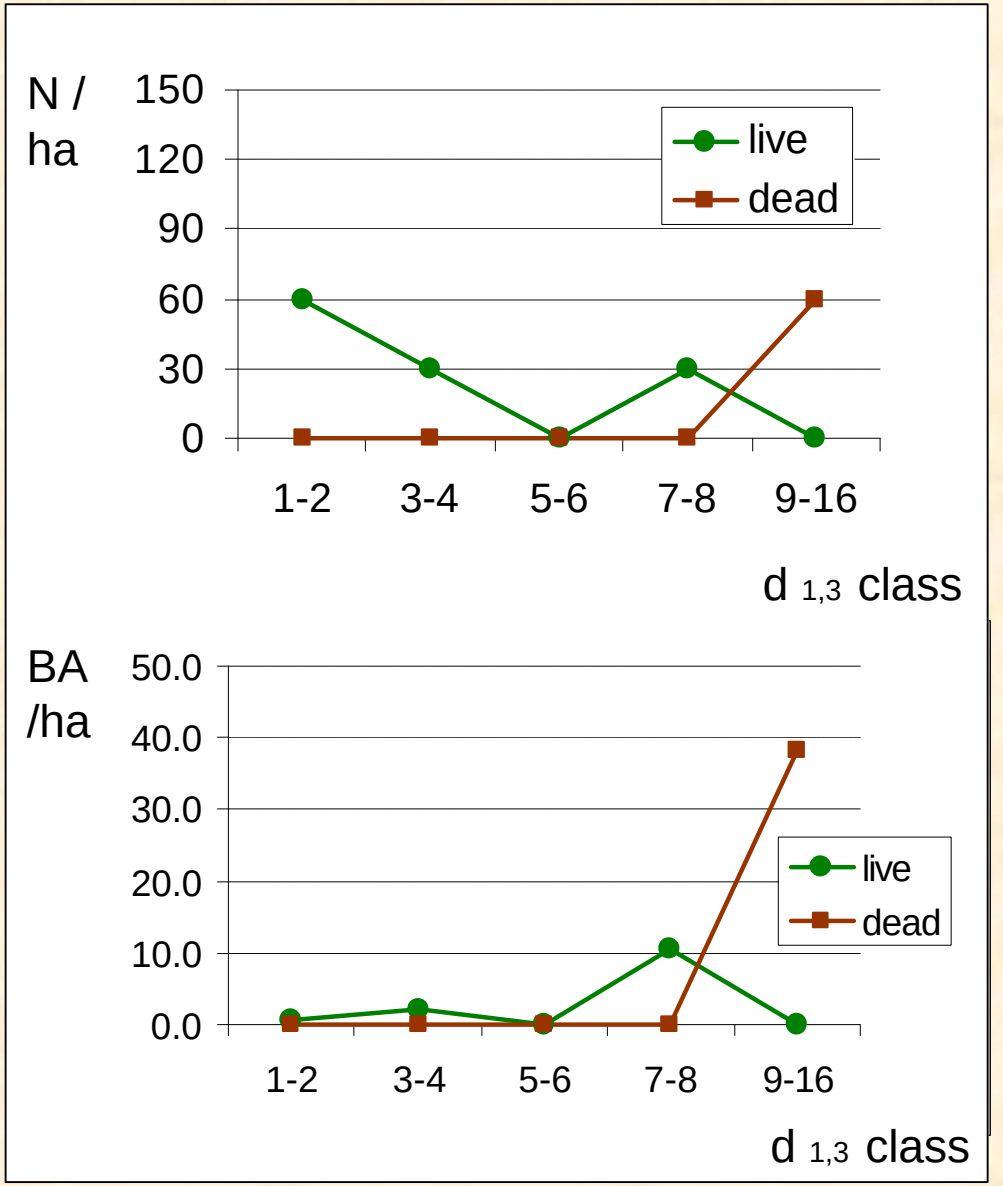

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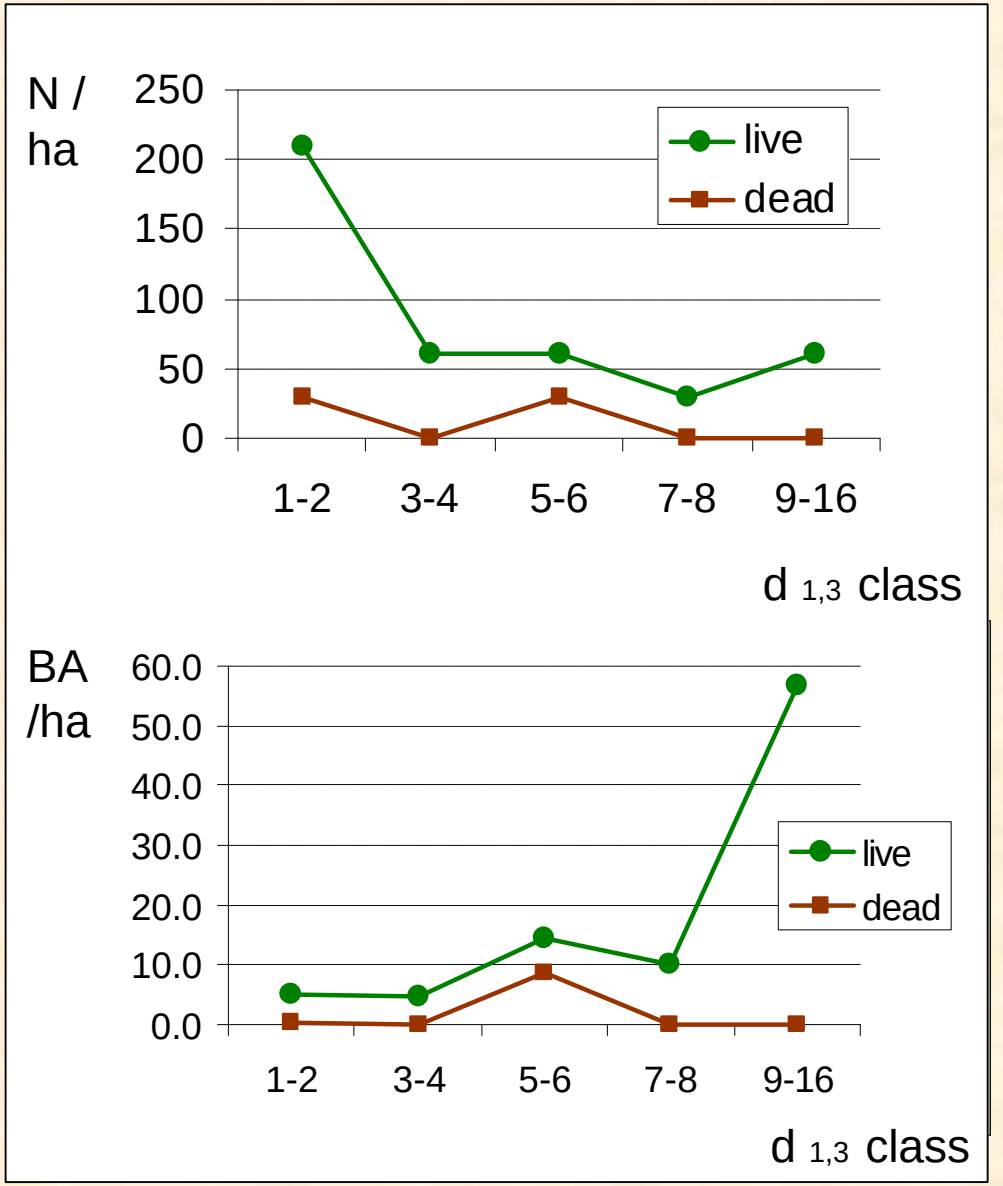
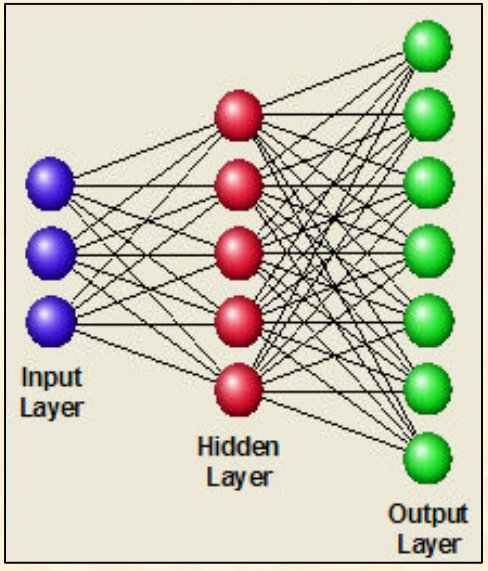


Classification using ANN
(Artificial Neural Network)

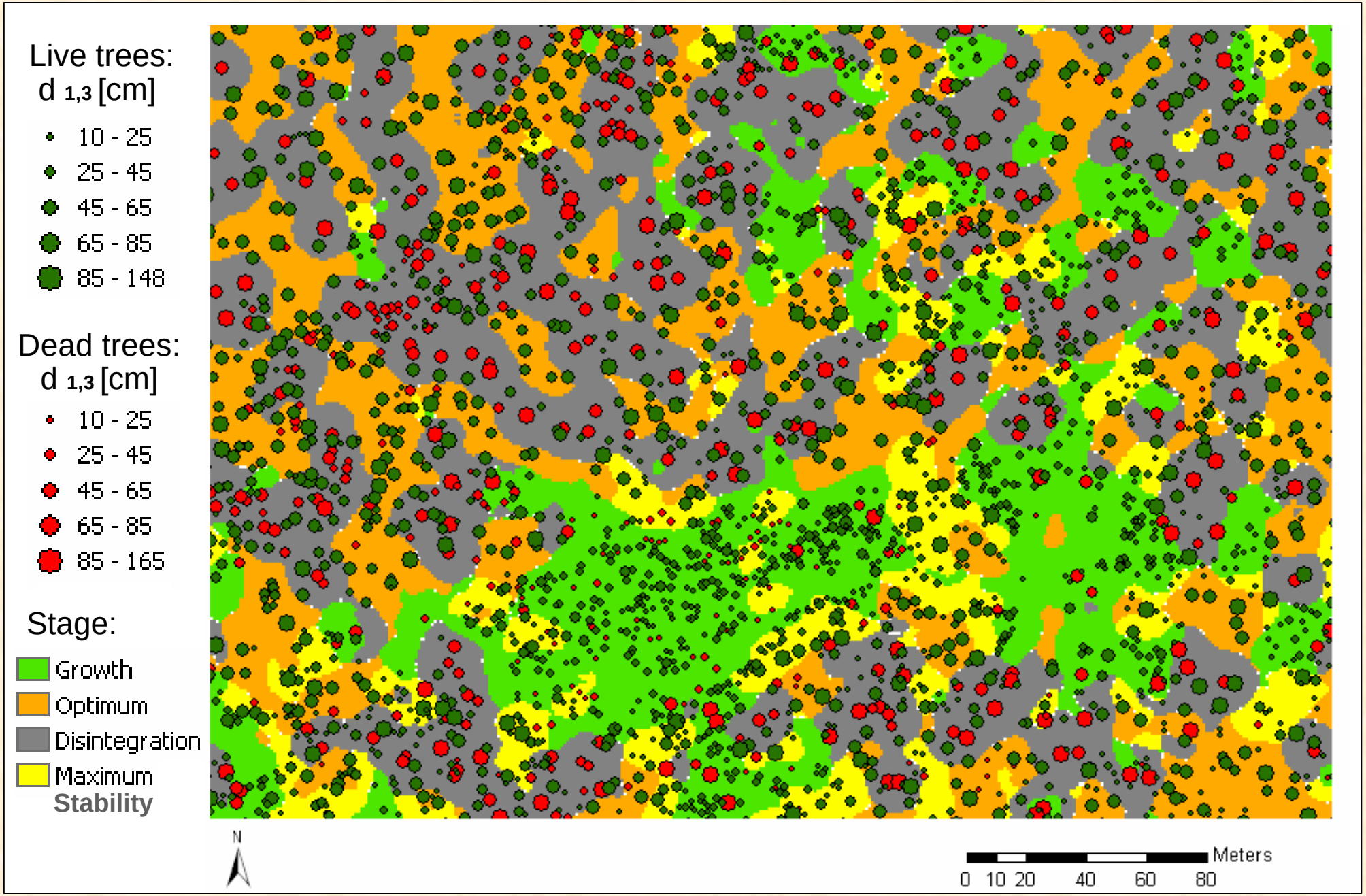
- Software IDRISI
- Multi-Layer Perceptron Architecture
- Back Propagation Algorithm



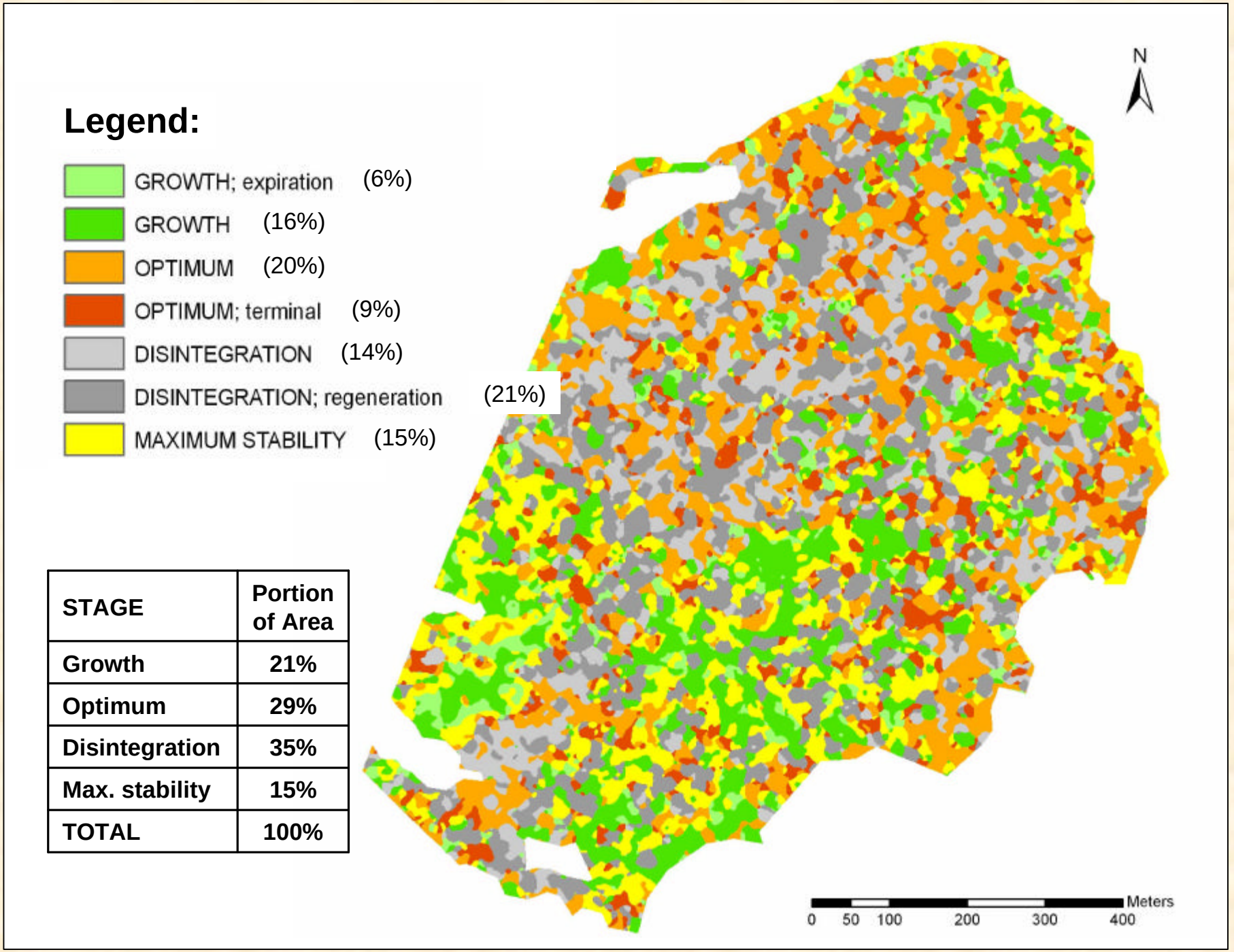
- Training of the Neural Network:
  - ➢ 20 typical training curves for every class (10 for learning; 10 for testing)

- Classification after training:
  - ➢ Map outputs

Classification using ANN



Resulting map of developmental stages and phases



STAGE	Portion of Area
Growth	21%
Optimum	29%
Disintegration	35%
Max. stability	15%
TOTAL	100%

Resulting map of developmental stages

Legend:

ANN classification:

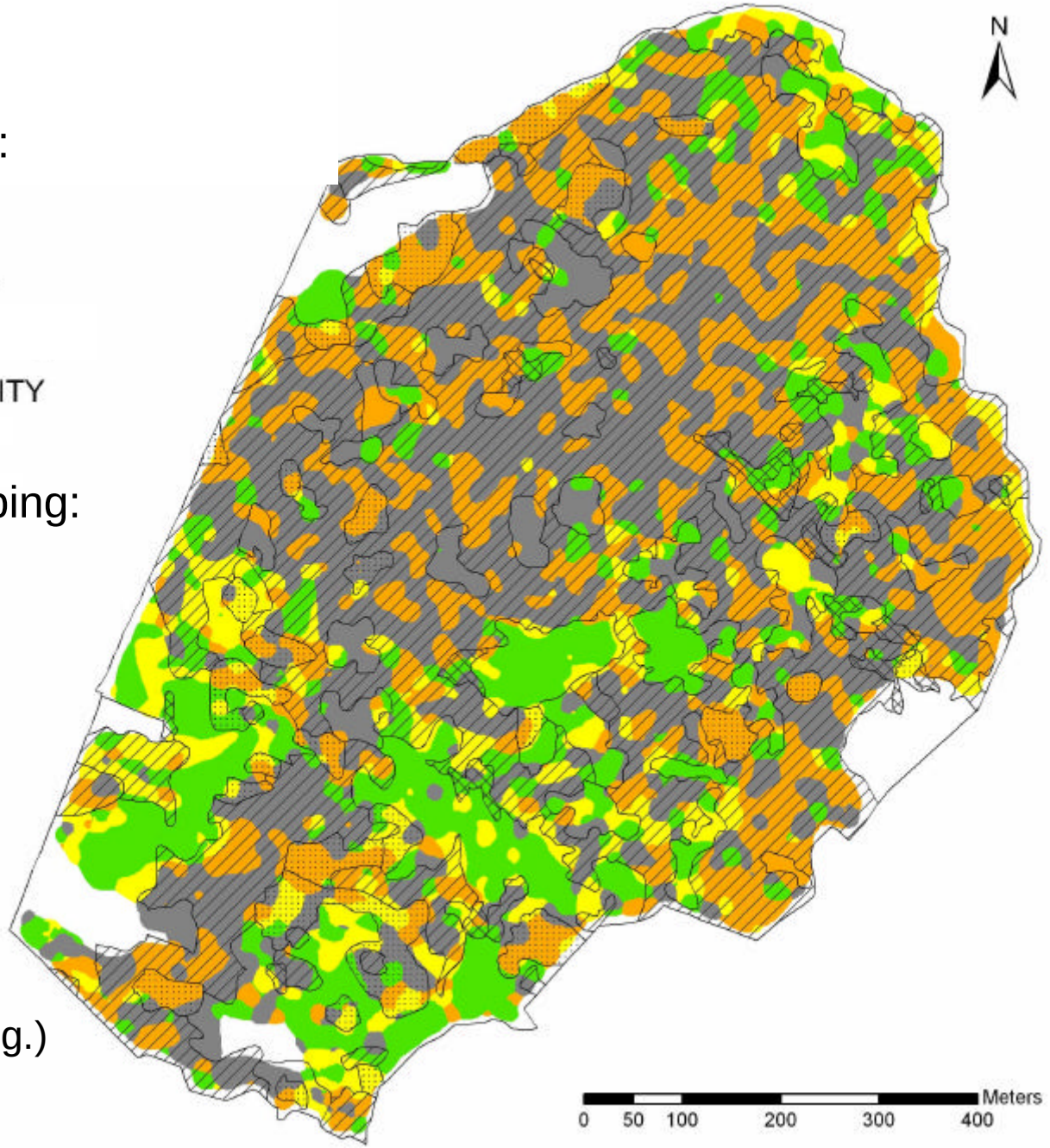
- GROWTH
- OPTIMUM
- DISINTEGRATION
- MAXIMUM STABILITY

Original field mapping:

- Growth
- Optimum
- Disintegration

Field-mapping problems:

- scale (optimum. vs. disinteg.)
- disinteg. vs. growth



Accuracy Assessment of the ANN Classification

Error Matrix for developmental phases			Reference Data									
			1	2	3	4	5	6	7	8	Total	User's
			G exp	G1	G2	O	O ter	D	D reg	M.S.	Class.	Accuracy
Classified data	1	GROWTH, expiration	7	1	2	0	4	0	1	8	23	**30.4%**
	2	GROWTH 1	3	21	0	0	0	0	1	1	26	**80.8%**
	3	GROWTH 2	0	1	23	3	0	0	0	0	27	**85.2%**
	4	OPTIMUM	0	0	0	25	9	0	0	7	41	**61.0%**
	5	OPTIMUM, terminal	0	0	0	0	9	0	0	0	9	**100.0%**
	6	DISINTEGRATION	0	1	0	0	5	16	5	0	27	**59.3%**
	7	DISINT., regeneration	0	2	0	0	0	0	16	1	19	**84.2%**
	8	MAXIMUM STABILITY	0	1	1	0	3	0	0	13	18	**72.2%**
		Total Reference	10	27	26	28	30	16	23	30	190	**Glob. Acc.**
		Producer's Accuracy	**70%**	**78%**	**88%**	**89%**	**30%**	**100%**	**70%**	**43%**		**68.4%**

Error Matrix for developmental STAGES			Reference Data					
			1	2	3	4	Total	User's
			Growth	Opt.	Disin.	M.S.	Class.	Accur.
Classification	1	GROWTH	58	7	2	9	76	**76.3%**
	2	OPTIMUM	0	43	0	7	50	**86.0%**
	3	DISINTEGRATION	3	5	37	1	46	**80.4%**
	4	MAX. STABILITY	2	3	0	13	18	**72.2%**
		Total Reference	63	58	39	30	190	**Glob. Acc.**
		Producer's Acc.	**92%**	**74%**	**95%**	**43%**		**79.5%**

Conclusions

- utilization of big amount of spatially explicit data
  - ➢ map of trees of Zofin forest reserve – a point GIS layer (70ha; 18 000 trees)
- prior selection of spatial scale, which is preserved during the whole mapping process
  - ➢ circle of 21m diameter was selected
- independent assessment of every particular site
  - ➢ tree parameters: coordinates, counts (DBH = 10 cm) and stand basal areas for both live and dead trees
- 1m step ! => incorporation of context and continuity
  - ➢ independent diameter distribution curve was carried out for every square meter of the reserve !

Thank you for your attention!