

**Biodiversity Monitoring Programme of
Russian Academy of Science
Center for Forest Ecology and Productivity of RAS**

**Assessment of vegetation diversity of the
North-Eastern forests in Kostroma region.
Upscaling vegetation data from forest-stand to
regional level**

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Soil Science of RAS**

Structure of the computer information-analytical system



Flowchart of vegetation diversity assessment



Обозначения: Д - деревья, К - кустарники, Т - травы

Steps of vegetation sample plots data proceeding to assess vegetation diversity at forest-stand level

- 1) расчет показателей разнообразия для каждого отдельного описания:_____
 - число видов по основным ярусам растительности,
 - число видов по жизненным формам (деревья, кустарники, травы),
 - общее число видов на площадке без повторов по ярусам,
 - число видов разных эколого-ценотических групп;
- 2) расчет экологических оценок описания по экологическим шкалам (Д.Цыганова, Г. Эленберга);
- 3) предварительная типизация описаний (по доминантам древостоя и доминирующей группе видов напочвенного покрова);
- 4) ординация описаний для выявления основных градиентов варьирования растительности;
- 5) уточнение типизации описаний;
- 6) расчет показателей разнообразия выделенных типов растительных сообществ:
 - общее число видов в целом в сообществе и в среднем на площадке,
 - число деревьев, кустарников и трав в целом в сообществе и в среднем на площадке,
 - число видов разных эколого-ценотических групп в целом в сообществе и в среднем на площадке,
 - коэффициенты флористического сходства между сообществами,
 - коэффициенты гетерогенности,
 - диапазоны и средние экологических факторов для сообществ;
- 7) оценка сукцессионного статуса выделенных типов сообществ

Number of vegetation sample plots in different forest types at the North-East of Kostroma region

	2003	2004	Всего
ельники, пихто-ельники			
PcBN	39	24	63
PcBr	15	35	50
PcGm	5	15	20
PcH	52	8	60
PcNB	30	29	59
PcS	5		5
PcVm	20	22	42
березняки			
BBN	3	8	11
BBr		12	12
BH	11		11
BNB	2	8	10
BVm	1	2	3

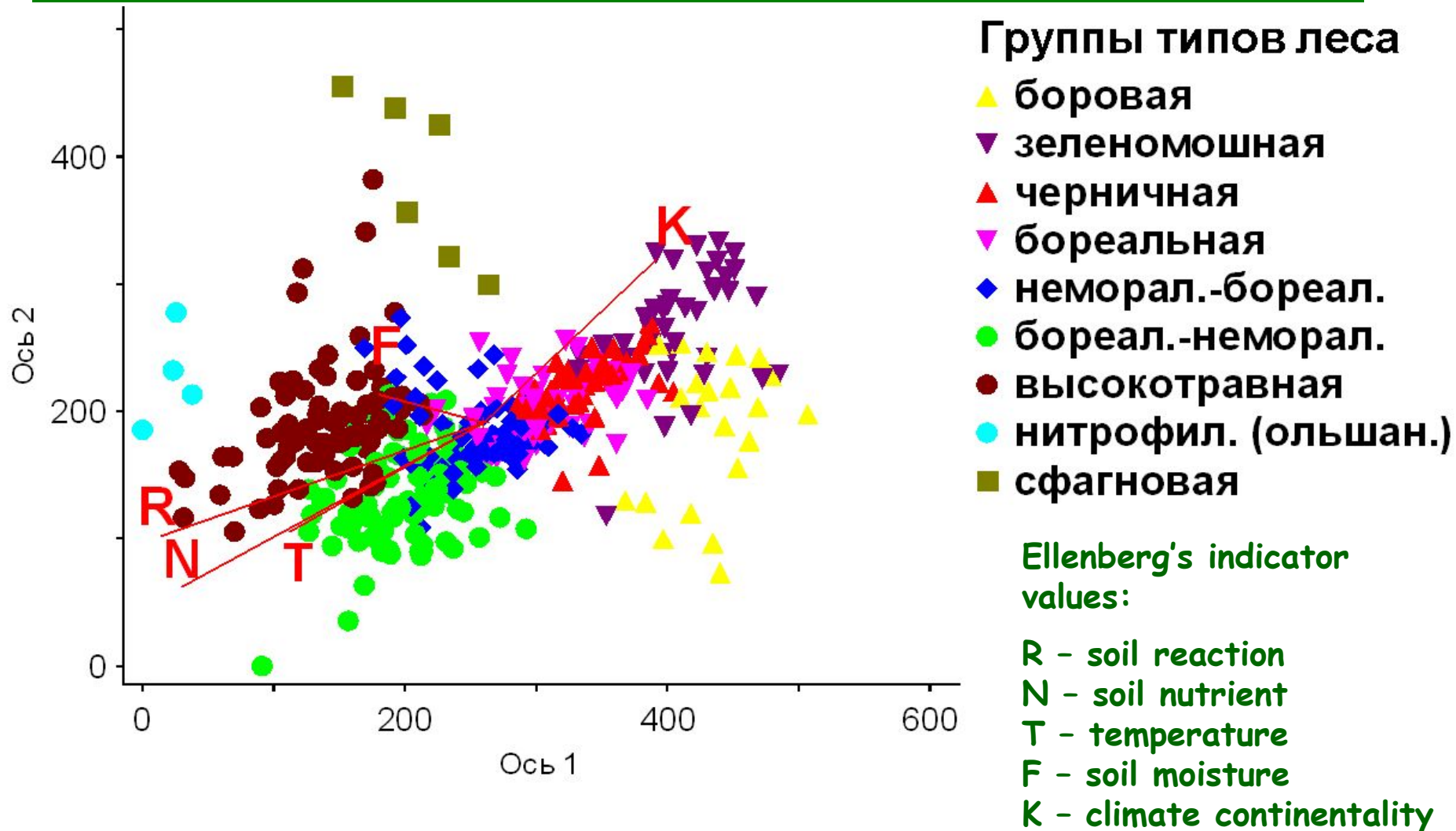
	2003	2004	Всего
сосняки			
PnBr	5		5
PnF		22	22
PnGm	8	13	21
PnNB	3		3
PnS	1		1
PnVm	8	2	10
осинники			
PpBN		18	18
PpBr		2	2
PpNB		3	3
липняки			
TBN		3	3
TH	6		6
ольшаники			
A	4		4

24 типа леса
444 описания

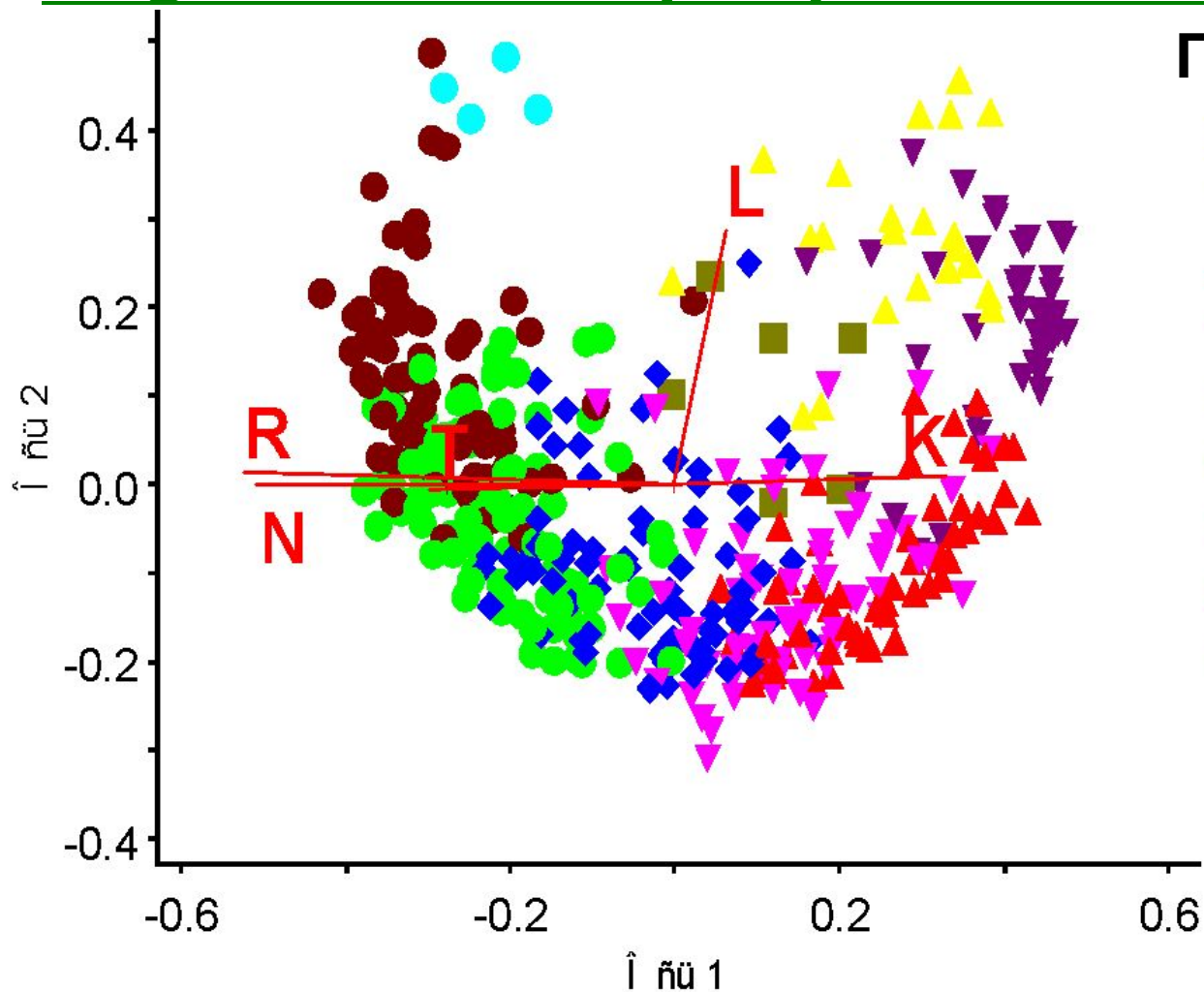
Number of phytosociological releves per forest type groups and per year

	F	Gm	Vm	Br	NB	BN	TH	Nt	S
2003		13	29	20	35	42	69	4	6
2004	22	28	26	49	40	53	8		
Всего	22	41	55	69	75	95	77	4	6

DCA ordination of the Kostroma vegetation sample plots



PCoA ordination of the Kostroma vegetation sample plots



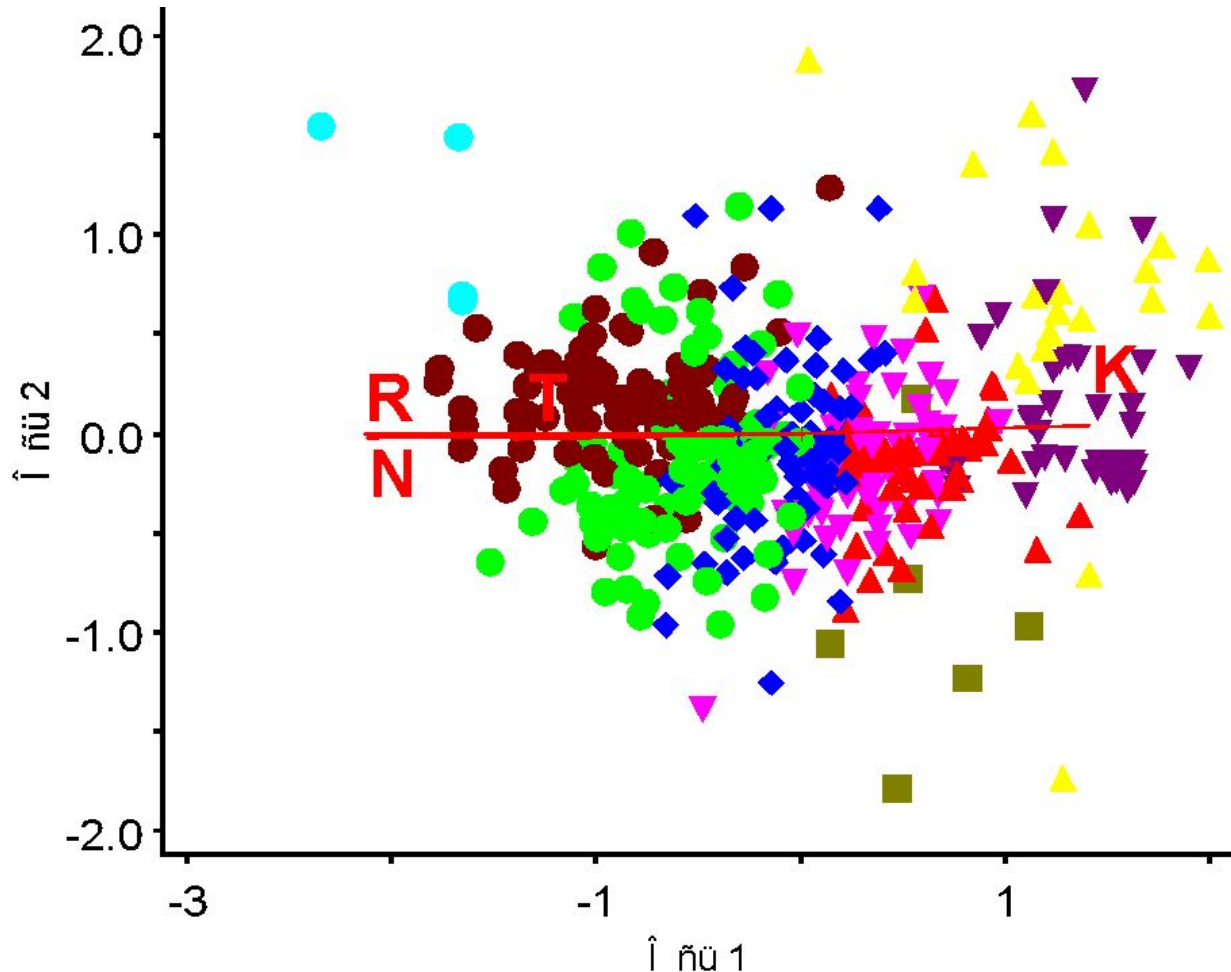
Группы типов леса

- ▲ áî õî âàÿ
- ▼ çãëáí î ì î ø í àÿ
- ▲ ÷ãõí è÷í àÿ
- ▼ áí õãàëüí àÿ
- ◆ í àì î õàë.-áí õãàë.
- áí õãàë.-í àì î õàë.
- âû ñî êî õãàáí àÿ
- í èõõî õ èë.(î ëüø áí .)
- ñõ àãí î âàÿ

Ellenberg's indicator values:

- R - soil reaction
- N - soil nutrient
- T - temperature
- F - soil moisture
- K - climate continentality

NMS ordination of the Kostroma vegetation sample plots



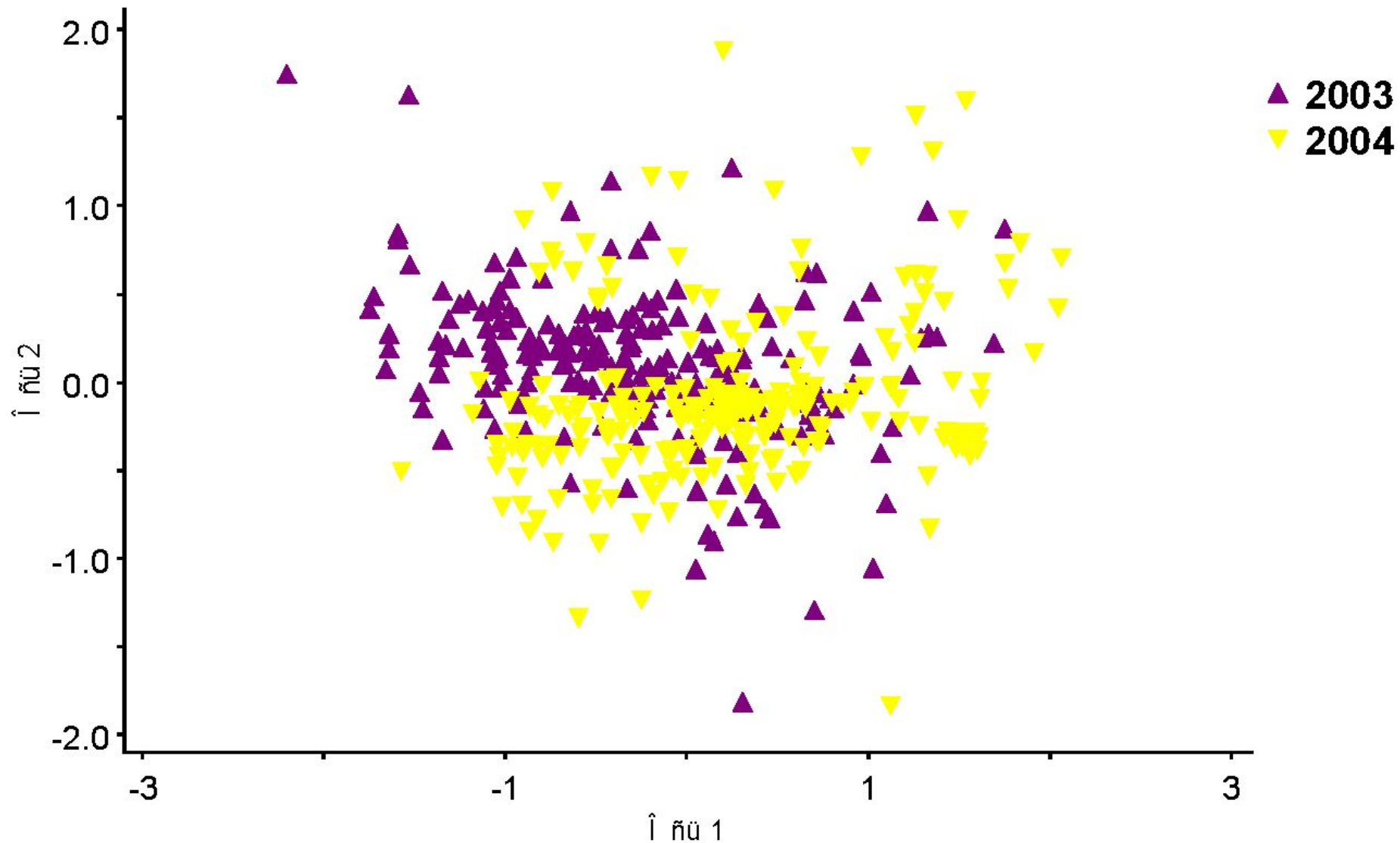
Группы типов леса

- ▲ áî õî âàÿ
- ▼ çãëáí î ì î ø í àÿ
- ▲ ÷ãõí è÷í àÿ
- ▼ áí õãàëüí àÿ
- ◆ í àí î õàë.-áí õãàë.
- áí õãàë.-í àí î õàë.
- âû ñî êí õõàáí àÿ
- í èõõî õ èë.(î ëüø áí .)
- ñõ àãí î âàÿ

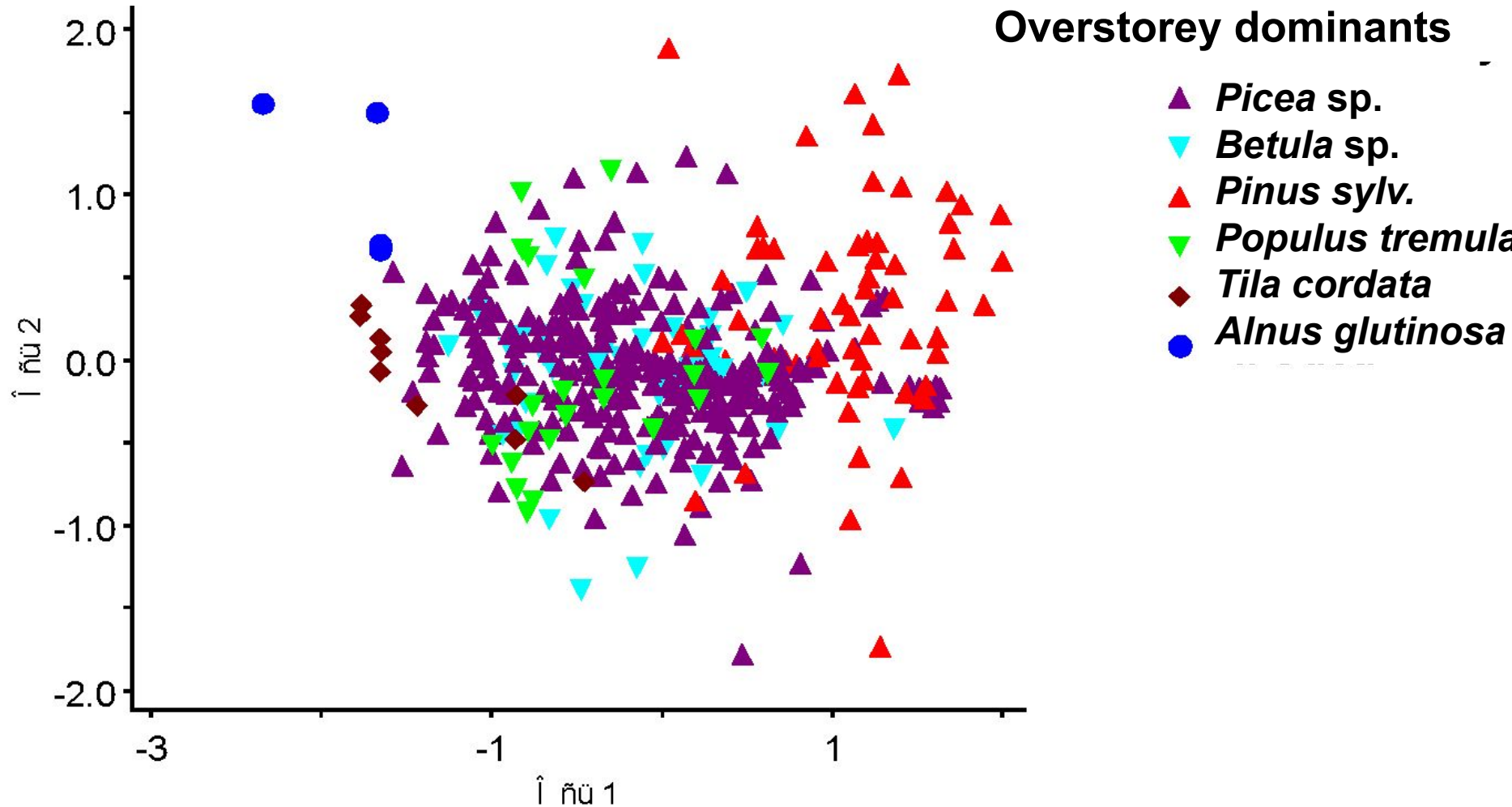
Ellenberg's indicator values:

- R - soil reaction
- N - soil nutrient
- T - temperature
- F - soil moisture
- K - climate continentality

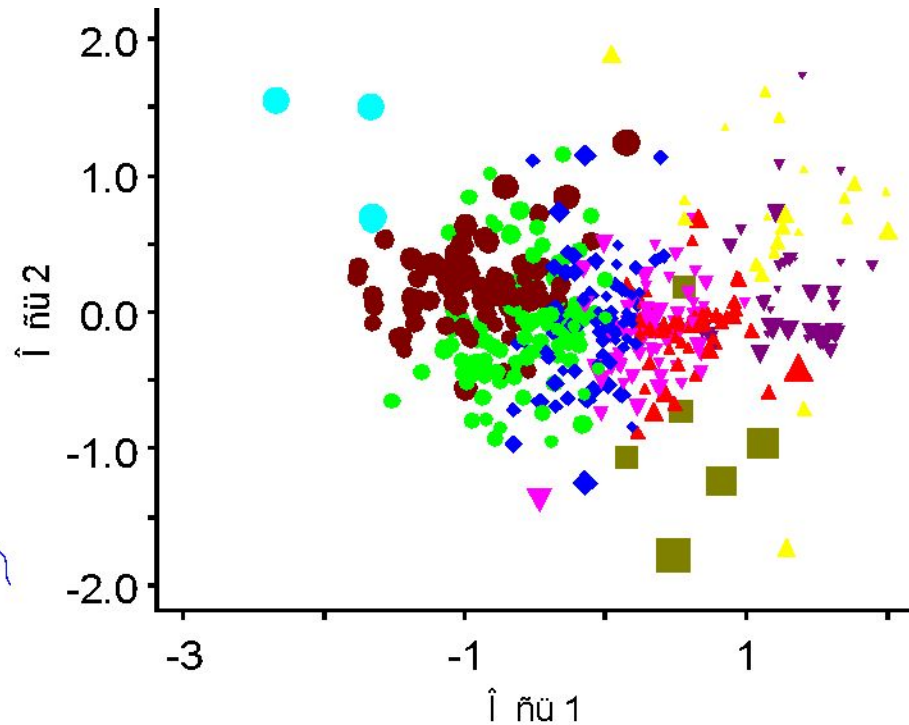
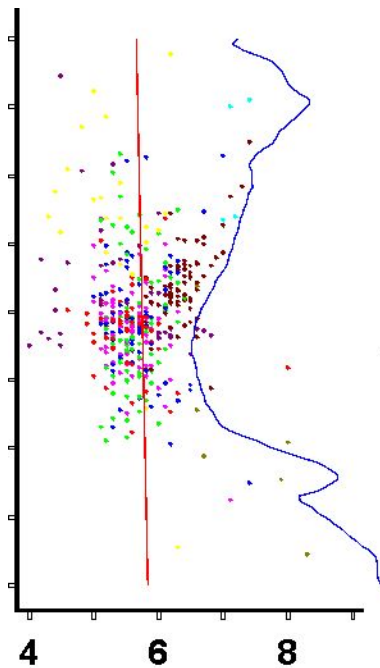
NMS ordination of the Kostroma vegetation sample plots



NMS ordination of the Kostroma vegetation sample plots



NMS ordination of the Kostroma vegetation sample plots with values F (soil moisture) overlay



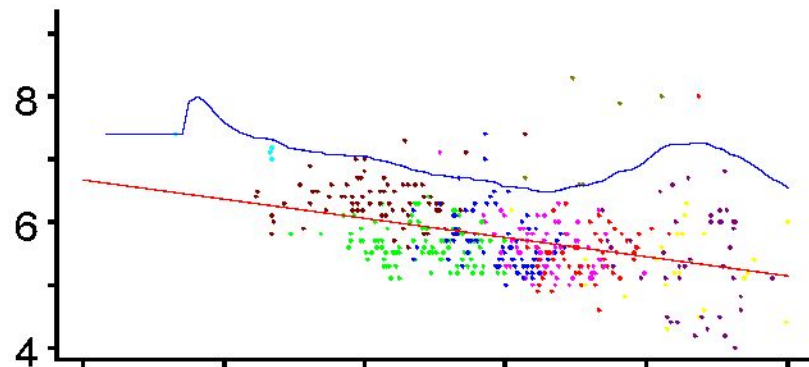
Groups

- F
- GM
- Vm
- Br
- NB
- BN
- TH
- Nt
- S

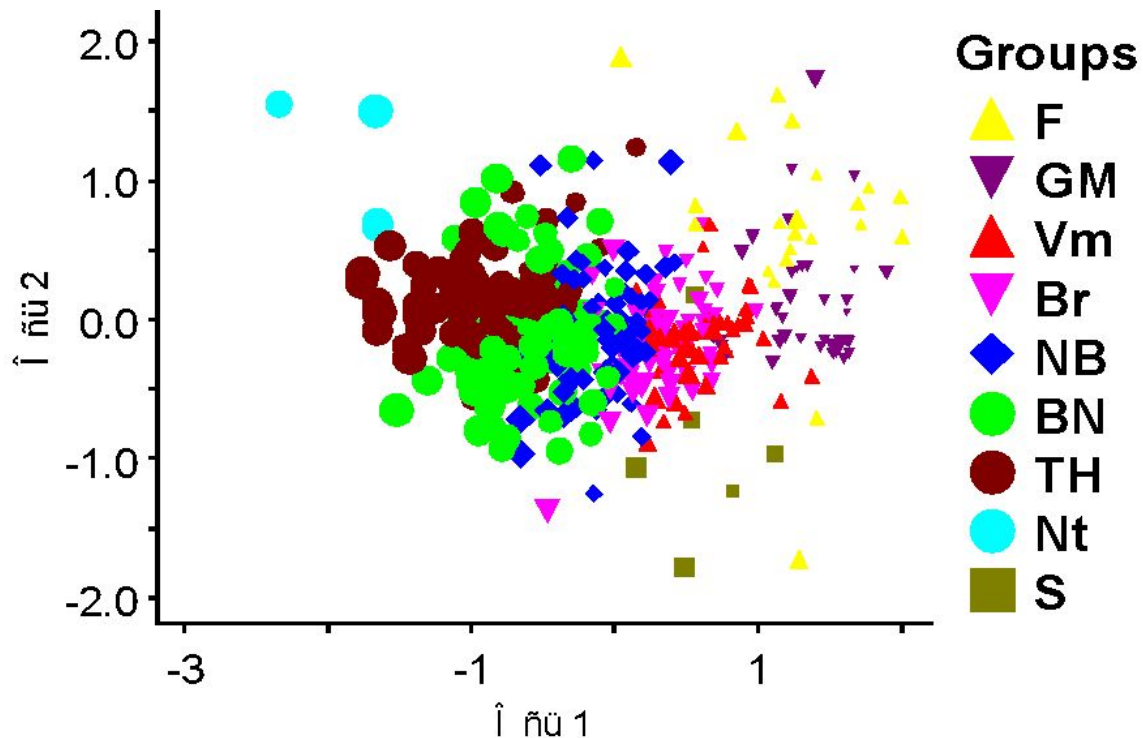
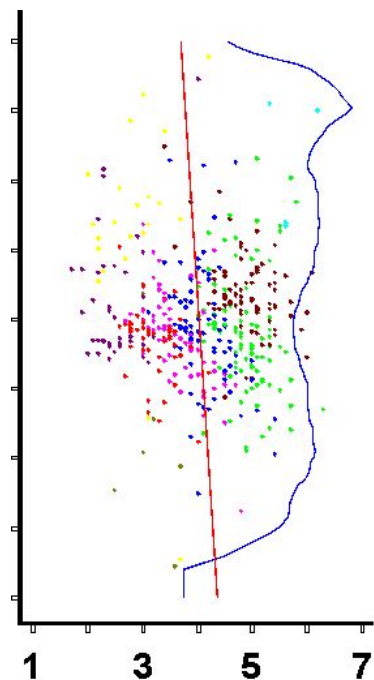
F

$\hat{\nu}_1$
 $r = -.413$ $\tau = -.323$

$\hat{\nu}_2$
 $r = -.040$ $\tau = .057$



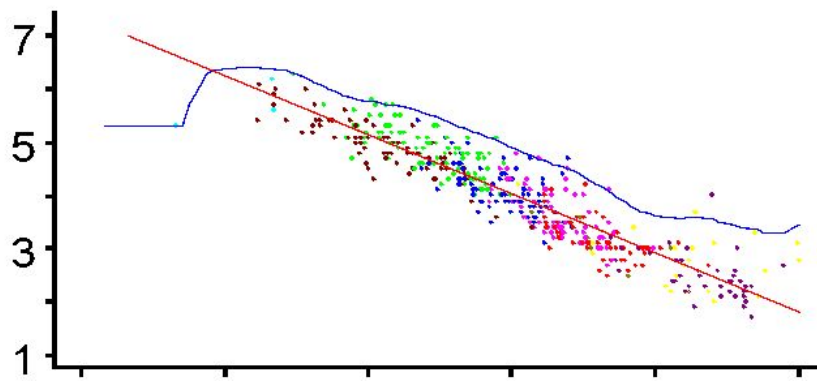
NMS ordination of the Kostroma vegetation sample plots with values N (soil nutrient) overlay



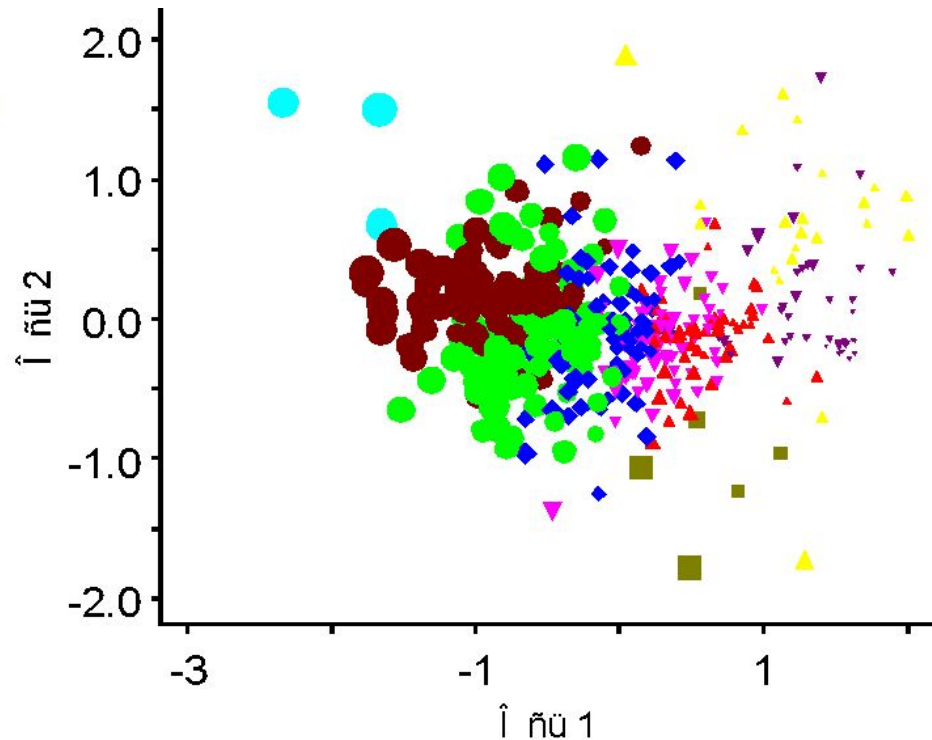
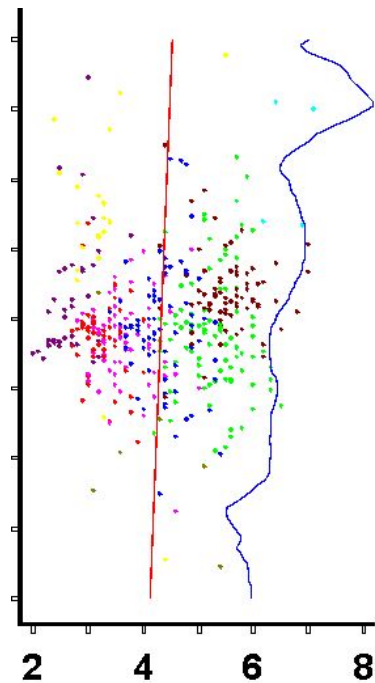
N

$\hat{\nu}_1$
 $r = -.923$ $\tau = -.792$

$\hat{\nu}_2$
 $r = -.085$ $\tau = -.057$



NMS ordination of the Kostroma vegetation sample plots with values R (soil reaction) overlay

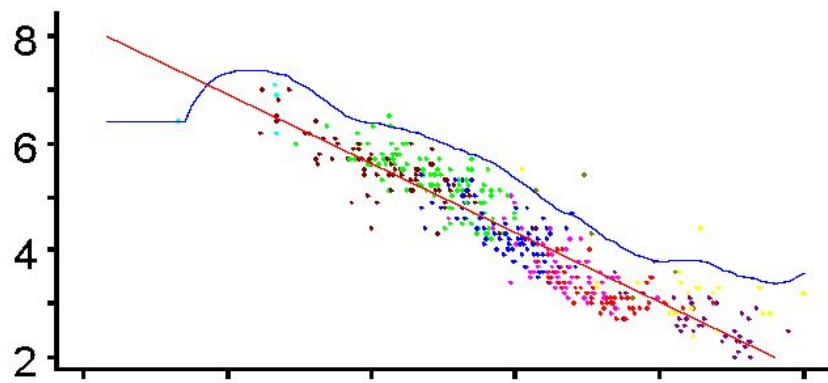


Groups

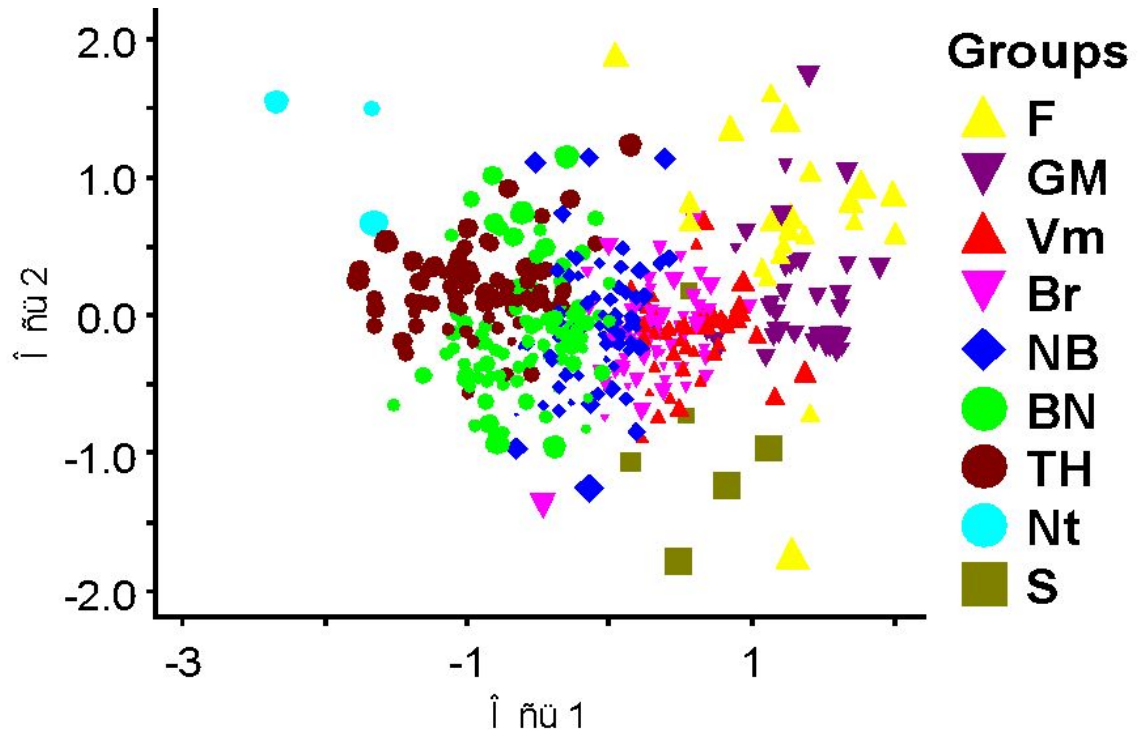
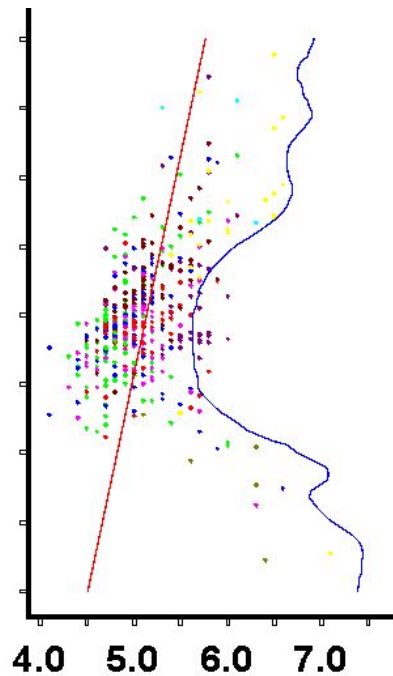
- ▲ F
- ▼ GM
- ▲ Vm
- ▼ Br
- ◆ NB
- BN
- TH
- Nt
- S

R

$\hat{\nu}_1$
 $r = -.924$ $\tau = -.802$
 $\hat{\nu}_2$
 $r = .040$ $\tau = .049$



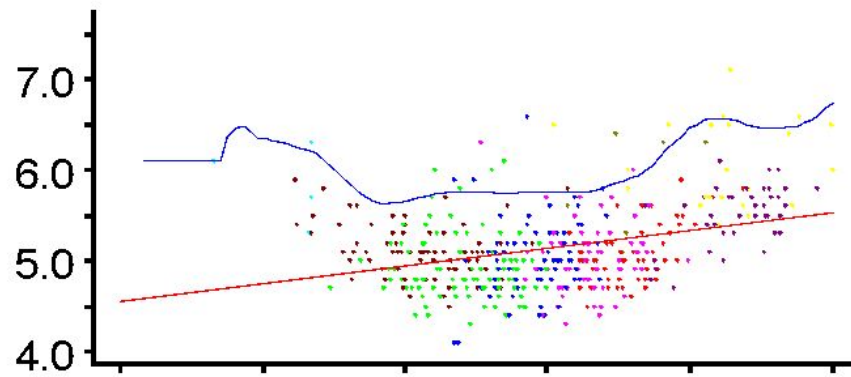
NMS ordination of the Kostroma vegetation sample plots with values L (light regime) overlay



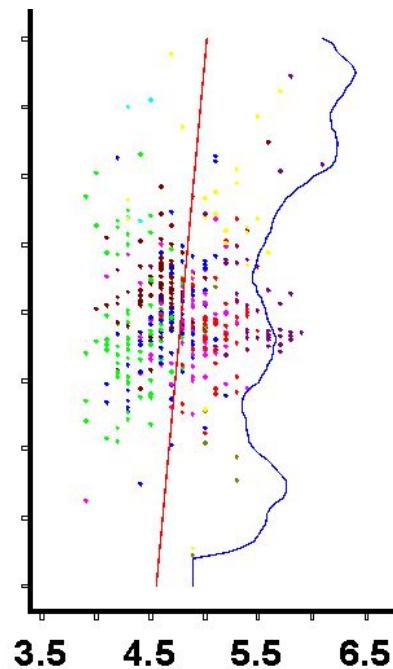
L

$\hat{\nu}_1$
r = .348 tau = .213

$\hat{\nu}_2$
r = .317 tau = .297



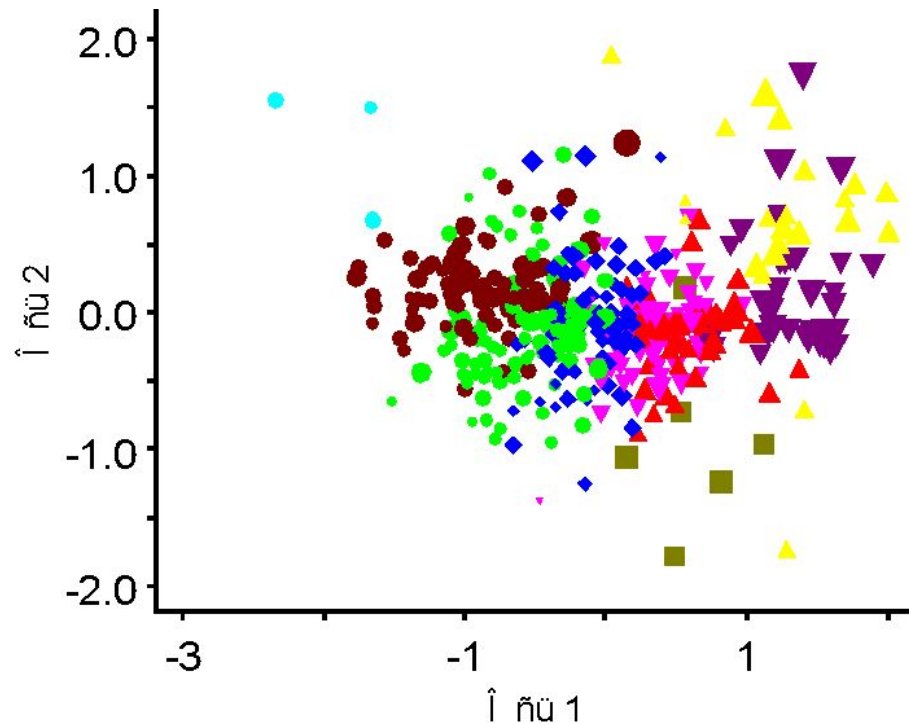
NMS ordination of the Kostroma vegetation sample plots with values K (climate continentality) overlay



K

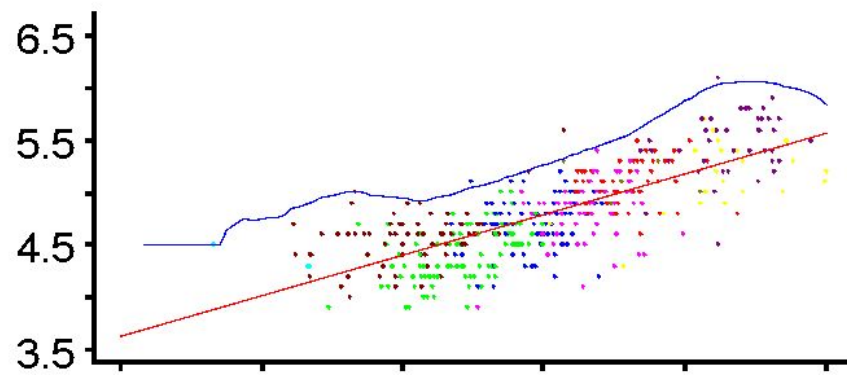
$\hat{\nu} 1$
 $r = .751$ $\tau = .584$

$\hat{\nu} 2$
 $r = .133$ $\tau = .060$

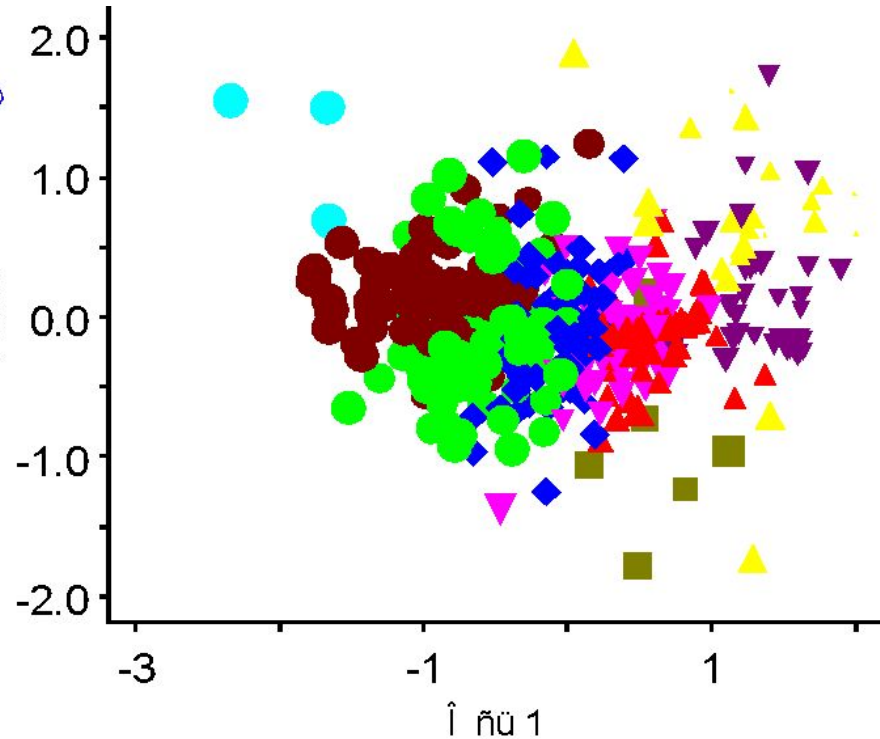
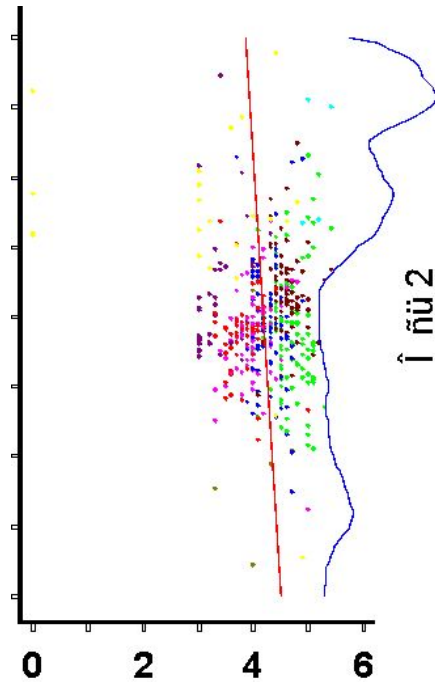


Groups

- ▲ F
- ▼ GM
- ▲ Vm
- ▲ Br
- ◆ NB
- BN
- TH
- Nt
- S



NMS ordination of the Kostroma vegetation sample plots with values T (temperature regime) overlay



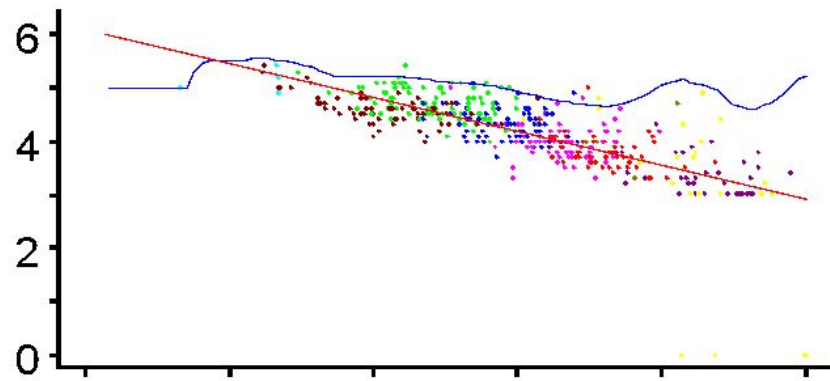
Groups

- ▲ F
- ▼ GM
- ▲ Vm
- ▼ Br
- ◆ NB
- BN
- TH
- Nt
- S

T

î ñü 1
 $r = -.751$ $\tau = -.633$

î ñü 2
 $r = -.110$ $\tau = .024$



Reliability of a difference between the forest types upon the species number at the plots

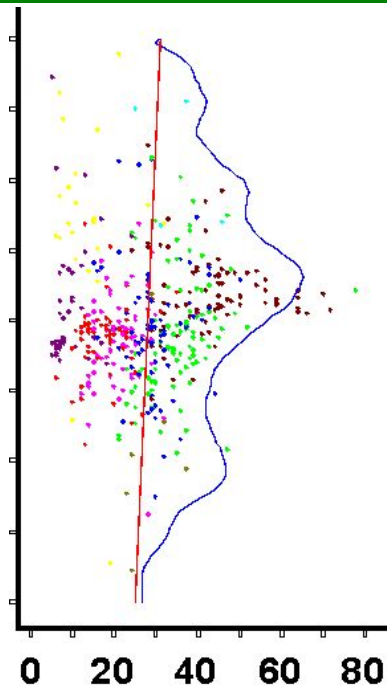
	BN	Br	F	Gm	NB	Nt	S	TH	Vm
BN		1	1	1	1	0	0	1	1
Br	1		1	1	1	0	0	1	0
F	1	1		0	1	1	1	1	0
Gm	1	1	0		1	1	1	1	1
NB	1	1	1	1		0	0	1	1
Nt	0	0	1	1	0		0	0	1
S	0	0	1	1	0	0		1	0
TH	1	1	1	1	1	0	1		1
Vm	1	0	0	1	1	1	0	1	

1 - различия между группами достоверны

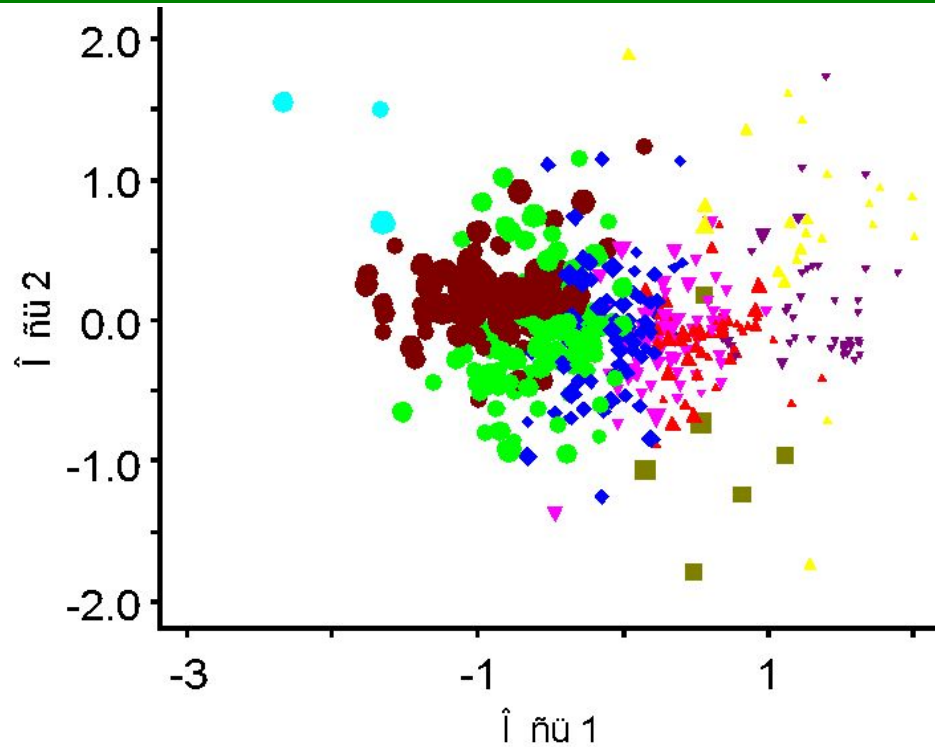
0 - различия между группами недостоверны

при $p < 0.05$

NMS ordination of the Kostroma vegetation sample plots with the number of vascular plants overlay

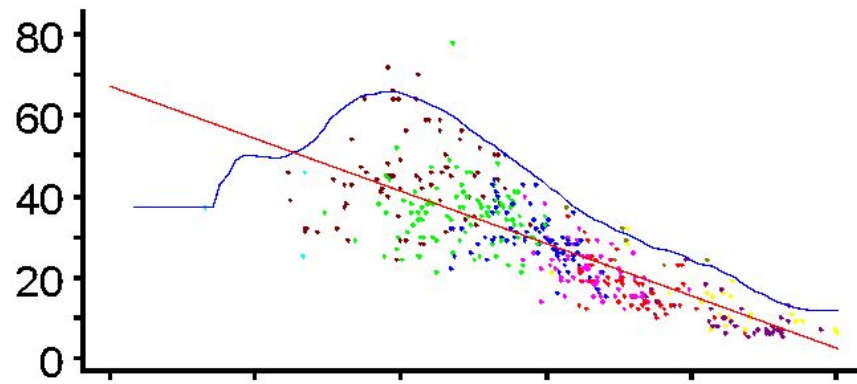


Sp
 $\hat{\nu} 1$
 $r = -.791$ $\tau = -.664$
 $\hat{\nu} 2$
 $r = .052$ $\tau = .100$

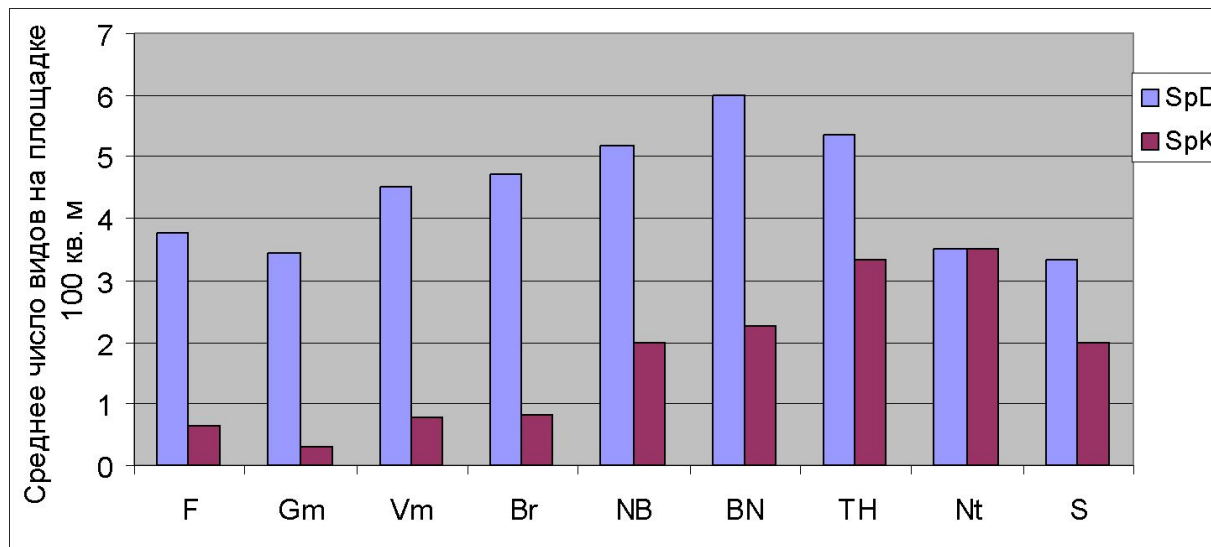
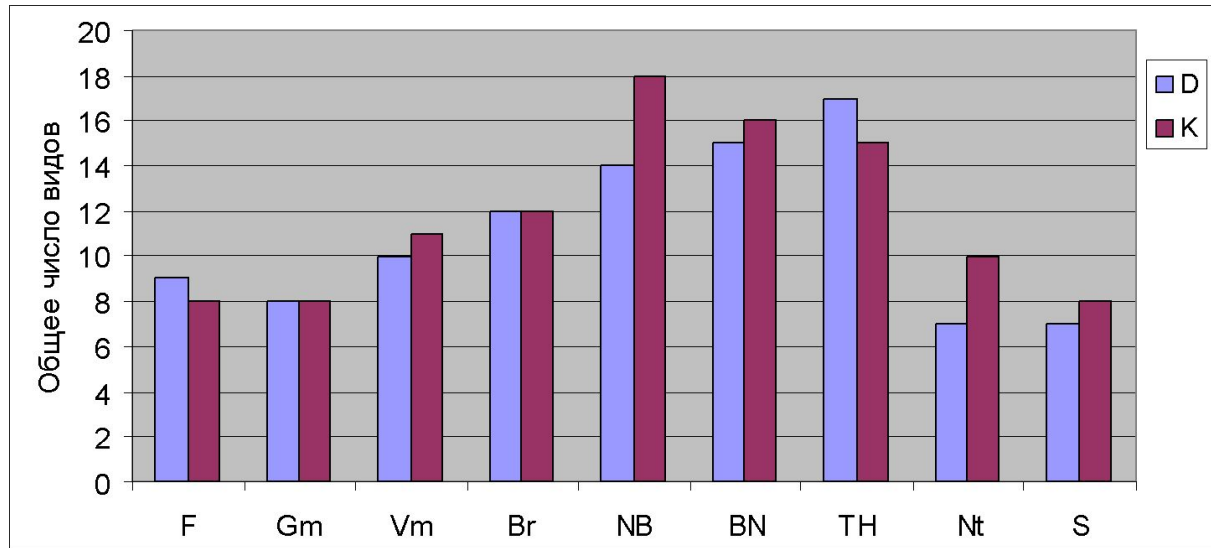


Groups

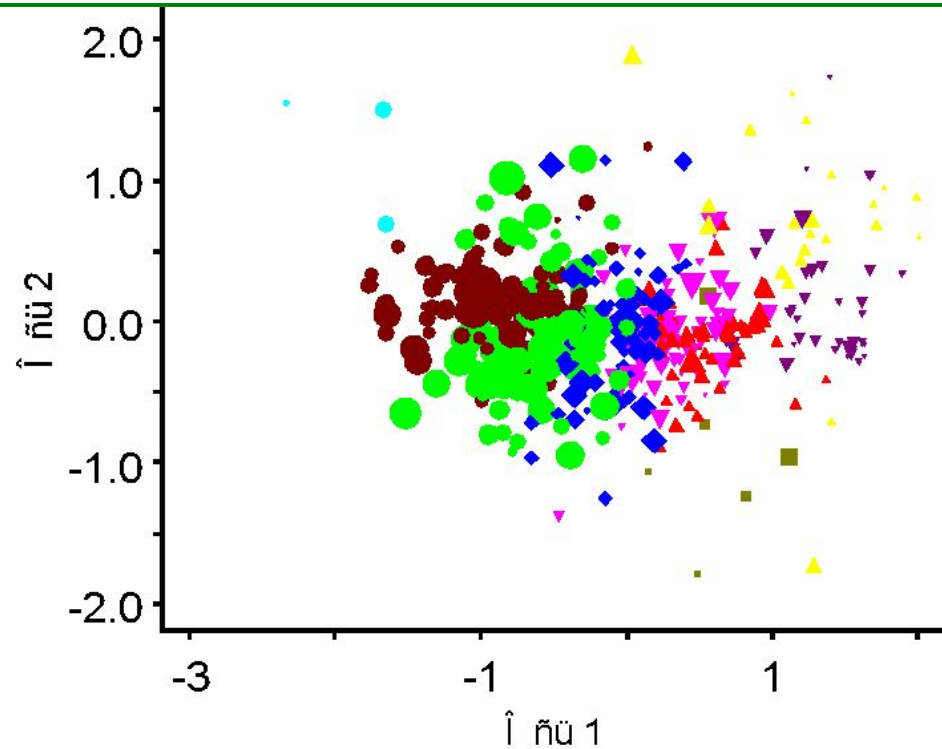
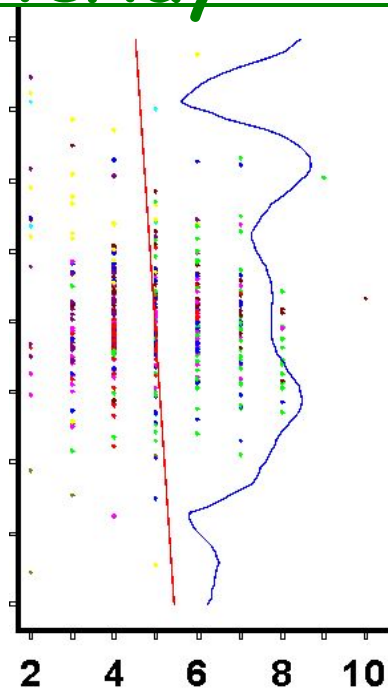
- ▲ F
- ▼ GM
- ▲ Vm
- ▼ Br
- ◆ NB
- BN
- TH
- Nt
- S



Tree and shrub species diversity of the forest types



NMS ordination of the Kostroma vegetation sample plots with the number of tree species overlay

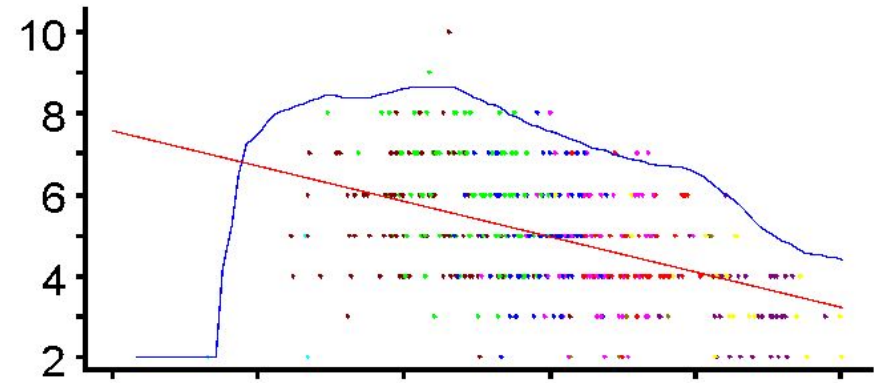


- Groups**
- ▲ F
 - ▼ GM
 - ▲ Vm
 - ▼ Br
 - ◆ NB
 - BN
 - TH
 - Nt
 - S

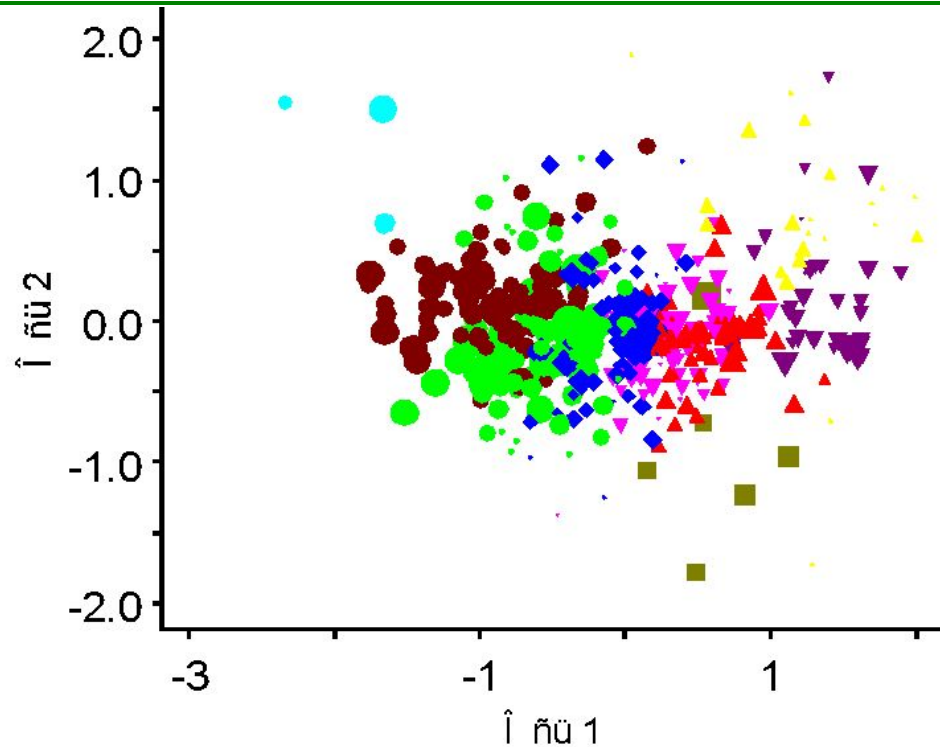
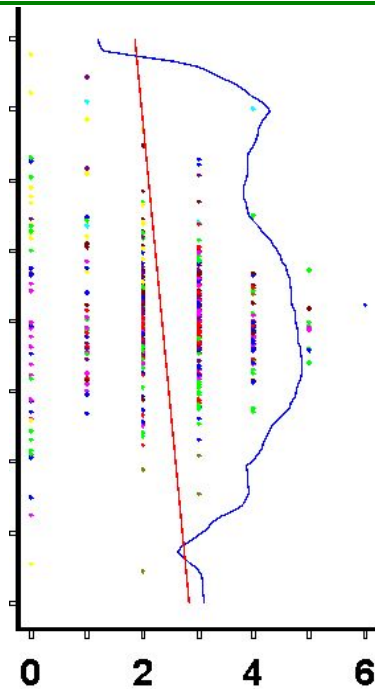
SpD

$\hat{\nu}_1$
 $r = -.475$ $\tau = -.368$

$\hat{\nu}_2$
 $r = -.072$ $\tau = -.028$



NMS ordination of the Kostroma vegetation sample plots with the number of tree species in overstorey overlay

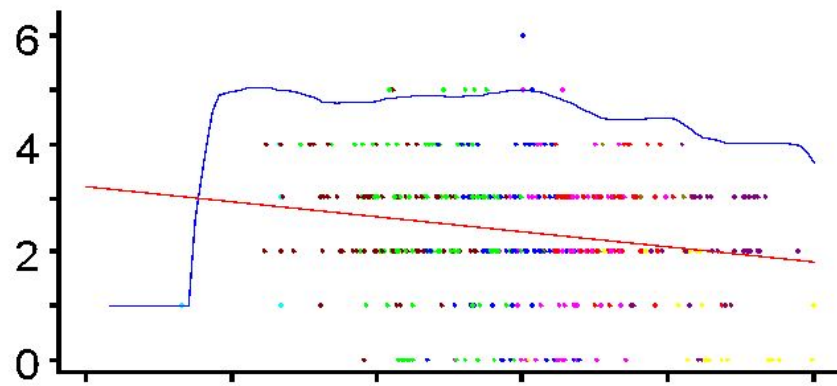


Groups

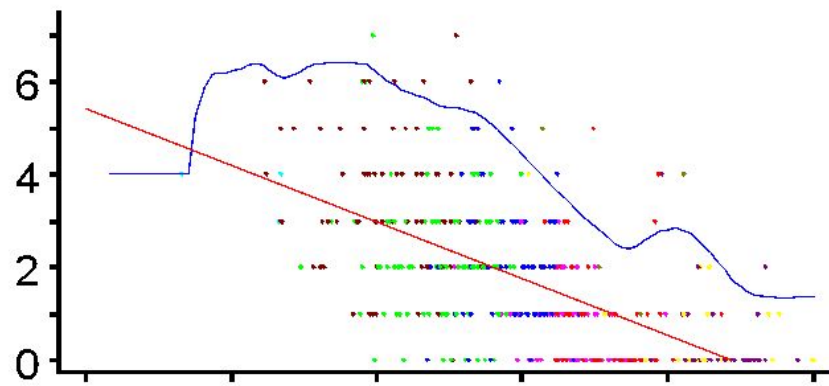
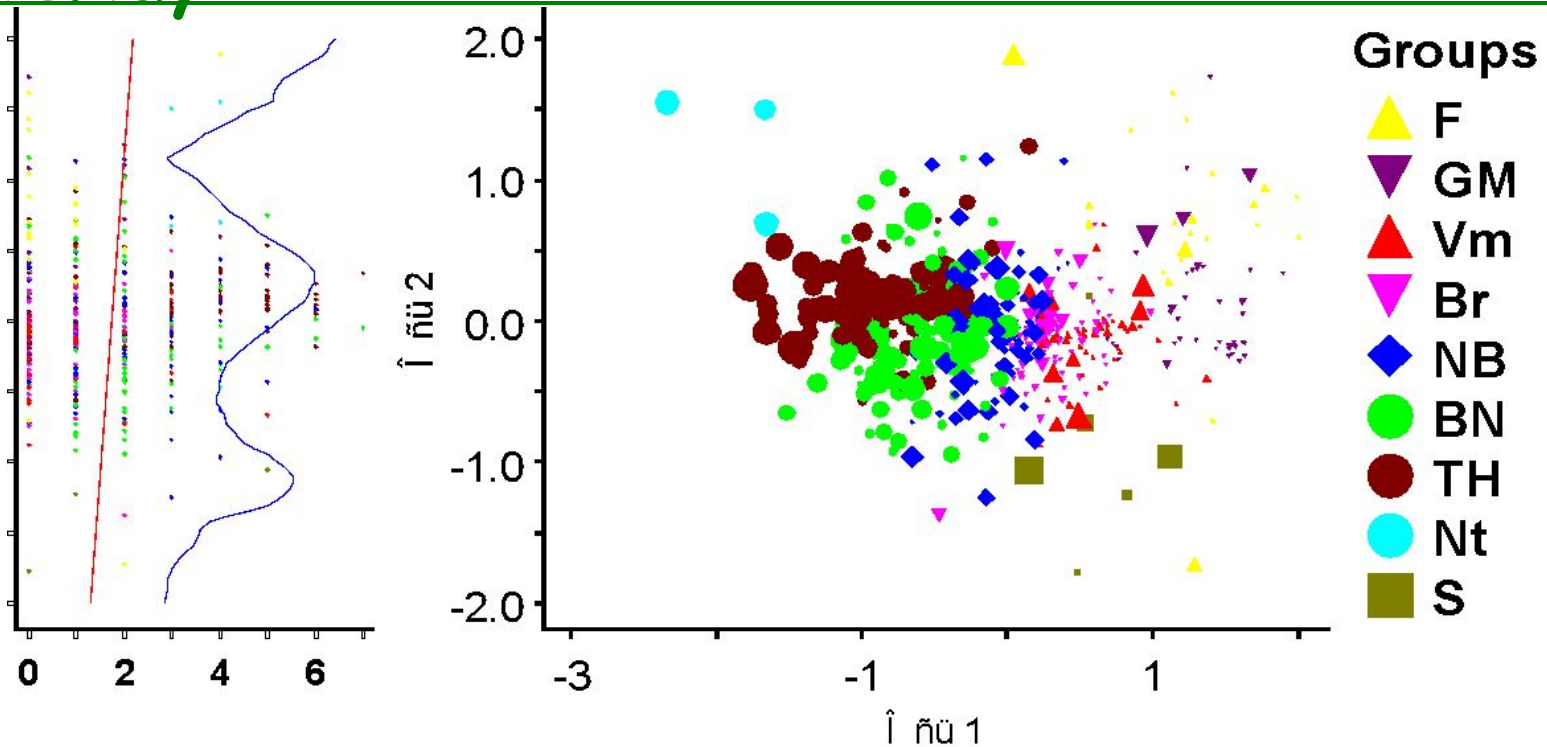
- F
- GM
- Vm
- Br
- NB
- BN
- TH
- Nt
- S

DA

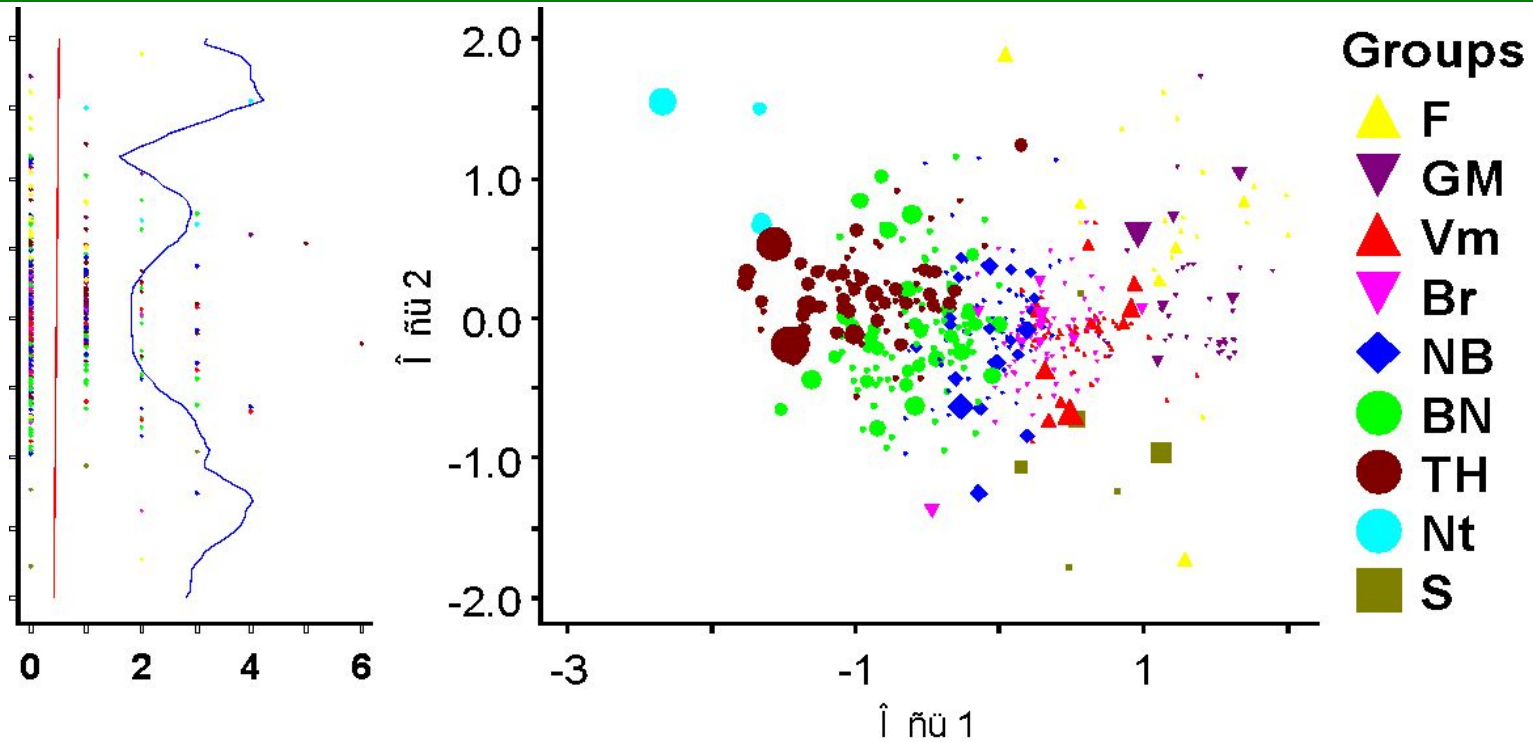
$\hat{\nu} 1$
 $r = -.189$ $\tau = -.132$
 $\hat{\nu} 2$
 $r = -.093$ $\tau = -.059$



NMS ordination of the Kostroma vegetation sample plots with the number of shrub species overlay

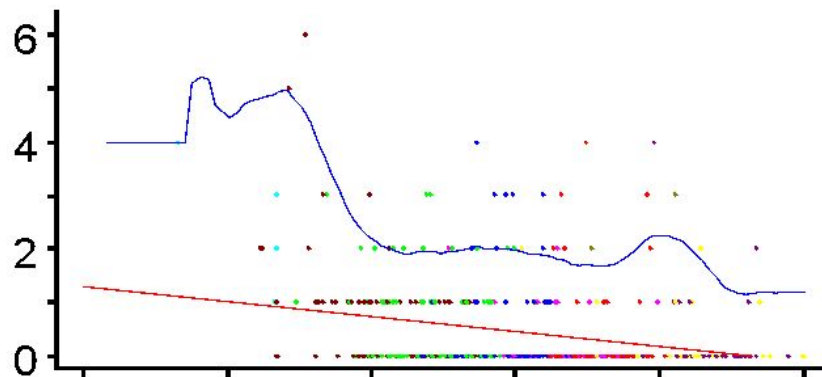


NMS ordination of the Kostroma vegetation sample plots with the number of shrub species in the upper understorey overlay

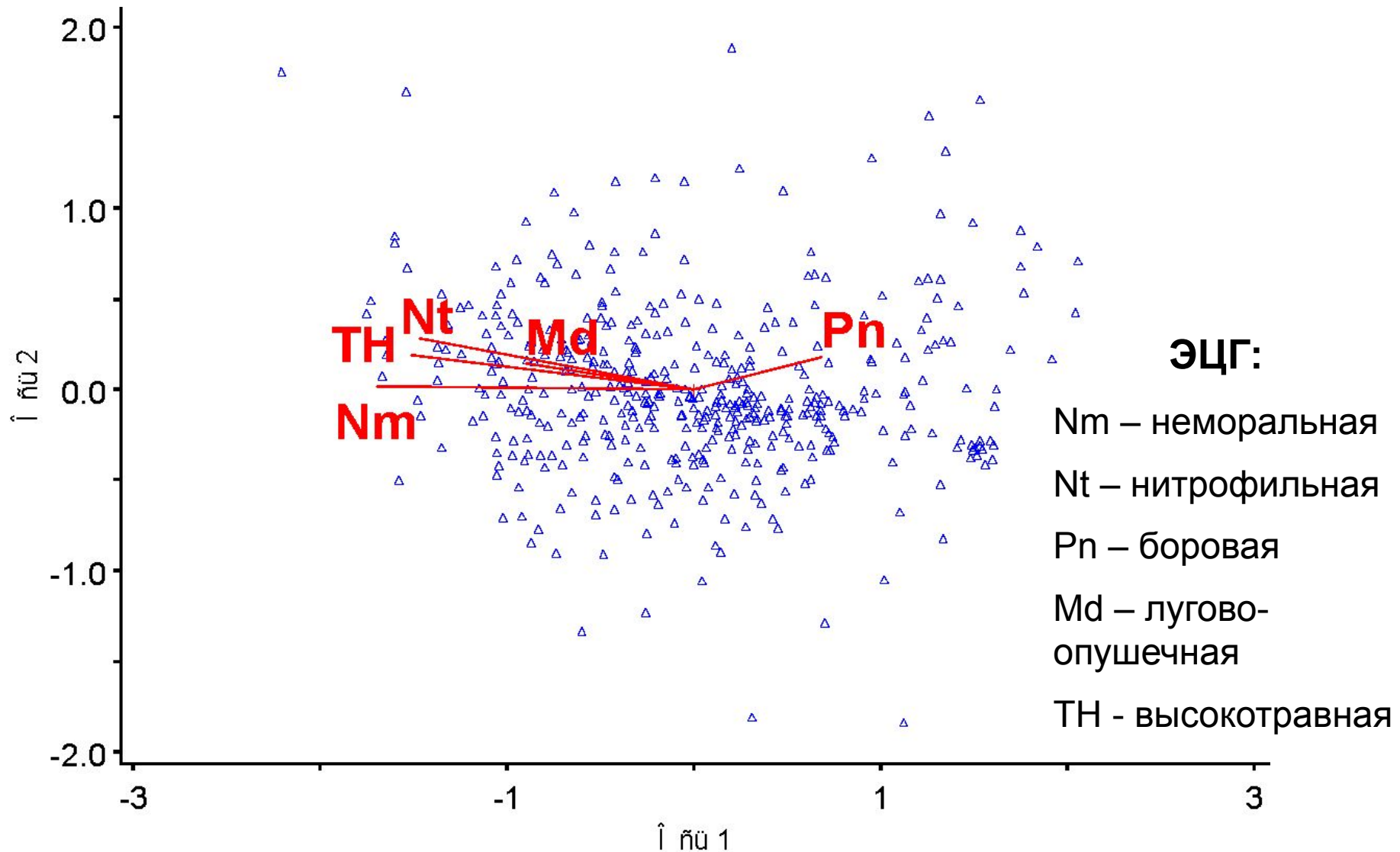


KB

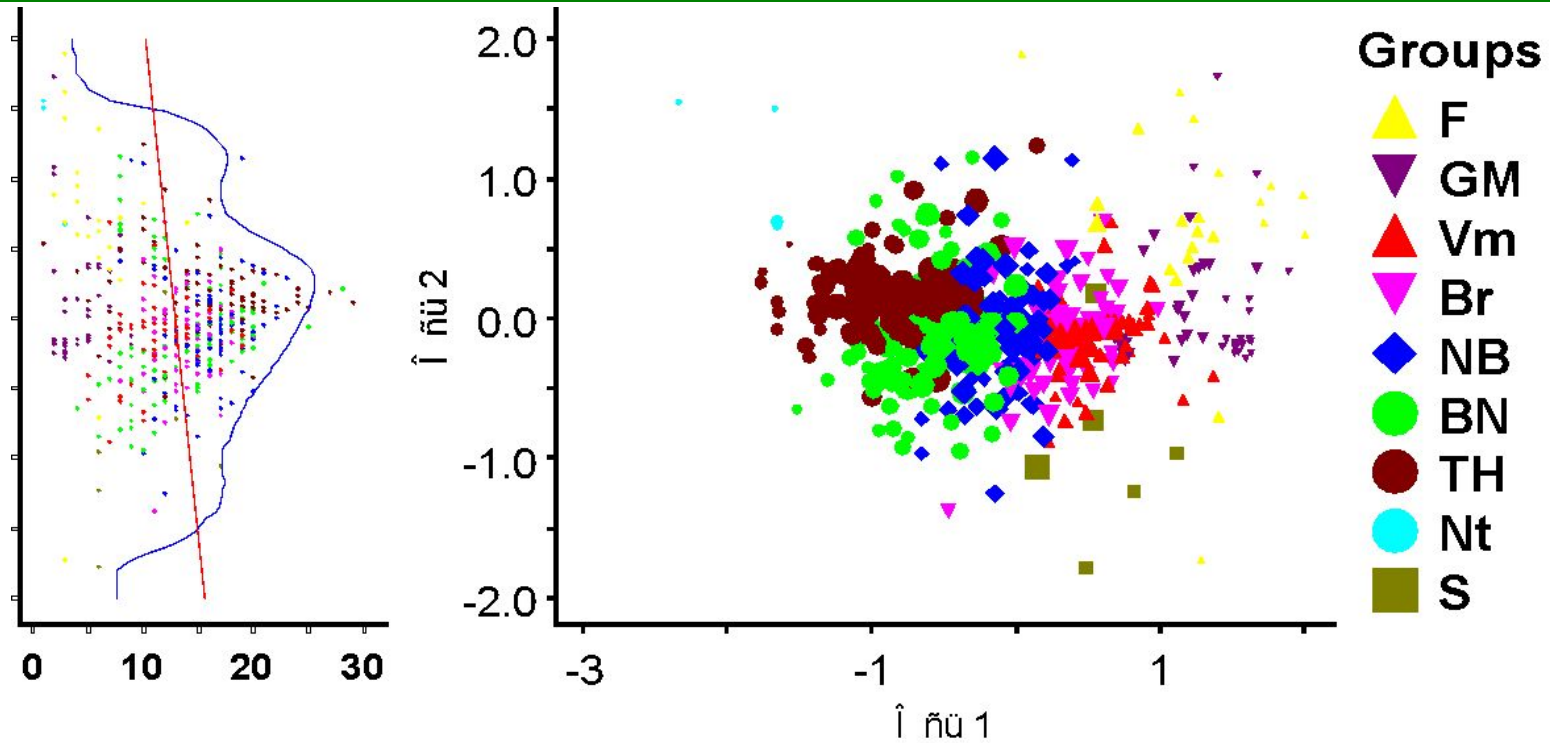
$\hat{\nu} 1$
 $r = -.257$ $\tau = -.216$
 $\hat{\nu} 2$
 $r = .014$ $\tau = .065$



NMS ordination of the Kostroma vegetation sample plots with the species number of different ecological-coenotic groups overlay



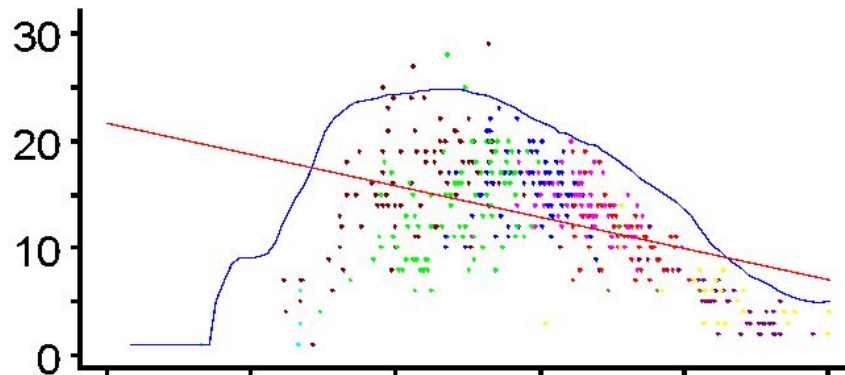
NMS ordination of the Kostroma vegetation sample plots with the number of boreal species overlay



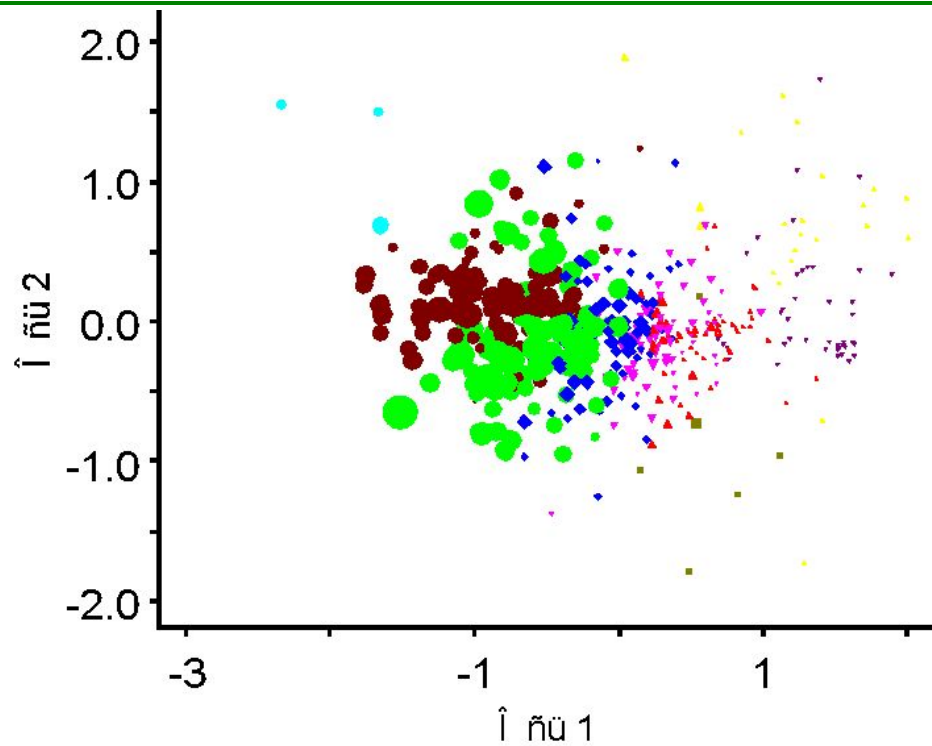
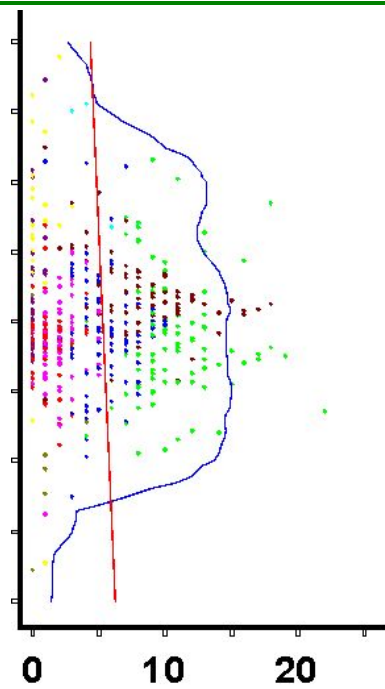
Br

$\hat{\nu} 1$
 $r = -.438$ $\tau = -.331$

$\hat{\nu} 2$
 $r = -.119$ $\tau = .011$



NMS ordination of the Kostroma vegetation sample plots with the number of nemoral species overlay



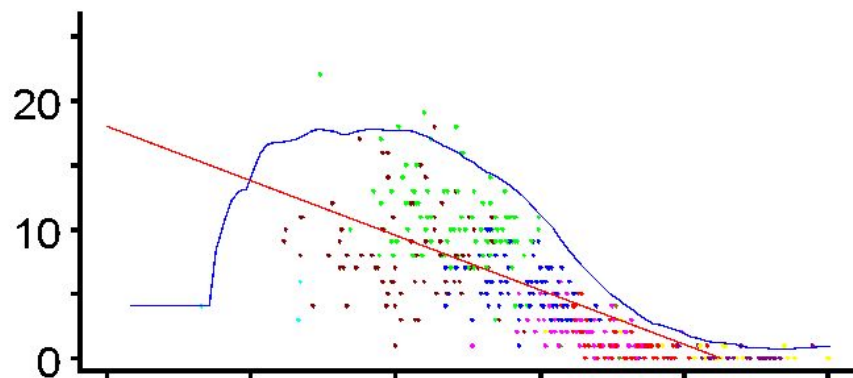
Groups

- ▲ F
- ▼ GM
- ▲ Vm
- ▼ Br
- ◆ NB
- BN
- TH
- Nt
- S

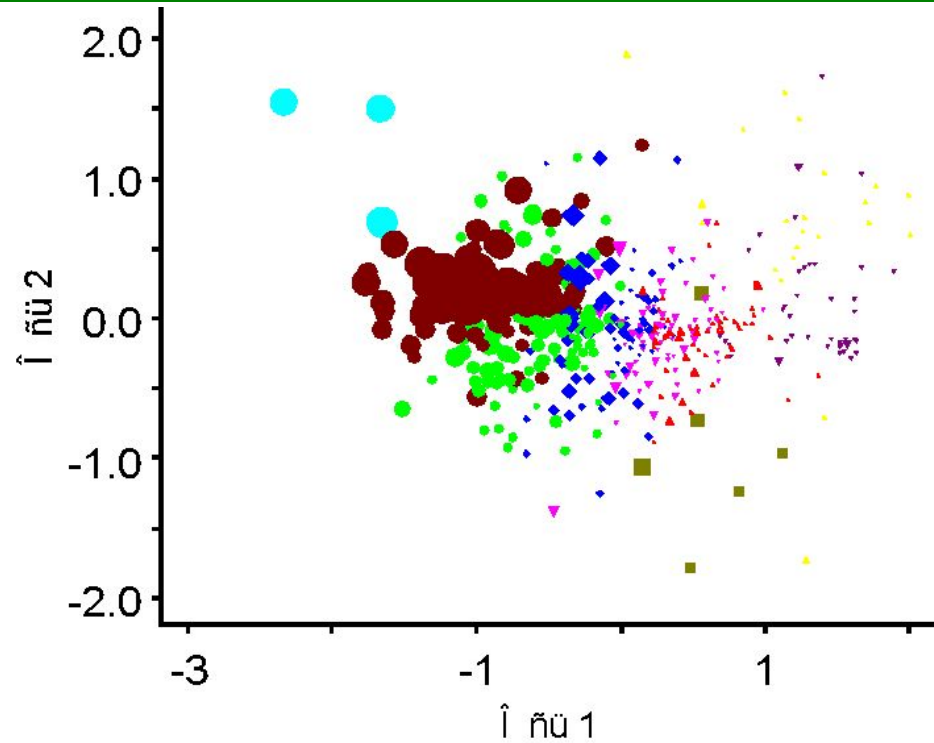
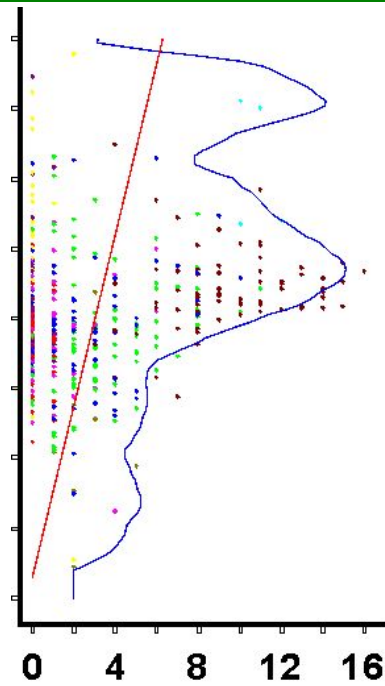
Nm

$\hat{\nu}_1$
 $r = -.751$ $\tau = -.671$

$\hat{\nu}_2$
 $r = -.048$ $\tau = -.007$



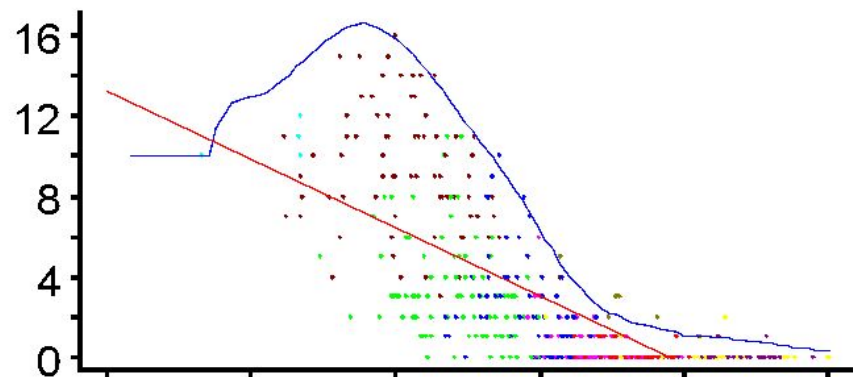
NMS ordination of the Kostroma vegetation sample plots with the number of nitrophilous species overlay



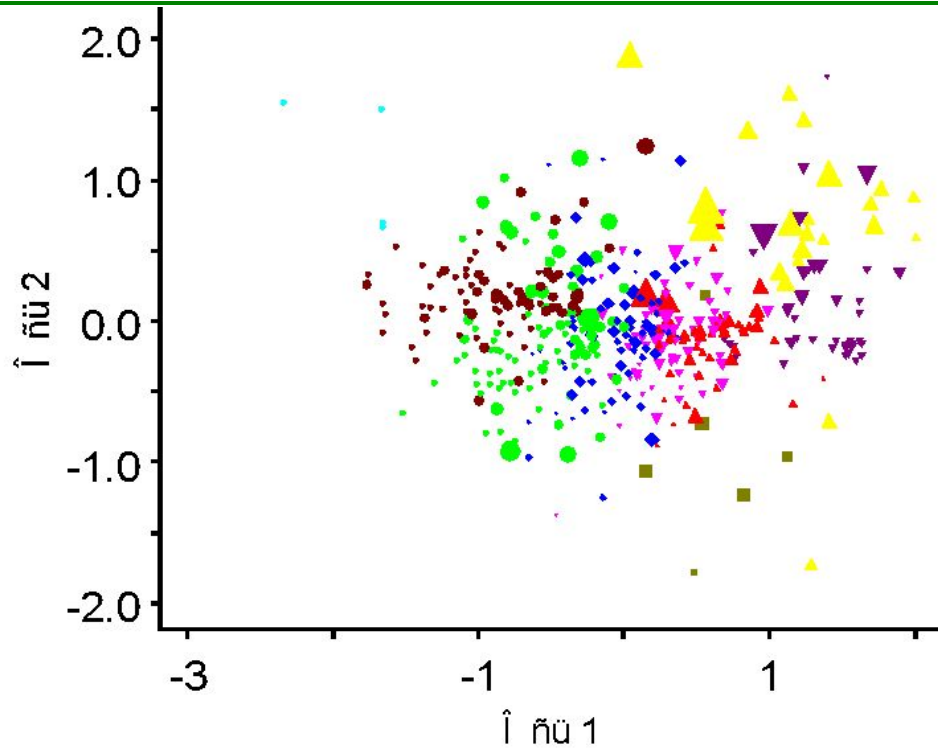
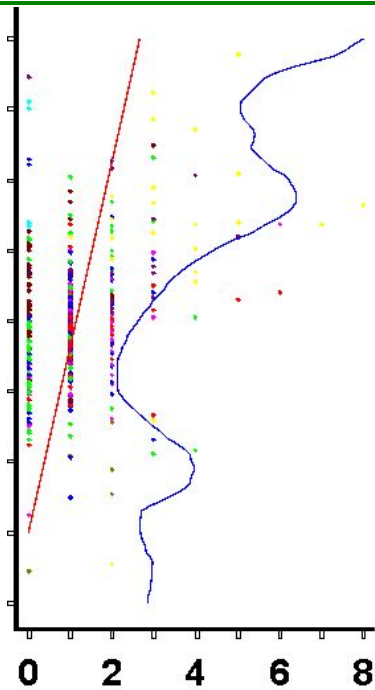
Groups

- ▲ F
- ▼ GM
- ▲ Vm
- ▼ Br
- ◆ NB
- BN
- TH
- Nt
- S

Nt
 $\hat{1} \text{ nũ } 1$
 $r = -.711 \text{ tau} = -.640$
 $\hat{1} \text{ nũ } 2$
 $r = .200 \text{ tau} = .130$



NMS ordination of the Kostroma vegetation sample plots with the number of piny species overlay

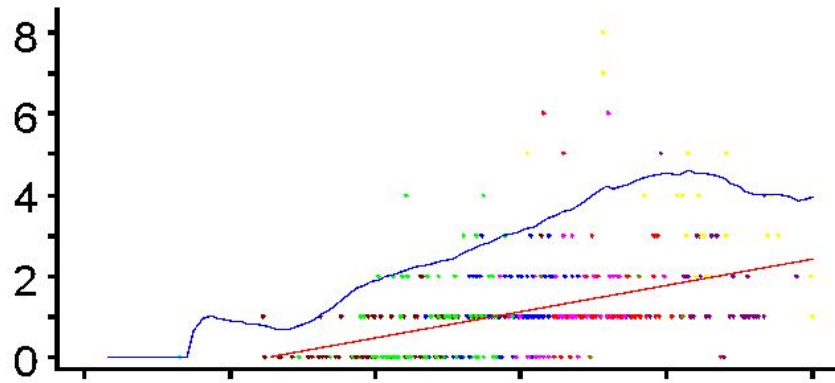


Groups

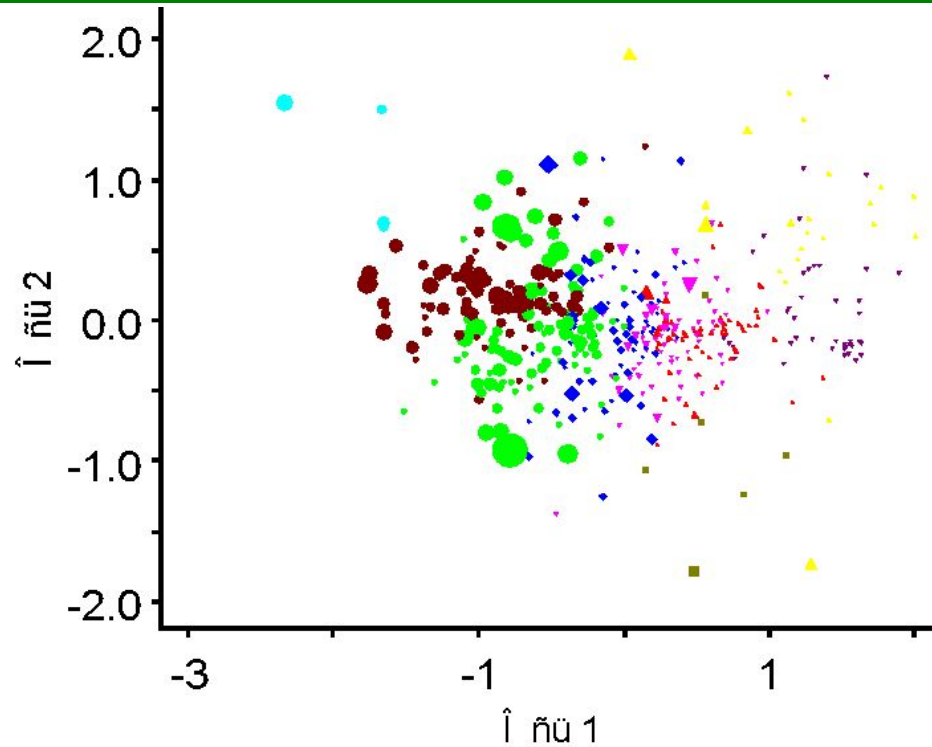
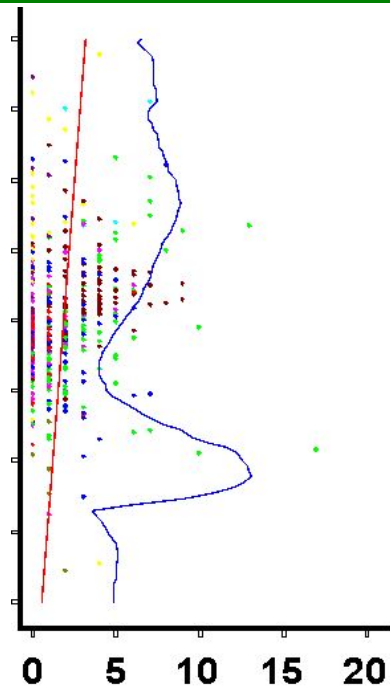
- ▲ F
- ▼ GM
- ▲ Vm
- ▼ Br
- ◆ NB
- BN
- TH
- Nt
- S

Pn

$\hat{\nu} 1$
 $r = .465$ $\tau = .429$
 $\hat{\nu} 2$
 $r = .311$ $\tau = .213$



NMS ordination of the Kostroma vegetation sample plots with the number of meadow species overlay

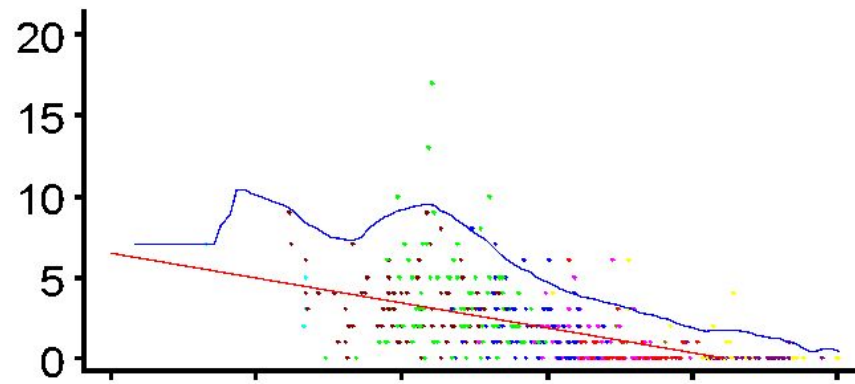


Groups

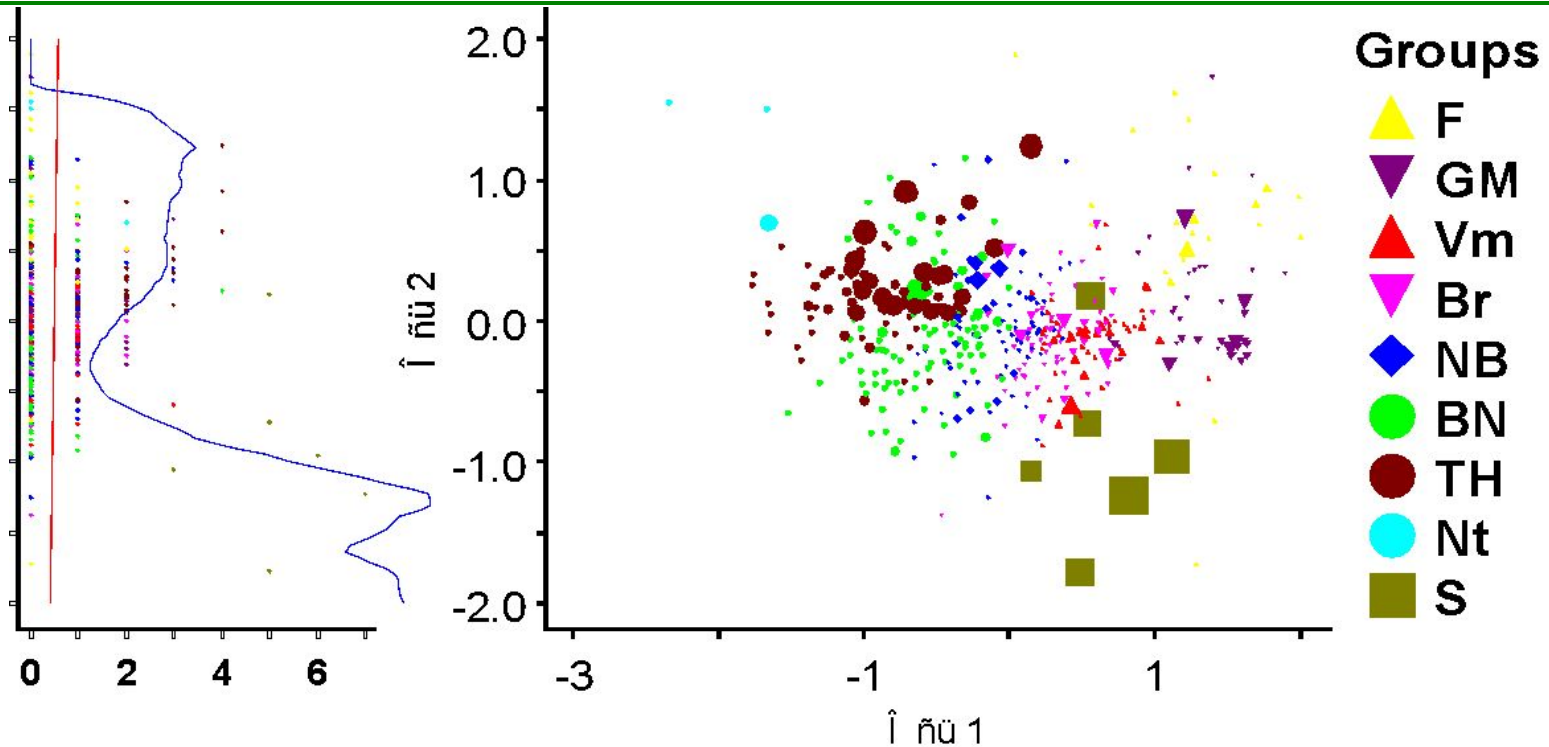
- ▲ F
- ▼ GM
- ▲ Vm
- ▼ Br
- ◆ NB
- BN
- TH
- Nt
- S

Md

$\hat{\nu}_1$
 $r = -.555$ $\tau = -.513$
 $\hat{\nu}_2$
 $r = .133$ $\tau = .153$



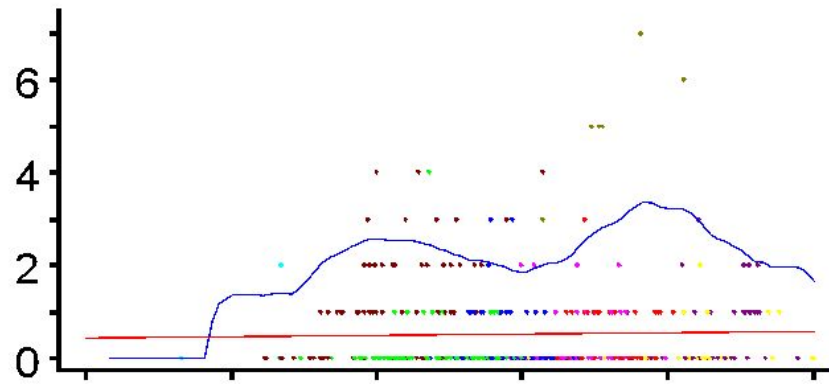
NMS ordination of the Kostroma vegetation sample plots with the number of oligotrophic species overlay



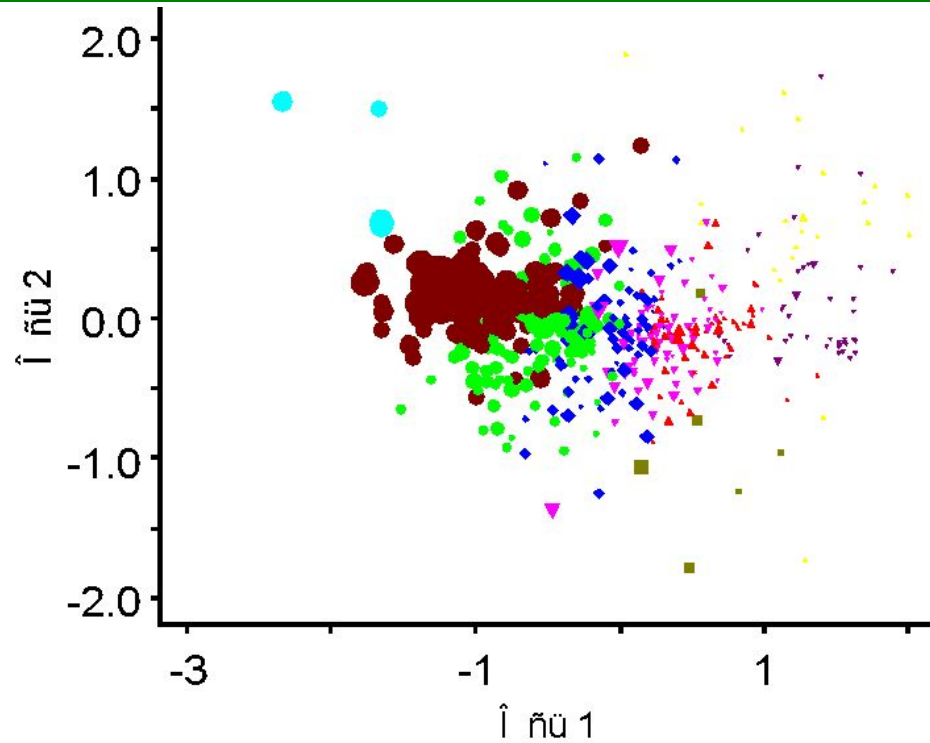
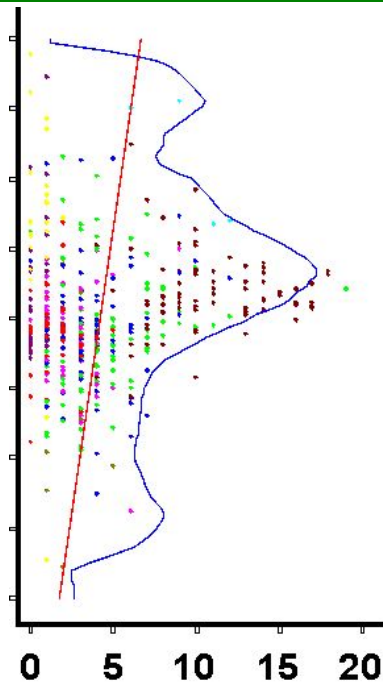
Olg

$\hat{I} \hat{n} \ddot{u} 1$
 $r = .021 \text{ tau} = -.010$

$\hat{I} \hat{n} \ddot{u} 2$
 $r = .019 \text{ tau} = .151$



NMS ordination of the Kostroma vegetation sample plots with the number of tall herbaceous species overlay

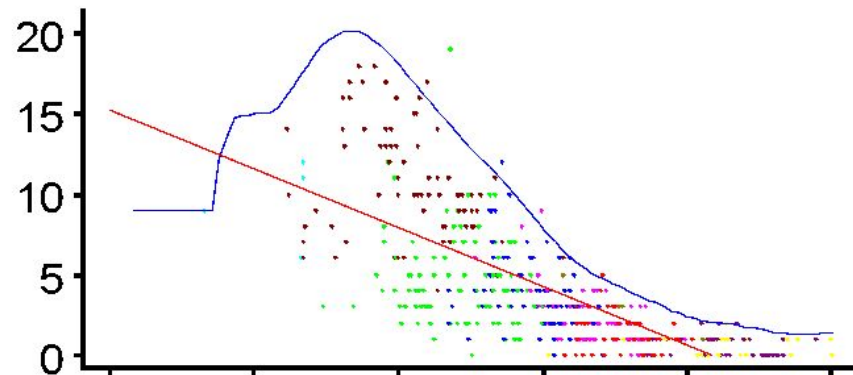


Groups

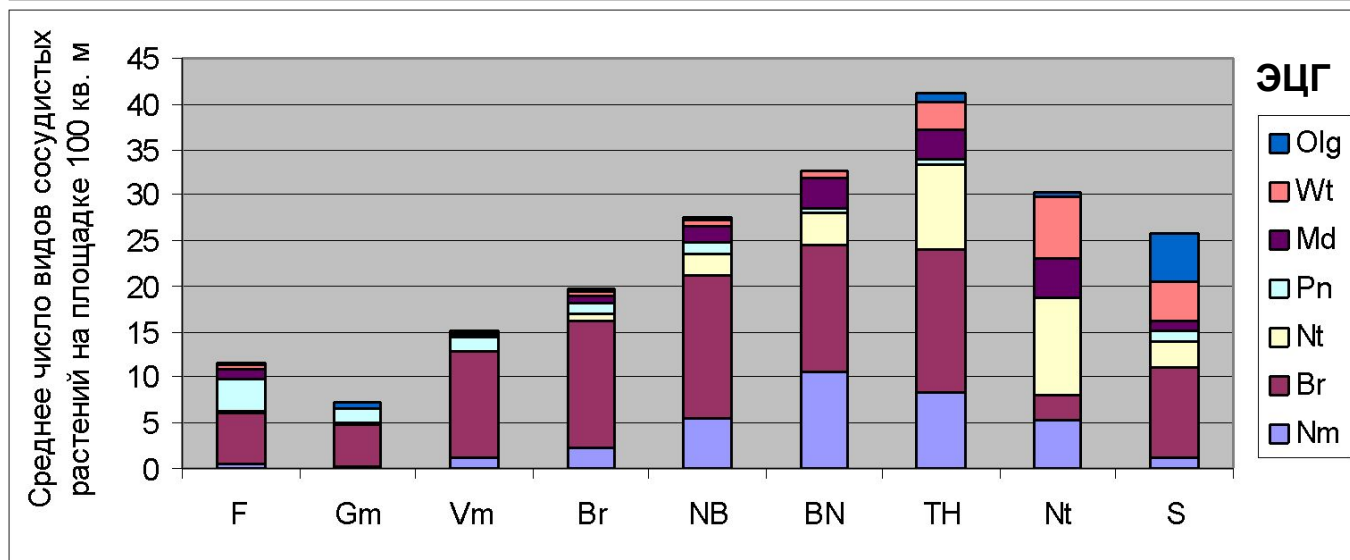
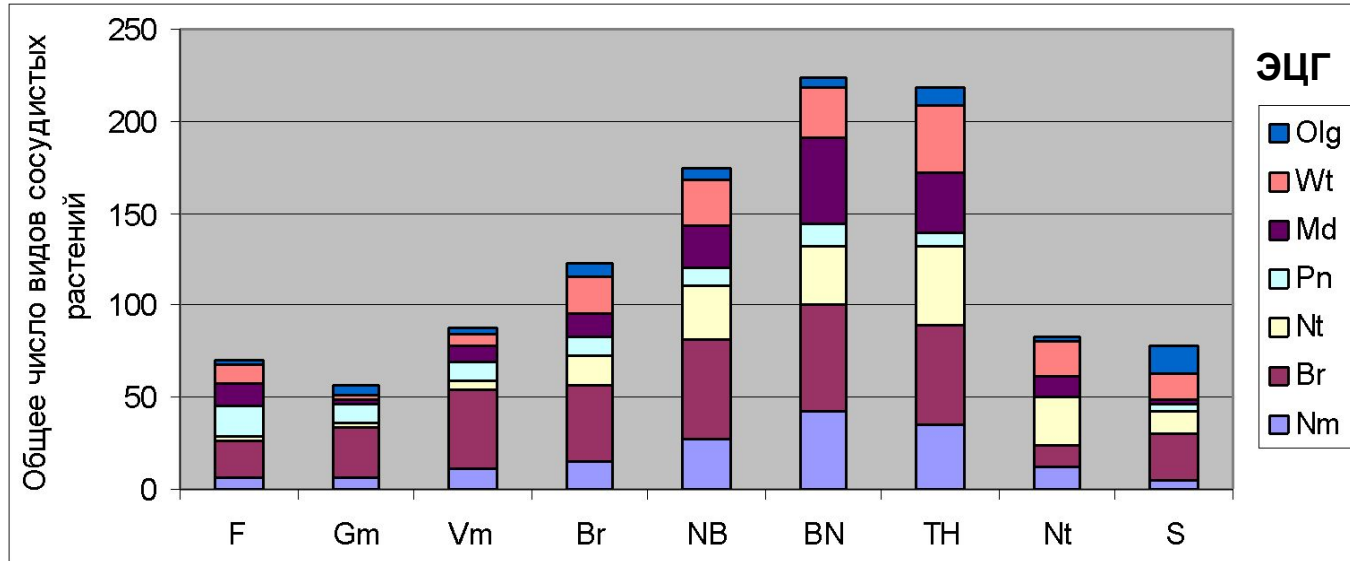
- ▲ F
- ▼ GM
- ▲ Vm
- ▼ Br
- ◆ NB
- BN
- TH
- Nt
- S

TH

$\hat{\nu} 1$
 $r = -.719$ $\tau = -.639$
 $\hat{\nu} 2$
 $r = .143$ $\tau = .100$

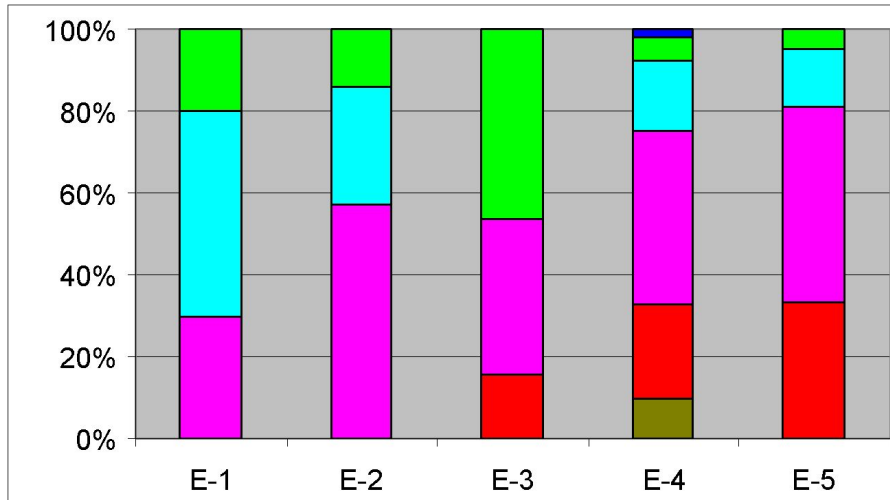


Ecological-coenotic structure of forest types

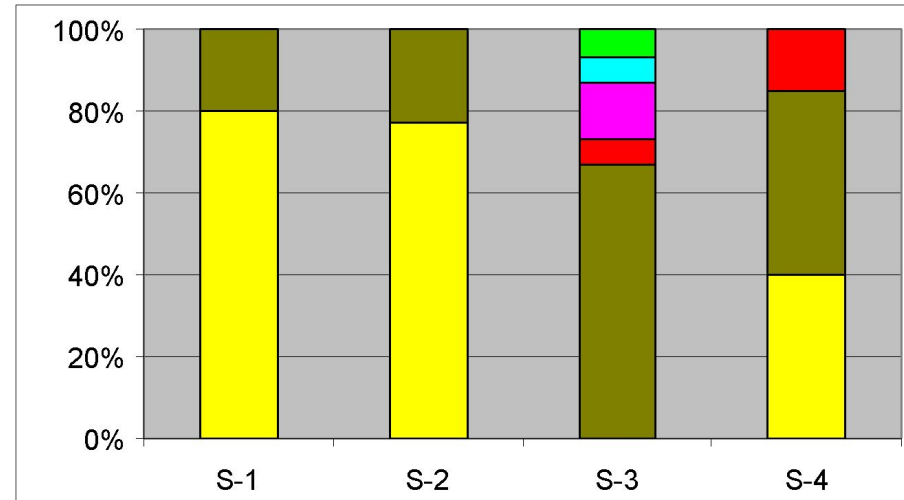


Forest types and succession variants from the 1st to 5th succession stage

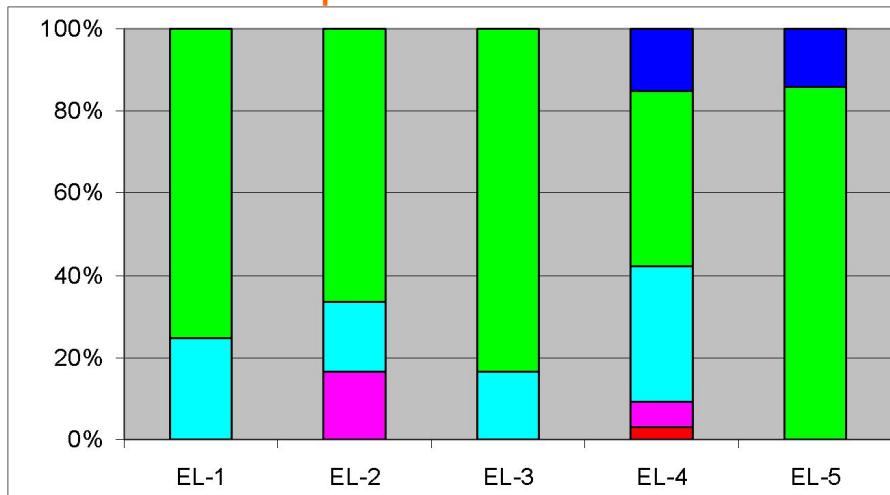
Spruce forest



Pine forest



Mixed spruce and lime forest



Forest types groups:

- H - высокотравная
- BN - бореально-неморальная
- NB - неморально-бореальная
- Br - бореальная
- Vm - черничная
- Gm - зеленомошная
- F - боровая

Generalization of local vegetation diversity indices

- путем непосредственного совмещения локальных точечных данных с картами лесонасаждений при использовании баз данных лесотаксационных описаний
- путем интерполяции локальных точечных значений характеристик разнообразия с использованием данных дистанционного зондирования и цифровой модели рельефа