USING GRIME'S MATHEMATICAL MODEL TO DEFINE ADAPTATION STRATEGY OF VASCULAR PLANTS IN THE NORTH OF RUSSIA

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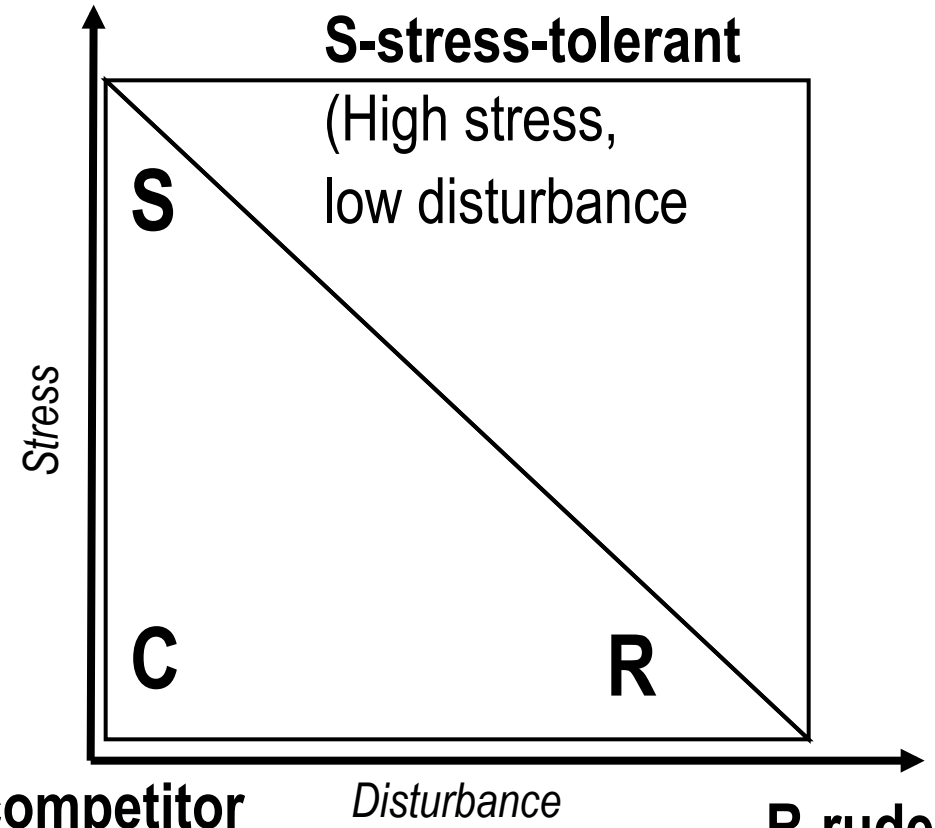
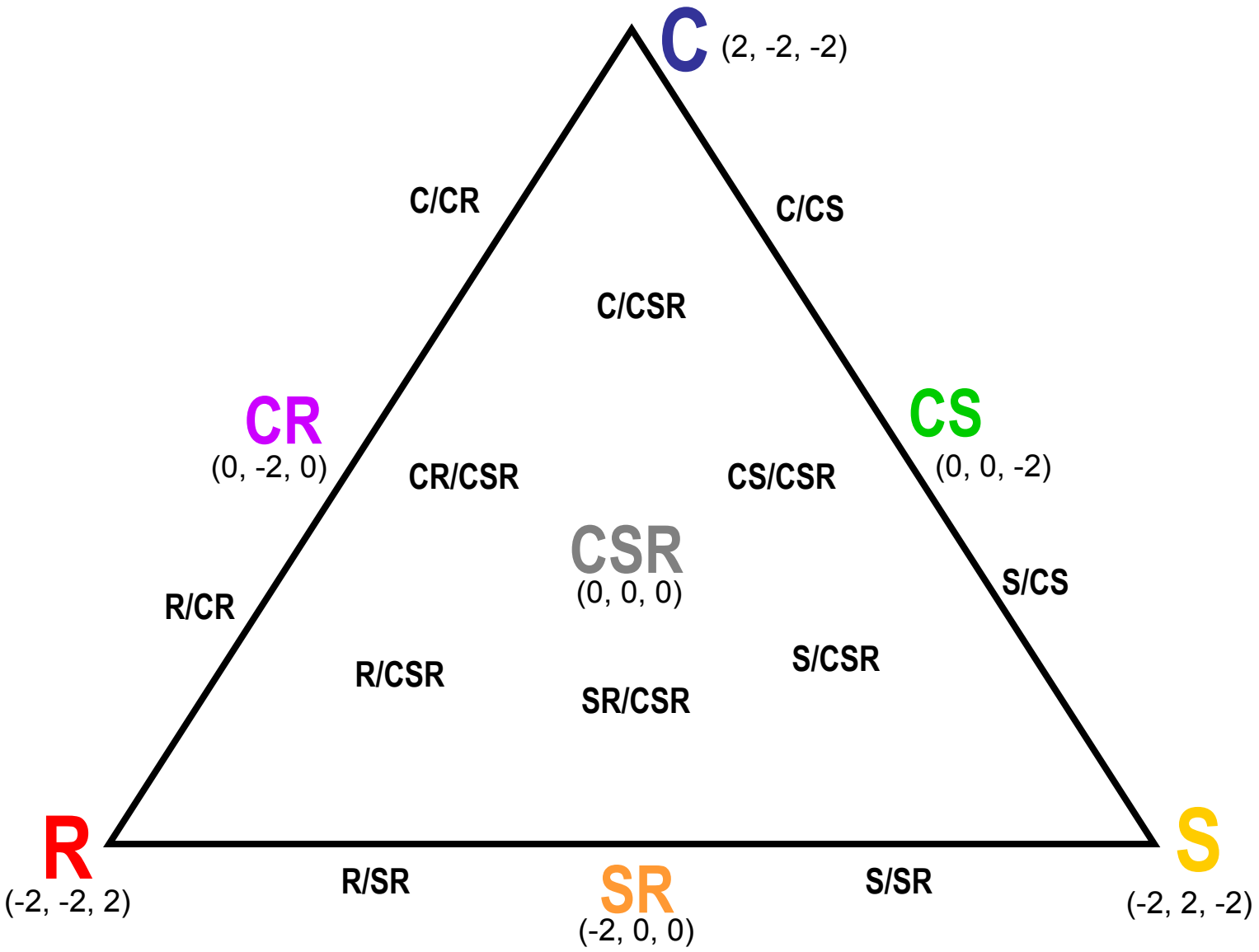
CAFF
Conservation of Arctic Flora and Fauna

Vegetation functional types



CSR classification
(Secondary and tertiary strategy)



The original model

Regression equations (separate for all C, S, R axes)

$$C = -2.5 + 0.118 * CH^2 + 0.076 * LS^2$$

$$S = 1.485 - 0.79 * CH^2 + 0.05 * DMC^2 - 0.129 * SLA^2 + 0.082 * LS^2$$

$$R = -2.5 - 0.158 * DMC + 0.31 * FP + 0.3 * FP - 0.327 * \ln(LDW) + 0.639 * SLA$$

CH – Canopy Height (cm)

LDW – Leafs Dry Weight (mg),

DMC – Dry Matter Content (%)

SLA – Specific Leaf Area (Area / Dry Weight) (mm^2/mg)

LS – Lateral Spread (six point classification)

FP – Flowering Period (count of months)

FS – Flowering Start (month number)

Hodgson J.G., Wilson P.J., Grime J.P., Thompson K. Allocating C-S-R plant functional types: a soft approach to a hard problem // Oikos. 1999. – Vol. 85. – P. 282-294.

Goals and objectives

Goal is to develop an approach to define functional types of vascular plants in the North of Russia based on the Grime's mathematical model

- Objectives:
  - Select several herbaceous species with clear position in CSR classification and measure all variables which are used in the Grime's model
  - Estimate relationships between these variables and functional types
  - Validate the original mathematical model
  - Adjust this model to our conditions and validate it

Sampling sites

Places of data collecting: the Ilych River basin – part of the Pechoro-Ilychsky Nature Reserve included in 1995 in the list of world heritage objects of UNESCO

Studied species

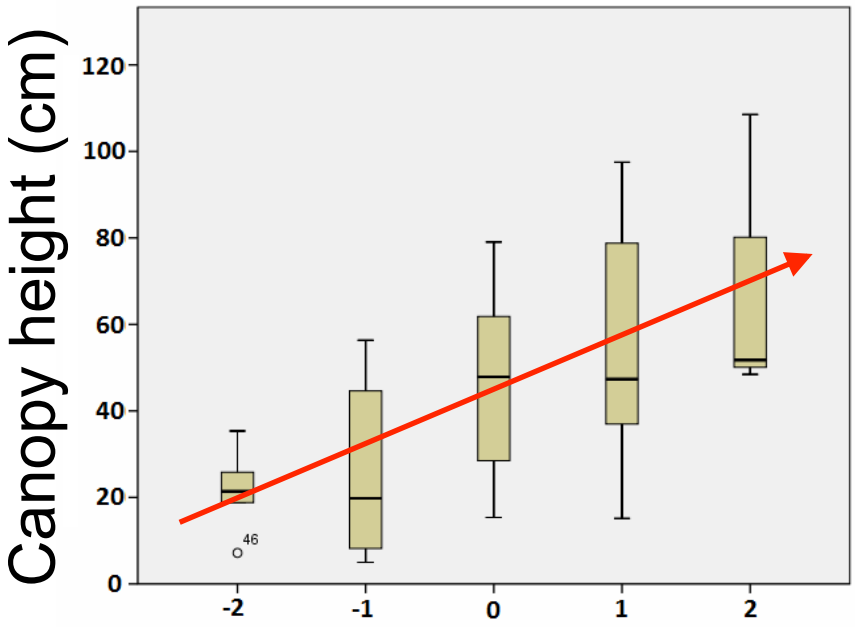
Species	Funct. type
Forest plants	
Melampyrum pratense	R/SR
Oxalis acetosella	S/CS
Trientalis europaea	S/CSR
Meadow plants	
Chamaenerion angustifolium	C
Ranunculus repens	CR
Rumex acetosella	SR/CSR
Marsh plants	
Andromeda polifolia	S/SC
Rubus chamaemorus	SC/CSR
Etc.	Etc.

About 40 dicots herbaceous plants of different functional types from different communities were analyzed.

Functional types were defined according to the Graim's classification

C-Axis (competitiveness)

Competitiveness is the relatively ability of the plants to capture different resources such as light or mineral nutrients. Usually this is achieved by large physical dimensions.

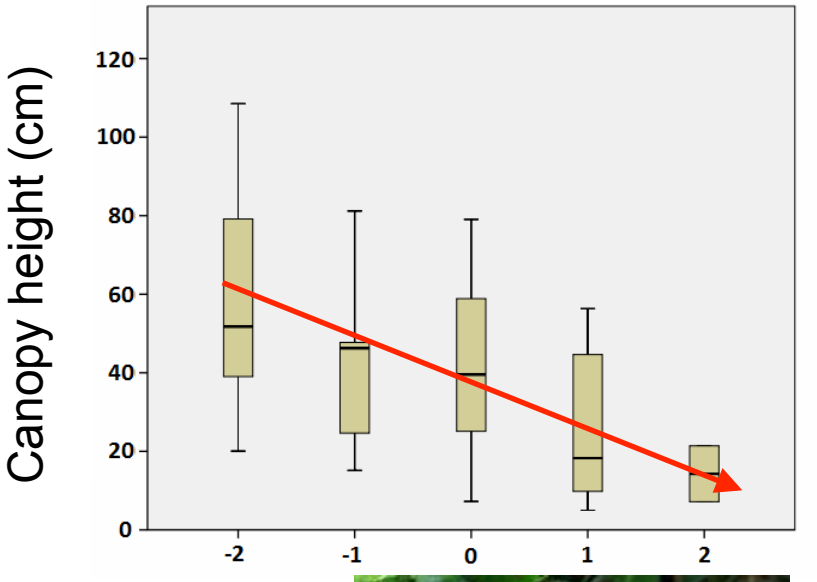


Chamerion angustifolium

Artemisia vulgaris

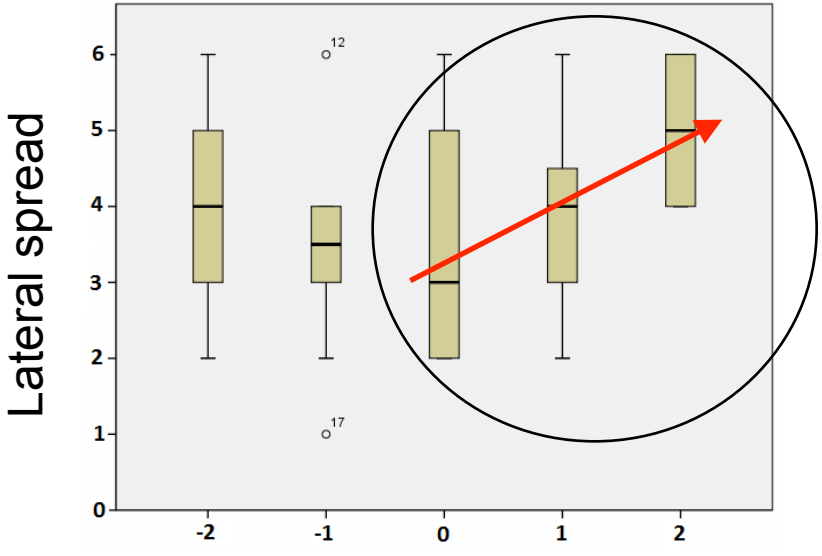
S-axis (stress-tolerance)

S-type is associated with low nutrient regime, low biomass, longer life cycle with mostly vegetative reproduction



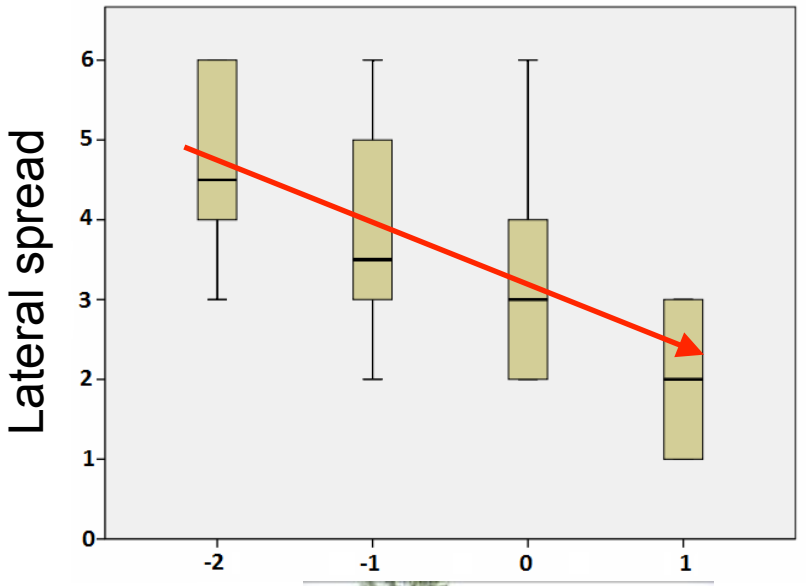
Pyrola rotundifolia

Rubus saxatilis



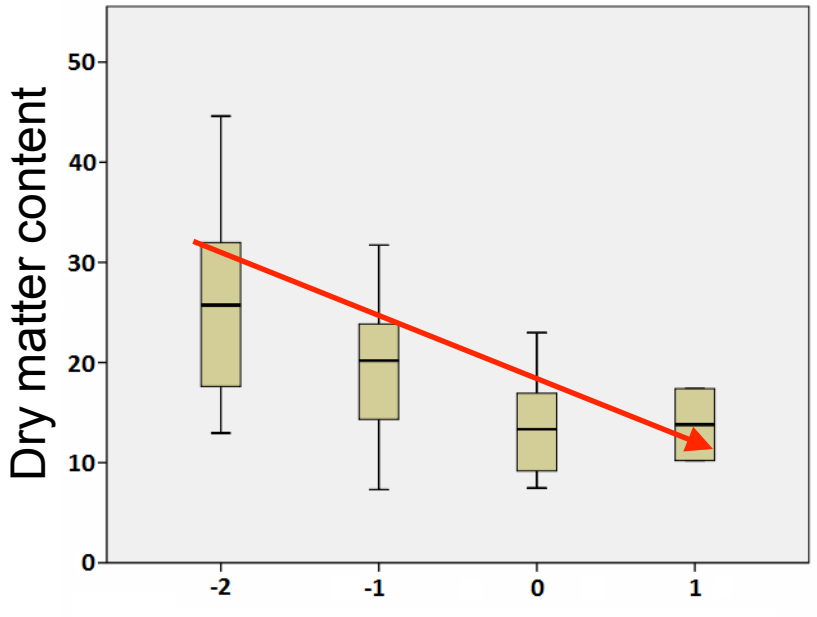
R-axis (ruderality)

Ruderal plants are usually characterized by short life cycle and seed reproduction



Melampyrum pratense

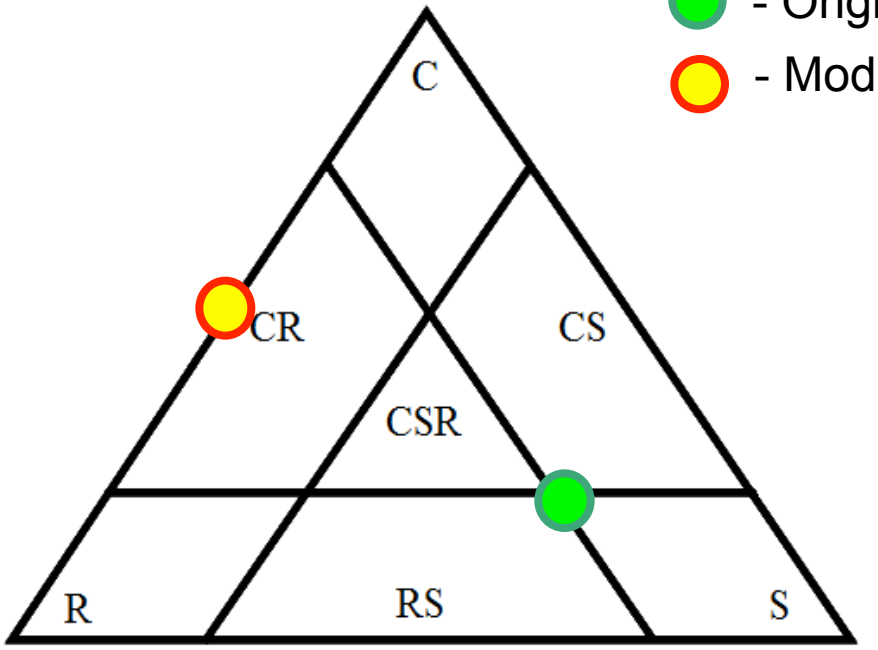
Taraxacum officinale



Distance

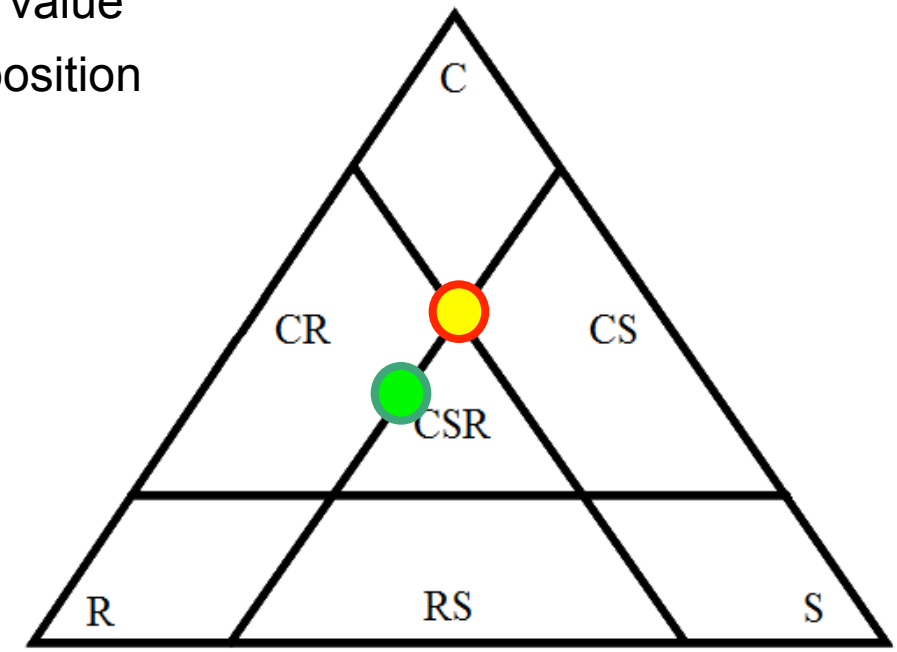
Distance 3 steps

- Original value
- Model position



Trientalis europaea
Original position – S/CSR
Model result – CR

Distance 1 step



Melampyrum pratense
Original position – R/SR
Model position – SR

Validation of the original model

Species	Funct. type (original)	Funct. type (model)	*Distance*
Achillea millefolium	*CSR*	*CR*	*2*
Antennaria dioica	*SR/CSR*	*R/CR*	*2*
Artemisia vulgaris	*C/CR*	*CR*	*1*
Geranium sylvaticum	*CSR*	*C/CR*	*2*
Melampyrum pratense	*R/SR*	*R/CR*	3
Polemonium caeruleum	*CSR*	*CR*	*2*
Ranunculus repens	*CR*	*CR*	*0*
Rubus chamaemorus	*SC/CSR*	*C/CR*	*2*
Rubus saxatilis	*S/CSR*	*C/CR*	*3*
Rumex acetosella	*SR/CSR*	*R/CR*	*2*
Stellaria holostea	*CSR*	*CR*	*2*
Taraxacum officinale	*R/CSR*	*CR*	*1*
Thalictrum minus	*S/CSR*	*CR*	*3*
Trientalis europea	*S/CSR*	*C/CR*	*3*
Trollius europeus	*SC/CSR*	*CR*	*3*
Valeriana wolgensis	*CSR*	*CR*	*2*
Vicia sepium	*C/CSR*	*C/CR*	*1*
Viola palustris	*SR/CSR*	*CR*	*2*

Adjusted model

	C-axis			S-axis			R-axis		
	B	t	p	B	t	p	B	t	p
Constant	*-.462*	*-,053*	*,958*	*-1,86*	*-,182*	*,859*	*3,317*	*2,449*	*,021*
CanopyHeight	.896	1,971	,077	-,948	-1,768	,107	-,001	-,844	,406
DryMatterContent	-,715	-,968	,356	,763	,875	,402	-,072	-2,863	,008
FloweringPeriod	-,005	-,016	,988	,189	,467	,650	-,143	-1,003	,324
LateralSpread	,552	1,699	,120	-,515	-1,343	,209	-,298	-3,027	,005
LeafDryWeight	-,061	-,142	,890	,120	,236	,818	-,002	-1,420	,167
SpecificLeafArea	-,289	-,508	,622	,403	,601	,561	-,029	-2,415	,023
FloweringStart	,126	,311	,762	-,014	-,029	,977	,077	,395	,696

B – model coefficients, t – Student's t-test value, p – significance level
Coefficient with p<0.1 have been marked (for S-axis the lowest p-value was marked)

Validation of the adjusted model

Species	Funct. type (original)	Funct. type (tuned model)	Distance
Achillea millefolium	***CSR***	**SC/CSR**	*1,0*
Antennaria dioica	***SR/CSR***	**SR/CSR**	*0,0*
Artemisia vulgaris	***C/CR***	**SC**	*2,0*
Geranium sylvaticum	***CSR***	**C/CSR**	*1,0*
Melampyrum pratense	***R/SR***	**SR**	*1,0*
Polemonium caeruleum	***CSR***	**CR/CSR**	*1,0*
Ranunculus repens	***CR***	**SR/CSR**	*2,0*
Rubus chamaemorus	***SC/CSR***	**SC/CSR**	*0,0*
Rubus saxatilis	***S/CSR***	**C/SC**	*2,0*
Rumex acetosella	***SR/CSR***	**C/CSR**	*2,0*
Stellaria holostea	***CSR***	**C/SC**	*2,0*
Taraxacum officinale	***R/CSR***	**SC/CSR**	*2,0*
Thalictrum minus	***S/CSR***	**SC/CSR**	*1,0*
Trientalis europea	***S/CSR***	**S/SC**	*1,0*
Trollius europeus	***SC/CSR***	**SC/CSR**	*0,0*
Valeriana wolgensis	***CSR***	**C/CR**	*2,0*
Vicia sepium	***C/CSR***	**C/SC**	*2,0*
Viola palustris	***SR/CSR***	**S**	*2,0*

Conclusions and directions for further research

- Different types of functional types are characterized by different values of variables. The most significant relationship were shown by canopy height for C and S axis, and Dry Matter Content, Lateral Spread and Specific Leaf Area for R-axis
- Verification of the original model showed a low convergence, especially for S-axis.
- Verification of the adjusted model showed more accurate results.
- To improve the model convergence we will involve additional information (for example concentrations of nitrogen and carbon in species). Also we will try to use data sets from international databases (LEDA, TRY-DB).

Our team

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Our studies were supported by the Russian Foundation for Basic Research (13-04-98829) and Government of the Komi Republic