

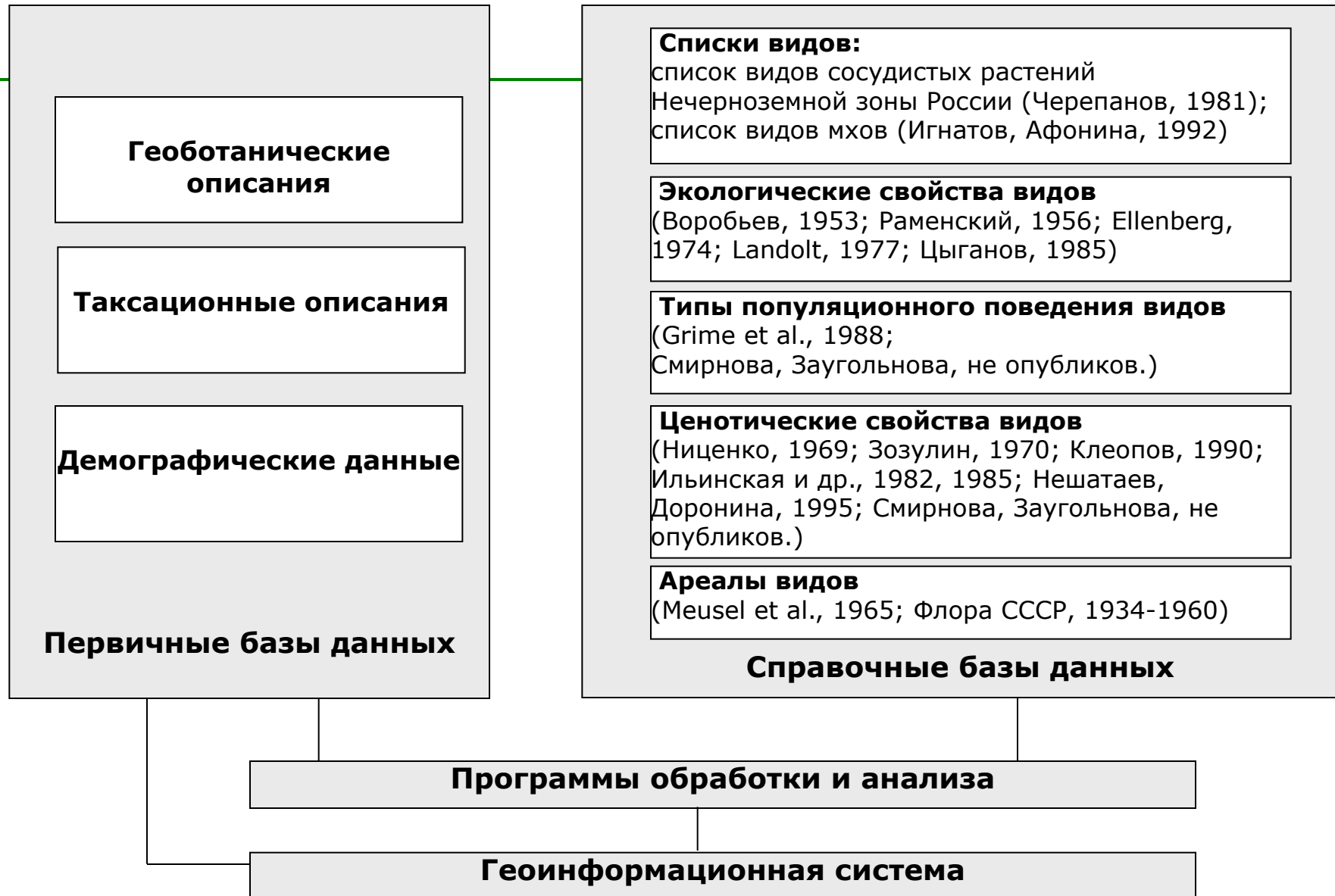
**Biodiversity Monitoring Programme of
Russian Academy of Science
Center for Forest Ecology and Productivity of RAS**

**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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Institute of Physicochemical and Biological Problems of
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

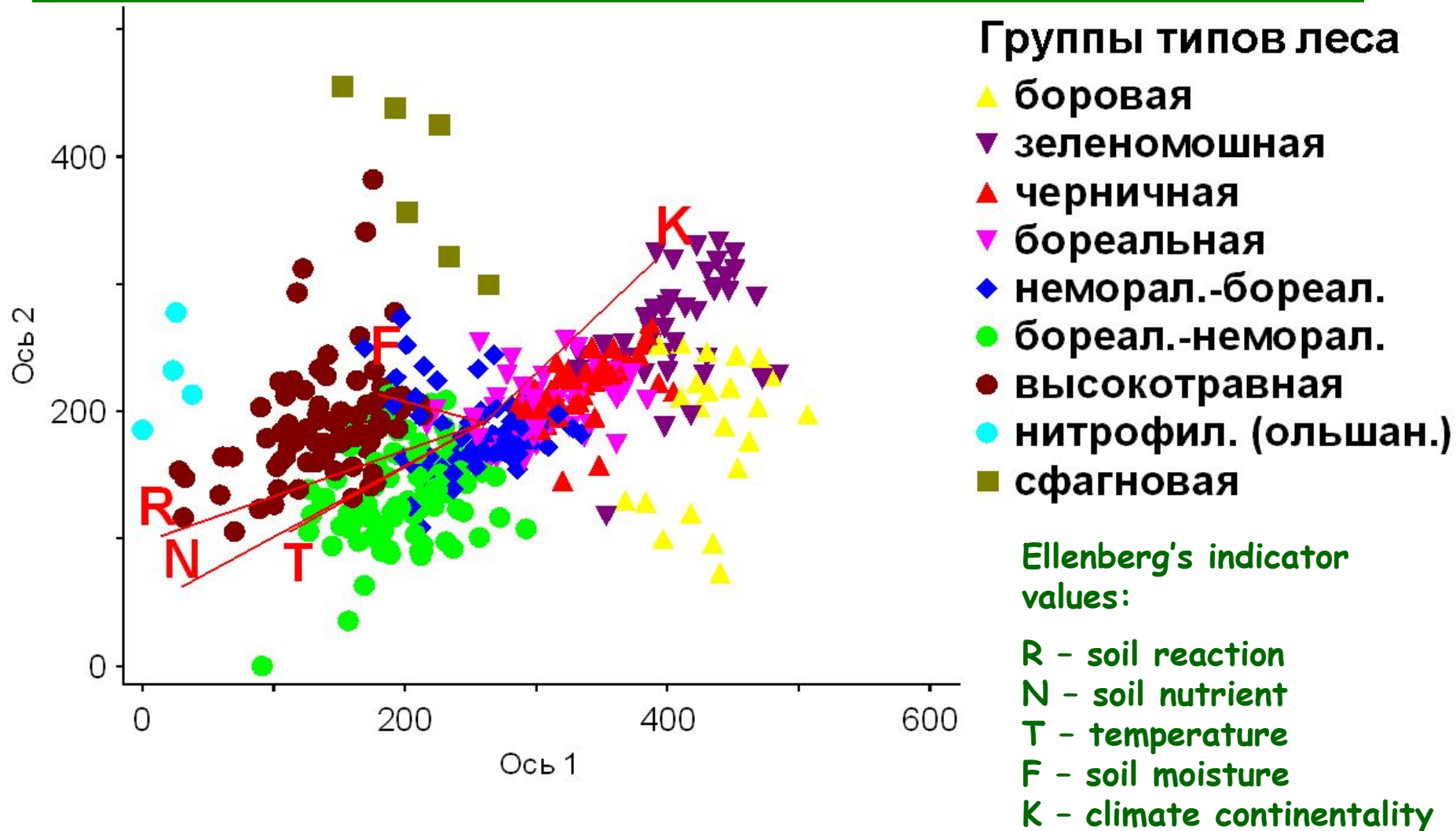
	2003	2004	Всего
сосняки			
PnBr	5		5
PnF		22	22
PnGm	8	13	21
PnNB	3		3
PnS	1		1
PnVm	8	2	10
осинники			
PpBN		18	18
PpBr		2	2
PpNB		3	3
липняки			
TBN		3	3
TH	6		6
ольшаники			
A	4		4

24 типа леса
444 описания

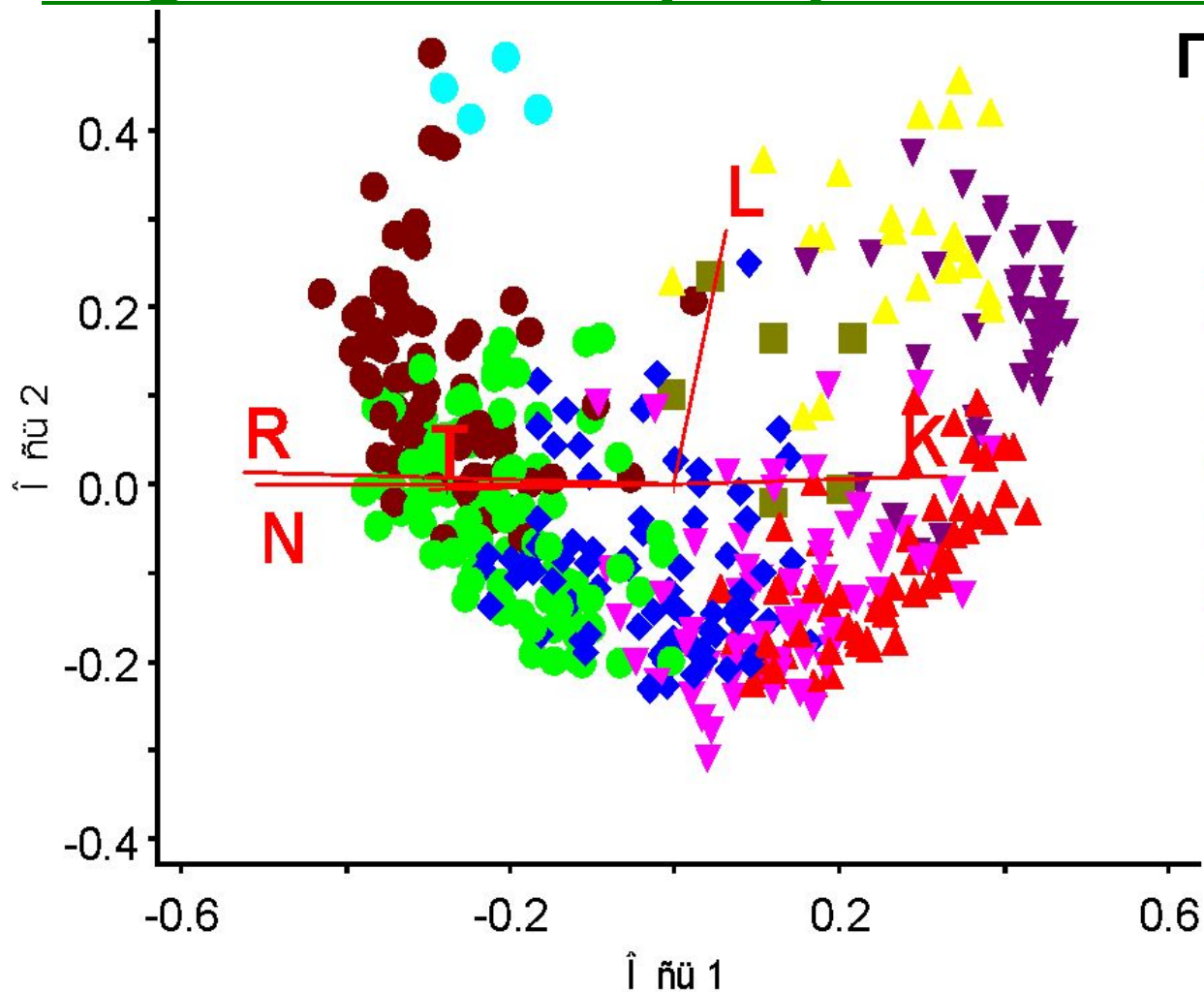
Number of phytosociological releves per forest type groups and per year

	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



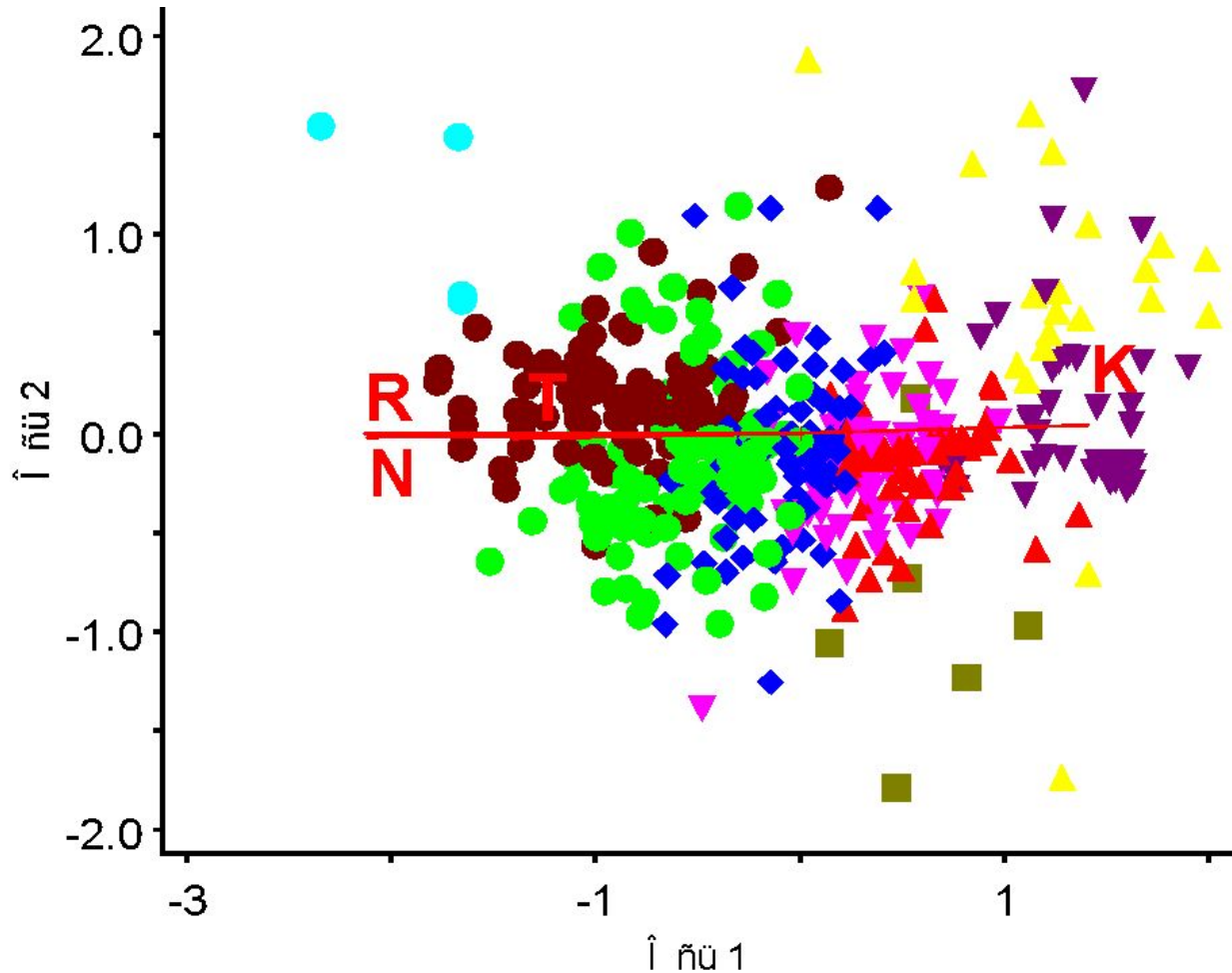
Группы типов леса

- ▲ áî õî âàÿ
- ▼ çãëáí î ì î ø í àÿ
- ▲ ÷ãõí è÷í àÿ
- ▼ áî õãàëüí àÿ
- ◆ í àì î õàë.-áî õãàë.
- áî õãàë.-í àì î õàë.
- âû ñî êî õãàáí àÿ
- í èòõî 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



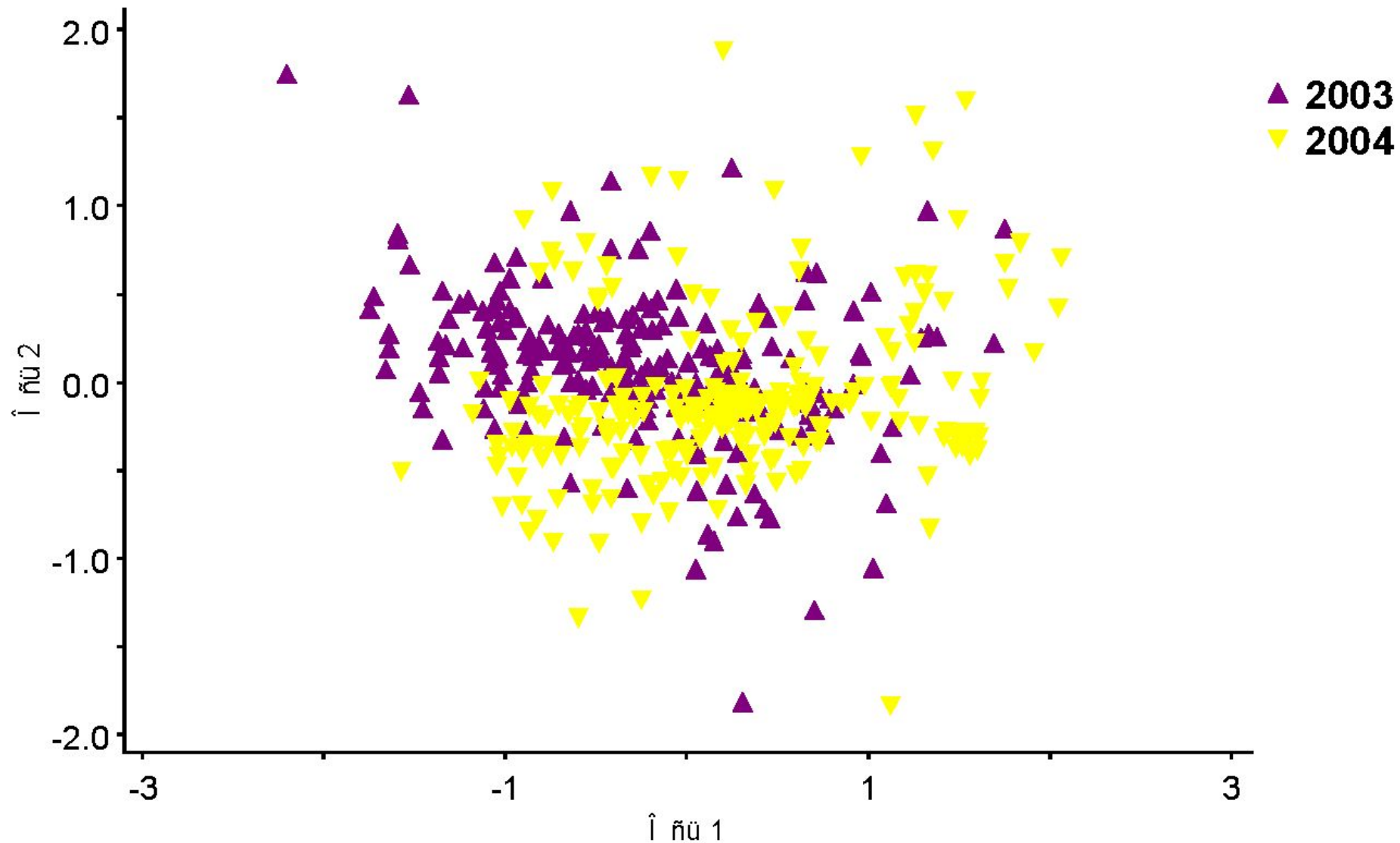
Группы типов леса

- ▲ 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

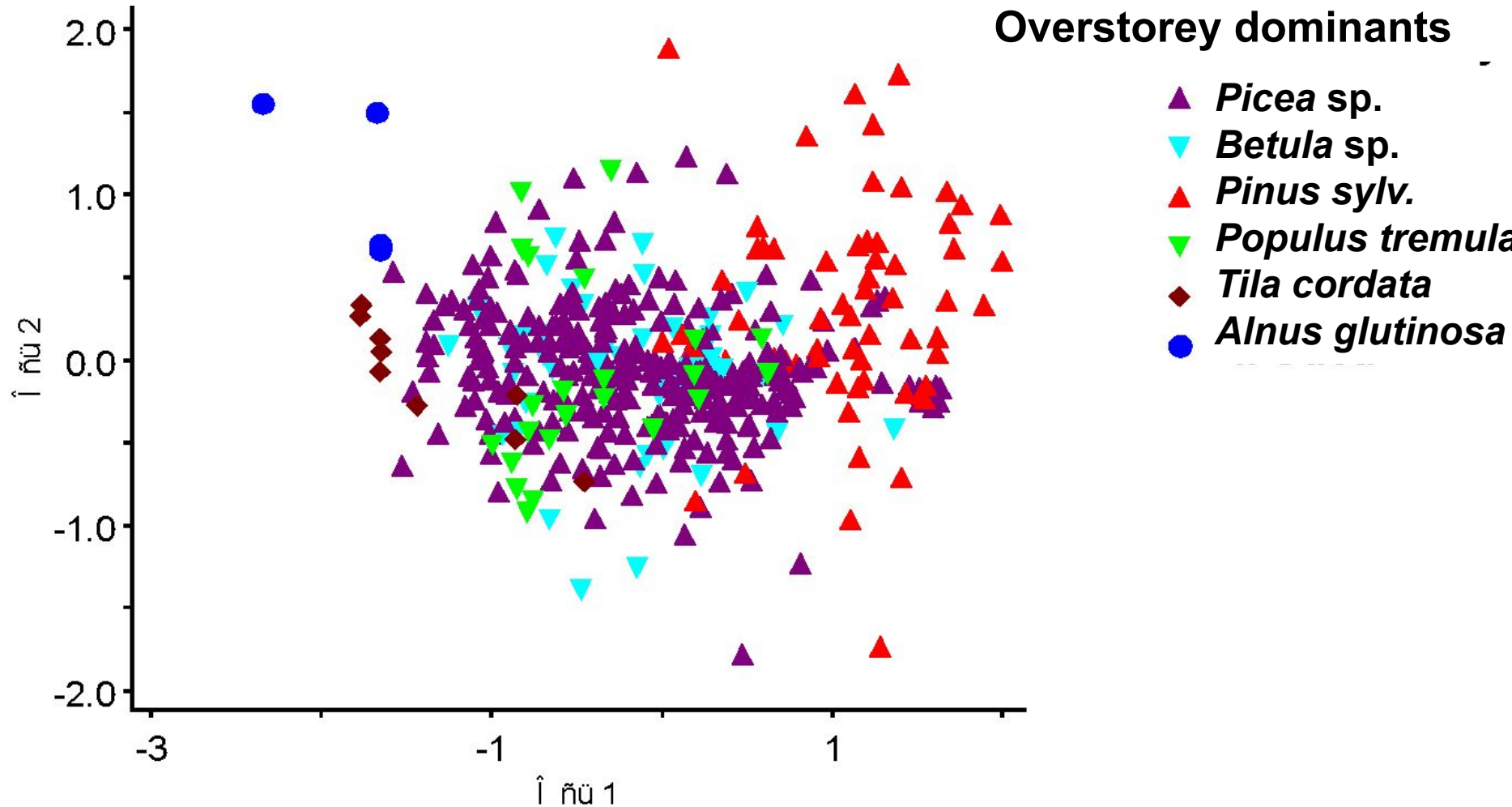
Ellenberg's indicator values:

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

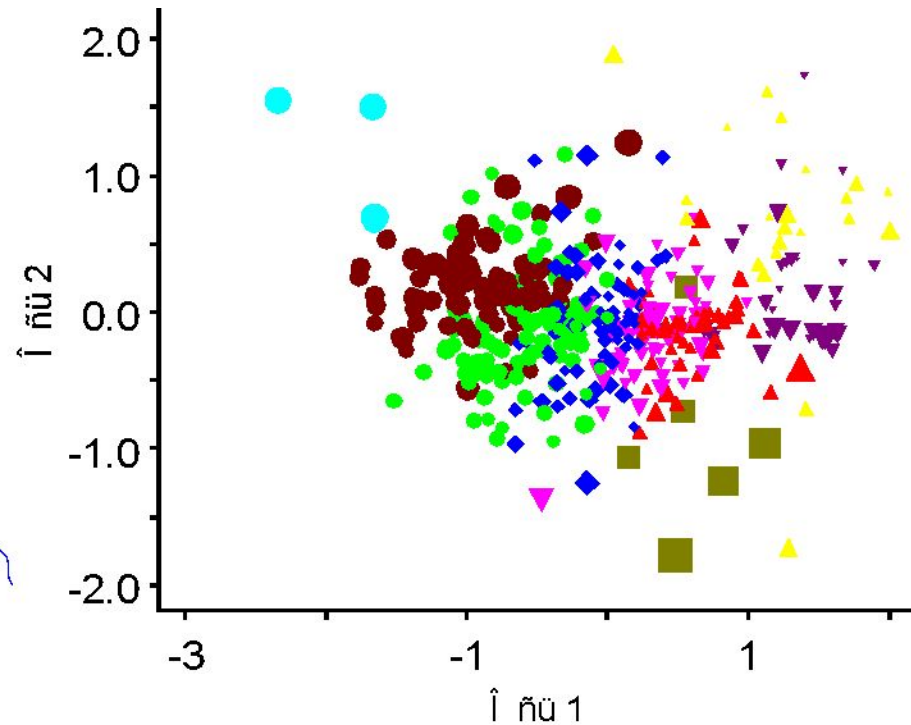
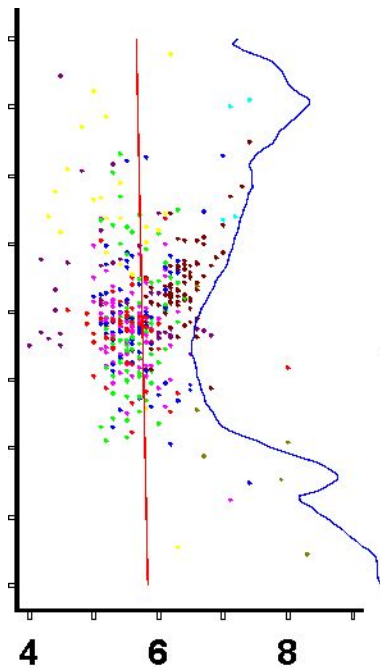
NMS ordination of the Kostroma vegetation sample plots



NMS ordination of the Kostroma vegetation sample plots



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



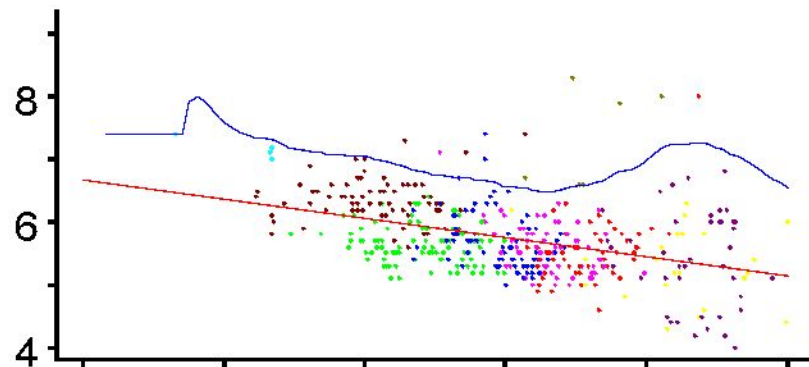
Groups

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

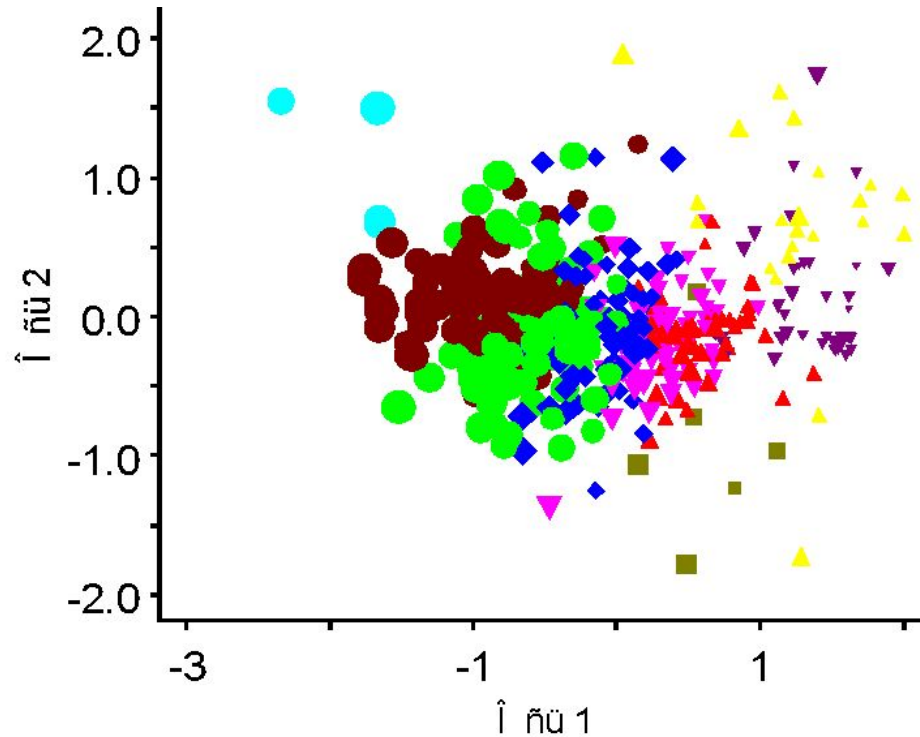
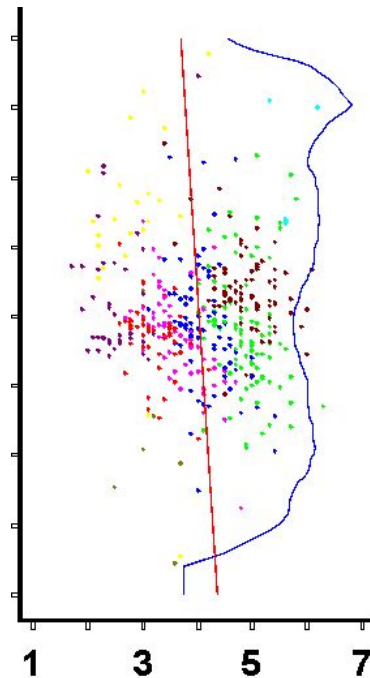
F

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

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



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



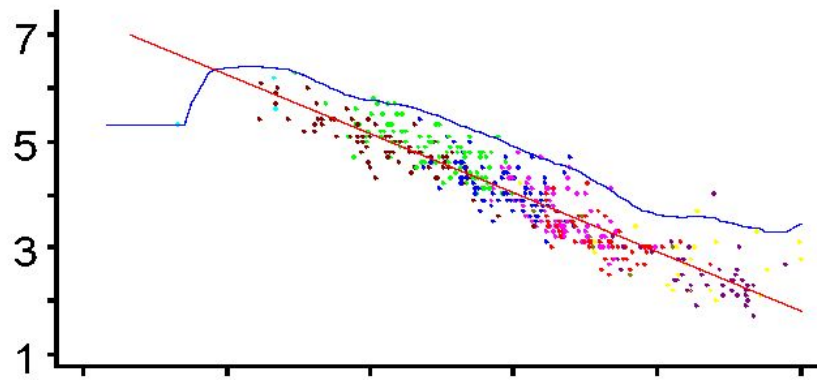
Groups

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

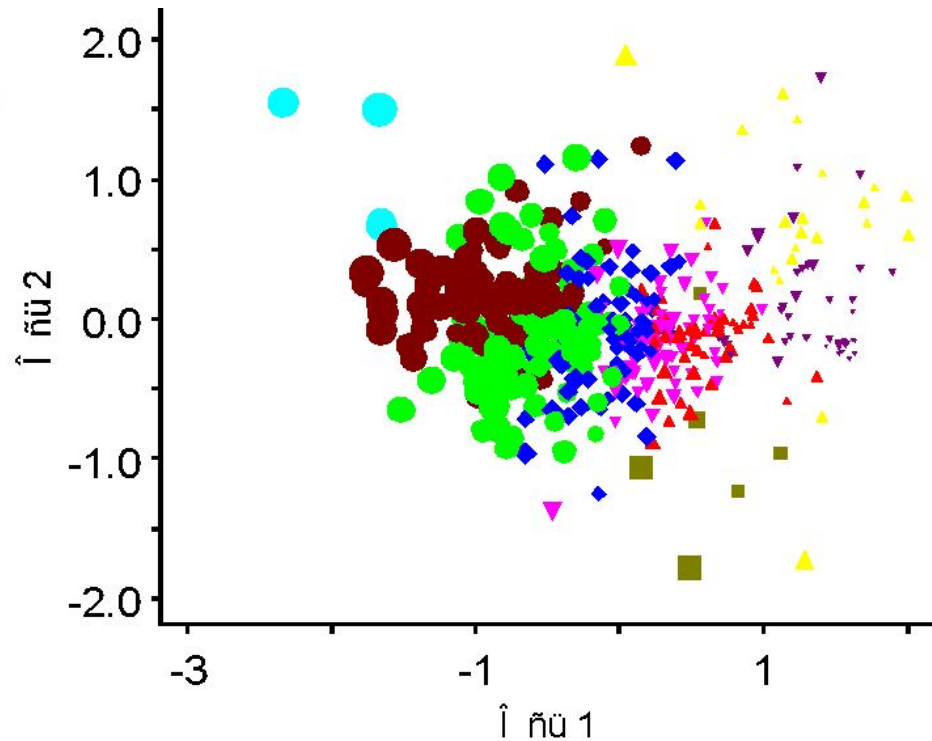
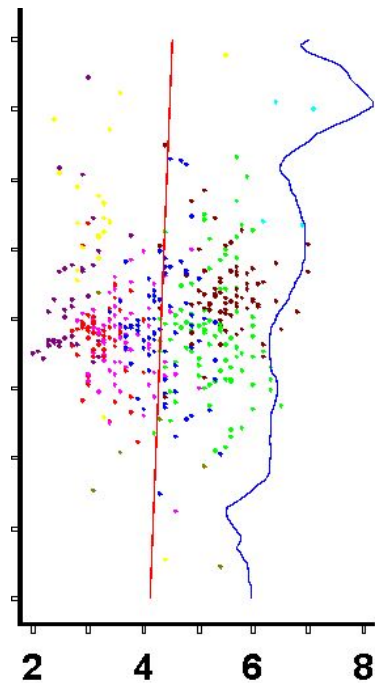
N

$\hat{\nu} 1$
 $r = -.923$ $\tau = -.792$

$\hat{\nu} 2$
 $r = -.085$ $\tau = -.057$



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

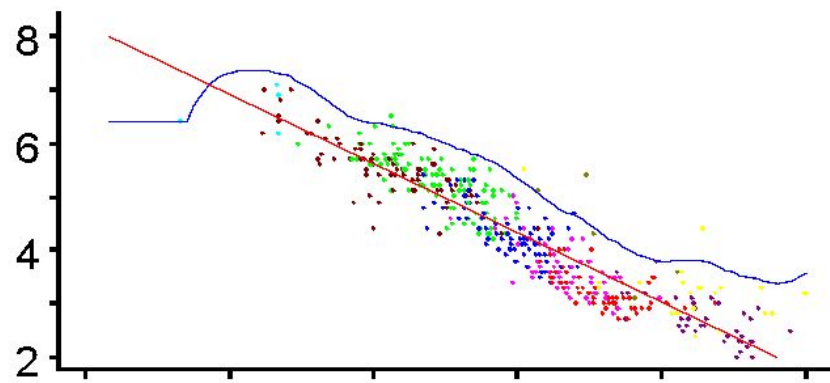


Groups

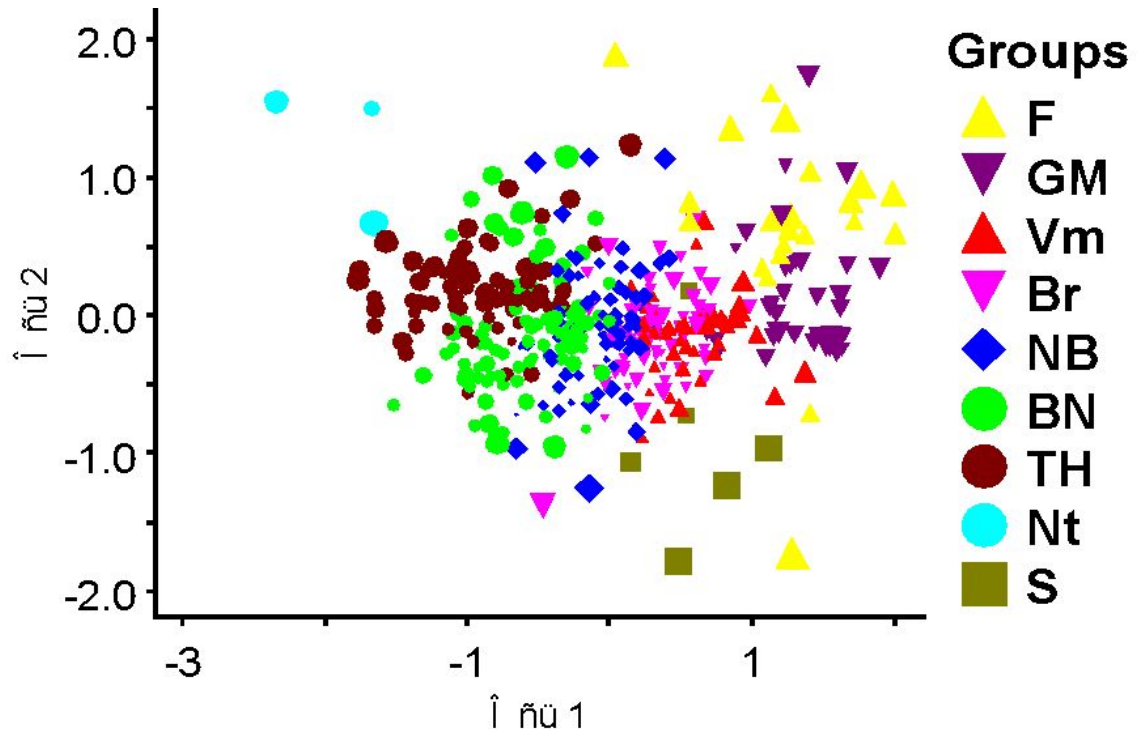
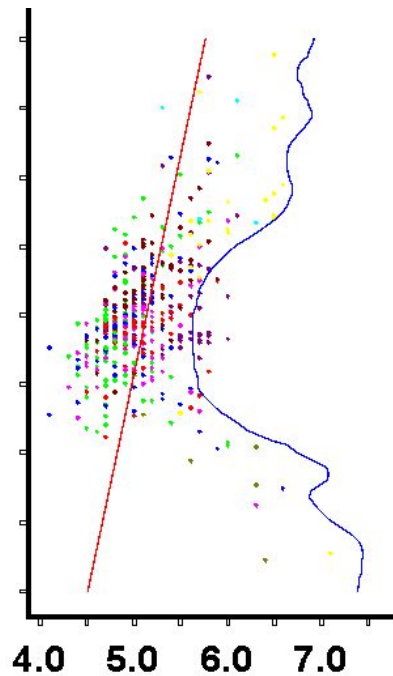
- ▲ F
- ▼ GM
- ▲ Vm
- ▼ Br
- ◆ NB
- BN
- TH
- Nt
- S

R

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



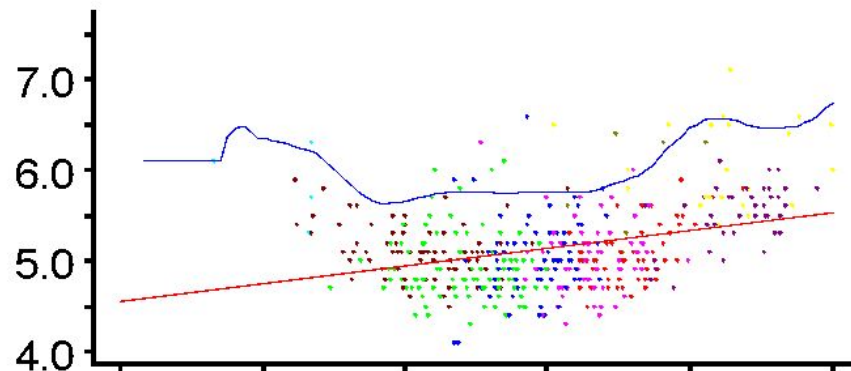
NMS ordination of the Kostroma vegetation sample plots with values L (light regime) overlay



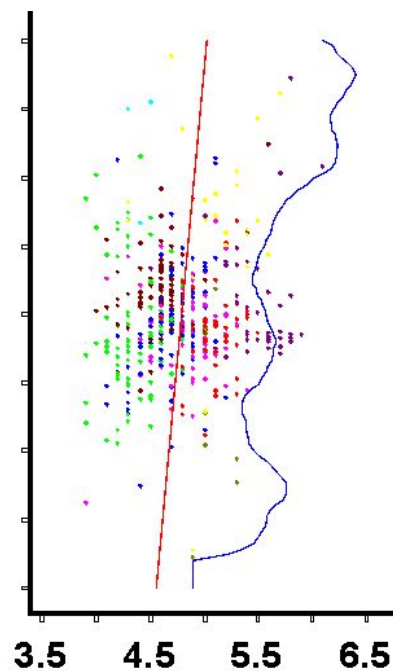
L

$\hat{\nu} 1$
 $r = .348$ $\tau = .213$

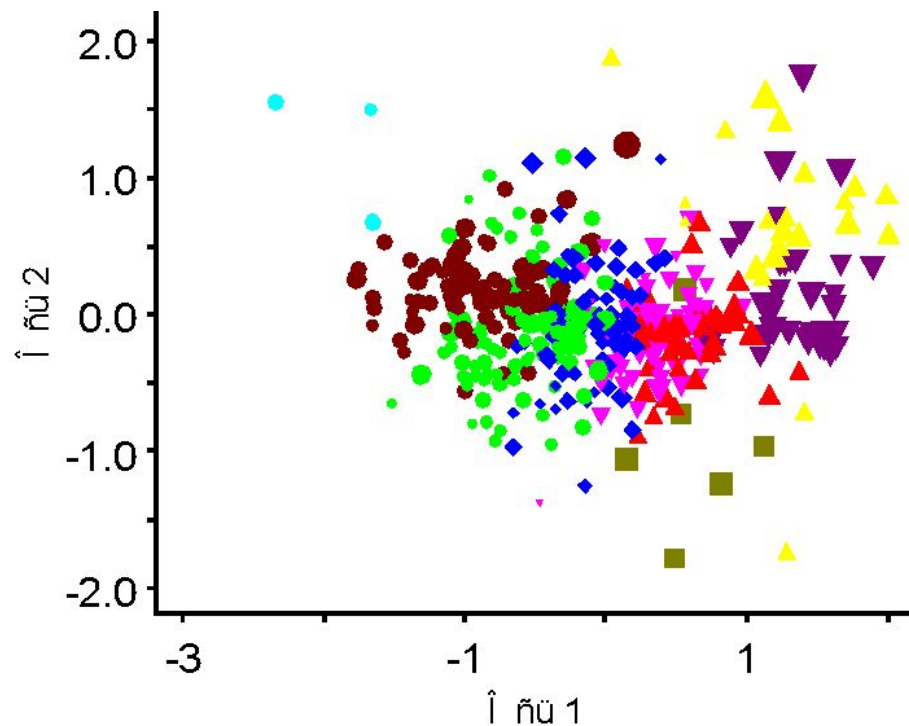
$\hat{\nu} 2$
 $r = .317$ $\tau = .297$



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

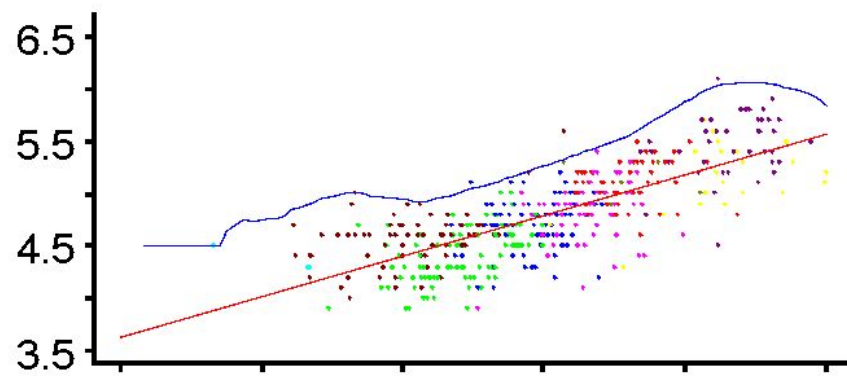


K
 $\hat{\nu} 1$
 $r = .751$ $\tau = .584$
 $\hat{\nu} 2$
 $r = .133$ $\tau = .060$

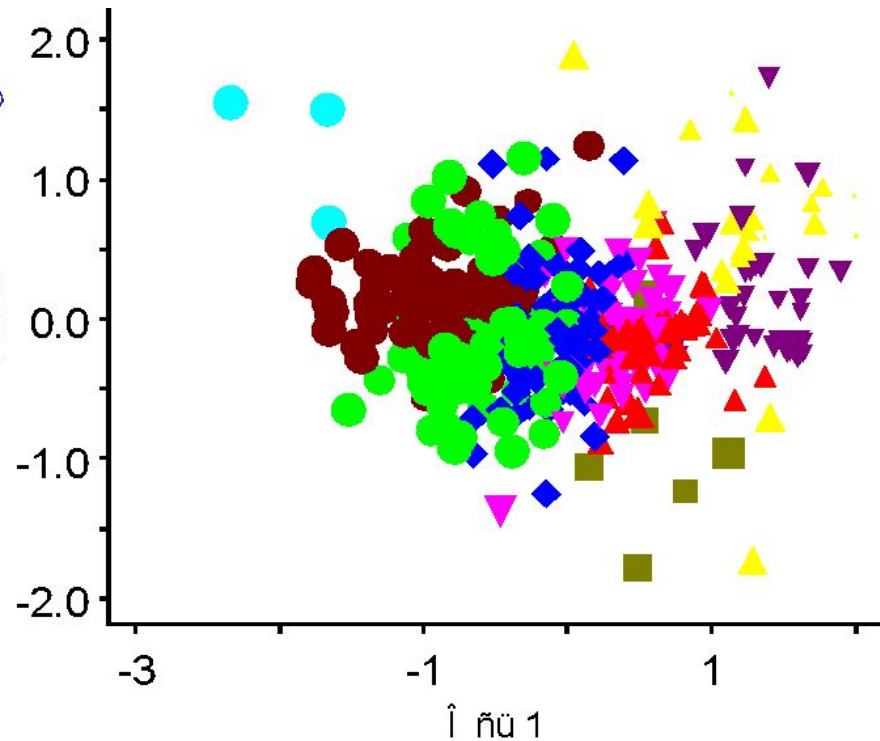
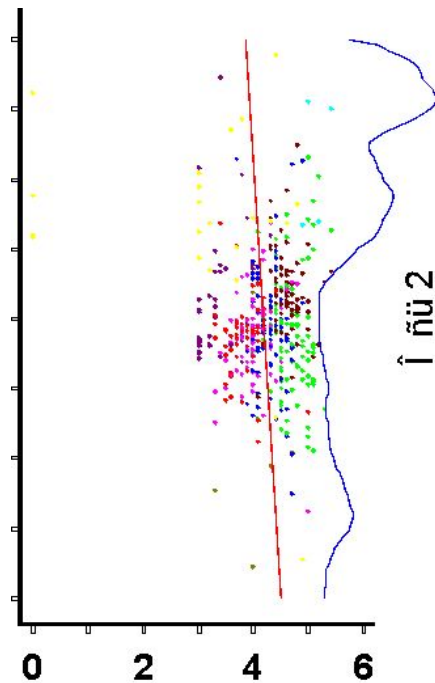


Groups

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



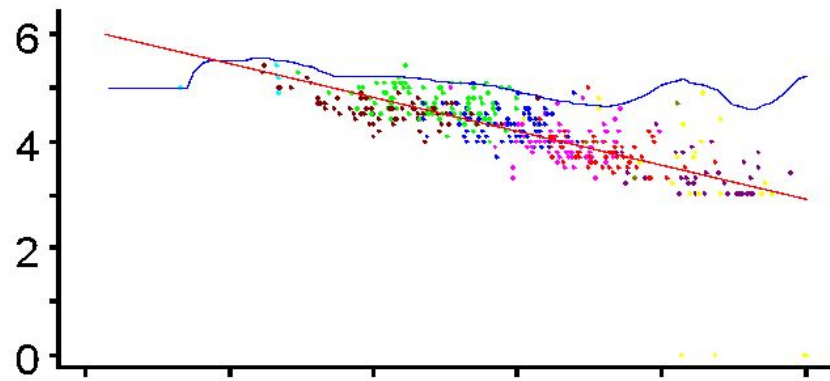
NMS ordination of the Kostroma vegetation sample plots with values T (temperature regime) overlay



Groups

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

T
nu 1
 $r = -.751$ $\tau = -.633$
nu 2
 $r = -.110$ $\tau = .024$



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

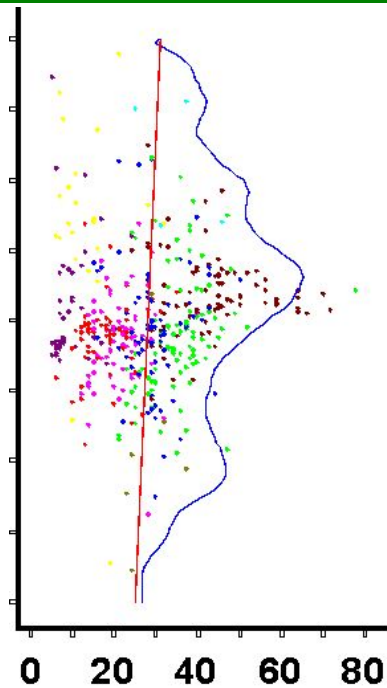
	BN	Br	F	Gm	NB	Nt	S	TH	Vm
BN		1	1	1	1	0	0	1	1
Br	1		1	1	1	0	0	1	0
F	1	1		0	1	1	1	1	0
Gm	1	1	0		1	1	1	1	1
NB	1	1	1	1		0	0	1	1
Nt	0	0	1	1	0		0	0	1
S	0	0	1	1	0	0		1	0
TH	1	1	1	1	1	0	1		1
Vm	1	0	0	1	1	1	0	1	

1 - различия между группами достоверны

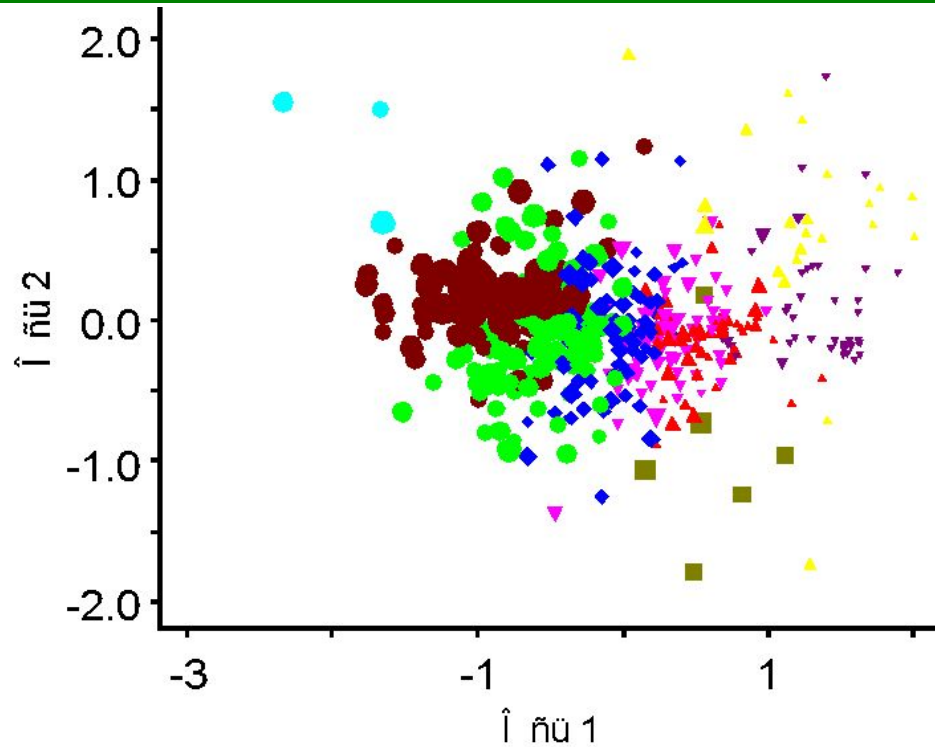
0 - различия между группами недостоверны

при $p < 0.05$

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

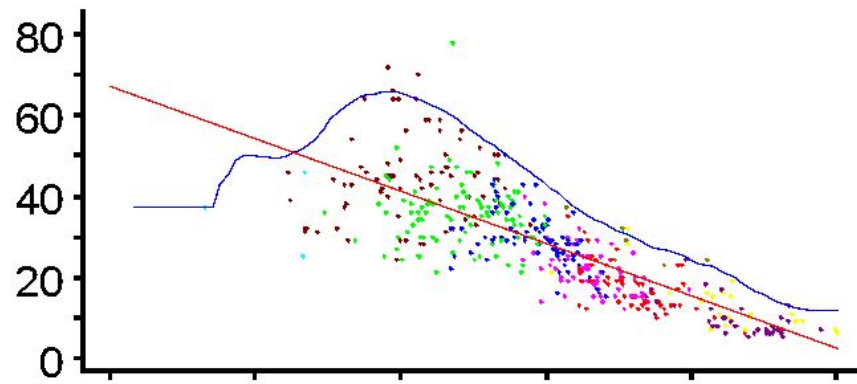


Sp
 $\hat{\nu} 1$
 $r = -.791$ $\tau = -.664$
 $\hat{\nu} 2$
 $r = .052$ $\tau = .100$

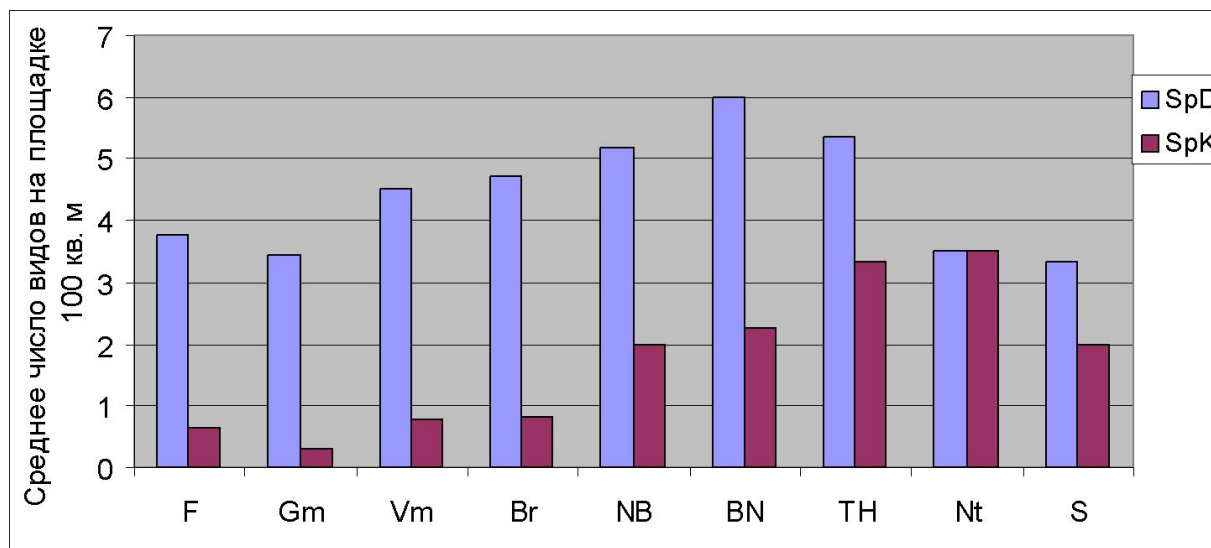
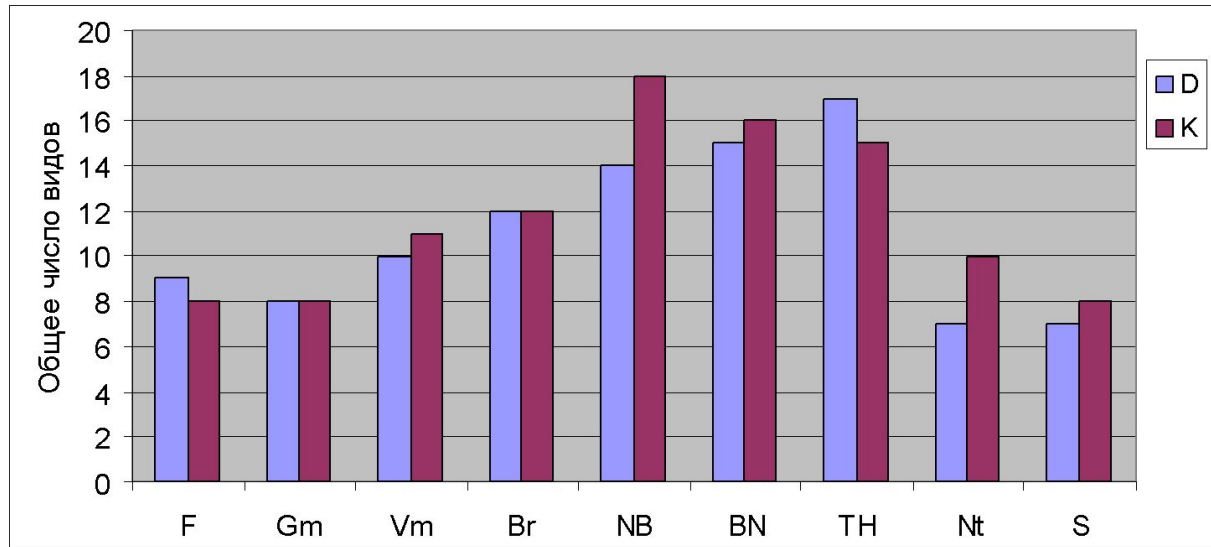


Groups

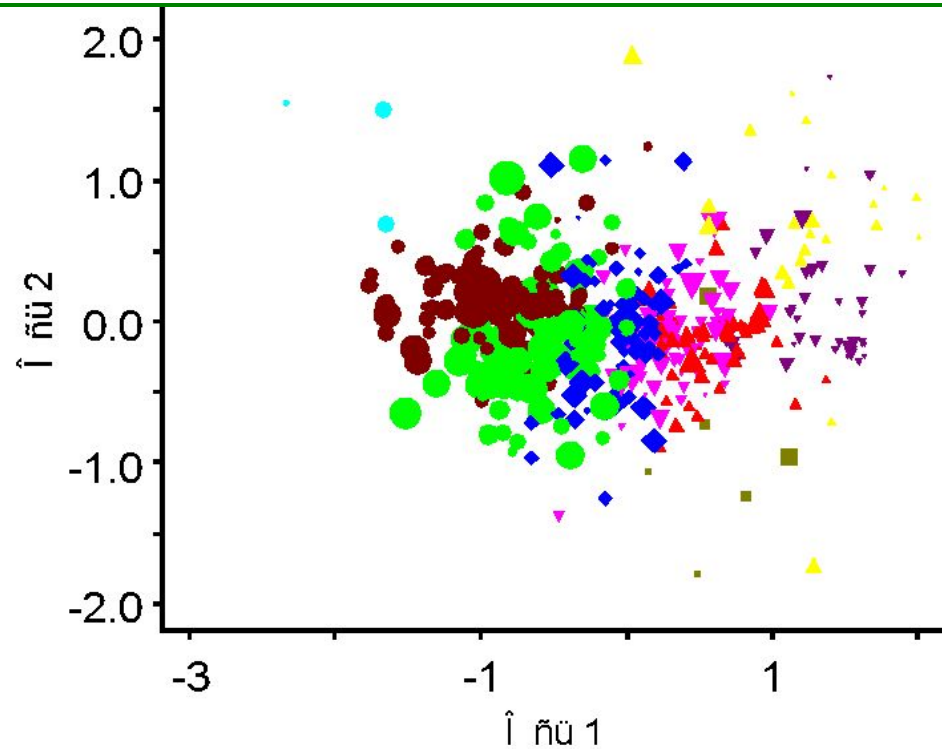
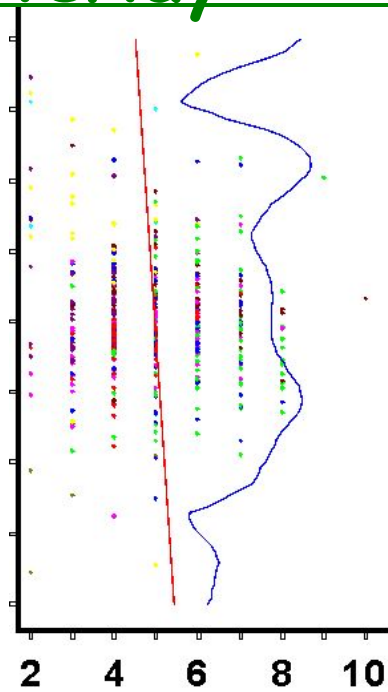
- ▲ F
- ▼ GM
- ▲ Vm
- ▼ Br
- ◆ NB
- BN
- TH
- Nt
- S



Tree and shrub species diversity of the forest types



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

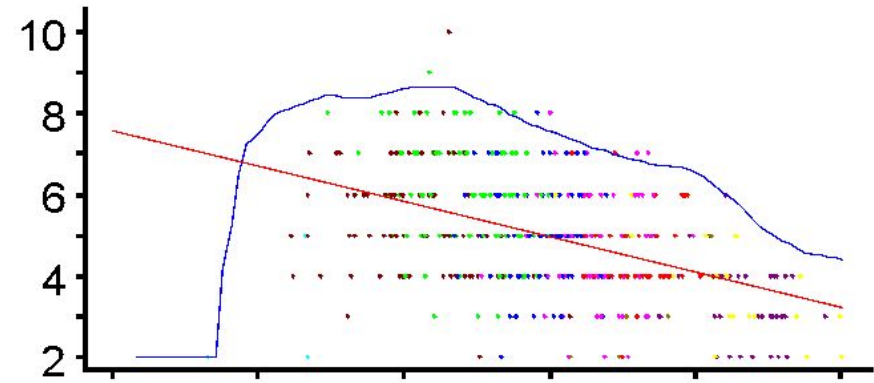


- Groups**
- ▲ F
 - ▼ GM
 - ▲ Vm
 - ▼ Br
 - ◆ NB
 - BN
 - TH
 - Nt
 - S

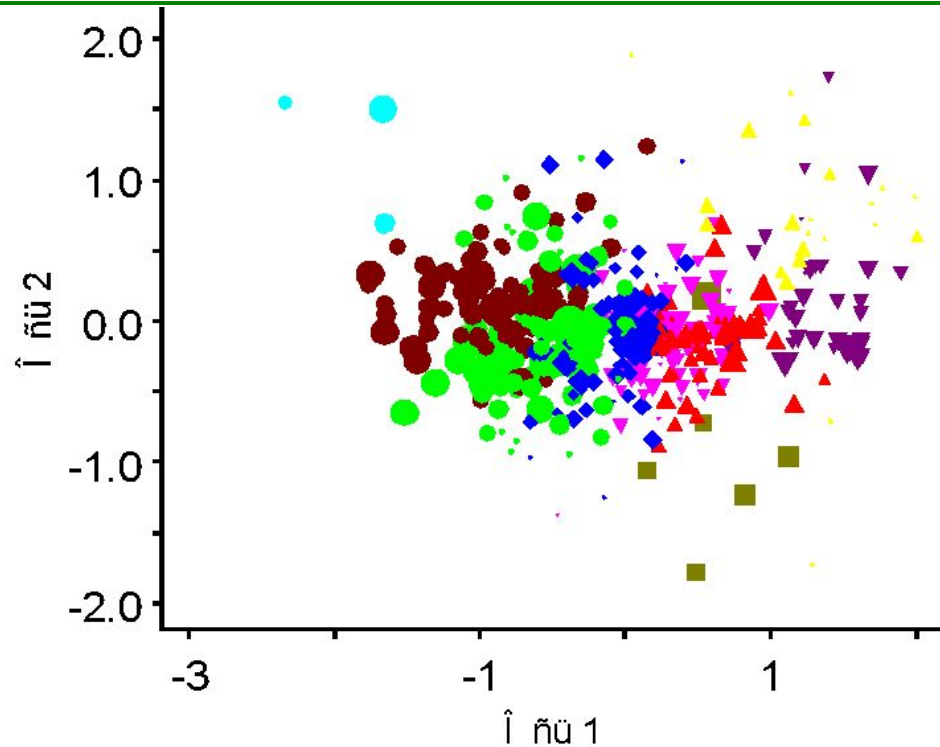
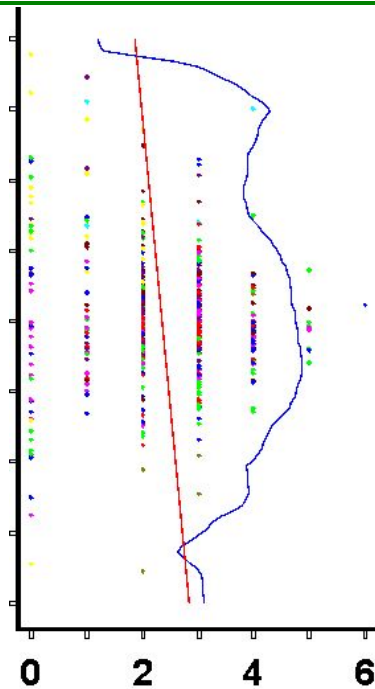
SpD

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

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



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

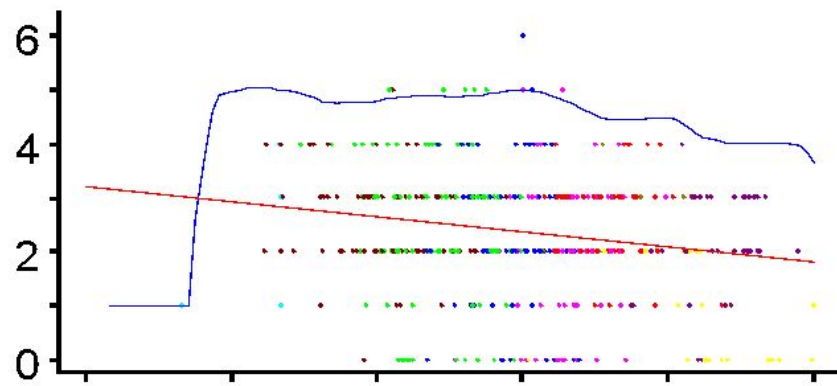


Groups

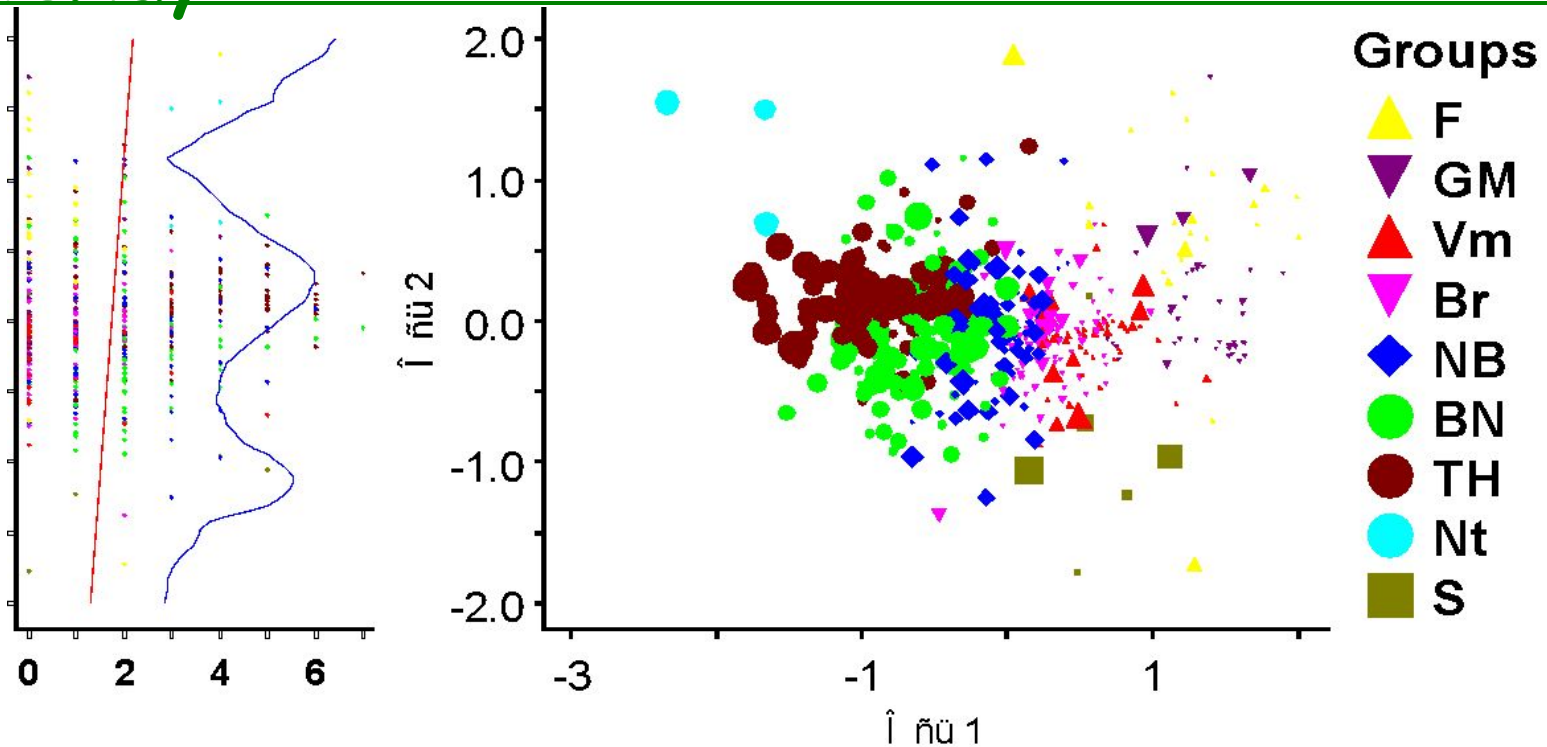
- ▲ F
- ▼ GM
- ▲ Vm
- ▼ Br
- ◆ NB
- BN
- TH
- Nt
- S

DA

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

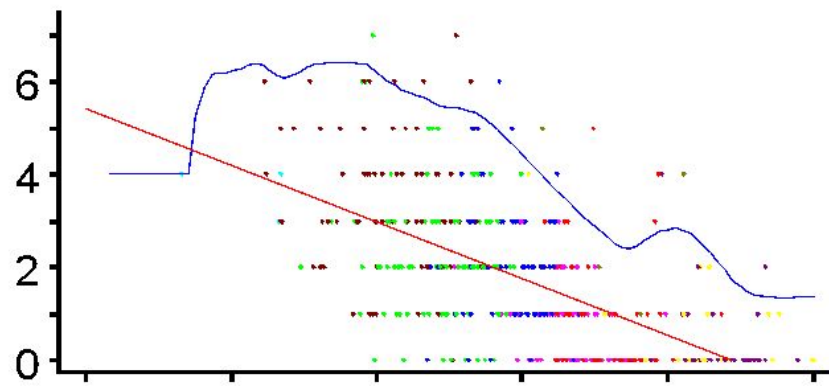


NMS ordination of the Kostroma vegetation sample plots with the number of shrub species overlay

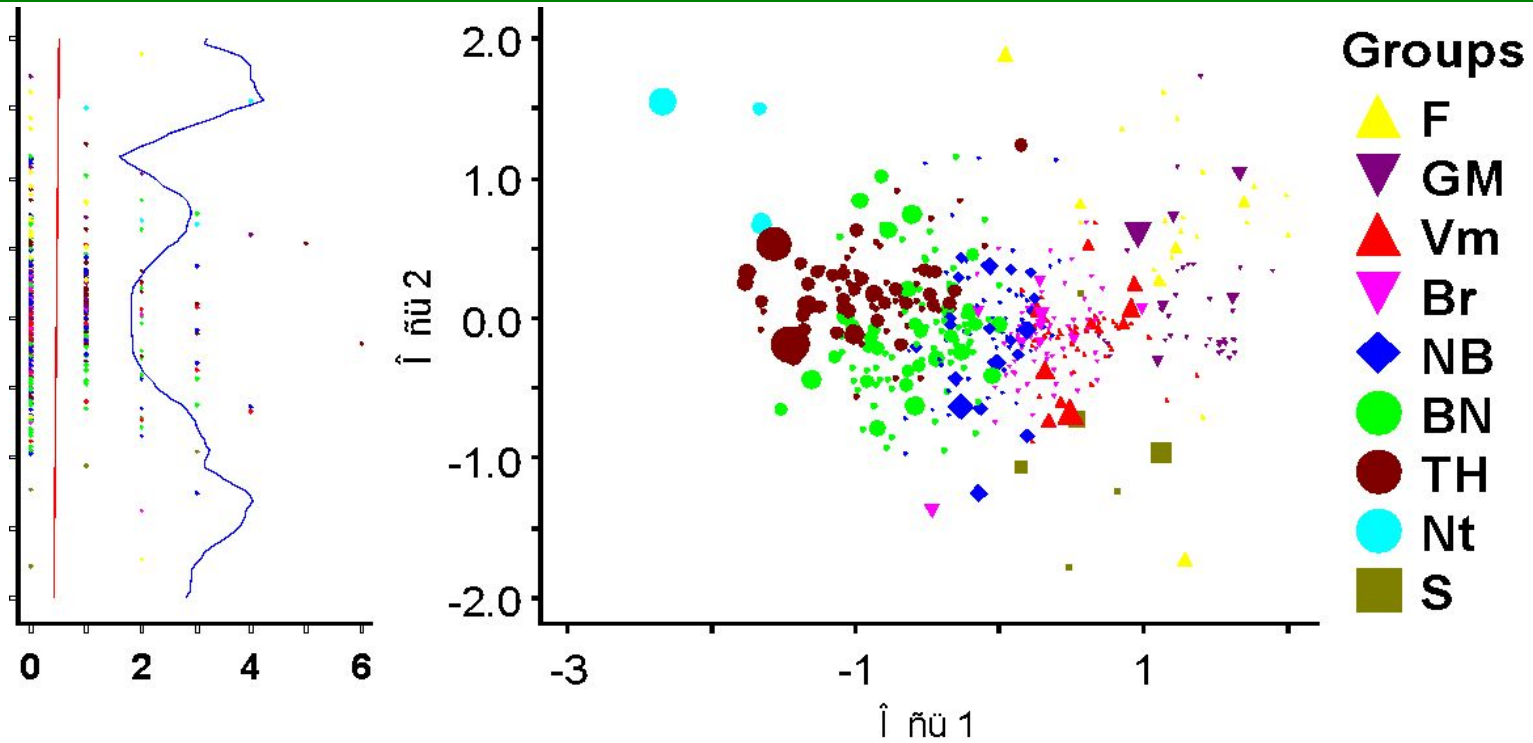


SpK

$\hat{\nu}_1$
 $r = -.601$ $\tau = -.500$
 $\hat{\nu}_2$
 $r = .063$ $\tau = .099$

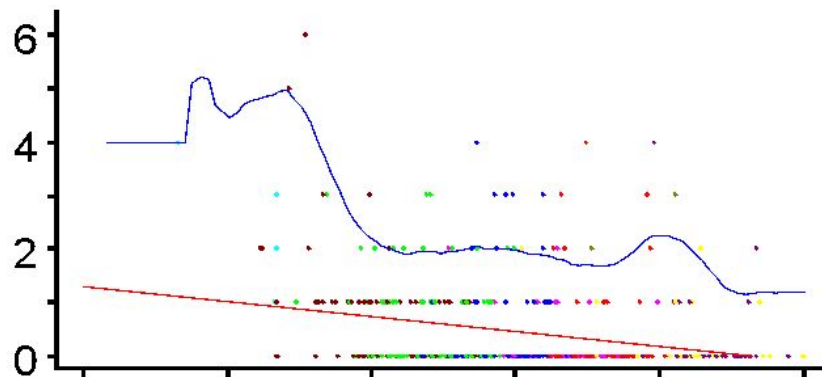


NMS ordination of the Kostroma vegetation sample plots with the number of shrub species in the upper understorey overlay

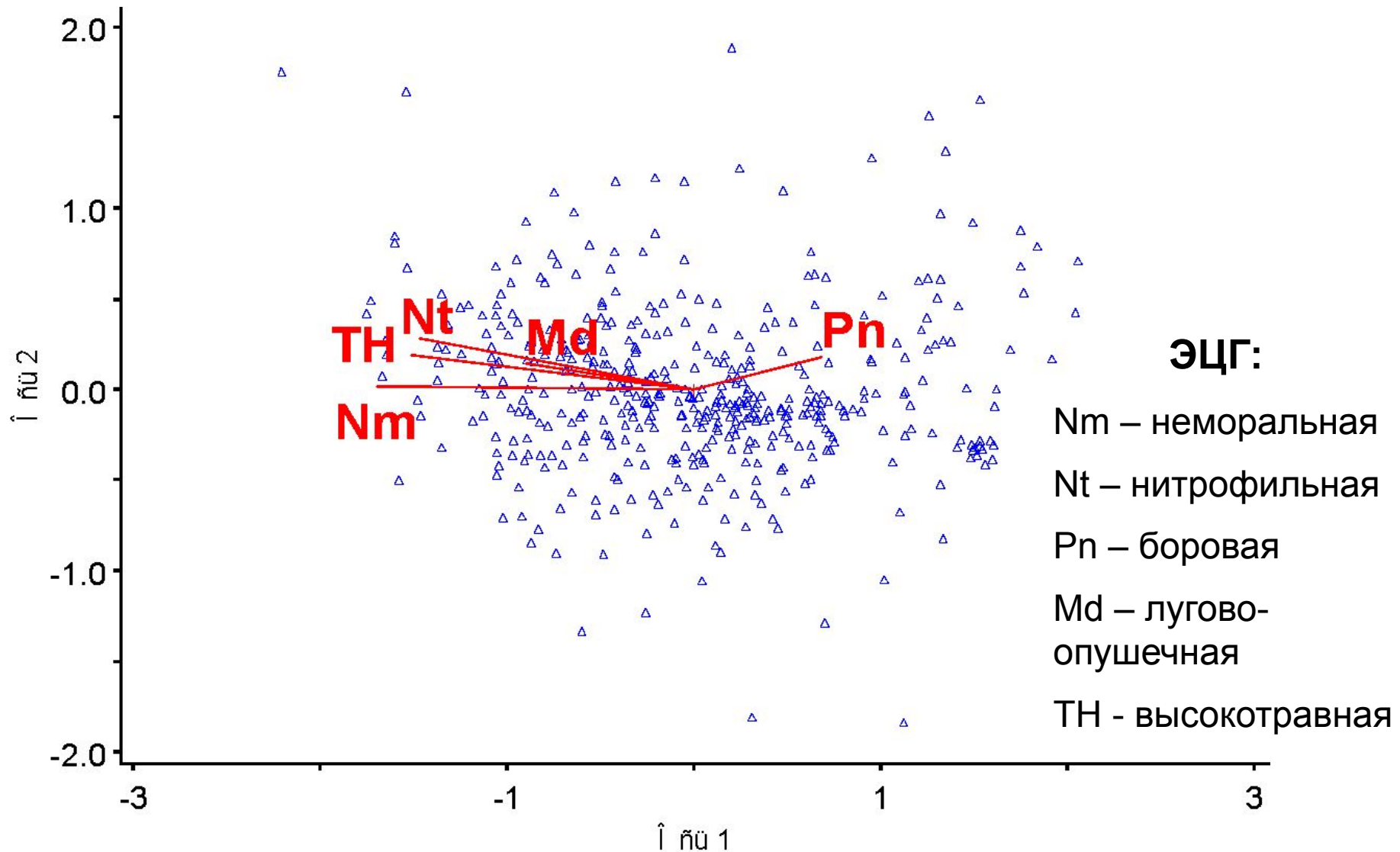


KB

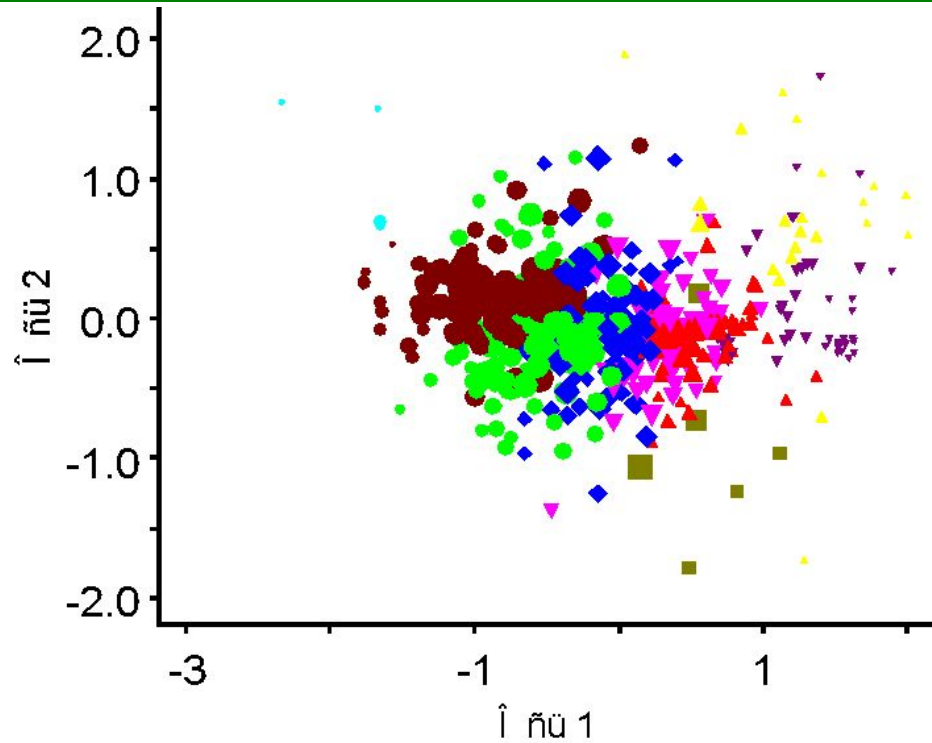
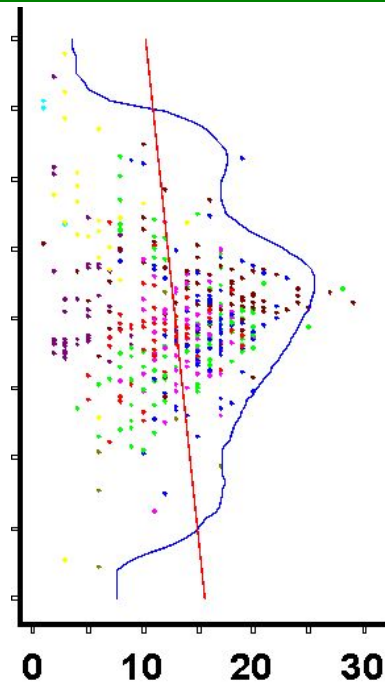
$\hat{\nu} 1$
 $r = -.257$ $\tau = -.216$
 $\hat{\nu} 2$
 $r = .014$ $\tau = .065$



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



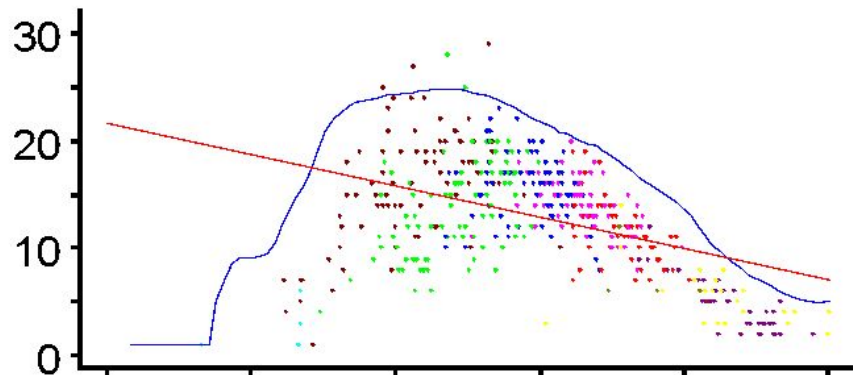
NMS ordination of the Kostroma vegetation sample plots with the number of boreal species overlay



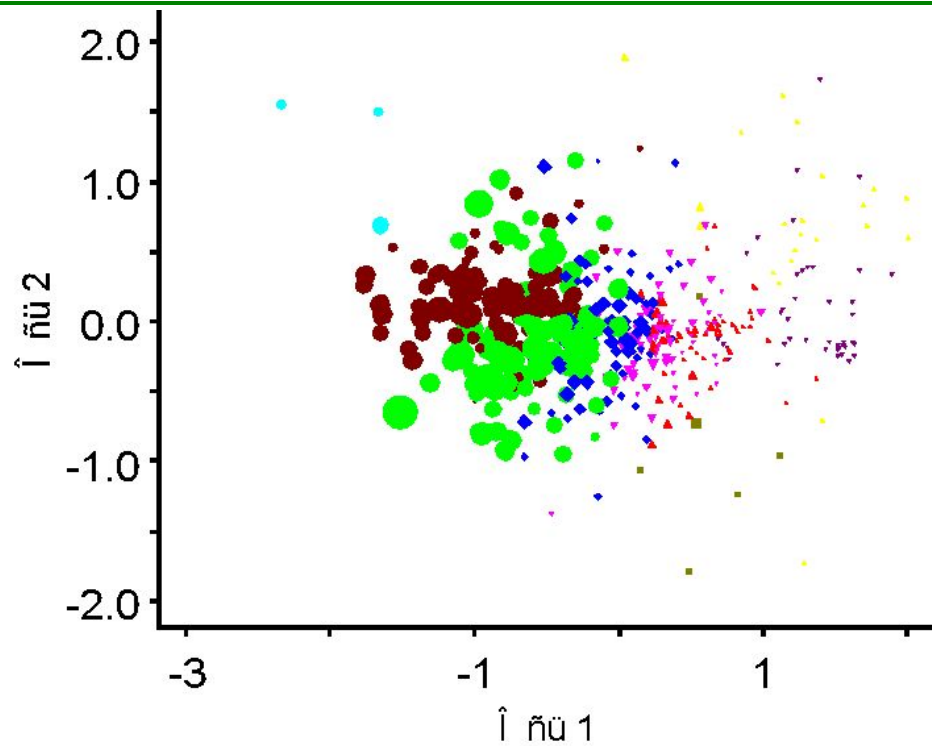
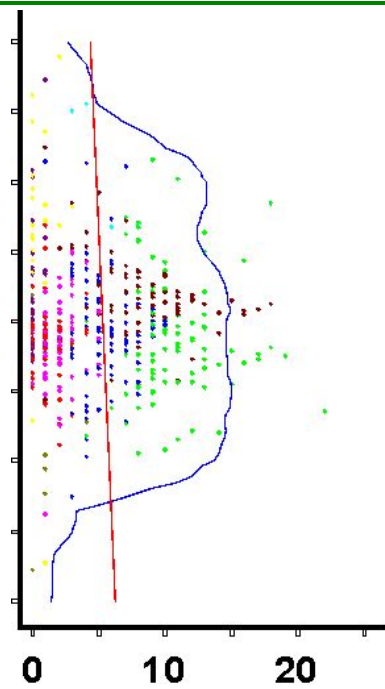
Br

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

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



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



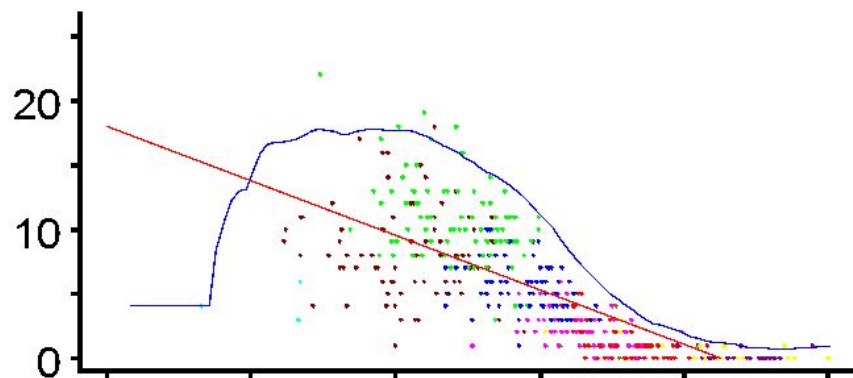
Groups

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

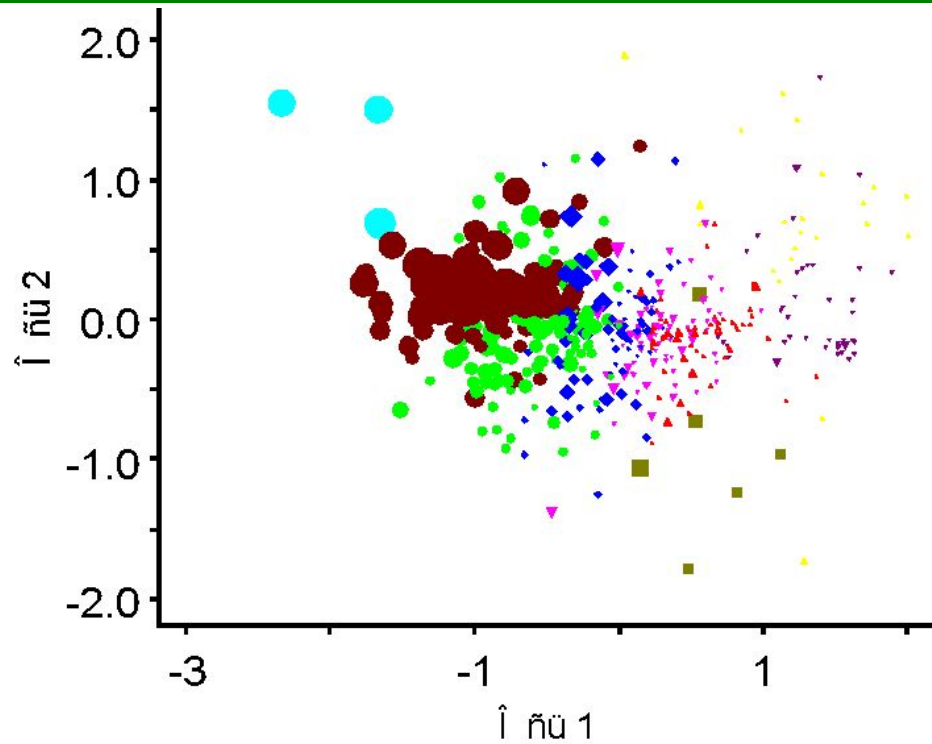
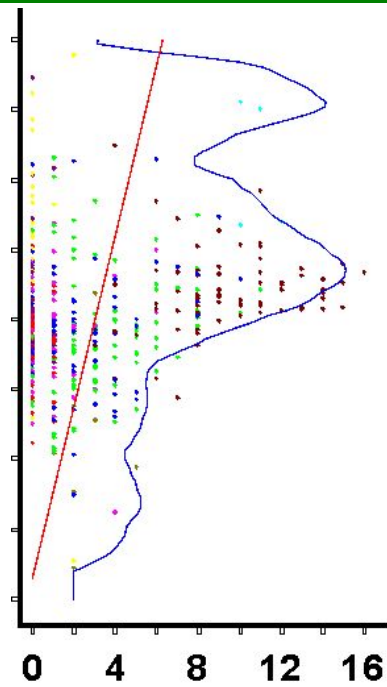
Nm

$\hat{\nu} 1$
 $r = -.751$ $\tau = -.671$

$\hat{\nu} 2$
 $r = -.048$ $\tau = -.007$



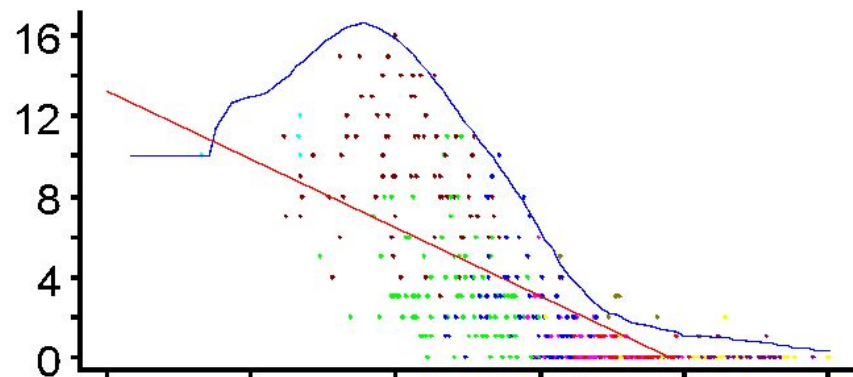
NMS ordination of the Kostroma vegetation sample plots with the number of nitrophilous species overlay



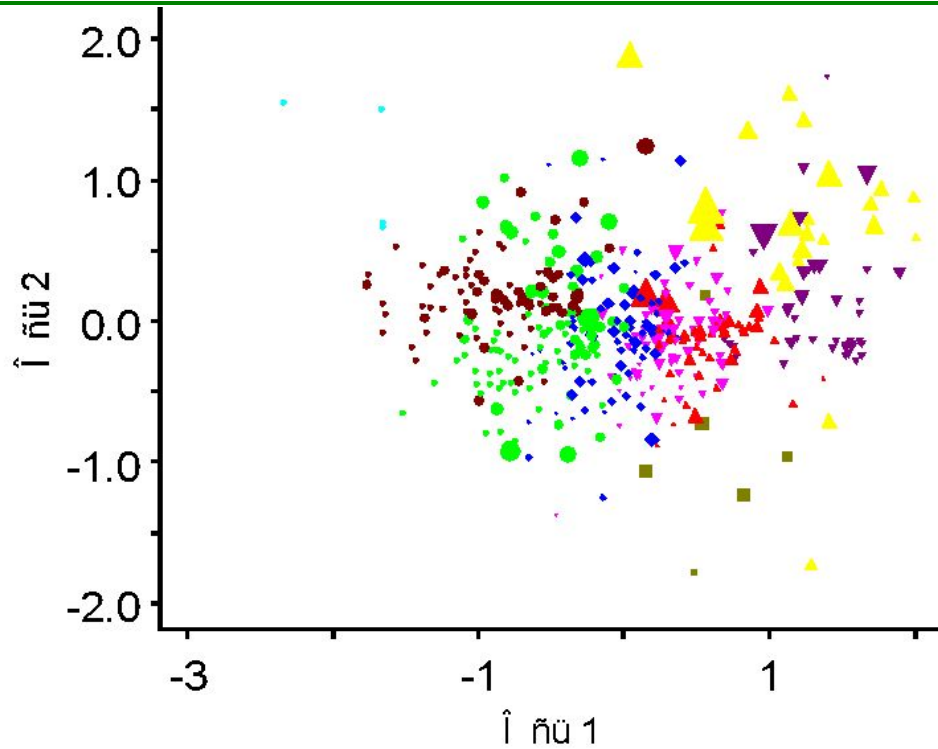
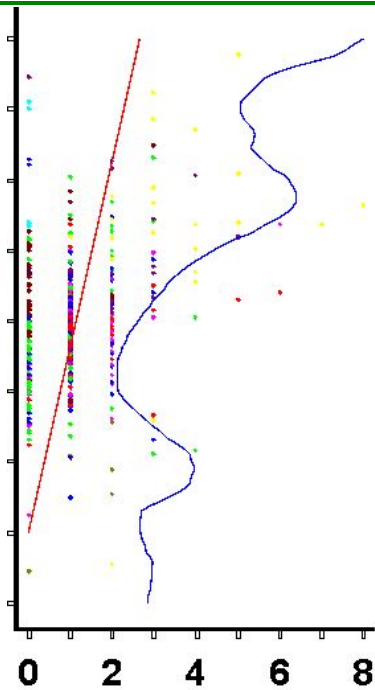
Groups

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

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



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

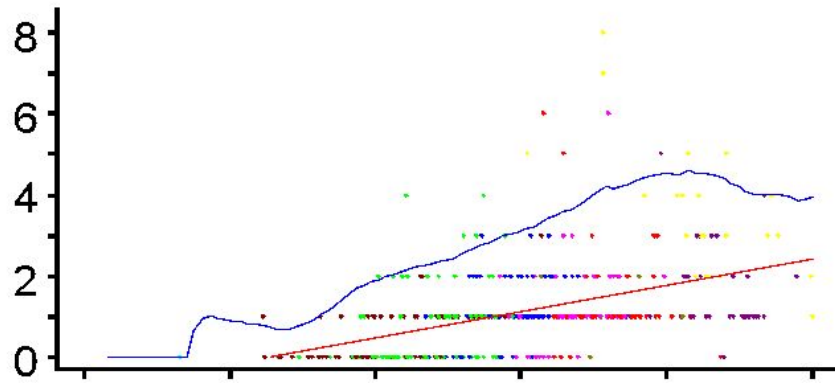


Groups

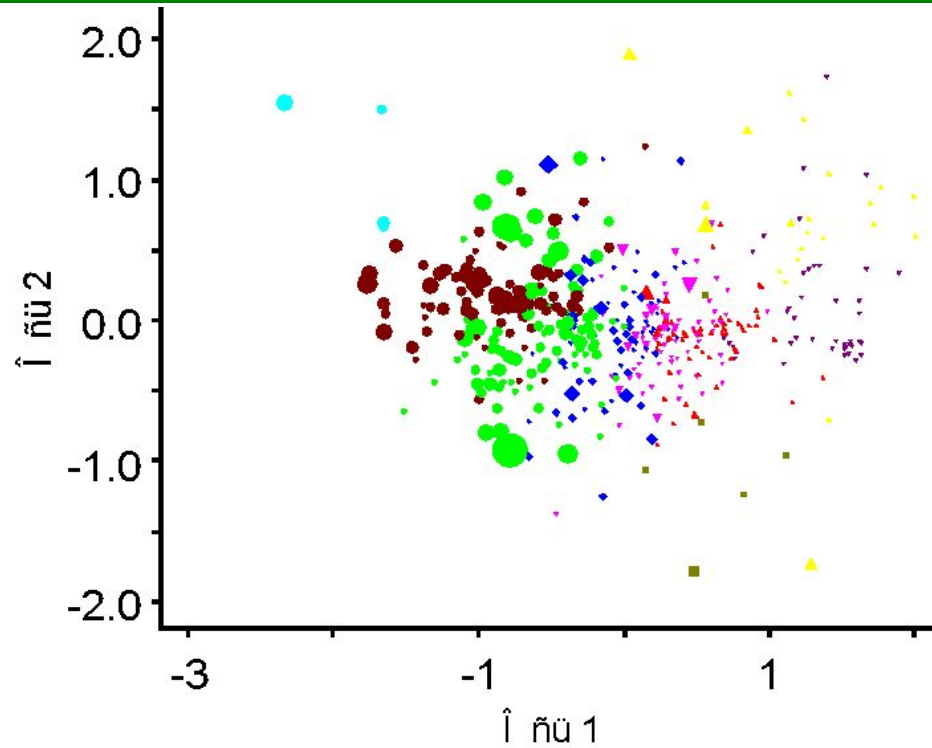
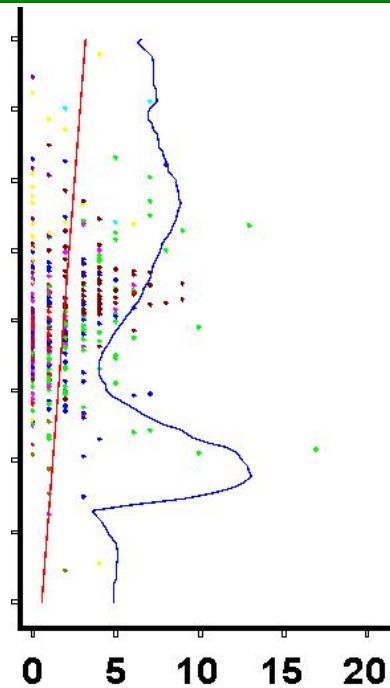
- ▲ F
- ▼ GM
- ▲ Vm
- ▼ Br
- ◆ NB
- BN
- TH
- Nt
- S

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

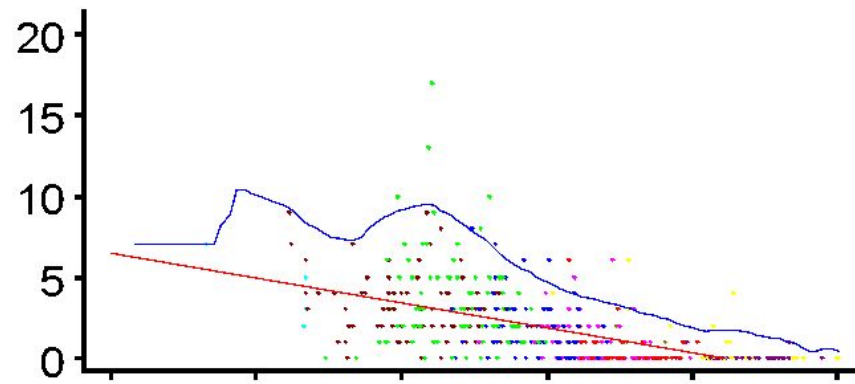


Groups

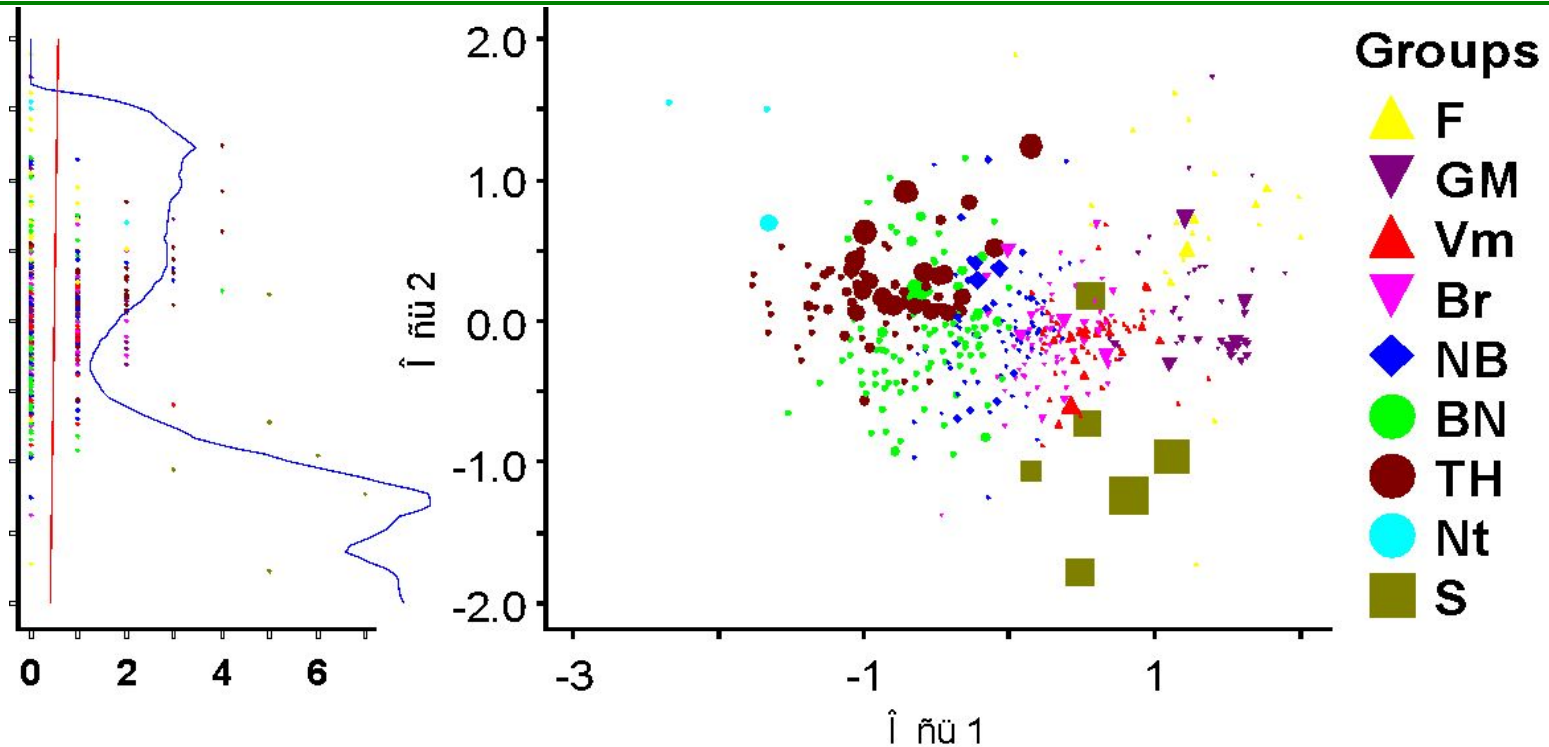
- ▲ F
- ▼ GM
- ▲ Vm
- ▼ Br
- ◆ NB
- BN
- TH
- Nt
- S

Md

$\hat{\nu} 1$
 $r = -.555$ $\tau = -.513$
 $\hat{\nu} 2$
 $r = .133$ $\tau = .153$



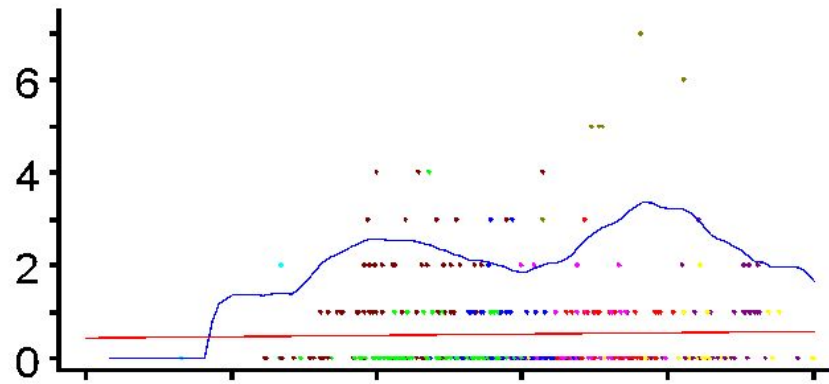
NMS ordination of the Kostroma vegetation sample plots with the number of oligotrophic species overlay



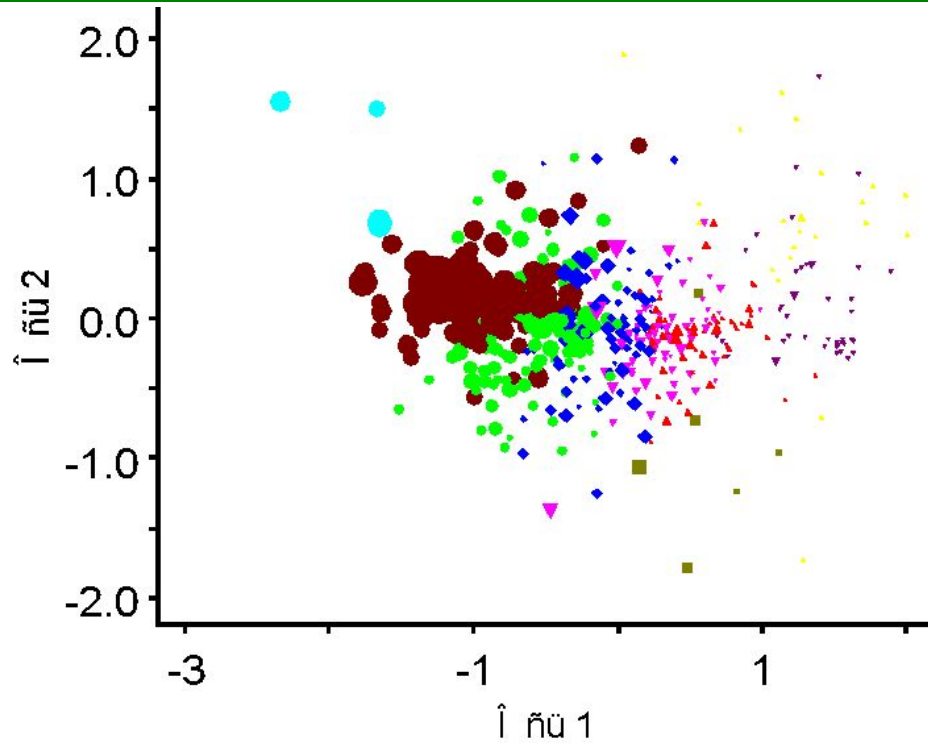
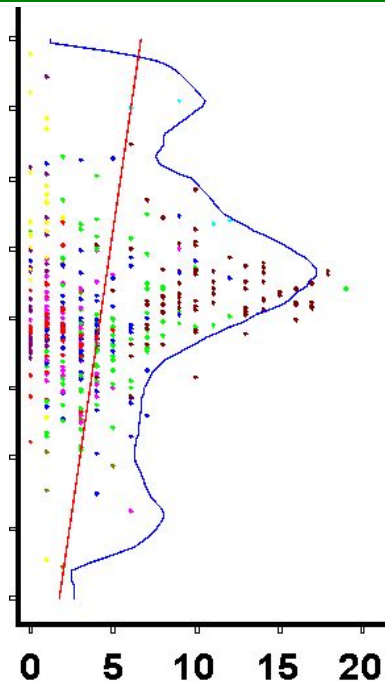
Olg

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

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



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

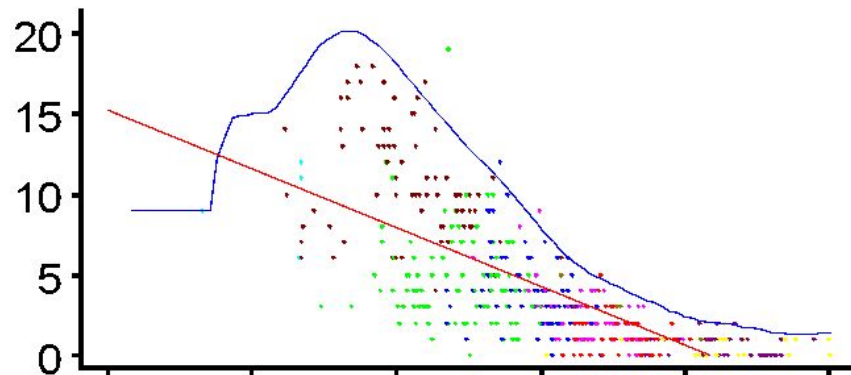


Groups

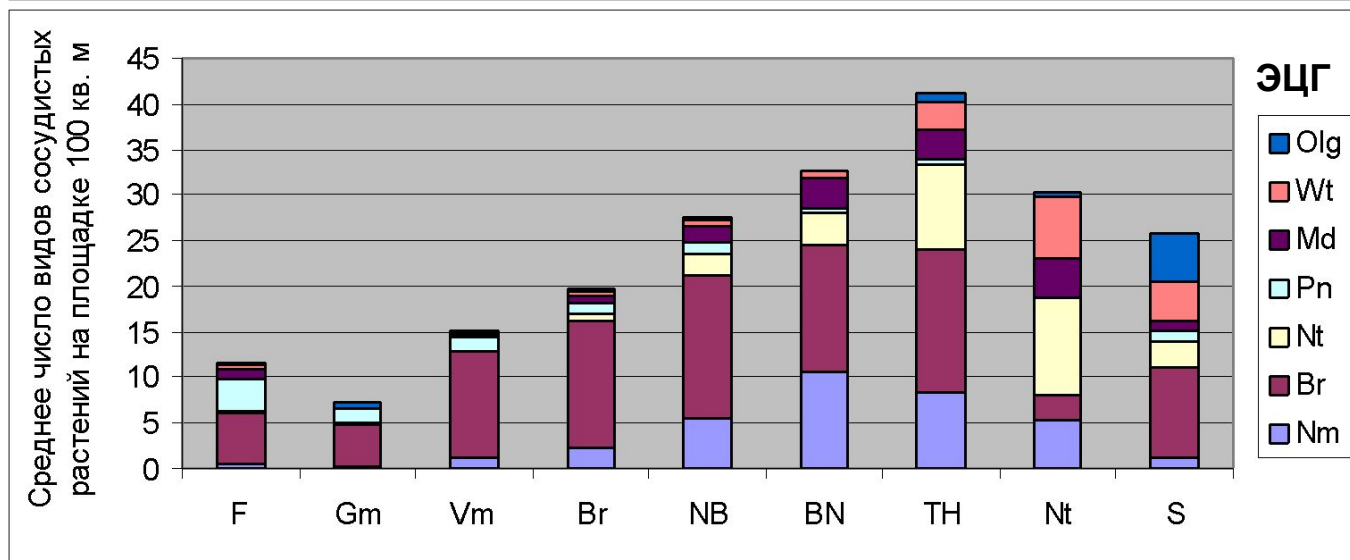
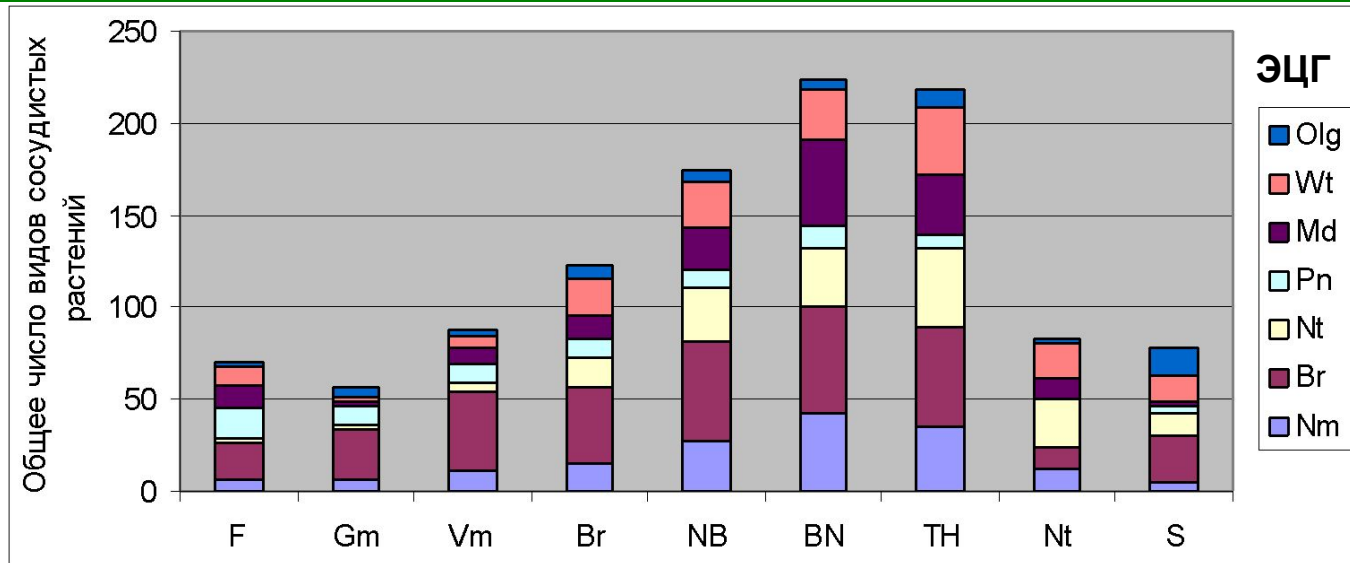
- ▲ F
- ▼ GM
- ▲ Vm
- ▼ Br
- ◆ NB
- BN
- TH
- Nt
- S

TH

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

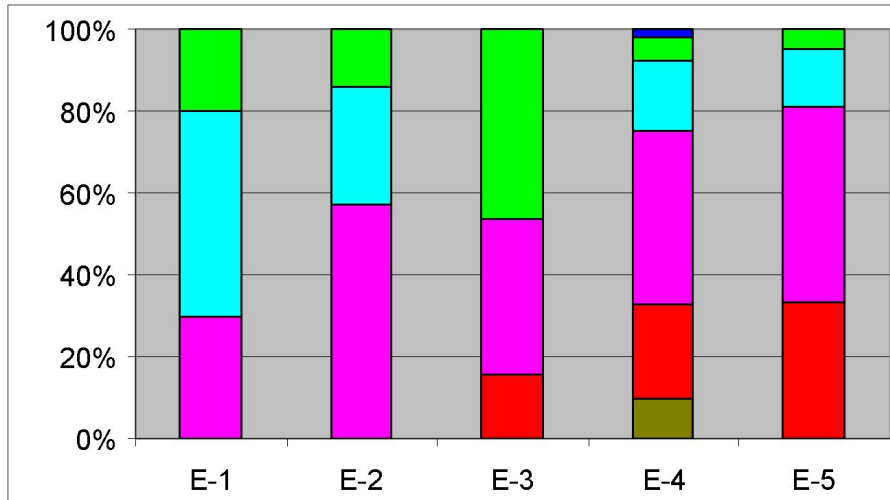


Ecological-coenotic structure of forest types

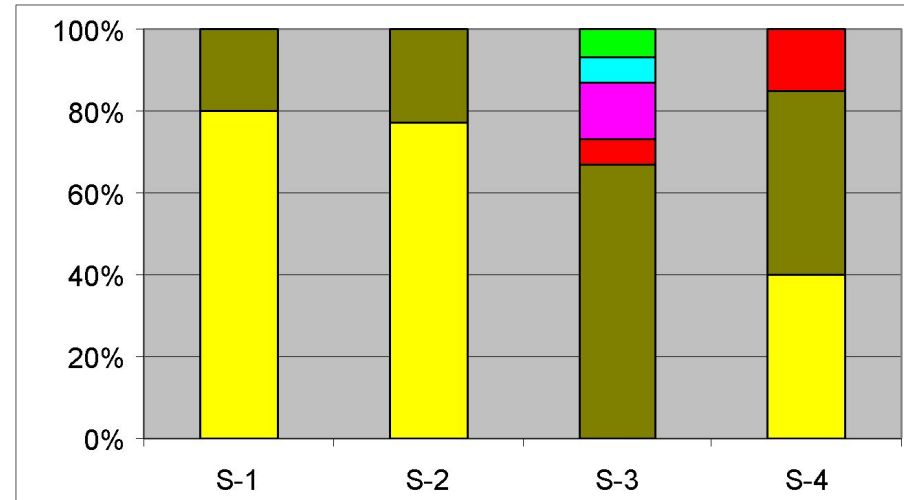


Forest types and succession variants from the 1st to 5th succession stage

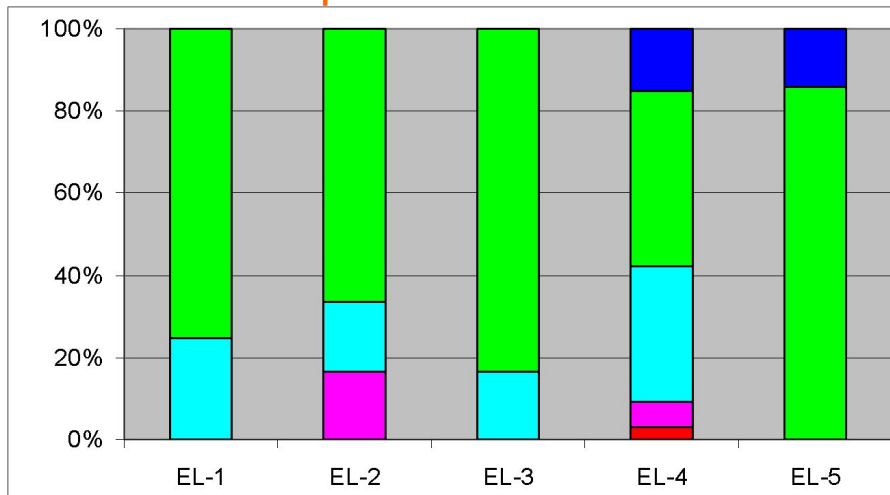
Spruce forest



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