Spatial Heterogeneity of Nitrogen in Plant Invasion Project Progress Report

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Progress Report Through Jan. 2009

This project investigated the role of spatial heterogeneity of nutrients and its influence on a plant community's susceptibility to new plant establishment. It consisted of creating a spatially heterogeneous nutrient treatment through minor nutrient amendment and then subsequently seeding the research site with 4 native weedy species to simulate a plant invasion.

Research was conducted at two sites: the Tracy Collin's property just north of the wind generation laboratories and the South Boulder Creek West Trail. The project design was identical at both sites. The design of the experiment at each site consisted of four different treatments: homogeneous nutrient amendment, heterogeneous nutrient amendment, no amendment with seeding, and no amendment without seeding. Each treatment consisted of 8 replicate plots, where each plot was a 2 x 2 m square. In May 2008, experimental plots were set-up using a large nail and washer to hammer blue flagging into the ground at each of the four corners of the plot to facilitate locating the site again in the future.

The homogeneous amendment plots received a consistent addition of nutrient throughout the plot: 4 g $N/m^2/yr$, 2.5 g $K/m^2/yr$, 1.25 g $P/m^2/yr$. The heterogeneous

amendment received the same amount of nutrients as the homogeneous treatment (Table 1). The two controls of no amendment with and without seeding did not receive any nutrients.

Table 1. Example of heterogeneous treatment plot with 16 subplots, + is nutrient amended subplot, 0 is no nutrient amended subplot.

0	+	0	+
+	0	+	0
0	+	0	+
+	0	+	0

After the plots were set-up and fertilized, plant surveys were conducted once in the early season June-July 2008 and again in the late season August 2008 (Table 2). These surveys were conducted using a point-intercept method, with 144 points in each plot. In January 2009, seeds of 4 native weeds that were collected from Boulder County during the summer of 2008 and were dispersed evenly amongst all the treatments except for the no amendment without seeding control (Table 3). The four species were: *Helianthus annuus, Helianthus petiolaris, Grindelia squarrosa, and Argemone polyanthemos*.

Table 2: Timetable of Research Project

Dates	Treatments			
	Heterogeneous Nutrient with Seeding	Homogeneous Nutrient with Seeding	No Amendment with Seeding	No Amendment without Seeding
May 2008-2010	Deposit nutrient pellets	Deposit nutrient pellets		
May-June & August 2008-2010	Plant Vegetation Survey	Plant Vegetation Survey	Plant Vegetation Survey	Plant Vegetation Survey
January 2009	Seeding 4 Native Species	Seeding 4 Native Species	Seeding 4 Native Species	
August 2010, nutrient sampling will occur.				

Table 3: Seeds Dispersed in Treatments: Homogeneous, Heterogeneous, No Amendment with seeding

Helianthus annuus	*Helianthus petiolaris*	*Grindelia squarrosa*	*Argemone polyanthemos*
240 seeds/m^2	46 seeds/m^2	373 seeds/m^2	103 seeds/m^2

According to the 3 year project design, fertilization treatments and plant surveys will take place again in 2009 and 2010, identical to what took place in 2008. Then in late August of 2010, after vegetation survey of the final year, a nutrient variability survey will be performed by obtaining about 10 soil samples from the study site. The soil sample requires collecting a 1 cm x 30 cm soil core from the rooting zone to measure soil nitrogen and phosphorus availability. To perform the nitrogen analyses, the samples would be extracted with saturated KCl within 1-2 hours of collection in the Bowman Lab at CU. Phosphorus analyses would rely on an extraction procedure using modified Bray's solution. A flow-injection colorimetric autoanalyzer (Lachat Instruments, Mequon, Wisconsin) would be used for all the nutrient.

As only one of the three years has been completed in this research project, only preliminary data is available at the time. However, once the project has concluded, BNCA will certainly receive a detailed report on the research project results.

Preliminary Data

At the Tracy Collins site, the average species richness was about 30 plant species per plot. For the entire Tracy Collins site, there were 90 plants identified mostly to the species, if not then to genus (Table 4). For the South Boulder Creek site, the average species richness was about 27 plant species per plot and 111 species in the entire site (Table 5). There were roughly 60 plant species that were found at both research sites.

Table 4: Plant Species at Tracy Collins Property Site

1. Achillea lanulosa	*31. Eriogonum sp.)*	*61. Paronychia jamesii*
2. Acosta diffusa	*32. Erysimum asperum*	*62. Paronychia sessiliflora*
3. Allium textile	*33. Gaillardia aristata*	*63. Pascopyrum smithii*
4. Alyssum parviflora	*34. Gaura coccinea*	*64. Penstamon secundafloris*
5. Ambrosia psilostachia	*35. Gutierreza sarothrae*	*65. Penstamon virens*
6. Andropogon gerardii	*36. Helianthus rigidus*	*66. Physaria sp.*
7. Antennaria sp.	*37. Hesperostipa comata*	*67. Poa agassizensis*
8. Apocinum carabinum	*38. Hetherothica sp.*	*68. Poa compressa*
9. Aristada purpurea	*39. Heterotheca foliosa*	*69. Podospernum sp.*
10. Artemesia frigida	*40. Heterothica velosa*	*70. Psorilidium tenuiflorum*
11. Artemesia ludoviciana	*41. Hypericum perforatum*	*71. Pterogonum elatum*
12. Aster porteri	*42. Koeleria macrantha*	*72. Ratibida columnifera*
13. Astragalus shortianus	*43. Lactuca serriola*	*73. Rumex acetorella*
14. Astragalus spatulatus	*44. Lequerella ludoviciana*	*74. Schizachyrium scoparium*
15. Bouteloua curtipendula	*45. Liatrus punctata*	*75. Scutellaria britanis*
16. Bouteloua gracile	*46. Linaria dalmatica*	*76. Silene antirnina*
17. Brea arvense	*47. Lithospernum sp.*	*77. Solidago nana*
18. Bromus japonicus	*48. Lomatium orientale*	*78. Solidago sp. (unk. 1)*
19. Bromus tectorum	*49. Muhlenbergia montanum*	*79. Solidao sp . (unk. 2)*
20. Camelina microcarpa	*50. Muhlenbergia wrightii*	*80. Sorghastium avenacum*
21. Carex sp.	*51. Musineon sp.*	*81. Sporobolus cryptadras*
22. Chicorium intybus	*52. Neolepia compeser*	*82. Sporobolus heterolepco*
23. Comandra umbellata	*53. Nothocalais cuspidata*	*83. Stipa occidentalis*
24. Convolvulus arvensis	*54. Oenetharia vidilosa*	*84. Talinum parviflorum*
25. Coryphantha missouriensis	*55. Oenethera howardii*	*85. Taraxacum officinale*
26. Draba reptans	*56. Oligosporus campestris*	*86. Tithalymus montanum*
27. Echinocereus viridiflorus	*57. Opuntia fragilis*	*87. Tradescantia occidentalis*
28. Elymus elymoides	*58. Opuntia macrorhiza*	*88. Tragapogon dubius ssp. major*
29. Eremogone fendleri	*59. Oxybaphus linearis*	*89. Viola nutallii*
20. Erigeron flagellaris	*60. Oxytropis lambertii*	*90. Virgulus ericoides*

Table 5: Plant Species at South Boulder Creek Site

1. Achillea lanulosa	*38. Dianthus armeri*	*75. Oxytropis sericeous*
2. Acosta diffusa	*39. Dicanthelium oligosanthes*	*76. Panicum vivgatum*
3. Agrostes exarata	*40. Echinocereus viridiflorus*	*77. Penstamon secundaflorus*
4. Agrostis gigantea	*41. Erigeron flagellaris*	*78. Penstamon virens*
5. Allium textile	*42. Eriogonum effusum*	*79. Phacelia heterophylla*
6. Alyssum parviflora	*43. Eriogonum umbellatum*	*80. Plantago lanceaoata*
7. Ambrosia psilostachia	*44. Erodium cicutarium*	*81. Plantago patigonica*
8. Andropogon gerardii	*45. Erysimum asperum*	*82. Pneumonanthe bigelovii*
9. Aphyllon fasiculatum	*46. Festuca arundacea*	*83. Poa agassizensis*
10. Arisida purpurea	*47. Gaillardia aristata*	*84. Poa compressa*
11.Artemesia frigida	*48. Gaura coccinea*	*85. Podospernum sp.*
12. Artemesia ludoviciana	*49. Hesperostipa comata*	*86. Potentilla ambigens*
13. Asclepias speciosa	*50. Heterotheca foliosa*	*87. Potentilla pensylvanicas*
14. Aster cordineri	*51. Heterothica velosa*	*88. Prunella vulgaris*
15. Aster laevis	*52. Hippochaete hyemalis*	*89. Psorilidium tenuifloraum*
16. Aster porteri	*53. Hypericum perforatum*	*90. Ratibida columnifera*
17. Astragalus shortianus	*54. Iris missouriensis*	*91. Rosea sai or asikalaris*
18. Bouteloua gracile	*55. Juncus articus*	*92. Rumex acetorella*
19. Brea arvense	*56. Juncus longistylis*	*93. Schizochirium scoparium*
20. Brickelia eupatorioides	*57. Lactuca serriola*	*94. Sisymbrium altissimum*
21. Bromus japonicus	*58. Liatrus punctata*	*95. Sisynchirium montanum*
22. Bromus tectorum	*59. Linaria dalmatica*	*96. Solidago canadaensis*
23. Camelina microcarpa	*60. Lithospernum sp.*	*97. Solidago sp.*
24. Campanula rotundifolia	*61. Lupinus sp.*	*98. Sorghastrum avenaceum*
25. Carduus nutans	*62. Medandriam dioicum*	*99. Sporobolus asper*
26. Carex pragacellis	*63. Medicago lupilina*	*100. Sporobolus cryptadras*
27. Carex sp.	*64. Melilotus alba*	*101. Sporobolus heterolepis*
28. Carduus nutans	*65. Neolepia compeser*	*102. Stipa occidentalis*
29. Chicorium intybus	*66. Oligoneuron rigidus*	*103. Talinum parviflorum*
30. Circium ungulatum	*67. Oligosporus campestris*	*104. Taraxacum officinale*
31. Circium vulgare	*68. Oligosporous dracumculus?*	*105. Toxicodendron rynbergii*
32. Comandra umbellata	*69. Oenothera villosa*	*106. Tradescantia occidentalis*
33. Convolvulus arvensis	*70. Onosmodium molle*	*107. Tragapogon dubius ssp. major*
34. Coryphantha missouriensis	*71. Opuntia fragilis*	*108. Vicia americana*
35. Dactylis glomerata	*72. Opuntia macrorhiza*	*109. Viola nutallii*
36. Dalea candida	*73. Oxalis dilleni*	*110. Virgulus ericoides*
37. Daucus carata	*74. Oxybaphus linearis*	*111. Yucca glauca*

Budget Accounting

General Description	Item Descriptions	Approximate Amount
Photo documentation supplies	Camera and memory card	$200
Plant mounting supplies	Acid free paper, binders, notebooks, etc.	$50
Plant survey supplies	Marker line, flags, hand lens, misc.	$50
Plot marking supplies	Nails, washers, measure tapes, hammers, flagging, and other hardware	$150
Nitrogen fertilizer	Slow release fertilizer	$50
Total		$500