Title: Nitrogen addition does not reduce the role of spatial asynchrony in stabilizing grassland communities

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Supporting Information

Figure S1. Effects of N addition on unweighted and biomass-weighted stability. The unweighted and biomass-weighted (**a**) alpha and (**b**) population stabilities were significantly reduced by N addition. The opened star symbol indicates data from the control. Black and gray symbols correspond to unweighted and biomass-weighted stability, respectively.

Figure S2. The initial structural equation model for N enrichment effects on gamma stability. All plausible pathways were considered, on the basis of theoretical and empirical predications.

Figure S3. Effects of N addition on beta dissimilarity at the 10-m^2 scale. Neither (**a**) the presence/absence-based index (Jaccard dissimilarity, β_J) nor (**b**) the abundance-based index (Bray-Curtis dissimilarity, β_{BC}) was altered by N addition. The open star symbol indicates data from the control.

Figure S4. Results of non-metric multidimensional scaling (NMDS) of plant communities across the N addition gradient. NMDS was performed based on Bray-Curtis dissimilarity (β_{BC}). Panel a-e correspond to year 2009-2013, respectively. All stresses < 0.2. Colors correspond to the rate of N addition (g N m^{-2} $year^{-1}$).

Figure S5. Effects of N enrichment on beta diversity and spatial asynchrony at the 5-m^2 scale. (**a**) N addition significantly reduced additive beta diversity (β_a), but not (**b**) multiplicative beta diversity (β_m), (**c**) β_J, (**d**) β_{BC}, or (**e**) beta variability (i.e., spatial asynchrony among 5 1-m^2 local communities). The open star symbol indicates data from the control.

Fig. S1

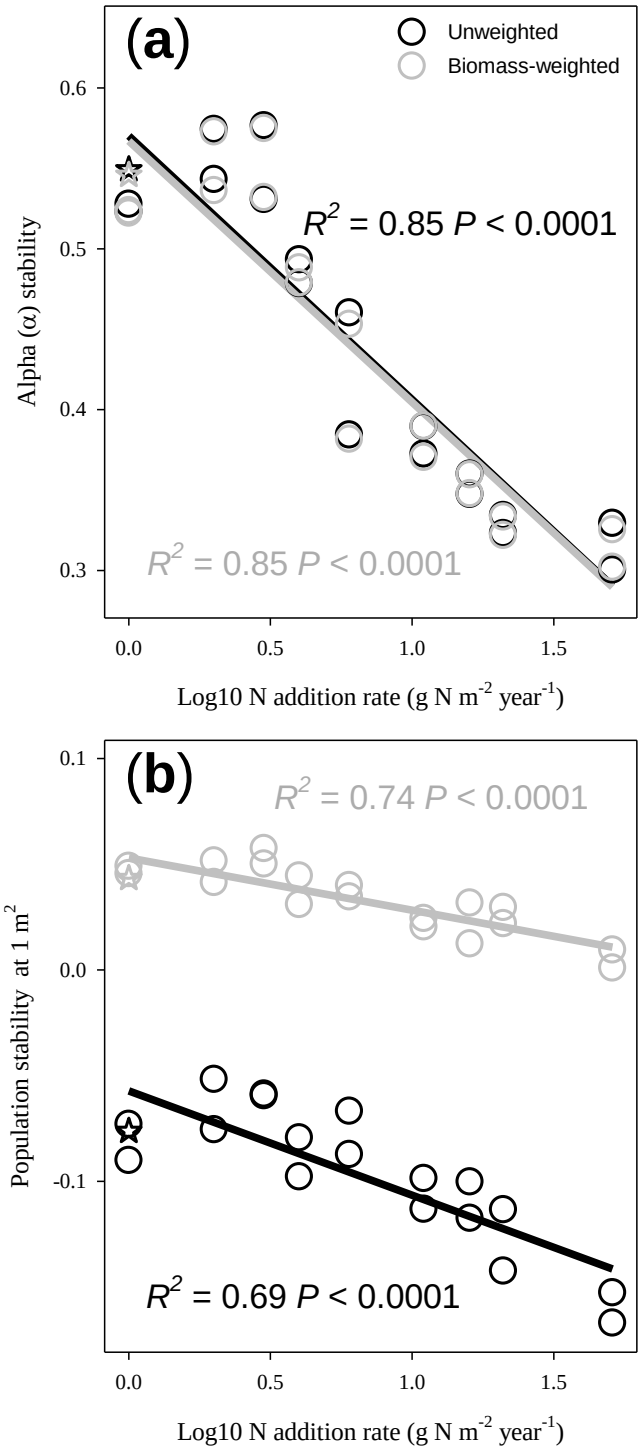
(a)
Unweighted
Biomass-weighted
R^2 = 0.85 P < 0.0001
R^2 = 0.85 P < 0.0001
Alpha (α) stability
0.6
0.5
0.4
0.3
0.0
0.5
1.0
1.5
Log10 N addition rate (g N m^{-2} year^{-1})
(b)
R^2 = 0.74 P < 0.0001
R^2 = 0.69 P < 0.0001
Population stability at 1 m^2
0.1
0.0
-0.1
0.0
0.5
1.0
1.5
Log10 N addition rate (g N m^{-2} year^{-1})

Fig. S2

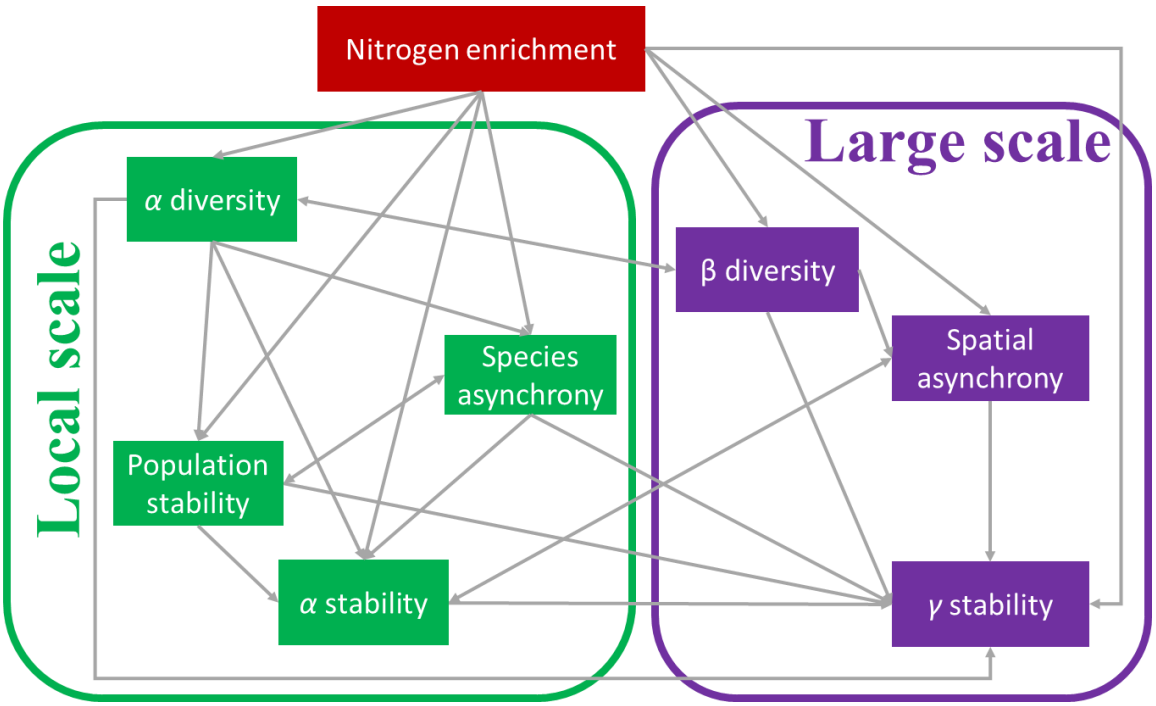
Nitrogen enrichment
Local scale
α diversity
Species asynchrony
Population stability
α stability
Large scale
β diversity
Spatial asynchrony
γ stability

Fig. S3

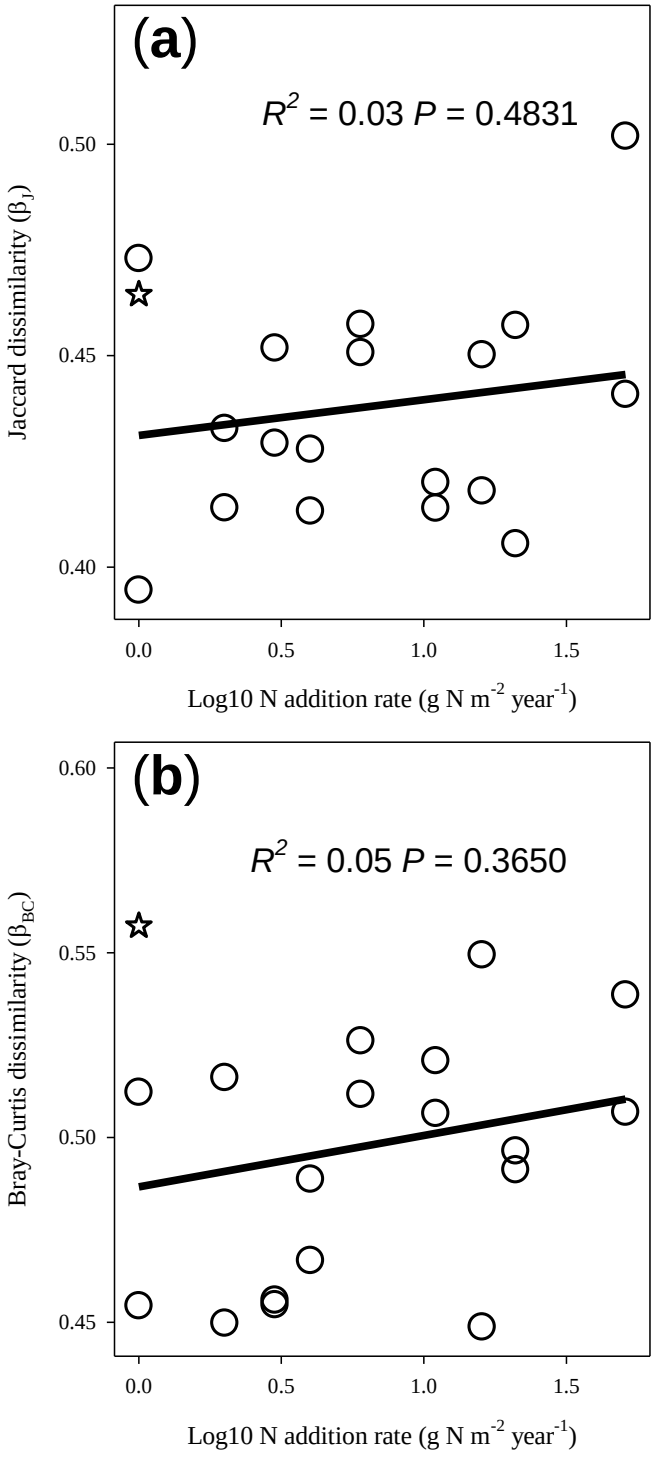
(a)
R^2 = 0.03 P = 0.4831
Jaccard dissimilarity (β_J)
0.50
0.45
0.40
0.0
0.5
1.0
1.5
Log10 N addition rate (g N m^{-2} year^{-1})
(b)
R^2 = 0.05 P = 0.3650
Bray-Curtis dissimilarity (β_{BC})
0.60
0.55
0.50
0.45
0.0
0.5
1.0
1.5
Log10 N addition rate (g N m^{-2} year^{-1})

Fig. S4

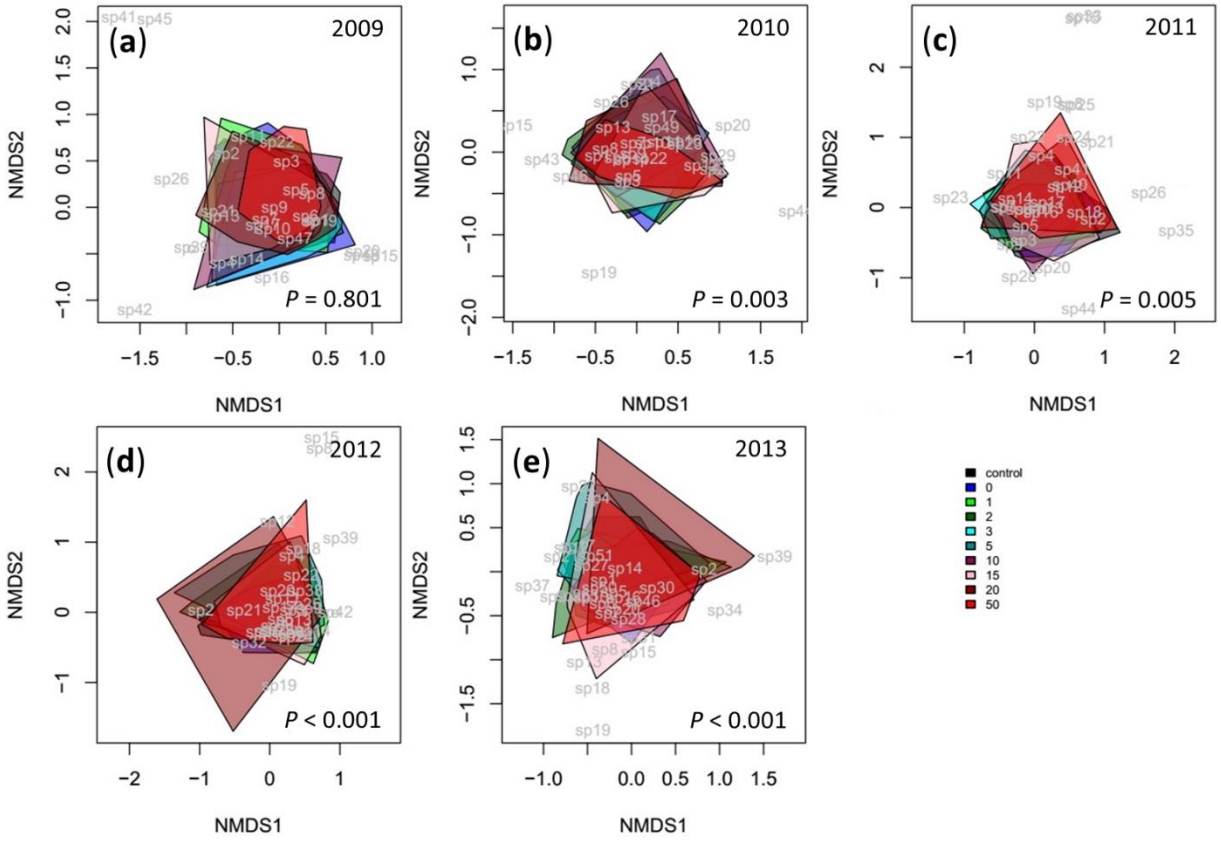
(a)
2009
P = 0.801
(b)
2010
P = 0.003
(c)
2011
P = 0.005
(d)
2012
P < 0.001
(e)
2013
P < 0.001
NMDS1
NMDS2
control
0
1
2
3
5
10
15
20
50

Fig. S5

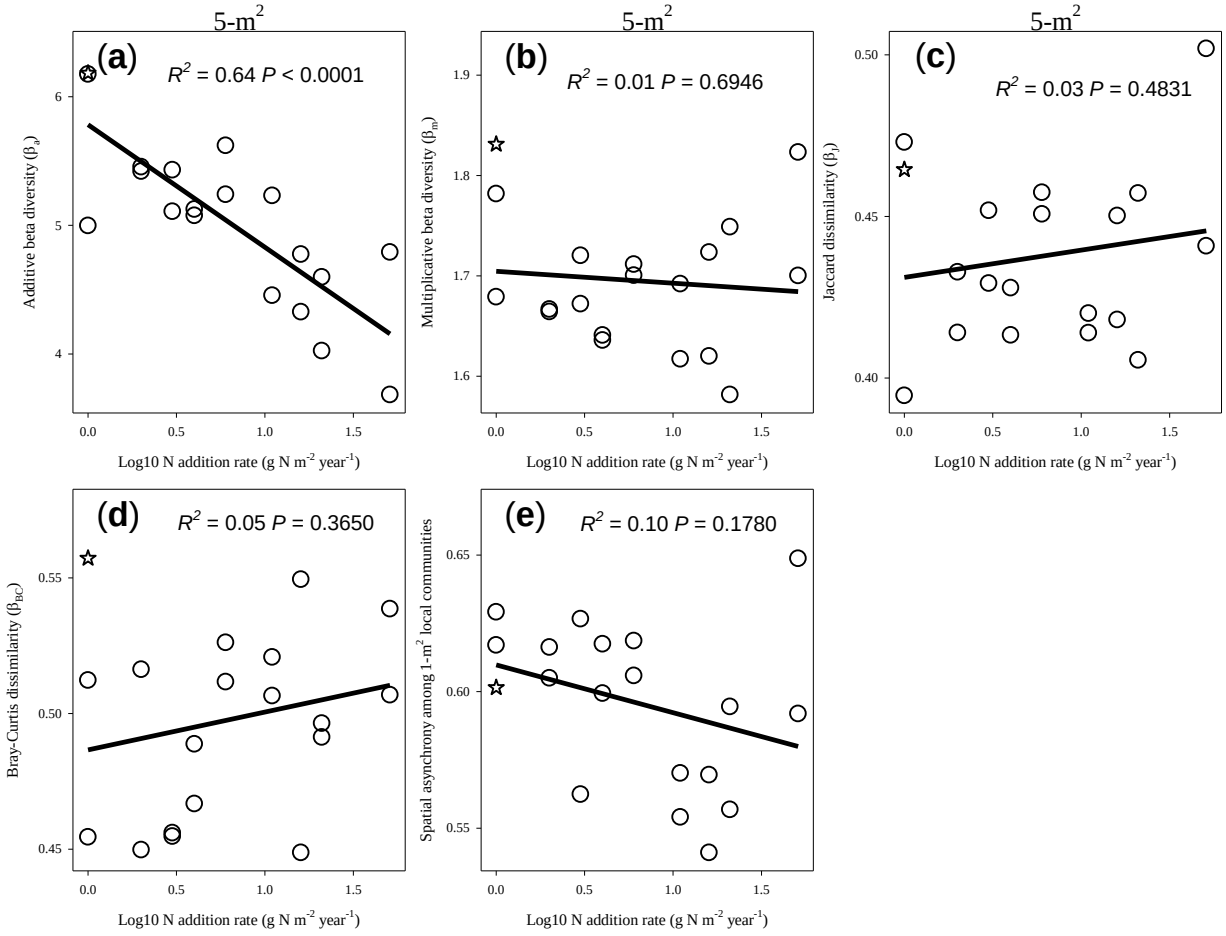
5-m2
(a)
R2 = 0.64 P < 0.0001
Additive beta diversity (βa)
(b)
R2 = 0.01 P = 0.6946
Multiplicative beta diversity (βm)
(c)
R2 = 0.03 P = 0.4831
Jaccard dissimilarity (βj)
(d)
R2 = 0.05 P = 0.3650
Bray-Curtis dissimilarity (βBC)
(e)
R2 = 0.10 P = 0.1780
Spatial asynchrony among 1-m2 local communities
Log10 N addition rate (g N m-2 year-1)

Table S1. The relative ANPP (ranked according to species ANPP in no N plots) and statistics of the regression between N addition rate and spatial asynchrony for each species. The listed species together accounted for at least 99% community ANPP in each treatment.

	Relative ANPP (%)																			Relationship between N rate and spatial asynchrony		
N addition rate (g N m^{-2} $year^{-1}$)	Control	0	1	2	3	5	10	15	20	50	0	1	2	3	5	10	15	20	50			
N addition frequency	Control	Twice $year^{-1}$									Monthly									*r*	*F-value*	*P-value*
Stipa grandis	33.8	38.0	39.8	47.8	37.9	34.7	37.1	32.3	36.8	27.7	32.4	38.9	50.4	40.1	36.0	36.4	45.6	34.7	35.3	–0.44	4.2	0.0567
Leymus chinensis	25.0	21.7	20.7	15.2	27.3	24.8	19.5	30.6	14.1	41.2	28.6	15.3	14.0	20.5	15.5	17.9	22.5	16.8	29.7	–0.78	26.9	<0.001
Achnatherum sibiricum	16.5	12.0	15.0	11.8	13.1	13.5	16.5	14.9	13.7	12.0	20.1	18.0	13.3	10.8	13.0	17.4	7.7	9.7	9.9	–0.21	0.8	0.3821
Agropyon cristatum	10.0	19.7	9.3	13.6	11.2	15.5	17.4	11.3	27.7	12.4	6.8	14.4	11.5	16.3	19.2	13.8	13.5	31.3	17.7	–0.18	0.6	0.4643
Carex korshinskyi	4.7	3.8	6.6	4.8	4.4	5.9	3.8	3.9	2.3	2.3	5.0	5.5	4.6	5.4	5.1	5.7	3.6	2.3	2.3	–0.45	4.3	0.0546
Cleistogenes squarrosa	3.9	2.6	3.6	3.1	3.1	1.5	1.6	1.8	1.5	1.3	3.3	3.1	2.7	2.7	2.1	2.9	2.3	1.6	0.8	–0.74	20.4	0.0003
Koeleria cristata	1.2	0.5	1.5	0.4	0.7	0.5	0.7	1.0	0.5	0.1	1.4	1.7	1.0	1.4	0.6	0.5	0.5	0.4	0.2	–0.49	5.4	0.0325
Festuca dahurica	2.2	0.1	0.2	0.1	0.1	0.1	0.0	0.4	0.0	0.0	0.2	0.2	0.1	0.3	0.0	0.0	0.0	0.0	0.2	–0.48	4.8	0.0435
Poa subfastigiata	1.1	0.4	0.4	0.8	0.2	0.4	0.4	0.1	0.0	0.0	0.5	0.5	0.5	0.2	0.3	0.6	1.8	0.3	0.1	–0.74	20.6	<0.001
Allium tenuissimum	0.4	0.3	0.4	0.5	0.4	0.4	0.3	0.1	0.1	0.1	0.6	0.3	0.2	0.4	0.3	0.1	0.3	0.2	0.1	–0.32	1.9	0.1862
Chenopodium glaucum	0.3	0.2	0.2	0.4	0.6	1.1	1.1	2.1	2.3	2.3	0.2	0.2	0.7	0.7	1.7	2.2	1.5	1.5	1.7	0.37	2.7	0.1203
Saussurea japonica	0.0	0.0	1.1	0.0	0.0	0.0	0.3	0.0	0.0	0.1	0.1	0.0	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.01	0.0	0.9866
Allium anisopodium	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	1.0000
Salsola collion	0.2	0.1	0.5	0.0	0.1	0.6	0.2	0.1	0.1	0.0	0.1	0.2	0.1	0.0	0.3	0.3	0.2	0.4	0.2	–0.32	1.9	0.1881
Iris tenuifolia	0.1	0.0	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.1	0.1	0.1	0.2	0.1	0.0	0.0	0.1	–0.14	0.3	0.5926
Thalictrum petaloideum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	–0.47	2.5	0.1449
Allium bidentatum	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–0.62	10.4	0.0050
Allium ramosum	0.1	0.1	0.2	0.1	0.1	0.2	0.0	0.1	0.0	0.1	0.0	0.1	0.2	0.1	0.1	0.1	0.0	0.0	0.1	0.17	0.5	0.493
Artemisia scoparia	0.1	0.1	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.7	0.8	0.0	0.0	0.0	–0.58	6.4	0.0248
Allium condensatum	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	1.0000
Potentilla bifurca	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.1	0.3	–0.24	0.7	0.4137
Kochia prostrate	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	1.0000
Dontostemon micranthus	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	–0.13	0.2	0.6292
Chenopodium aristatum	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	–0.12	0.2	0.6499
Galium verum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	1.0000
Summed relative ANPP (%)	99.7	99.9	99.9	99.5	99.6	99.5	99.3	98.7	99.2	99.8	99.9	99.9	99.6	99.5	98.8	99.0	99.5	99.3	98.5			