Section 3

Study Site and Measurement Plan for Konza Prairie (KONZ), Manhattan, Kansas

KONZ

Directions to Site

From Interstate 70, Kansas

1. Take exit 313 off Interstate 70 onto HWY 177 (this is the Manhattan exit).
2. Drive north on HWY 177 to the bridge crossing the Kansas River near Manhattan (about 13.5 km from I-70).
3. Immediately before crossing the bridge, take a left (south) on Riley Rd.
4. Follow Riley Rd. along river valley for about 10 km to Kings Creek.
5. Take the first road (left turn) after crossing Kings Creek to Konza Prairie. Parking area is approximately 1.5 km from turnoff.

KONZ

Major Cover Types

Major cover types encountered in BigFoot study site

1. Tallgrass prairie
2. Shortgrass prairie
3. Shrub community
4. Gallery forest

Cover type qualifiers

1. Cattle grazed
2. Bison grazed
3. Ungrazed
4. Burn frequency

Cover type descriptions

Tallgrass prairie

Acronym:	TGPR
Species:	big bluestem, Indian grass, little bluestem, switchgrass, and other forbs
Architecture:	1–1.5 m tall at full flush
Land form:	bottomlands, deep soils, unexposed aspects
Comments:	A wide, poorly defined gradient exists between the tallgrass and shortgrass prairies.

Shortgrass prairie

Acronym:	SGPR
Species:	blue grama, hairy grama, xeric forbs
Architecture:	10–20 cm tall at full flush
Land form:	exposed ridgetops, shallow claypan soils
Comments:	A wide, poorly defined, gradient exists between the tallgrass and shortgrass prairies.

Shrub community

Acronym:	SHRB
Species:	smooth sumac and *Cornus* spp.
Architecture:	1–2 m tall, very dense, thin stems, closed canopy
Land form:	exposed ridgetops, shallow claypan soils

Comments:	Shrubs form patches in drainage gulches and seeps. Shrub communities also occur adjacent to creeks and as a transition between prairie and forest.

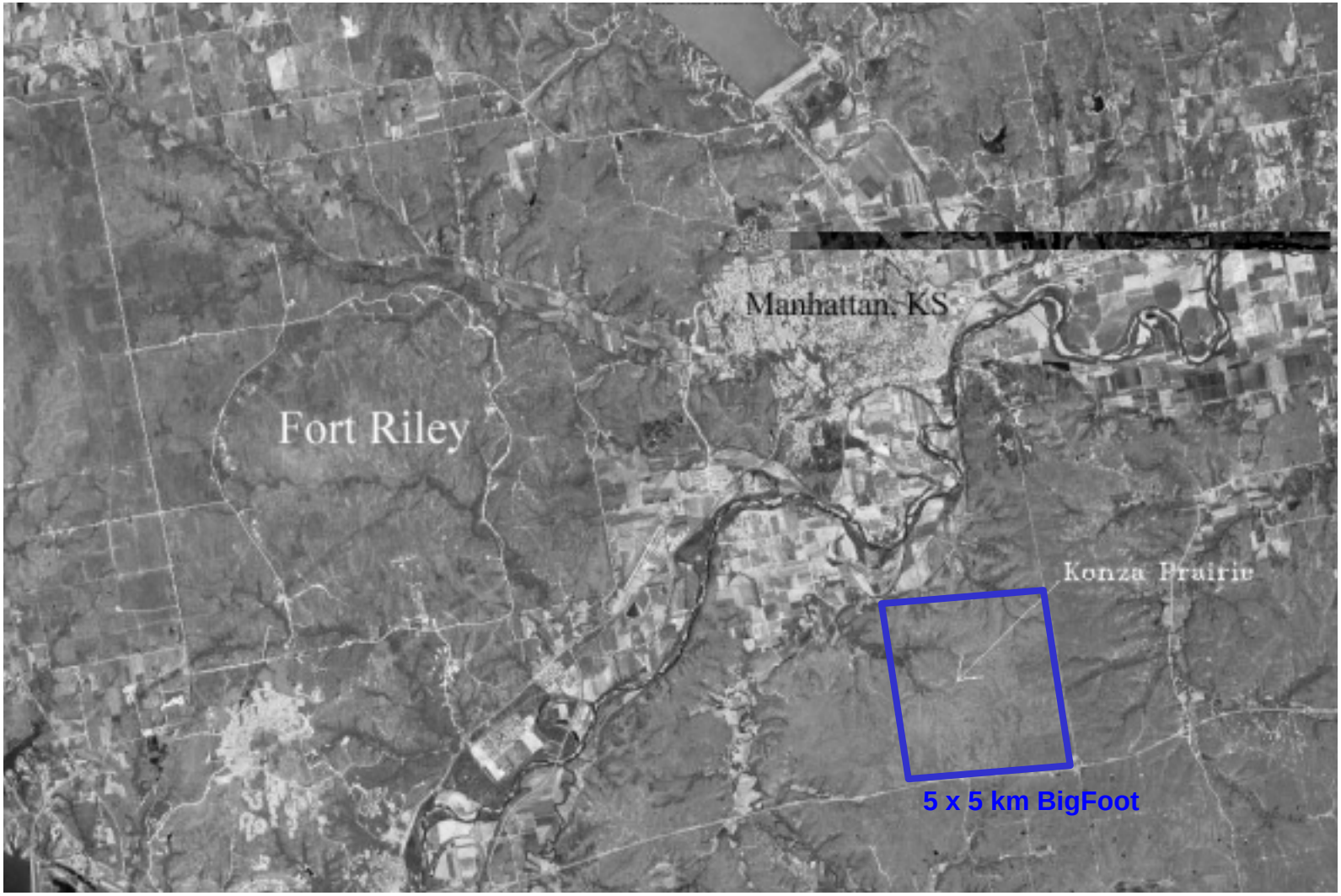
Gallery forest

Acronym:	GALF
Species:	oaks, elm, hackberry, walnut, and hickory
Architecture:	15–20 m tall closed canopy but lots of edge supports; significant understory with open canopy at 3–5 m
Land form:	lowlands, largely riparian
Comments:	This is a diverse community that includes transition communities such as open savanna and shrub. About 6% of Konza is gallery forest.

Cover type qualifiers and additional comments

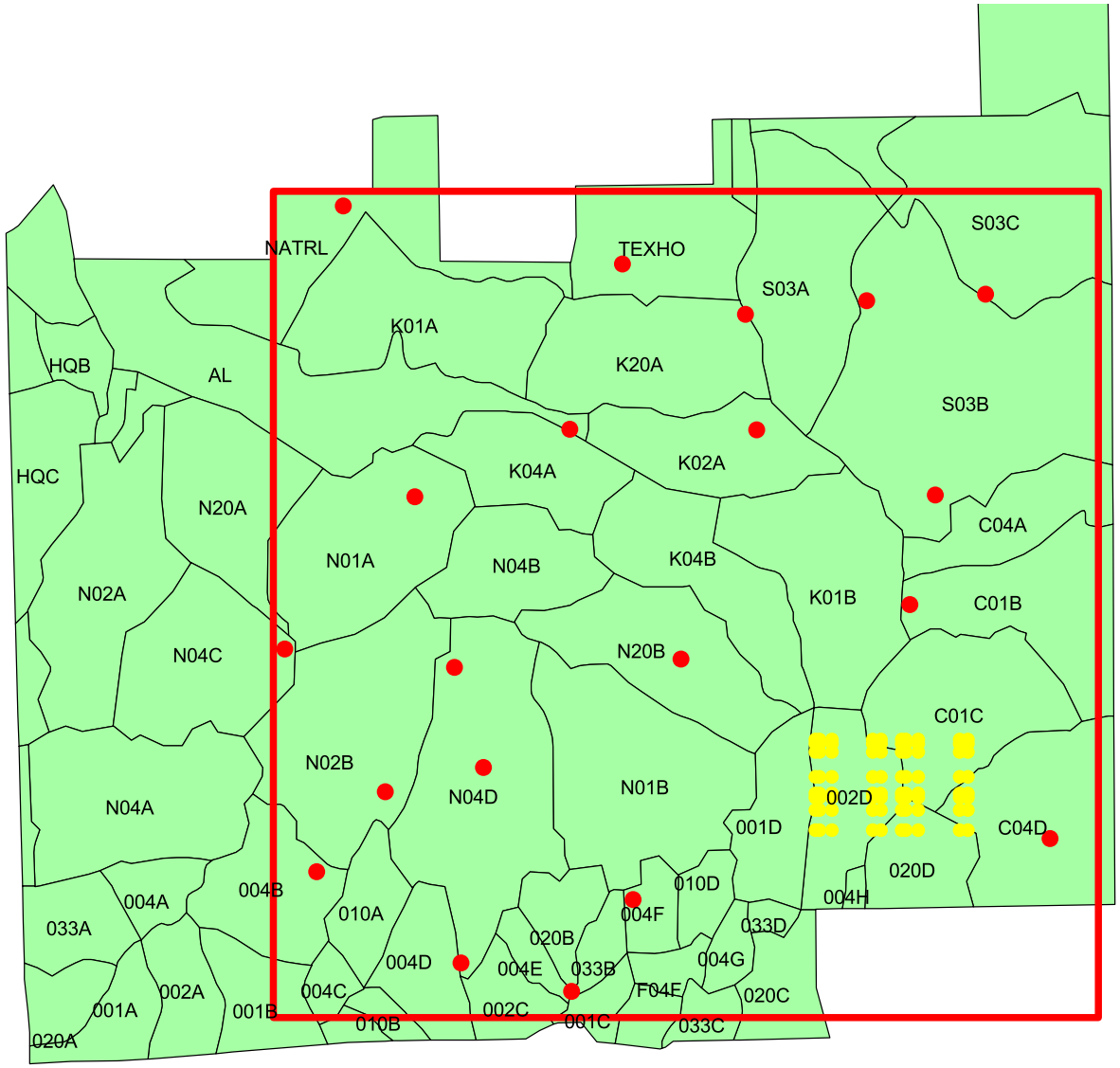
Konza (Figure 3.1) is divided into over 60 managed experimental watersheds. The management practices vary in grazing regime and fire frequency (Figure 3.2). Grazing treatments include cattle grazing, bison grazing, and no grazing. Fire regimes vary by frequency (1-, 2-, 4-, 10-, or 20-year fire cycles) and timing (winter, summer, fall, and spring burning). While not all combinations of burning and grazing regimes are practiced, many are making the Konza landscape very diverse. The BigFoot design cannot sample each of these management areas. The management history of each study plot will be recognized as a cover type qualifier since the management practice will influence species composition, vegetation structure, and function.

Figure 3.1. Location of BigFoot study site in relation to the surrounding landscape.



Konza Prairie Research Natural Area SPOT image obtained from http://climate.konza.ksu.edu/images/spot91b.jpb

Figure 3.2. Location of study plots in Konza Prairie Research Natural Area management units.



5x5km BigFoot site
Extensive plots
Intensive plots
Konza management units

N-grazed by Bison
K-Kings creek (ungrazed)
C-grazed by cattle
S-S. creek (ungrazed)
HQ-headquarters
AL-lowland agricul.
WP-white pasture (cattle gr.)
THP-texas hog pasture (cattle grazed)
2, 4, 10, 20 - years between burns
A, B, C, D - treatment reps
W - winter burn
Su - summer burn
F - fall burn
Sp - spring burn
Nat TR - nature trail

Konza Prairie Research Natural Area management unit obtained from ftp://ftp.konza.ksu.edu/pub/arc-infor/wshd.e00.

KONZ

Plot Placement Rationale

Positioning of intensive sampling grid

The intensive sampling grid will consist of 80 individual plots (25 x 25 m) arranged in a systematic spatial cluster design (Figures 3.3 and 3.4; Table 3.1). The 80-plot grid extends 925 m east to west and 550 m north to south. The intensive sampling grid at KONZ will be centered on the eddy flux tower located in the every-other-year burning management unit. The purpose of the intensive sampling grid is to provide accurate characterization of vegetation characteristics for the tower footprint and determine the degree and scale of spatial autocorrelation among land cover types.

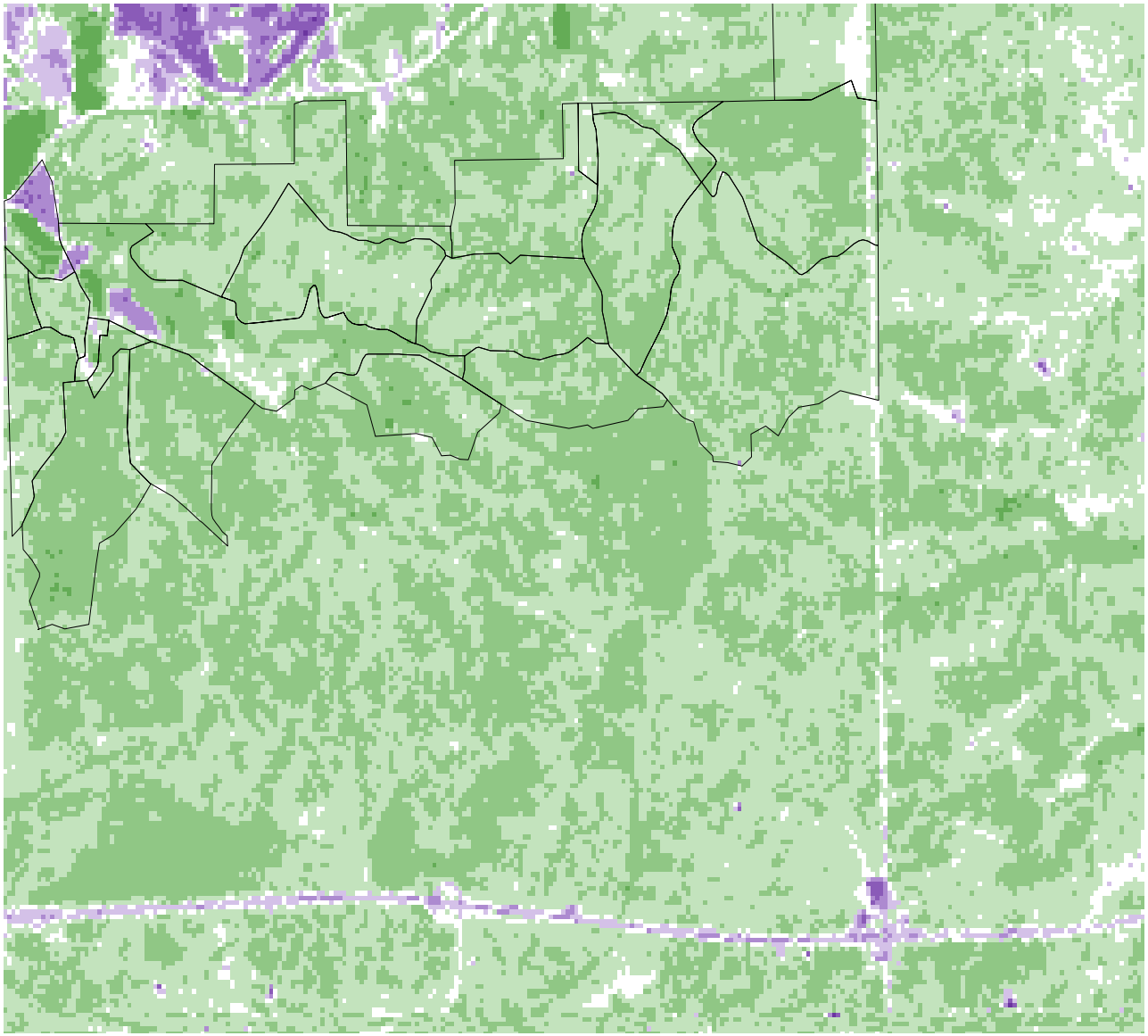
Positioning of the intensive sampling grid in this manner will not place any plots too close to the flux tower (nearest plot >50 m away)

Positioning of extensive sampling plots

The extensive sample plots will consist of 20 individual plots (each measuring 25 x 25 m) randomly stratified throughout the 5 x 5 km study area. The purposes of the extensive sample plots will be to verify that cover type-specific characteristics hold over multi-kilometer distances and to measure vegetation characteristics of unique ecosystems that influence the 25-km^2 MODIS surface but were not present in the tower footprint.

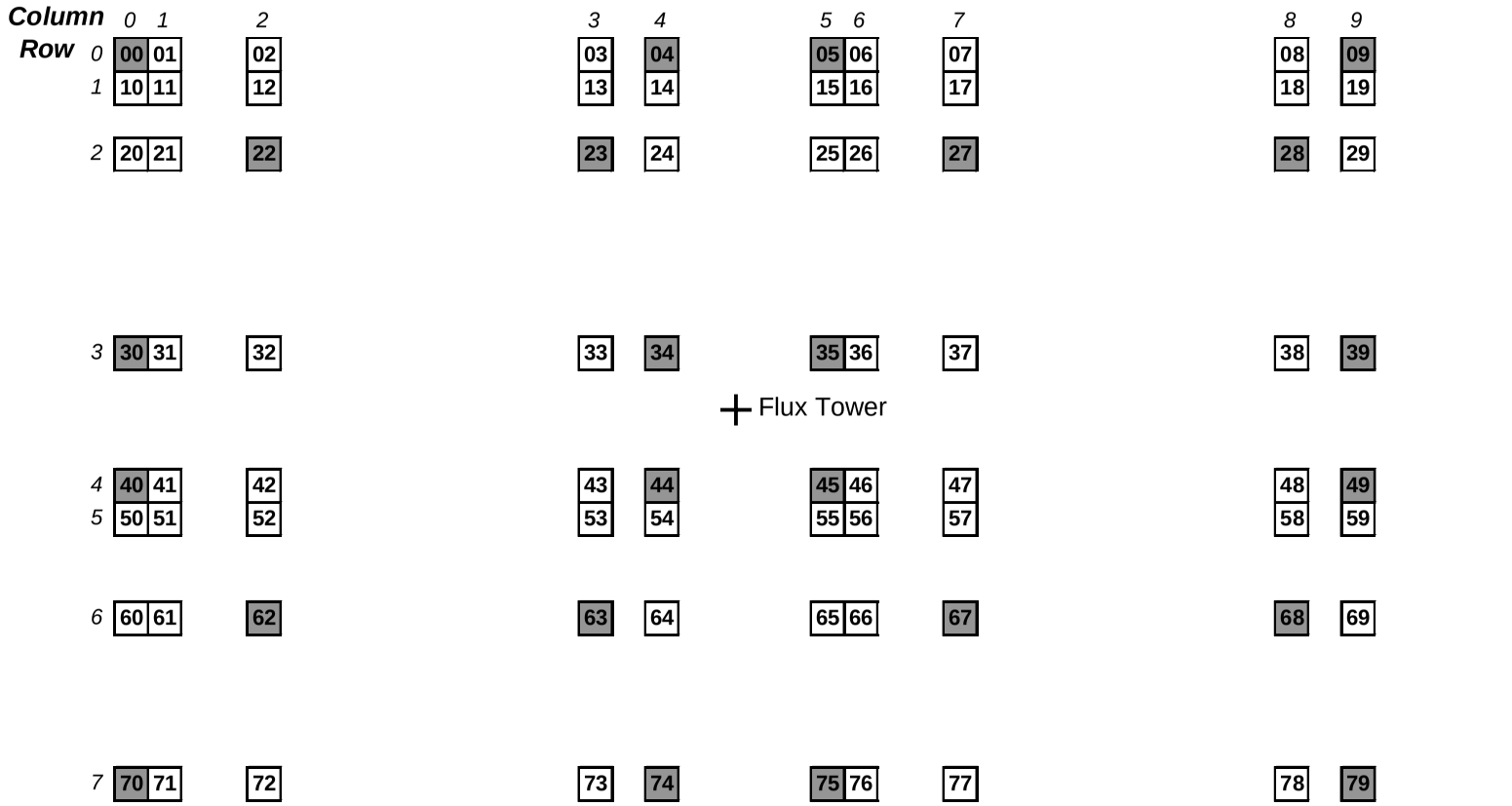
At the KONZ site, the 5 x 5 km BigFoot study area will be centered on the Konza Prairie research area. The 20 external plots will be randomly stratified throughout the 5 x 5 km study area such that plots will be at least 600 m from each other. Four of the 20 random points were relocated to new random locations because the original locations were on farms on which we did not have permission to conduct research or occurred in nonrepresentative land cover types.

Figure 3.3. Location of study plots in relation to a standardized normalized difference vegetation index (NDVI) image for the Konza Prairie.

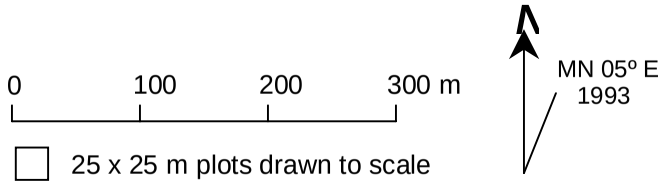


NDVI calculated from LandSat TM Image

Figure 3.4. Location of intensive study plots surrounding KONZ flux tower.



Flux Tower: 711,598 E 4328265 N (UTM NAD 27; zone 14)
Plot 00 center: 711106.5 E 4328747 N



3rd-order plots*

2nd- or 1st-order plots*

* See “Sampling Intensity” subsection

Table 3.1. KONZ plot locations and descriptions

Plot number	Plot center UTM easting*	Plot center UTM northing*	Cover type	Sampling intensity**	Comments
00	711,106.50	4,328,747.00		2	
01	711,131.50	4,328,747.00		3	
02	711,206.50	4,328,747.00		3	
03	711,456.50	4,328,747.00		3	
04	711,506.50	4,328,747.00		2	
05	711,631.50	4,328,747.00		2	
06	711,656.50	4,328,747.00		3	
07	711,731.50	4,328,747.00		3	
08	711,981.50	4,328,747.00		3	
09	712,031.50	4,328,747.00		2	
10	711,106.50	4,328,722.00		3	
11	711,131.50	4,328,722.00		3	
12	711,206.50	4,328,722.00		3	
13	711,456.50	4,328,722.00		3	
14	711,506.50	4,328,722.00		3	
15	711,631.50	4,328,722.00		3	
16	711,656.50	4,328,722.00		3	
17	711,731.50	4,328,722.00		3	
18	711,981.50	4,328,722.00		3	
19	712,031.50	4,328,722.00		3	
20	711,106.50	4,328,672.00		3	
21	711,131.50	4,328,672.00		3	
22	711,206.50	4,328,672.00		2	
23	711,456.50	4,328,672.00		2	
24	711,506.50	4,328,672.00		3	
25	711,631.50	4,328,672.00		3	
26	711,656.50	4,328,672.00		3	
27	711,731.50	4,328,672.00		2	
28	711,981.50	4,328,672.00		2	
29	712,031.50	4,328,672.00		3	
30	711,106.50	4,328,522.00		2	
31	711,131.50	4,328,522.00		3	
32	711,206.50	4,328,522.00		3	
33	711,456.50	4,328,522.00		3	
34	711,506.50	4,328,522.00		2	
35	711,631.50	4,328,522.00		2	
36	711,656.50	4,328,522.00		3	
37	711,731.50	4,328,522.00		3	
38	711,981.50	4,328,522.00		3	
39	712,031.50	4,328,522.00		2	
40	711,106.50	4,328,422.00		2	
41	711,131.50	4,328,422.00		3	
42	711,206.50	4,328,422.00		3	
43	711,456.50	4,328,422.00		3	
44	711,506.50	4,328,422.00		2	
45	711,631.50	4,328,422.00		2	

Table 3.1 (continued)

Plot Number	Plot center UTM easting*	Plot center UTM northing*	Cover type	Sampling intensity**	Comments
46	711,656.50	4,328,422.00		3	
47	711,731.50	4,328,422.00		3	
48	711,981.50	4,328,422.00		3	
49	712,031.50	4,328,422.00		2	
50	711,106.50	4,328,397.00		3	
51	711,131.50	4,328,397.00		3	
52	711,206.50	4,328,397.00		3	
53	711,456.50	4,328,397.00		3	
54	711,506.50	4,328,397.00		3	
55	711,631.50	4,328,397.00		3	
56	711,656.50	4,328,397.00		3	
57	711,731.50	4,328,397.00		3	
58	711,981.50	4,328,397.00		3	
59	712,031.50	4,328,397.00		3	
60	711,106.50	4,328,322.00		3	
61	711,131.50	4,328,322.00		3	
62	711,206.50	4,328,322.00		2	
63	711,456.50	4,328,322.00		2	
64	711,506.50	4,328,322.00		3	
65	711,631.50	4,328,322.00		3	
66	711,656.50	4,328,322.00		3	
67	711,731.50	4,328,322.00		2	
68	711,981.50	4,328,322.00		2	
69	712,031.50	4,328,322.00		3	
70	711,106.50	4,328,197.00		2	
71	711,131.50	4,328,197.00		3	
72	711,206.50	4,328,197.00		3	
73	711,456.50	4,328,197.00		3	
74	711,506.50	4,328,197.00		2	
75	711,631.50	4,328,197.00		2	
76	711,656.50	4,328,197.00		3	
77	711,731.50	4,328,197.00		3	
78	711,981.50	4,328,197.00		3	
79	712,031.50	4,328,197.00		2	
80	710,321.30	4,329,030.30		2	
81	710,780.30	4,330,416.20		2	
82	708,110.00	4,327,739.30		2	
83	712,170.80	4,331,239.60		2	
84	709,123.70	4,328,370.50		2	
85	711,865.50	4,330,022.40		2	
86	712,562.90	4,327,942.40		2	
87	708,273.40	4,331,775.10		2	
88	709,966.20	4,331,424.50		2	
89	708,705.60	4,330,013.90		2	
90	708,527.20	4,328,225.70		2	

Table 3.1 (continued)

Plot Number	Plot center UTM easting*	Plot center UTM northing*	Cover type	Sampling intensity**	Comments
91	708,947.00	4,328,979.20		2	
92	710,029.30	4,327,572.30		2	
93	709,659.40	4,327,016.90		2	
94	710,711.70	4,331,117.80		2	
95	708,986.90	4,327,189.30		2	
96	711,449.30	4,331,198.60		2	
97	711,711.50	4,329,359.10		2	
98	709,647.90	4,330,422.00		2	
99	707,917.80	4,329,090.10		2	

* UTM (Universal Transverse Mercator) NAD27 (projected as tower location given us by Konza) zone 14.

** Six of the 2nd-order plots will be upgraded to 1st-order plots (NPP_B plots) at the time of tube installation.

KONZ

Sampling Intensity Among Plots

According to the BigFoot sampling design, each of the 25 x 25 m plots will be sampled at one of three levels of intensity:

Sampling intensity	Parameters quantified	Number of plots (of 100 total plots)
3rd-order	Vegetation cover, species composition, plant biomass, leaf area index (LAI), and fraction absorbed photosynthetic active radiation (f_{APAR})	56
2nd-order	3rd-order measurements + aboveground net primary productivity (NPP_A)	38
1st-order	2nd-order measurements + aboveground net primary productivity (NPP_B)	6

Assignment of second-order plots

All 20 of the extensive plots (plot numbers 80–99) will be assigned second-order status. In addition, 24 of the 80 intensive plots will be assigned second-order status. These 24 second-order plots were chosen from the 80 intensive plots in a manner that maximizes the distance among plots in an attempt to minimize autocorrelation among plots.

Assignment of first-order plots

Fine root NPP will be measured on only six first-order status plots because of the large labor costs of measuring fine root NPP. Three replicate plots in each of the two most abundant cover types will be sampled to estimate fine root NPP for Konza. Each first-order plot will be located in an independent vegetation community (i.e., separated by at least one other community).

At the KONZ site, three first-order plots will be located in shortgrass prairie and three plots located in gallery forest. Five minirhizotrons will be installed in each first-order plot. The plots to be selected will be unknown until the plots are surveyed and established, which will occur in the summer of 1999.

Assignment of third-order plots

The remaining 50 plots will be third-order status plots. The distribution of first-, second-, and third-order plots will be 56, 38, and 6, respectively.

KONZ

Vegetation Characteristics to be Measured

According to the BigFoot objectives it is necessary to quantify vegetation cover, LAI, f_{APAR}, and aboveground biomass for each 25 x 25 m plot and aboveground and belowground NPP for a subset of plots. Each of these characteristics has multiple components that require separate measurement. Below is a list of the 20 vegetation characteristics to be measured (in at least some of the plots), followed by Table 3.2, describing the protocol for taking each of the measurements.

Aboveground Biomass (all plots)

1. moss layer
2. understory
3. small tree wood and leaf
4. large tree wood and leaf

Belowground Biomass (1st-order plots only)

5. coarse roots
6. fine roots

Aboveground NPP (2nd- and 1st-order plots only)

7. moss production
8. understory stem production
9. small tree stem production
10. large tree stem production
11. total foliage production

Belowground NPP (1st-order plots only)

12. coarse root production
13. fine root production

Leaf Area Index and Vegetation Cover (all plots)

14. leaf area index measured optically
15. leaf area index measured using allometry (for forests only)
16. f_{APAR} measured optically
17. vegetation cover

Scaling parameters (sitewide averages may be adequate measured in six of the exterior 2nd-order plots)

18. moss mass per ground area
19. specific leaf area of dominant canopy species
20. leaf N concentration of dominant canopy species

Table 3.2. Vegetation sampling methodology for KONZ*

Measurement	Example	Method	Subplot number	Subplot size	Timing	Comments
1) Moss mass	Feather moss or sphagnum					Not significant at KONZ
2) Understory mass	Grasses, forbs, and small shrubs	Clip at base, dry, and weigh all understory in subplot	10	0.05 m^2	4 times per year	Details regarding the accurate annual sampling of prairie species not yet fully determined
3) Small tree mass	Sumac, *Cornus*, and saplings <2.5 cm DBH**	Count stems and basal diameter in subplots and scale to tree mass w/ allometric equations	5	1–25 m^2 depending on tree density (enough to get 4 trees/subplot)	Midsummer	Plot surveys in 1999 will help make distinction between understory shrubs and small trees
4) Large tree aboveground mass	Oaks, elms, and other trees >2.5 cm diameter	Plot-centered prism plots to count stems by size; stem counts scaled to tree mass w/ allometric equations	1	Variable-radius prism plots	Midsummer	
5) Coarse root mass	Tree roots >2.5 mm diameter	Plot-centered prism sweep to count stems by size; stem counts scaled to root mass w/ allometric equations	1	Variable-radius prism plots	Midsummer	Methods for coarse root measurement in grasses undetermined

Table 3.2 (continued)

Measurement	Example	Method	Subplot number	Subplot size	Timing	Comments
6) Fine root mass	Root 2 mm or less in diameter	The inside of clear tubes inserted into ground are periodically viewed with a digital camera. Area of fine roots seen in images are scaled to mass/area using gravimetric constants	5 tubes	2-D image totaling about 30 cm^2	4 times seasonally	Size cutoff and scaling factors depend on further methods development
7) Moss growth						No significant at KONZ
8) Understory stem growth	New stem growth of small perennials	Based on bud scarring, new stem growth is separated from the understory biomass samples and weighed	5	0.25 m^2	After growing season for which NPP is calculated	Sampled from the same plots used to determine small tree mass
9) Small tree wood NPP	Annual stem and branch growth of sumac, *Cornus*, and tree saplings <2 cm DBH	Radial increment of tree determined from basal cores or disks; increment scaled to stem growth w/allometric equations	4	1-25 m^2 depending on tree density (enough to get 4 trees/subplot)	After growing season for which NPP is calculated	Sampled from the same plots used to determine small tree mass
10) Large tree wood NPP	Annual bole and branch growth of oak, elm, and other trees >2 cm DBH	Radial increment of trees counted in prism plots determined from cores taken at BH; increment scaled to stem growth w/ prism factor and allometric equations	1	Variable-radius plots	After growing season for which NPP is calculated	Same trees used to determine aboveground biomass

Table 3.2 (continued)

Measurement	Example	Method	Subplot number	Subplot size	Timing	Comments
11) Foliage NPP	Leaves senesced from (and presumed grown in) canopy over one growing season	Litter traps for shrub and forest ecosystems; clip plots for prairie ecosystems	5	0.25-m^2 litter traps	Litter collected over the growing season for which NPP is calculated	Details regarding the accurate sampling of prairie species not yet fully determined
12) Coarse root NPP	Annual growth of roots >2 mm diameter	Calculated as an allometric function of aboveground stem growth (meas. no. 10)	1	Variable-radius plots for trees	After growing season for which NPP is calculated	Allometry for shrub and forest ecosystems not relevant for prairies
13) Fine root NPP	Roots <2 mm diameter	The insides of clear tubes inserted into ground are periodically viewed with a digital camera; gross increase in area of fine roots seen in images is scaled to mass/area using constants	5 tubes	2-D image totaling about 30 cm^2	4 times seasonally	
14) LAI (optical)	½ total leaf area in canopy per unit ground area	Measured at points in plot using LAI 2000 (LAI computed from sunlight attenuation as it passes through canopy)	5	Point samples	4 times seasonally	
15) LAI (allometry)	½ total leaf area in canopy per unit ground area	Foliar mass values are scaled to area using species-specific specific leaf area values (meas. no. 18)	1	Variable-radius plots	Any time	Forest and shrub communities only

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Table 3.2 (continued)

Measurement	Example	Method	Subplot number	Subplot size	Timing	Comments
16) f_{APAR}	Fraction of PAR absorbed by canopy	Measured at points in plot using LAI 2000 (computed from same measurement as LAI)	5	Point samples	4 times seasonally	
17) Vegetation cover	Vertical projection of vegetation to ground area	Mean crown completeness using digital true-color camera	5	1 m^2	Midsummer	
18) Moss mass per ground area						No significant moss component at KONZ
19) Specific leaf area	Leaf area per unit leaf mass by species	Fresh leaves are weighed and measured with a leaf area meter				Sitewide averages will be determined by taking leaf samples only at selected plots
20) Leaf nitrogen concentration	% nitrogen by mass of leaves from dominant tree species	Fresh leaves are dried, digested by Kjeldahl incubation, and colormetrically analyzed for nitrogen				Sitewide averages will be determined by taking leaf samples at only a few selected plots

* Grassland plots will require only a subset of these measurements.
** DBH = diameter at breast height.

KONZ

Subplot Placement

The 25 x 25 m plot is the experimental unit. In our final analysis each plot will yield *one* value for each vegetation characteristic measured. Where appropriate, multiple fixed-area subplots will be sampled within each plot. The subplots are positioned in the 25 x 25 m plot such that

1. they are spatially stratified throughout the plot and not clustered in one area,
2. they are simple and convenient to deploy in the field, and
3. they do not interfere with one another.

The subplots will be established in a regular pattern in each plot based on the cardinal compass directions. Figures 3.5 and 3.6 and Tables 3.3 and 3.4 illustrate the protocol for placing subplots in both forested and grassland plots at KONZ.

Figure 3.5. Placement of KONZ grassland plots

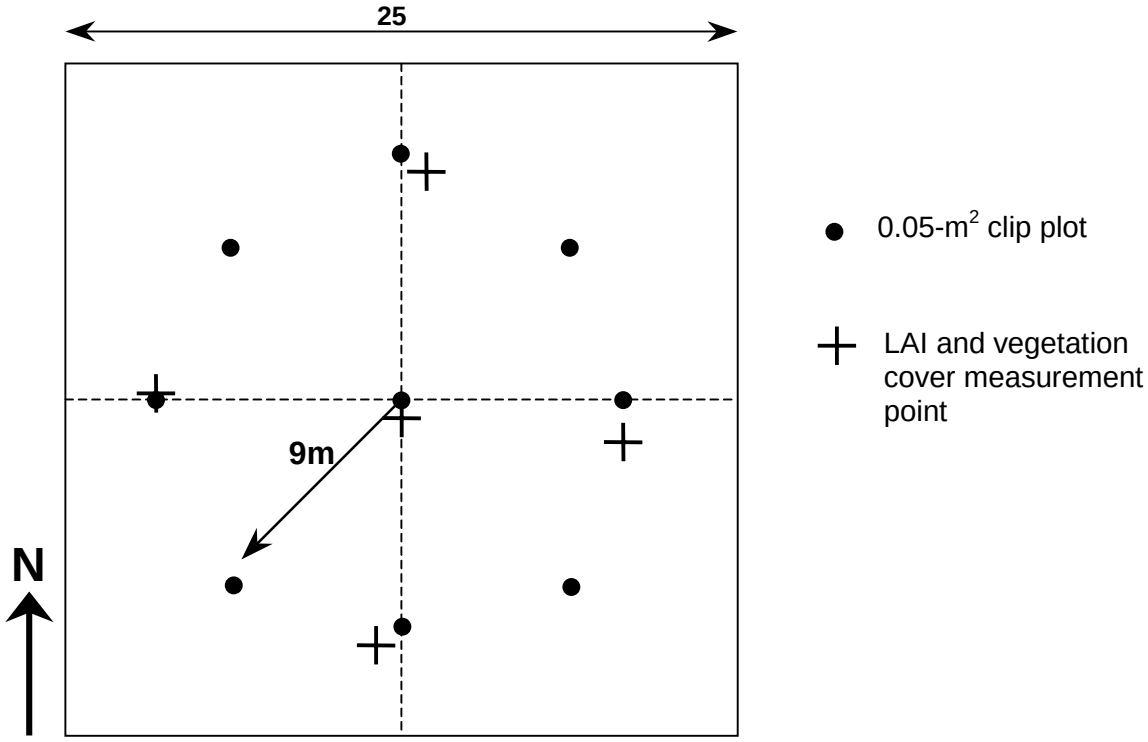

Figure 3.6. Placement of KONZ forested plots

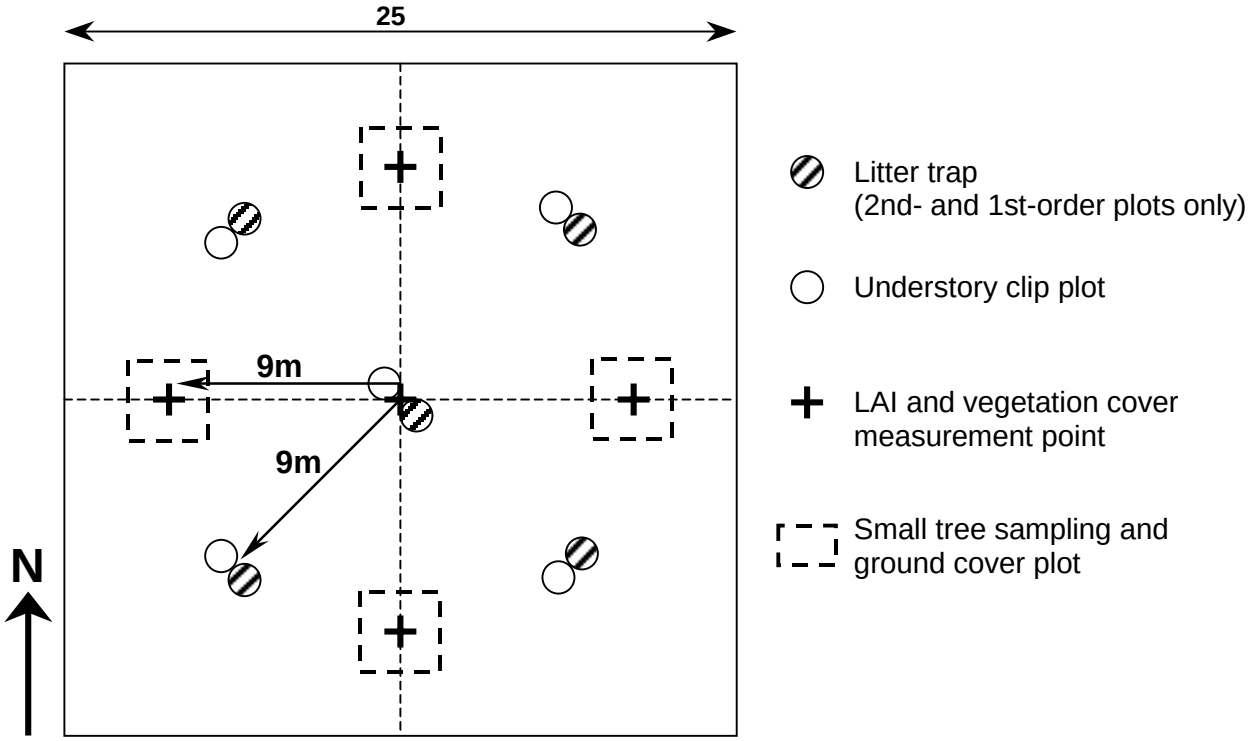

Table 3.3. Subplot placement protocol for KONZ grassland plots

Subplot	Number of subplots	Position in 25 × 25 m plot
Vegetation clip plot	9	One clip plot near plot center and eight more 9 m N, NE, E, SE, S, SW, and W, from plot center. These locations should be only approximate so as to afford multiple samples a year w/o clipping the same place twice
LAI and vegetation cover sample points	5	One positioned near plot center and four more positioned 9 m N, S, E, and W from plot center
Minirhizotron tubes (1st-order plots only)	5	One positioned near plot center and four more positioned 9 m N, S, E, and W from plot center (or anywhere they can be installed)

Table 3.4. Subplot placement protocol for KONZ forested plots

Subplot	Number of subplots	Position in 25 × 25 m plot
Understory clip plots	5	One positioned near plot center and four more positioned 9 m NW, NE, SE, and SW from plot center
Litter traps (2nd- and 1st-order plots only)	5	Placed adjacent to the understory clip plots
Small tree stem survey plots	4	Four fixed-area subplots centered at points 9 m N, S, E, and W from plot center
Variable-radius plots	1	One variable-radius plot made from plot center
LAI and vegetation cover sample points	5	One positioned near plot center and four more positioned 9 m N, S, E, and W from plot center
Minirhizotrons (1st-order plots only)	5	Placed adjacent to the understory clip plots (or anywhere they can be installed)

KONZ

Tentative 1999 Field Calendar

Month	Week	Day of year	Measurements
July	2	185	Survey in plots and install minirhizotrons

Full field campaigns will occur in 2000 and 2001.

KONZ

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