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RECENT PONDEROSA PINE (PINUS PONDEROSA) OCCURRENCE IN NEBRASKA SANDHILLS PRAIRIE

A Thesis

Presented to the

Department of Biology

and the

Faculty of the Graduate College

University of Nebraska

In Partial Fulfillment

of the Requirements for the Degree

Masters of Arts

University of Nebraska at Omaha

by

Ernest M. Steinauer

April 1986

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THESIS ACCEPTANCE

Accepted for the faculty of the Graduate College, University of Nebraska, in partial fulfillment of the requirements for the degree Master of Arts, University of Nebraska at Omaha.

Thesis Committee

Name	Department
Ann Antlfinger	Biology
James K. Wood	Chemistry

Thomas B. Bragg
Chairman

22 April 1986
Date

ACKNOWLEDGEMENTS

I would like to express my appreciation to The Nature Conservancy for supporting this project and for allowing me to do the field work on the Niobrara Valley Preserve. Thanks are extended to Bill deGraw for help in preparing slides for seminar presentations, to Dave Sutherland for help with graphs and to Larry Stephens for help with statistical analyses. Thanks also go to my family and friends, especially to Ellen, for putting up with my long hours of work on this project. I would also like to thank my committee members, Ann Antlfinger and James Wood, for their interest in this project and critical review of the manuscript. Special thanks to Tom Bragg for his wise counsel, many hours of work on this project and for spurring my interest in plant ecology.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Four stands of ponderosa pine (*Pinus ponderosa*), situated within sandhills prairie sites in north central Nebraska, were evaluated for age distribution, reproductive status and spatial distribution. Trees were generally young; of the 563 individuals sampled, 11 had establishment dates prior to 1900 with the oldest dated 1868. All trees greater than 55 years old bore cones. Initial tree establishment appears to have occurred on north facing slopes where both the oldest trees and 92% of all trees observed were located. Age structure data show pine populations are increasing in all four prairie sites. This study shows that, under present management, ponderosa pine is invading the sandhills prairie.

INTRODUCTION

The Nebraska Sandhills Prairie (*Andropogon* - *Calamovilfa*) (Küchler 1964), covering 5 M ha, is the largest sand dune area in North America. Ponderosa pine (*Pinus ponderosa*), a dominant species of western coniferous forests, is located along the western and north central margins of the sandhills prairie reaching its eastern limit in the Niobrara River Valley. The eroded edge of the Crookston Table on the north side of the river consists of steep cliffs and rocky, xeric soils. It supports the largest populations of ponderosa pine in the vicinity of the sandhills. Smaller, scattered stands of pine, however, are found on the south side of the Niobrara River between the deciduous forests of the valley walls and the prairies of the sandhills proper. Dense shade prevents pine seedling establishment within the deciduous forest (Pool 1914, Tolstead 1942, Harrison 1980) and frequent fires and competition from grasses are believed to have prevented ponderosa pine from invading into the pristine prairie (Tolstead 1942, Harrison 1980). The planted forests at Halsey and Valentine, Nebraska, demonstrate the ability of ponderosa pine to survive in the sandhills. The 1965 fire at Halsey that destroyed a large portion of the forest, however, shows their susceptibility to burning.

The recent spread of ponderosa pine into adjacent prairies has been documented in the Black Hills of South Dakota (Gartner and Thompson 1972) and along the Little

Missouri River in North Dakota (Potter and Green 1964), presumably because of the lack of fires. Invasion of sandy soils was more likely than finer textured soils. In addition, several years of above average moisture may be necessary for seedling establishment (Curtis and Lynch 1957, Wells 1970). Fires were frequent in the Nebraska Sandhills before European settlement (Pool 1914). While specific causes of such fires are not known, Moore (1972) attributes 32% of presettlement prairie fires in the north central plains region to Native Americans, 14% to whites and the remainder unascribed. Based on recent records, lightning was likely to constitute a major portion of these unascribed fires (Westover 1984). Though fires still occur, their number and extent have been greatly reduced (Bragg 1985). Lower fire frequency may be responsible for the apparent invasion of ponderosa pine into sandhills prairie south of the Niobrara River (Harrison 1980).

This study was based on the hypothesis that woody plants are invading the prairie as a consequence of recent changes in the fire regime. This invasion (1) should be reflected in the life history characteristics of the extant tree stands and (2) should show an increase in tree establishment at the time of European settlement of the region. To test this hypothesis, the age structure was determined for selected ponderosa pine stands in sandhills prairie sites. The data were examined for a relationship between the time of European settlement and the establishment and expansion of ponderosa pine stands. In addition, the study assessed relationships between successful tree establishment and topography and aspect.

MATERIALS AND METHODS

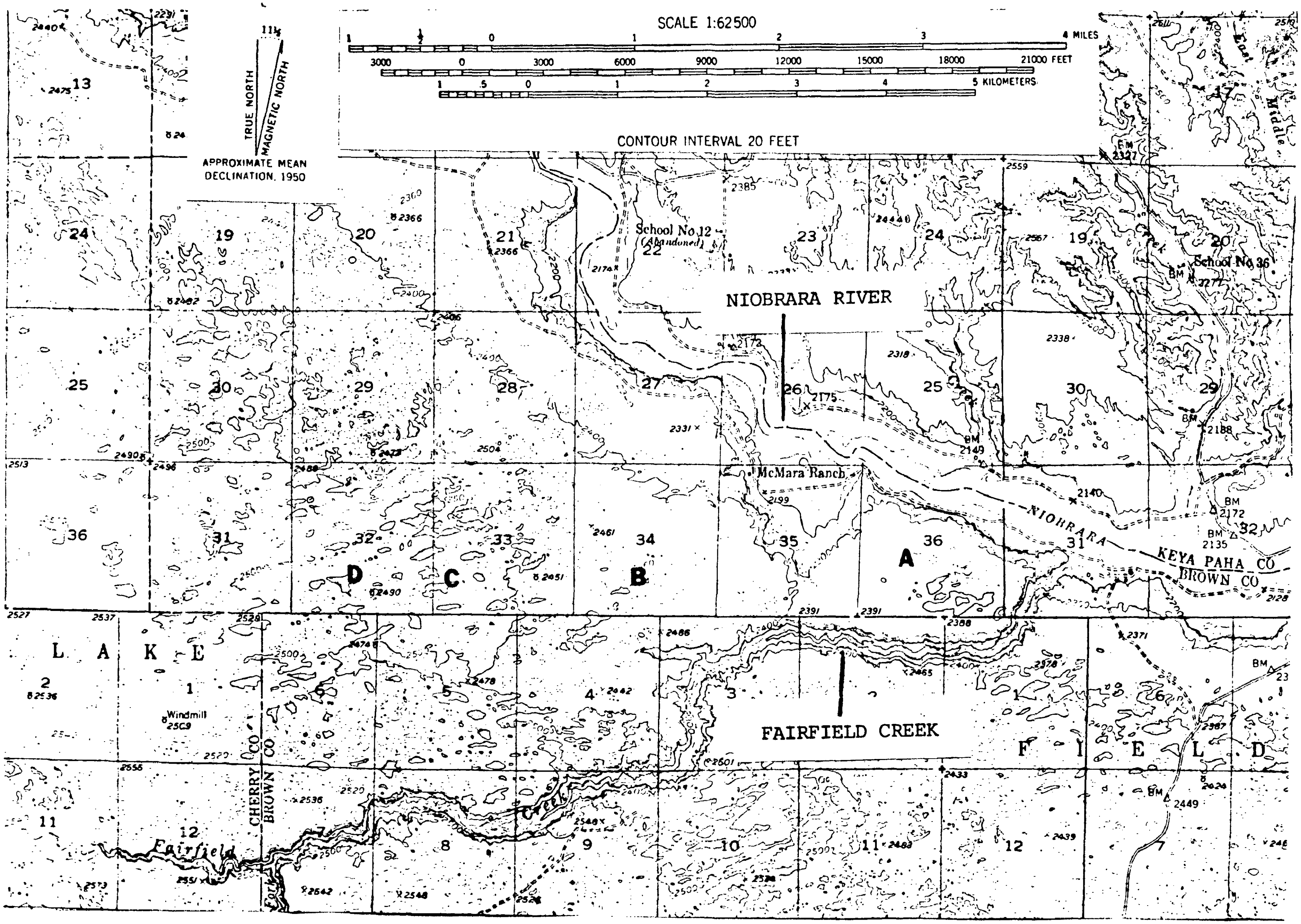
Study Sites.

This study was conducted at the Niobrara Valley Preserve, a 22,000 ha area owned and managed by The Nature Conservancy. The preserve is located along the Niobrara River in north central Nebraska. The area is of particular ecological interest because it contains a region of overlap of the eastern deciduous forest and the western coniferous forest and because it contains remnant boreal forest species. Rainfall for the region averages 51 cm per year, most of which occurs in the summer months. Mean monthly temperatures range from -5 C in January to 24 C in July (NOAA 1984). Soils of the sandhills proper are primarily sand and sandy loam (Elder 1969).

In the late 19th century, settlers removed much of the pine from the wooded portion of the Niobrara River Valley. The extent of lumbering is unclear but some ponderosa pine survived and still occur along the canyons of the Niobrara River and its tributaries. Most of these trees, particularly in the study area, are less than 100 years old. Older trees, up to 350 years old, can be found scattered along upper slopes of the canyon walls (Bragg 1985). In addition, some ponderosa pine can be found growing within the sandhills prairie some distance from their typical canyon habitat. Early accounts indicate that ponderosa pine occurred as widely scattered, lone trees or small groups in sandhills prairie sites (Pool 1914) though little reproduction was observed (Tolstead 1942). Presently, numerous stands of ponderosa pine, some quite extensive, can be found within the prairie.

The study was conducted in a prairie area within which ponderosa pine stands had become established. This area is located between the Niobrara River and Fairfield Creek, one of the Niobrara's principal tributaries. It has been hypothesized that the deep canyons of these waterways have protected the areas between them from prairie fires which swept from the southwest (Harrison 1980). Relatively dense and extensive pine stands occupy the eastern portion of this area. Stands become increasingly smaller, more scattered, and more distant from seed sources to the west. Four study sites, labeled A, B, C and D, were selected along an east-west line which bisected the area between Fairfield Creek and the Niobrara River (Fig. 1). These sites are increasingly more distant from a seed source and are hypothesized to represent a decrease in protection from southwesterly fires. Pine density was highest in Site A. The pines in this area occurred in east-west bands alternating with prairie vegetation. This orientation reflects the dune topography in which the ridges run in an east-west direction; north and south facing slopes predominate. To insure that both the edge and the interior of the tree bands were sampled, a 150 m x 10 m rectangular plot was established with the long axis running at right angles to the ridges. The plot was situated in such a way

Fig. 1. Study sites (A, B, C and D) within the Niobrara Valley Preserve. (Norden Quadrangle, Scale 1 : 62500)


SCALE 1:62500
4 MILES
21000 FEET
5 KILOMETERS
CONTOUR INTERVAL 20 FEET
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1950
NIOBRARA RIVER
FAIRFIELD CREEK
School No.12 (Abandoned)
School No.36
McMara Ranch
NIOBRARA
KEYA PAHA CO
BROWN CO
CHERRY CO
LAKE
FIELD
Windmill
Fairfield
Creek
East
Middle
A
B
C
D

that it incompassed a representative sample of the forested and open areas of the site as a whole. Site D included the western-most mid-prairie pine trees. Compared to Site A, Sites B, C and D supported smaller more isolated stands of pine which typically occupied a single dune top. For each of these three sites, a single stand was selected to typify the immediate area. Irregularly sized plots were used at these sites because of the shape of the pine stands and because of considerable distances between some trees. The boundaries of these plots were determined by connecting the outermost trees. The specific size of each plot was determined from maps using the average of three plane polarimeter readings.

Age Determination.

In June, 1984, all individual pine trees that were (1) rooted within the study plots, and (2) estimated to be greater than 1 yr old, were labeled, mapped and sampled for age determination. Trees were considered to be less than 1 year old based on the presence of cotyledons and the absence of true leaves. Diameter at breast height (dbh) was recorded for all individuals greater than 1.3 m in height. For smaller trees, actual height was recorded. Reproductive condition, as determined by the presence of megagametophytic or microgametophytic cones, was also recorded.

Tree age was determined by one of three methods. For trees large enough to core, an increment was extracted from approximately 0.5 m above the base. Core samples that proved to be uncountable were replaced by cores collected at later dates. Complete cores could not be obtained from some trees because of internal anomalies. These cores were counted as accurately as possible. In addition, five small trees were sampled, both at ground level and at coring height, to determine the time required for pines to reach coring height. Based on these data, four years were added to the age of all cored trees when calculating the year of establishment.

For trees too small to core but greater than 0.5 m in height, a partial cross section of the stem was cut at ground level. Trees less than 0.5 m in height were indirectly sampled since removing a partial cross section was destructive to the individual. Regression analysis of trees for which both age and height were known indicated that age of small trees could not be accurately estimated by height ($r = 0.1$, $P < 0.002$), therefore maximum age of these small trees was estimated from scatter plots of age vs. height for each study site. Trees of this size occurred in large numbers only in Site A. This degree of precision was adaquate to assess reproductive trends in recent years.

Cores and wedges were prepared by routine dendrochronological methods (Stokes and Smiley 1968). All samples were counted at least three times using a dissecting microscope. Counts obtained were considered accurate to within 2-3 years. Tree ages were grouped into 5-year age class categories. Because of the method of estimating age of young trees, the first three age classes were grouped for

Site A and the first two age classes were similarly grouped for each of Sites B, C and D. The different treatment of sites was necessary because of the slower growth rate at Site A, perhaps a response to higher tree density at this site. The age distributions of the sites were tested for similarity using the Kolmogorov-Smirnov test (Sokal and Rohlf 1969).

Establishment and Spatial Patterns.

In order to determine pine establishment patterns in relation to dune topography, slope compass direction at each individual tree location was recorded. Also, tree distance from the ridge top was determined from maps for Sites A, B and D. Site C was not evaluated for this parameter because of the lack of a discernable ridge top. Mean distance and the range of distances from the ridge top were calculated for 10 year age categories in Sites A, B and D combined. The 0-9 and 10-19 year age categories were combined to be consistent with the necessary grouping of trees less than 15 years of age in Site A. An Analysis of Variance ($P < 0.05$) was used to test for significant differences in the means and Duncan's Multiple Range Test ($P < 0.05$) was used to test for individual differences among the means (Ott 1984). In addition, the distance to the nearest neighbor was measured to determine spatial patterns at all sites using Nearest-Neighbor-Analysis (Clark and Evans 1954). The value "J" is the ratio of the actual mean distance to the nearest neighbor compared to the expected distance if individuals in the population were randomly distributed. For some trees at Site A, the distance recorded was to a tree outside the plot boundary.

RESULTS

A total of 563 pines was sampled, 342 at Site A, 104 at Site B, 39 at Site C and 78 at Site D (Fig. 1, Appendix Table 1). Pine density was considerably higher at Site A than at the other sites (Table 1). Nearest neighbor analysis of tree distribution indicated that pines in Sites B, C and D were evenly distributed while those in Site A were highly aggregated.

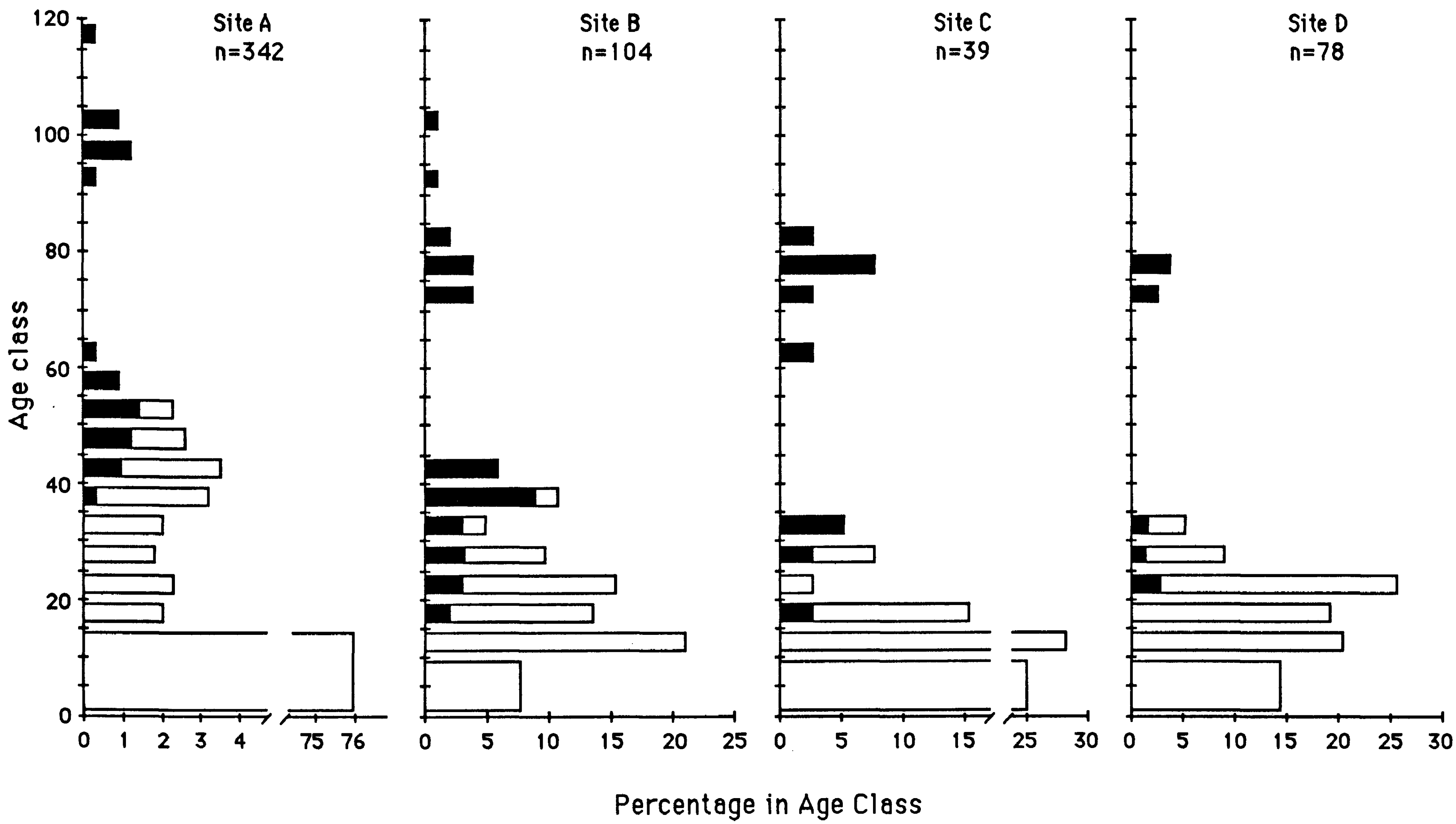
Pines in dense stands assumed strongly excurrent growth forms while those in open areas had a more spreading appearance. The majority of trees observed appeared healthy and vigorous. Some individuals, in a small, dense stand of about 25 trees at Site A, were stunted and had slender, curved trunks and only a few short branches. This thicket contained 5 dead trees. Other dead trees, all less than 0.5 m in height, were also found, mostly at Site A. In addition, one Site A tree, about 2 m in height, had most of the bark removed, probably by a porcupine. No evidence of large, old dead trees, such as stumps or fallen logs, were found at any of the study sites. It seems likely that mortality is greatest in seeds and very young seedlings and lowest in established individuals, despite evidence of browsing in many sapling-sized trees.

Of all trees sampled, 90% were less than 45 years old and only 11 were established before 1900 (9 in Site A and 2 in Site B), of which the oldest was dated 1868 (Fig. 2). The mean value (± 2 SE) of the five oldest trees in each Site was

Table 1. Density and spatial patterns of ponderosa pines by site. J = Nearest neighbor value. J < 1 indicates aggregated distributions, J = 1 indicates random distributions and J > 1 indicates even distributions. P = probability of a significant J value.

Sites	Density (No./0.01ha)	Nearest-Neighbor	
		J	P
A	22.5	0.49	<0.01
B	3.7	1.39	<0.05
C	2.4	1.15	<0.05
D	1.2	1.23	<0.01

Fig. 2. Age distributions of ponderosa pine by site. n = number of pines sampled. Shaded portion of bars indicates reproductive portion of the age class.


Site A
n=342
Site B
n=104
Site C
n=39
Site D
n=78
Age class
Percentage in Age Class
120
100
80
60
40
20
0
0 1 2 3 4 75 76
0 5 10 15 20 25
0 5 10 15 25 30
0 5 10 15 20 25 30

104 ± 3.0 yrs in Site A, 89 ± 4.4 yrs in site B, 78 ± 1.6 yrs in Site C and 75 ± 1.2 yrs in Site D.

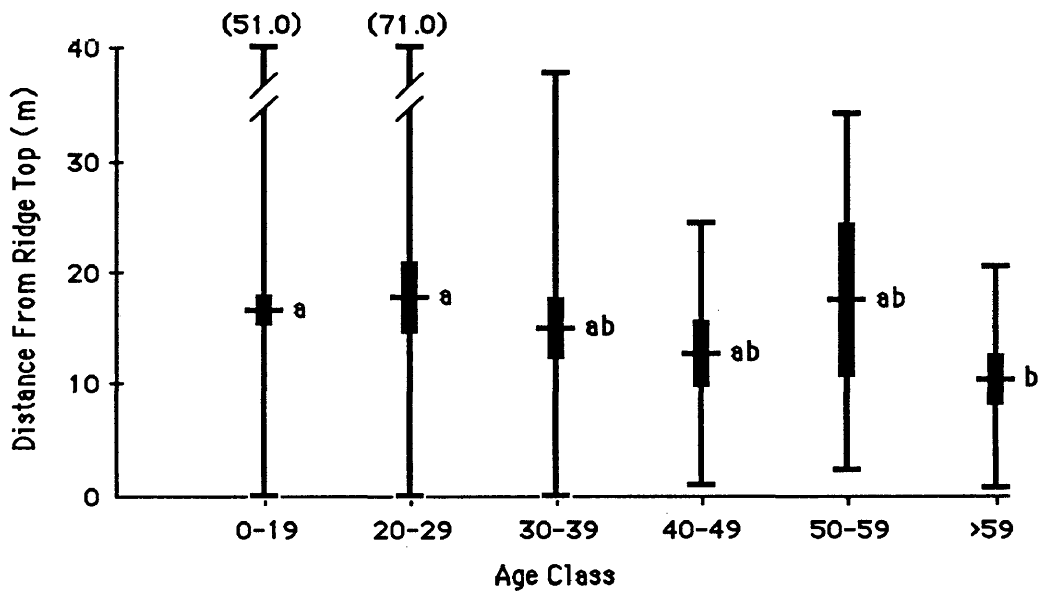
The age distributions of all sites were significantly different from each other ($P < 0.05$) except for Sites C and D (Table 2). All the age distributions had similar temporal patterns, a small number of trees in the oldest age categories, followed by a gap of 25-30 years with little or no successful reproduction, and increasing numbers in the youngest age classes (Fig. 2). Though individual stands have time periods during which no trees were established, overall there has been at least some successful reproduction in most years since the 1880's. Pine trees in the study area were found to produce cones by age 20 though most begin somewhat later. Reproductive activity was noticeably later in the dense stand of Site A (Fig. 2). Cones were found on all trees greater than 55 years of age.

Of the trees sampled, 92% were situated on north facing slopes with less than 1% on south and east facing slopes (Appendix Table 1). Further, significant differences were found between average distance of individual trees from ridge tops ($F = 3.0$, $df = 5$, $P < 0.05$) (Fig. 3). Individuals of the oldest age group were found significantly closer to the ridge tops and they occupied a narrower range of distances from the ridge top than did the younger age groups at all sites tested.

Table 2. Pairwise comparison of age distributions by site using the Kolmogorov-Smirnov Test. TS = test statistic, CV = critical value, * indicates significant difference (P < 0.05).

Sites	TS	CV
A-B	0.581	0.152*
A-C	0.402	0.230*
A-D	0.571	0.171*
B-C	0.269	0.255*
B-D	0.217	0.203*
C-D	0.192	0.266

Fig. 3. Distance of trees from ridge tops by age categories (in years)for Sites A, B and D combined. Horizontal line = mean, bar = $\pm$ 2SE, vertical line = range. Means followed by same letter do not differ significantly (Duncan's Procedure, $P < 0.05$).



(51.0)
(71.0)
40
30
20
10
0
Distance From Ridge Top (m)
a
a
ab
ab
ab
b
0-19
20-29
30-39
40-49
50-59
>59
Age Class

DISCUSSION

This study documents (1) that ponderosa pine is invading sandhills prairie and that this invasion was initiated at approximately the same time as European settlement, and (2) that pines initially are established on upper north-facing slopes.

Ponderosa Pine Invasion.

The age structure of the four mid-prairie stands shows that ponderosa pine is invading the sandhills prairie with all stands having substantially more young than old trees (Fig. 2). Further, there was little evidence of mortality in any but the youngest age classes indicating that once pine are established within the prairie, they continue to increase in number for some time, apparently in excess of 100 years. This expansion occurred in most years since initial establishment, even during the drought years of the 1930's, although trees were established only at Site A during this xeric time period.

Specific years of successful establishment varied among sites suggesting that microsite conditions may play an important role in pine establishment. Of particular interest is the large number of seedlings present at Site A, most of which were under the canopies of older trees where grass density was low. Here, seedlings have developed without competition from herbacous vegetation. The understory of the other sites, where pine seedlings were less common, consisted of a nearly continuous grass cover. Grass is known to compete intensely with pine seedlings, especially for moisture (Larson and Schubert 1969, Madany and West 1983). Recent changes in grazing practices have increased grass cover in sites B, C and D, which may explain the decrease in pine establishment at these sites.

In addition to documenting the ongoing invasion of ponderosa pine, this study shows that the invasion has occurred recently, following European settlement in the late 1800s. Only 11 of 563 trees were dated prior to 1900 and, of these, the oldest was dated to 1868. Further, the absence of old tree stumps or downed trees suggests that pines had not occupied the study sites before the current trees were established. These data support early reports from the area that indicate the restriction of ponderosa pine to canyon walls of the Niobrara River and its major tributaries (Pool 1914, Bragg 1985).

Restriction of pine to canyons may have been a consequence of frequent prairie fires (Pool 1914). With European settlement, the fire return interval in the vicinity of the study area increased from an average of 3.5 yrs between 1851 and 1900 to 8.5 yrs between 1901 and 1950 (Bragg 1985). This change in the fire regime may have permitted the establishment of trees of sufficient size to withstand subsequent fires.

Fire alone, however, may not account for pine invasion since the distance to a seed source, protection from fire and cattle grazing have all been reported to affect pine establishment. The decline in average stand age from east (104 yrs) to west (75 yrs) in the study area is consistent with hypotheses relating stand establishment both to protection from fires and distance from a seed source. First, the increasing distance to source trees from Site A to Site D decreases the likelihood of seed transport to the site. Second, a gradient of protection from fires is hypothesized going from considerable protection in the east to less in the west as previously discussed. In addition, an increase in cattle grazing since settlement may have influenced pine establishment. Madany and West (1983), for example, found more pine saplings in grazed than ungrazed pine forests. They attributed this to reduced competition from grasses following grazing.

Mid-Prairie Pine Establishment.

This study shows that the first ponderosa pine to become established in mid-prairie sites did so on the upper portions of north-facing slopes. This may be a consequence of several, interrelated factors. First, north slopes are more mesic and thus more suitable for seedling establishment. Second, fewer high intensity fires occur on the leeward slope (Gartner and Thompson 1972), which, within the study area, are north-facing slopes. Third, ridge tops may have been sites of blowouts before current management practices stabilized the sand dunes. Such partially stabilized blowouts may provide pine seedlings a site both free from competition and protected from fires.

Based on this study, a hypothetical sequence of pine invasion in the area might begin with pine restricted to canyon walls by recurrent prairie fires and competition with grasses. A post-settlement decrease in fire frequency and concommitant decrease in grass cover via cattle grazing may have promoted successful pine establishment in sandhills prairie locations. Those areas most protected from fires and closest to seed sources would have been invaded first. Initially established on upper, north-facing slopes, pines would have subsequently spread over most of the north-facing slopes with only limited establishment on south-facing slopes. This increase in population size would be enhanced by a decline in herbaceous understory which would otherwise inhibit pine establishment. From this distribution, which describes current conditions in some areas, pines seem likely to continue to expand in the absence of fire. The results of this study show that pine is invading portions of the Sandhills Prairie and suggest that, if current conditions continue, particularily fire suppression, portions of the sandhills may succeed to a ponderosa pine dominated community.

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APPENDIX

Appendix Table 1. Data set. S = Site: A = Site A, B = Site B, C = Site C, D = Site D. # = tree number, A = tree age, H = tree height, D = diameter at breast height, X = X map coordinate, Y = Y map coordinate, N = distance to nearest neighbor (m), R = reproductive condition (0 = not reproducing, 1 = reproducing), Sa = sample type collected for aging (0 = wedge, 1 = core, 2 = estimated), Sl = slope direction (N = north, E = east, S = south, W= west), Di = distance from ridge top (m). -1 = no data.

S	#	A	H	D	X[1]	Y[1]	N	R	Sa	Sl	Di
A	1	14	1.0	-1	0.1	3.2	2.5	0	0	S	2.8
A	2	54	-1	38.2	5.0	17.3	0.3	1	1	N	2.3
A	3	13	0.3	-1	4.5	19.4	0.6	0	0	N	4.4
A	4	14	0.2	-1	5.0	19.3	0.3	0	0	N	4.3
A	5	14	1.5	-1	4.3	20.4	0.2	0	0	N	5.4
A	6	13	0.7	-1	4.8	20.6	0.3	0	0	N	5.6
A	7	16	0.5	-1	4.9	20.1	0.3	0	0	N	5.1
A	8	10	0.6	-1	4.7	20.3	0.2	0	0	N	5.3
A	9	10	0.5	-1	4.5	20.5	0.2	0	0	N	5.5
A	10	16	1.0	-1	4.0	22.0	0.7	0	0	N	7.0
A	11	14	1.4	-1	3.8	21.5	0.2	0	0	N	6.5
A	12	14	1.6	-1	3.6	21.6	0.3	0	0	N	6.6
A	13	20	1.4	-1	3.4	20.9	1.0	0	0	N	5.9
A	14	13	0.9	-1	2.3	20.9	1.0	0	0	N	5.9
A	15	12	0.5	-1	1.7	21.3	1.0	0	0	N	6.3
A	16	13	1.2	-1	1.0	20.9	0.2	0	0	N	5.9
A	17	-1	0.2	-1	-1	-1	0.2	0	2	N	-1
A	18	13	1.5	-1	0.1	20.3	0.3	0	0	N	5.3
A	19	12	0.4	-1	0.3	20.5	0.3	0	0	N	5.5
A	20	8	0.5	-1	-1	-1	0.4	0	0	N	-1
A	21	12	0.8	-1	0.9	19.3	0.4	0	0	N	4.3
A	22	14	0.6	-1	0.8	19.0	0.1	0	0	N	4.0
A	23	10	-1	-1	0.8	18.9	0.2	0	0	N	3.9
A	24	12	0.4	-1	1.6	19.3	0.1	0	0	N	4.3
A	25	15	0.4	-1	-1	-1	0.1	0	0	N	-1
A	26	11	1.8	-1	1.3	19.8	0.2	0	0	N	4.8
A	27	16	1.0	-1	1.6	19.8	0.2	0	0	N	4.8
A	28	15	1.2	-1	2.7	19.7	1.2	0	0	N	4.7
A	29	48	-1	15.6	4.4	27.4	2.0	0	1	N	12.3
A	30	45	-1	8.3	4.9	30.4	0.4	0	1	N	15.4
A	31	35	-1	7.3	2.0	30.3	0.2	0	1	N	15.3
A	32	33	-1	4.1	2.0	30.5	0.2	0	1	N	15.5
A	33	31	2.0	-1	2.1	30.4	0.2	0	0	N	15.4
A	34	30	1.4	-1	3.4	31.1	0.8	0	0	N	16.1
A	35	22	2.0	-1	1.0	33.0	1.0	0	0	N	18.0
A	36	50	-1	8.6	4.1	31.8	0.2	0	1	N	16.8
A	37	41	-1	5.1	4.1	31.9	0.2	0	1	N	16.9
A	38	35	-1	4.8	3.9	31.7	0.1	0	1	N	16.7
A	39	37	-1	3.5	4.0	32.0	0.2	0	1	N	17.0
A	40	62	-1	20.4	3.8	32.5	0.4	1	1	N	17.5

Appendix Table 1. Data set (continued).

S #	A	H	D	X	Y	N	R	Sa	Sl	Di
A 41	46	-1	23.6	3.2	33.2	0.5	1	1	N	18.2
A 42	25	-1	-1	3.0	33.0	0.5	0	0	N	18.0
A 43	50	-1	24.8	3.8	35.9	0.4	1	1	N	20.9
A 44	44	-1	19.1	4.2	35.7	0.4	1	1	N	10.7
A 45	47	-1	20.1	3.8	35.4	0.4	1	1	N	10.4
A 46	-1	0.2	-1	3.8	36.1	0.3	0	2	N	21.1
A 47	14	0.5	-1	2.3	36.9	1.0	0	0	N	21.9
A 48	-1	0.4	-1	1.9	37.4	0.2	0	2	N	22.4
A 49	-1	0.4	-1	1.7	37.3	0.2	0	2	N	22.3
A 50	-1	<.5	-1	0.7	37.0	-1	0	2	N	22.0
A 51	-1	0.3	-1	1.0	36.1	1.0	0	2	N	21.1
A 52	7	0.3	-1	-1	-1	1.0	0	0	N	-1
A 53	-1	<.5	-1	2.0	37.4	0.1	0	2	N	22.4
A 54	6	0.4	-1	2.6	39.1	1.1	0	0	N	24.1
A 55	40	-1	9.5	3.4	38.8	1.2	0	1	N	23.8
A 56	-1	<.5	-1	3.3	39.4	1.2	0	2	N	24.4
A 57	13	0.4	-1	0.6	39.6	0.4	0	0	N	24.6
A 58	-1	0.2	-1	0.8	39.7	0.4	0	2	N	24.7
A 59	40	-1	22.9	1.3	40.8	0.7	1	1	N	25.8
A 60	17	0.5	-1	1.1	41.2	0.7	0	0	N	26.2
A 61	40	-1	16.9	4.0	42.1	1.3	0	1	N	27.1
A 62	41	-1	19.1	0.4	43.3	2.5	1	1	N	28.3
A 63	-1	0.3	-1	4.7	43.4	0.4	0	2	N	28.4
A 64	-1	0.4	-1	4.5	43.7	0.5	0	2	N	28.7
A 65	-1	<.5	-1	4.1	45.2	0.1	0	2	N	30.2
A 66	-1	<.5	-1	3.9	45.1	0.2	0	2	N	30.1
A 67	-1	<.5	-1	4.3	45.3	0.1	0	2	N	30.3
A 68	-1	<.5	-1	4.3	45.0	0.2	0	2	N	30.0
A 69	-1	0.3	-1	3.6	46.1	-1	0	2	N	31.1
A 70	-1	0.3	-1	3.6	46.1	-1	0	2	N	31.1
A 71	-1	0.4	-1	3.9	46.0	0.3	0	2	N	31.0
A 72	12	0.6	-1	3.6	46.1	0.1	0	0	N	31.1
A 73	12	0.6	-1	3.4	46.1	0.2	0	0	N	31.1
A 74	-1	0.4	-1	1.6	46.6	1.3	0	2	N	31.6
A 75	-1	0.3	-1	1.0	45.7	0.3	0	2	N	30.7
A 76	-1	0.4	-1	1.5	44.9	0.1	0	2	N	29.9
A 77	-1	0.4	-1	1.4	44.9	0.1	0	2	N	29.9
A 78	-1	0.4	-1	1.3	44.8	0.1	0	2	N	29.8
A 79	-1	0.3	-1	1.0	44.6	0.1	0	2	N	29.6
A 80	-1	0.2	-1	1.0	44.6	0.3	0	2	N	29.6
A 81	-1	0.2	-1	1.2	44.6	0.3	0	2	N	29.6
A 82	-1	0.2	-1	0.6	46.0	0.6	0	2	N	31.0
A 83	15	1.5	-1	4.8	49.8	3.0	0	0	N	34.8
A 84	43	-1	25.5	2.8	98.3	8.0	1	1	N	-1
A 85	99	-1	64.3	3.9	112.5	1.3	1	1	N	7.5
A 86	-1	0.3	-1	3.7	113.7	1.3	0	2	N	8.7
A 87	-1	0.3	-1	3.0	115.1	0.5	0	2	N	10.1
A 88	-1	<.5	-1	3.6	116.3	0.6	0	2	N	11.3

Appendix Table 1. Data set (continued).

S #	A	H	D	X	Y	N	R	Sa	Sl	Di
A 89	14	0.6	-1	2.8	115.5	0.5	0	0	N	10.5
A 90	9	0.6	-1	1.4	114.2	0.1	0	0	N	9.2
A 91	-1	<.5	-1	1.5	114.2	0.1	0	2	N	9.2
A 92	-1	0.4	-1	1.5	115.6	1.2	0	2	N	10.6
A 93	-1	0.3	-1	2.0	116.5	0.4	0	2	N	11.5
A 94	-1	0.3	-1	1.9	116.8	0.4	0	2	N	11.8
A 95	-1	0.3	-1	2.5	116.4	0.9	0	2	N	11.4
A 96	8	0.6	-1	3.1	116.3	0.8	0	0	N	11.3
A 97	-1	<.5	-1	3.6	117.4	0.8	0	2	N	12.4
A 98	15	0.7	-1	4.2	115.9	0.2	0	0	N	10.9
A 99	-1	0.4	-1	4.2	116.0	0.2	0	2	N	11.0
A100	12	1.1	-1	4.3	116.9	0.8	0	0	N	11.9
A101	13	1.1	-1	4.8	117.5	0.7	0	0	N	12.5
A102	15	0.8	-1	4.4	118.1	0.5	0	0	N	13.1
A103	-1	0.2	-1	4.7	118.4	0.5	0	2	N	13.4
A104	22	-1	7.6	3.5	135.0	4.0	0	1	N	-1
A105	94	-1	42.3	1.0	135.6	0.5	1	1	N	6.7
A106	102	-1	44.6	0.5	136.2	-1	1	1	N	1.2
A107	100	-1	43.6	0.3	135.8	-1	1	1	N	0.8
A108	24	0.7	-1	1.1	137.7	2.0	0	0	N	2.7
A109	-1	0.3	-1	3.1	140.2	0.6	0	2	N	5.2
A110	-1	0.2	-1	2.6	140.0	0.6	0	2	N	5.0
A111	-1	0.4	-1	2.0	141.9	-1	0	2	N	6.9
A112	-1	0.3	-1	2.0	141.9	-1	0	2	N	6.9
A113	-1	0.4	-1	1.9	141.9	0.1	0	2	N	6.9
A114	-1	0.2	-1	2.9	141.4	1.1	0	2	N	6.4
A115	-1	0.3	-1	2.2	141.9	0.2	0	2	N	6.9
A116	-1	0.2	-1	2.6	142.3	0.5	0	2	N	7.3
A117	-1	0.2	-1	3.3	142.4	0.5	0	2	N	7.4
A118	-1	0.2	-1	3.3	143.2	0.6	0	2	N	7.2
A119	23	0.7	-1	0.2	140.6	0.5	0	0	N	5.6
A120	26	1.3	-1	0.7	141.4	0.4	0	0	N	6.4
A121	-1	0.3	-1	0.2	141.1	0.2	0	2	N	6.1
A122	-1	0.2	-1	0.1	141.1	0.2	0	2	N	6.1
A123	-1	0.2	-1	0.5	142.0	0.1	0	2	N	7.0
A124	-1	0.3	-1	0.5	142.0	0.1	0	2	N	7.0
A125	-1	0.4	-1	0.6	142.0	0.2	0	2	N	7.0
A126	-1	0.2	-1	0.8	142.0	0.1	0	2	N	7.0
A127	-1	0.2	-1	0.8	141.9	0.1	0	2	N	6.9
A128	-1	0.3	-1	0.7	141.9	0.2	0	2	N	6.9
A129	-1	0.2	-1	1.0	142.0	0.3	0	2	N	7.0
A130	-1	0.4	-1	0.9	141.9	0.1	0	2	N	6.9
A131	-1	0.4	-1	0.9	141.8	0.1	0	2	N	6.8
A132	-1	0.3	-1	1.2	142.7	0.4	0	2	N	7.7
A133	-1	0.3	-1	1.3	142.3	0.2	0	2	N	7.3
A134	-1	0.3	-1	1.6	142.2	0.2	0	2	N	7.2
A135	-1	0.4	-1	1.5	141.8	0.6	0	2	N	6.8
A136	-1	0.4	-1	2.1	142.3	0.1	0	2	N	7.3

Appendix Table 1. Data set (continued).

S #	A	H	D	X	Y	N	R	Sa	Sl	Di
A137	-1	0.3	-1	2.1	142.5	0.2	0	2	N	7.5
A138	13	0.7	-1	1.5	143.0	0.1	0	0	N	8.0
A139	-1	<.5	-1	2.1	142.3	0.3	0	2	N	7.3
A140	-1	<.5	-1	1.4	143.2	0.3	0	2	N	8.2
A141	-1	0.4	-1	0.7	143.2	0.9	0	2	N	8.2
A142	-1	0.2	-1	0.9	144.6	0.2	0	2	N	9.6
A143	-1	0.3	-1	1.0	144.6	0.2	0	2	N	9.6
A144	-1	0.2	-1	1.0	144.6	0.1	0	2	N	9.6
A145	-1	0.2	-1	1.9	144.5	0.5	0	2	N	9.5
A146	-1	0.4	-1	1.0	145.4	0.7	0	2	N	10.4
A147	-1	0.4	-1	1.5	143.8	0.3	0	2	N	8.8
A148	-1	0.4	-1	1.7	143.8	0.3	0	2	N	8.8
A149	-1	0.3	-1	2.0	143.9	0.2	0	2	N	8.8
A150	-1	0.2	-1	2.2	142.7	0.2	0	2	N	7.7
A151	-1	0.4	-1	2.3	143.7	0.2	0	2	N	8.7
A152	-1	0.3	-1	1.9	143.8	0.1	0	2	N	8.8
A153	-1	0.2	-1	1.9	143.8	0.1	0	2	N	8.8
A154	-1	0.3	-1	3.2	144.0	0.8	0	2	N	9.0
A155	-1	0.2	-1	1.7	146.9	0.5	0	2	N	11.9
A156	-1	0.2	-1	0.6	147.4	0.7	0	2	N	12.4
A157	-1	0.2	-1	0.4	146.6	0.5	0	2	N	11.6
A158	-1	0.4	-1	1.6	147.3	0.5	0	2	N	12.3
A159	-1	0.4	-1	2.1	147.4	0.5	0	2	N	12.4
A160	-1	0.4	-1	2.9	148.0	0.6	0	2	N	13.0
A161	-1	0.4	-1	1.5	148.2	0.5	0	2	N	13.2
A162	16	0.5	-1	2.1	148.4	0.3	0	0	N	13.4
A163	-1	0.3	-1	1.1	148.0	0.3	0	2	N	13.0
A164	-1	0.3	-1	0.6	148.3	0.2	0	2	N	13.3
A165	-1	0.3	-1	0.6	148.4	0.2	0	2	N	13.8
A166	-1	0.2	-1	1.2	148.4	0.4	0	2	N	13.4
A167	-1	0.2	-1	0.2	148.7	0.6	0	2	N	13.7
A168	-1	0.3	-1	0.3	149.3	0.5	0	2	N	14.3
A169	-1	0.4	-1	0.7	149.0	0.5	0	2	N	14.0
A170	-1	0.4	-1	0.1	148.1	0.9	0	2	N	13.1
A171	-1	0.3	-1	2.4	149.7	0.6	0	2	N	14.7
A172	-1	0.2	-1	3.2	149.8	0.6	0	2	N	14.8
A173	13	0.8	-1	4.0	148.8	0.2	0	0	N	13.8
A174	-1	0.2	-1	4.1	148.8	0.2	0	2	N	13.8
A175	-1	0.4	-1	3.8	148.2	0.5	0	2	N	13.2
A176	30	1.2	-1	5.9	149.0	0.8	0	0	N	14.0
A177	21	-1	1.1	5.3	147.3	0.6	0	1	N	12.3
A178	38	-1	4.5	9.3	149.6	0.9	0	1	N	14.6
A179	26	0.6	-1	8.0	147.9	0.3	0	0	N	12.9
A180	101	-1	35.7	8.2	148.0	0.3	1	1	N	13.0
A181	38	-1	5.1	5.6	145.5	0.5	0	1	N	10.5
A182	36	1.0	-1	6.4	142.8	0.4	0	0	N	7.8
A183	100	-1	36.6	5.4	143.0	0.5	1	1	N	8.0
A184	96	-1	36.3	6.3	143.3	0.5	1	1	N	8.3

Appendix Table 1. Data set (continued).

S #	A	H	D	X	Y	N	R	Sa	Sl	Di
A185	102	-1	39.8	6.5	141.2	1.3	1	1	N	6.2
A186	21	-1	1.9	9.0	143.1	0.5	0	1	N	8.1
A187	55	-1	21.6	9.2	139.7	3.3	1	1	N	4.7
A188	11	1.2	-1	5.9	118.8	1.5	0	0	N	13.8
A189	11	0.8	-1	5.9	117.4	1.7	0	0	N	12.4
A190	14	1.0	-1	6.1	116.9	1.8	0	0	N	11.9
A191	7	0.7	-1	7.9	118.0	0.8	0	0	N	13.0
A192	13	1.0	-1	7.7	115.1	0.7	0	0	N	10.1
A193	15	0.8	-1	5.3	51.0	0.7	0	0	N	36.0
A194	13	1.1	-1	5.5	51.2	0.7	0	0	N	36.2
A195	54	-1	20.4	7.1	49.0	2.5	1	1	N	34.0
A196	32	-1	3.5	7.2	47.0	0.5	0	1	N	32.0
A197	10	0.6	-1	6.7	44.3	0.2	0	0	N	29.3
A198	19	1.1	-1	8.8	43.5	0.6	0	0	N	28.5
A199	28	1.1	-1	9.5	44.0	0.6	0	0	N	29.0
A200	58	-1	38.8	9.0	42.7	1.0	1	1	N	27.7
A201	54	-1	15.6	6.9	34.1	1.0	1	1	N	19.1
A202	59	-1	17.2	8.0	33.0	1.2	1	1	N	18.0
A203	50	-1	20.7	9.6	33.4	1.7	1	1	N	18.4
A204	43	-1	9.9	5.9	33.9	0.7	0	1	N	18.9
A205	42	-1	6.7	6.3	33.5	0.4	0	1	N	18.5
A206	39	-1	5.1	6.5	32.7	0.4	0	1	N	17.7
A207	29	-1	4.8	6.5	33.0	0.3	0	1	N	18.0
A208	55	-1	8.3	6.0	33.1	0.5	0	1	N	18.1
A209	43	-1	5.4	5.9	33.2	0.7	0	1	N	18.2
A210	32	1.1	-1	6.4	32.3	0.3	0	0	N	17.3
A211	42	-1	5.4	7.8	31.6	1.1	0	1	N	16.6
A212	41	-1	7.0	6.0	31.4	1.1	0	1	N	16.4
A213	51	-1	12.1	7.9	30.4	1.1	0	1	N	15.4
A214	50	-1	17.8	8.6	31.8	1.1	0	1	N	16.8
A215	116	-1	54.1	6.5	29.3	1.3	1	1	N	14.3
A216	56	-1	17.8	9.4	29.8	0.2	1	1	N	14.8
A217	53	-1	12.7	9.2	29.8	0.2	0	1	N	14.8
A218	38	-1	6.4	8.4	29.2	0.9	0	1	N	14.2
A219	49	-1	7.0	7.4	29.0	1.2	0	1	N	14.0
A220	45	-1	6.7	7.3	27.7	1.2	0	1	N	12.7
A221	52	-1	22.3	9.3	27.8	1.8	1	1	N	12.8
A222	41	-1	5.1	5.1	30.2	0.8	0	1	N	15.2
A223	46	-1	6.0	5.2	29.4	0.5	0	1	N	14.4
A224	33	-1	4.1	5.1	20.6	0.4	0	1	N	5.6
A225	23	-1	4.1	6.1	18.7	1.7	0	1	N	3.7
A226	39	-1	9.9	5.3	20.2	0.3	0	1	N	5.2
A227	37	-1	5.7	5.2	20.0	0.3	0	1	N	5.0
A228	-1	<.5	-1	-1	-1	-1	0	2	N	-1
A229	-1	<.5	-1	-1	-1	-1	0	2	N	-1
A230	-1	<.5	-1	-1	-1	-1	0	2	N	-1
A231	-1	<.5	-1	7.9	42.2	1.2	0	2	N	27.2
A232	-1	<.5	-1	6.8	43.8	2.2	0	2	N	28.3

Appendix Table 1. Data set (continued).

S #	A	H	D	X	Y	N	R	Sa	Sl	Di
A233	-1	<.5	-1	6.8	44.3	1.0	0	2	N	29.4
A234	-1	<.5	-1	7.0	43.9	2.2	0	2	N	28.9
A235	-1	<.5	-1	5.8	44.3	2.0	0	2	N	29.3
A236	-1	<.5	-1	5.8	44.1	2.0	0	2	N	29.1
A237	-1	<.5	-1	6.1	44.0	3.2	0	2	N	29.0
A238	-1	<.5	-1	6.4	43.9	3.2	0	2	N	28.9
A239	-1	<.5	-1	5.2	44.8	7.8	0	2	N	29.8
A240	-1	<.5	-1	5.4	45.8	6.3	0	2	N	30.8
A241	-1	<.5	-1	6.0	45.6	1.0	0	2	N	30.6
A242	-1	<.5	-1	6.1	45.6	1.0	0	2	N	30.6
A243	-1	<.5	-1	7.9	46.3	1.4	0	2	N	31.1
A244	-1	<.5	-1	7.8	46.6	2.8	0	2	N	31.6
A245	-1	<.5	-1	7.9	47.2	2.0	0	2	N	32.7
A246	-1	<.5	-1	7.9	47.0	2.0	0	2	N	32.0
A247	-1	<.5	-1	8.0	46.4	1.4	0	2	N	31.4
A248	-1	<.5	-1	8.8	46.2	2.2	0	2	N	31.2
A249	-1	<.5	-1	8.7	45.8	4.1	0	2	N	30.8
A250	-1	<.5	-1	9.1	46.2	1.4	0	2	N	31.2
A251	-1	<.5	-1	8.8	47.1	0.0	0	2	N	32.1
A252	-1	<.5	-1	8.7	47.1	1.0	0	2	N	32.1
A253	-1	<.5	-1	8.6	47.3	2.2	0	2	N	32.3
A254	-1	<.5	-1	8.8	47.1	0.0	0	2	N	32.1
A255	-1	<.5	-1	9.1	47.2	2.0	0	2	N	32.2
A256	-1	<.5	-1	9.1	47.0	1.0	0	2	N	32.0
A257	-1	<.5	-1	9.6	48.0	2.8	0	2	N	33.0
A258	-1	<.5	-1	9.3	46.9	2.3	0	2	N	31.9
A259	-1	<.5	-1	9.0	47.0	1.0	0	2	N	32.0
A260	-1	<.5	-1	9.5	48.3	3.1	0	2	N	33.3
A261	-1	<.5	-1	9.8	47.8	2.8	0	2	N	32.8
A262	-1	<.5	-1	8.3	51.2	2.5	0	2	N	36.8
A263	-1	<.5	-1	6.9	114.8	8.5	0	2	N	9.8
A264	-1	<.5	-1	8.5	118.5	0.0	0	2	N	13.5
A265	-1	<.5	-1	8.5	118.5	0.0	0	2	N	13.5
A266	-1	<.5	-1	8.5	118.5	0.0	0	2	N	13.5
A267	-1	<.5	-1	8.5	118.5	0.0	0	2	N	13.5
A268	-1	<.5	-1	8.5	118.5	0.0	0	2	N	13.5
A269	-1	<.5	-1	7.1	118.8	1.1	0	2	N	13.8
A270	-1	<.5	-1	8.5	142.8	5.8	0	2	N	7.8
A271	-1	<.5	-1	7.0	142.5	6.7	0	2	N	7.5
A272	-1	<.5	-1	6.8	143.3	3.1	0	2	N	8.3
A273	-1	<.5	-1	6.5	143.2	2.2	0	2	N	8.2
A274	-1	<.5	-1	6.0	142.8	4.0	0	2	N	7.8
A275	-1	<.5	-1	5.8	142.3	1.4	0	2	N	7.3
A276	-1	<.5	-1	5.7	142.2	1.4	0	2	N	7.2
A277	-1	<.5	-1	5.7	142.0	2.0	0	2	N	7.0
A278	-1	<.5	-1	5.0	142.3	7.1	0	2	N	7.3
A279	-1	<.5	-1	5.0	143.1	1.4	0	2	N	8.1
A280	-1	<.5	-1	5.1	143.0	1.4	0	2	N	8.0

Appendix Table 1. Data set (continued).

S #	A	H	D	X	Y	N	R	Sa	Sl	Di
A281	-1	<.5	-1	5.2	143.2	2.2	0	2	N	8.2
A282	-1	<.5	-1	5.3	143.4	0.0	0	2	N	8.4
A283	-1	<.5	-1	5.3	143.5	1.0	0	2	N	8.5
A284	-1	<.5	-1	5.5	143.5	1.4	0	2	N	8.5
A285	-1	<.5	-1	5.6	143.6	1.4	0	2	N	8.6
A286	-1	<.5	-1	5.9	144.9	6.7	0	2	N	9.9
A287	-1	<.5	-1	7.6	144.2	8.1	0	2	N	9.2
A288	-1	<.5	-1	8.1	145.0	6.0	0	2	N	10.0
A289	-1	<.5	-1	7.5	145.0	6.0	0	2	N	10.0
A290	-1	<.5	-1	6.8	145.0	7.0	0	2	N	10.0
A291	-1	<.5	-1	8.7	145.3	2.2	0	2	N	10.3
A292	-1	<.5	-1	8.9	145.6	1.0	0	2	N	10.6
A293	-1	<.5	-1	8.9	145.5	1.0	0	2	N	10.5
A294	-1	<.5	-1	8.8	145.5	1.0	0	2	N	10.5
A295	-1	<.5	-1	9.0	145.8	1.0	0	2	N	10.8
A296	-1	<.5	-1	8.9	145.8	1.0	0	2	N	10.6
A297	-1	<.5	-1	9.8	146.7	1.4	0	2	N	11.7
A298	-1	<.5	-1	9.8	147.1	1.0	0	2	N	12.1
A299	-1	<.5	-1	9.8	147.0	1.0	0	2	N	12.0
A300	-1	<.5	-1	9.7	146.8	1.4	0	2	N	11.8
A301	-1	<.5	-1	9.7	147.2	1.4	0	2	N	12.2
A302	-1	<.5	-1	9.6	147.3	1.0	0	2	N	12.3
A303	-1	<.5	-1	9.5	147.3	1.0	0	2	N	12.3
A304	-1	<.5	-1	9.2	147.4	2.0	0	2	N	12.4
A305	-1	<.5	-1	9.2	147.2	2.0	0	2	N	12.2
A306	-1	<.5	-1	9.9	147.6	4.2	0	2	N	12.6
A307	-1	<.5	-1	9.1	147.9	1.4	0	2	N	12.9
A308	-1	<.5	-1	8.5	147.8	2.0	0	2	N	12.8
A309	-1	<.5	-1	8.5	147.6	1.4	0	2	N	12.6
A310	-1	<.5	-1	8.6	147.5	1.4	0	2	N	12.5
A311	-1	<.5	-1	9.0	148.1	2.2	0	2	N	13.1
A312	-1	<.5	-1	9.1	148.4	1.0	0	2	N	13.8
A313	-1	<.5	-1	9.1	148.3	1.0	0	2	N	13.3
A314	-1	<.5	-1	9.2	148.0	1.4	0	2	N	13.0
A315	-1	<.5	-1	5.7	149.7	3.6	0	2	N	14.7
A316	-1	<.5	-1	6.7	149.0	8.0	0	2	N	14.0
A317	-1	<.5	-1	6.0	149.5	3.6	0	2	N	14.5
A318	-1	<.5	-1	7.1	149.8	8.9	0	2	N	14.8
A319	-1	<.5	-1	5.0	149.6	7.1	0	2	N	14.6
A320	-1	<.5	-1	5.1	148.9	2.0	0	2	N	13.9
A321	-1	<.5	-1	5.1	148.7	2.0	0	2	N	13.7
A322	-1	<.5	-1	6.0	145.6	2.0	0	2	N	10.6
A323	-1	<.5	-1	6.0	145.8	1.4	0	2	N	10.8
A324	-1	<.5	-1	5.9	145.9	1.4	0	2	N	10.9
A325	-1	<.5	-1	6.1	146.3	1.4	0	2	N	11.3
A326	-1	<.5	-1	6.2	146.4	1.4	0	2	N	11.4
A327	-1	<.5	-1	6.4	145.9	4.1	0	2	N	10.9
A328	-1	<.5	-1	4.9	144.7	2.2	0	2	N	9.7

Appendix Table 1. Data set (continued).

S #	A	H	D	X	Y	N	R	Sa	Sl	Di
A329	-1	<.5	-1	5.0	144.5	2.2	0	2	N	9.5
A330	-1	<.5	-1	5.3	144.2	4.2	0	2	N	9.2
A331	-1	<.5	-1	4.8	143.8	5.8	0	2	N	8.8
A332	-1	<.5	-1	7.2	19.2	1.2	0	2	N	4.2
A333	-1	<.5	-1	5.5	42.0	1.4	0	2	N	27.0
A334	-1	<.5	-1	5.6	41.9	1.4	0	2	N	26.9
A335	-1	<.5	-1	9.0	46.3	1.4	0	2	N	31.3
A336	-1	<.5	-1	9.4	47.4	2.0	0	2	N	32.4
A337	-1	<.5	-1	9.4	47.2	2.0	0	2	N	32.2
A338	-1	<.5	-1	8.2	117.0	1.0	0	2	N	12.0
A339	-1	<.5	-1	9.9	119.4	1.7	0	2	N	14.4
A340	-1	<.5	-1	4.0	142.4	7.0	0	2	N	7.4
A341	-1	<.5	-1	5.3	143.4	0.0	0	2	N	8.4
A342	-1	<.5	-1	8.8	148.3	2.8	0	2	N	13.3
B 1	27	-1	19.4	112.3	15.2	27.0	1	1	E	21.3
B 2	8	1.0	-1	88.7	13.9	3.3	0	0	W	2.4
B 3	16	-1	2.2	85.2	14.8	3.3	0	1	W	5.5
B 4	20	-1	19.4	86.1	8.6	4.0	1	1	W	3.9
B 5	25	-1	18.5	84.0	4.7	4.0	1	1	W	6.3
B 6	72	-1	36.9	84.3	8.3	6.0	1	1	W	7.1
B 7	12	-1	2.5	71.1	1.8	6.0	0	1	W	18.1
B 8	92	-1	15.6	72.7	0.5	1.0	1	1	W	16.5
B 9	104	-1	72.9	73.2	3.3	1.0	1	1	W	16.5
B 10	42	-1	42.3	67.2	10.0	10.5	1	1	W	24.4
B 11	32	-1	15.6	54.0	10.4	12.0	0	1	W	37.8
B 12	16	-1	9.9	87.1	33.8	14.5	0	1	S	3.1
B 13	41	-1	26.7	105.3	76.9	0.5	1	1	N	8.7
B 14	38	-1	20.4	105.5	76.6	0.5	1	1	N	9.4
B 15	40	-1	20.4	105.6	76.9	0.5	1	1	N	11.0
B 16	40	-1	19.7	99.6	75.8	0.5	1	1	N	2.4
B 17	35	-1	29.6	99.4	76.0	0.5	1	1	N	2.4
B 18	41	-1	21.6	99.6	76.3	0.5	1	1	N	4.7
B 19	39	-1	27.4	102.0	80.8	5.0	1	1	N	7.9
B 20	29	-1	23.2	96.2	62.5	2.7	1	1	N	3.9
B 21	21	-1	15.6	93.3	59.5	1.7	1	1	N	5.5
B 22	11	1.0	-1	95.3	60.4	0.1	0	0	N	3.9
B 23	11	1.0	-1	89.5	63.0	2.7	0	0	N	11.0
B 24	-1	-1	-1	95.2	60.4	0.1	0	2	N	4.7
B 25	18	-1	9.2	93.8	59.6	1.8	0	1	N	3.9
B 26	18	-1	8.3	90.5	60.0	1.8	0	1	N	7.9
B 27	32	-1	21.0	87.3	56.3	4.5	1	1	N	6.3
B 28	40	-1	34.7	85.1	61.9	1.0	1	1	N	11.8
B 29	20	-1	-1	85.2	62.3	1.0	0	0	N	13.4
B 30	28	-1	3.8	81.9	62.1	3.2	0	1	N	8.7
B 31	32	-1	10.2	83.0	58.1	1.2	0	1	N	9.4
B 32	21	-1	1.3	81.7	58.1	1.2	0	1	N	15.0
B 33	29	-1	11.8	82.6	64.8	3.2	0	1	N	15.7
B 34	75	-1	-1	79.4	57.5	2.7	1	0	N	11.0

Appendix Table 1. Data set (continued).

S #	A	H	D	X	Y	N	R	Sa	Sl	Di
B 35	26	-1	-1	78.9	60.5	2.2	0	0	N	13.4
B 36	24	-1	17.2	81.9	51.6	3.2	0	1	N	3.9
B 37	42	-1	33.4	79.6	48.6	1.8	1	1	N	2.4
B 38	37	-1	19.4	80.6	47.8	1.8	1	1	N	0.8
B 39	41	-1	33.1	74.6	49.0	3.4	1	1	N	5.5
B 40	21	-1	10.2	75.8	44.3	4.7	0	1	W	-1
B 41	22	-1	5.8	71.2	49.0	3.7	0	1	N	6.3
B 42	40	-1	26.1	71.9	52.0	3.7	1	1	N	8.7
B 43	27	-1	10.8	71.5	55.1	3.2	0	1	N	11.8
B 44	40	-1	25.8	67.6	44.6	0.3	1	1	N	2.4
B 45	41	-1	15.9	67.6	44.4	0.3	1	1	N	0.8
B 46	38	-1	26.7	62.7	46.4	5.5	1	1	N	5.5
B 47	30	-1	16.9	54.8	45.2	4.7	1	1	N	3.1
B 48	16	-1	14.6	51.3	49.0	2.2	0	1	W	6.3
B 49	14	-1	4.8	47.2	52.6	1.3	0	1	W	8.7
B 50	10	<.5	-1	53.5	50.0	2.2	0	0	W	7.1
B 51	16	-1	11.1	46.3	53.0	1.3	1	1	W	9.4
B 52	21	-1	13.1	42.5	53.2	3.6	0	1	N	7.9
B 53	79	-1	48.5	56.1	58.4	2.2	1	1	N	15.0
B 54	84	-1	46.8	54.5	59.1	2.2	1	1	N	15.7
B 55	22	-1	4.0	60.3	58.0	2.2	0	1	N	16.5
B 56	23	1.0	-1	59.3	60.6	1.1	0	0	N	18.9
B 57	30	-1	5.0	58.3	60.6	0.6	0	1	N	18.9
B 58	37	-1	7.9	57.9	61.0	0.6	0	1	N	19.7
B 59	21	-1	3.8	52.5	62.5	3.8	0	1	N	19.7
B 60	24	-1	15.0	41.6	59.1	6.5	1	1	N	14.2
B 61	39	-1	10.8	32.8	61.6	7.2	0	1	N	15.7
B 62	79	-1	71.5	32.1	60.5	1.2	1	1	N	14.2
B 63	78	-1	38.0	38.1	66.6	1.2	1	1	N	20.5
B 64	75	-1	45.5	5.0	57.6	1.3	1	1	N	7.9
B 65	75	-1	44.7	4.5	58.8	1.3	1	1	N	8.7
B 66	84	-1	48.0	3.6	62.2	3.5	1	1	N	11.0
B 67	11	1.0	-1	12.9	56.5	1.7	0	1	N	8.7
B 68	13	-1	3.0	14.4	57.1	1.7	0	1	N	10.2
B 69	13	-1	5.9	2.2	72.2	1.0	0	1	N	18.1
B 70	16	-1	5.6	3.1	72.4	1.0	0	1	N	19.7
B 71	27	-1	14.4	12.6	71.5	10.0	0	1	N	23.6
B 72	14	-1	5.4	34.8	75.7	0.4	0	1	N	29.9
B 73	15	-1	5.7	35.1	75.9	0.4	0	1	N	30.7
B 74	14	-1	11.0	42.2	77.4	7.0	0	1	N	32.3
B 75	15	-1	9.0	45.0	82.1	0.4	0	1	N	37.0
B 76	12	-1	7.4	44.8	82.0	0.4	0	1	N	36.2
B 77	15	-1	12.8	49.0	88.4	5.0	0	1	N	44.1
B 78	13	-1	4.7	48.4	93.7	0.4	0	1	N	48.8
B 79	12	-1	4.7	48.4	93.9	0.4	0	1	N	48.0
B 80	12	-1	4.7	55.9	88.5	3.5	0	1	N	46.5
B 81	7	-1	-1	56.5	81.6	3.5	0	0	N	39.4
B 82	13	1.0	-1	124.5	67.0	18.3	0	1	E	16.5

Appendix Table 1. Data set (continued).

S #	A	H	D	X	Y	N	R	Sa	Sl	Di
B 83	12	-1	3.9	126.5	45.5	12.7	0	1	E	4.7
B 84	14	1.0	-1	138.6	44.2	11.0	0	1	S	6.3
B 85	18	-1	7.6	138.6	54.7	0.4	0	1	L	3.9
B 86	20	-1	7.0	138.6	55.0	0.4	0	1	N	5.5
B 87	22	-1	18.8	142.2	58.0	4.1	0	1	N	7.9
B 88	14	1.0	-1	142.4	62.3	0.3	0	1	N	12.6
B 89	13	-1	4.7	142.4	62.4	0.3	0	1	N	13.4
B 90	23	-1	19.4	20.5	65.5	8.0	0	1	N	16.5
B 91	23	-1	3.1	167.4	65.3	0.2	0	1	N	15.0
B 92	18	-1	4.4	167.5	65.3	0.2	0	1	N	15.0
B 93	80	-1	63.0	172.5	65.0	5.0	1	1	N	12.6
B 94	25	-1	20.3	174.7	75.3	7.5	0	1	E	24.4
B 95	29	-1	19.7	181.9	58.1	14.2	0	1	L	16.3
B 96	35	-1	27.0	174.2	46.5	11.0	1	1	N	4.7
B 97	16	-1	8.8	175.8	66.9	0.4	0	1	N	15.0
B 98	17	-1	8.0	175.9	66.6	0.4	0	1	N	14.2
B 99	22	-1	2.3	179.1	69.1	7.0	0	1	N	17.3
B100	15	-1	6.8	189.8	72.4	6.3	0	1	N	21.3
B101	-1	<.5	-1	70.9	49.0	-1	0	2	N	6.3
B102	-1	<.5	-1	67.6	45.6	-1	0	2	N	4.7
B103	-1	<.5	-1	74.3	9.9	-1	0	2	S	16.5
B104	-1	<.5	-1	71.1	11.0	-1	0	2	S	19.7
C 1	19	-1	5.7	12.3	-6.9	11.0	0	1	N	-1
C 2	32	-1	24.5	2.1	4.2	12.0	1	1	N	-1
C 3	76	-1	54.0	13.3	3.5	11.0	1	1	N	-1
C 4	77	-1	46.8	29.6	6.6	2.5	1	1	N	-1
C 5	74	-1	43.5	30.8	4.7	2.5	1	1	N	-1
C 6	30	-1	22.5	39.1	12.2	7.3	1	1	N	-1
C 7	27	-1	20.0	41.6	6.7	0.4	0	1	N	-1
C 8	27	-1	14.4	50.3	3.3	11.0	0	1	N	-1
C 9	10	0.3	-1	-1	-1	0.4	0	0	N	-1
C 10	80	-1	40.5	103.2	-1	7.0	1	1	N	-1
C 11	16	0.5	-1	100.8	6.6	7.0	0	0	N	-1
C 12	65	-1	66.3	4.7	27.1	16.5	1	1	N	-1
C 13	11	-1	4.2	0.9	42.4	16.5	0	1	N	-1
C 14	14	-1	5.0	0.9	66.0	7.1	0	1	N	-1
C 15	12	-1	5.2	7.5	61.0	7.1	0	1	N	-1
C 16	22	-1	12.3	17.8	72.0	15.6	0	1	N	-1
C 17	12	-1	-1	38.7	60.5	0.1	0	1	N	-1
C 18	13	-1	1.0	38.7	60.5	0.1	0	1	N	-1
C 19	13	1.2	-1	18.7	39.5	7.7	0	1	N	-1
C 20	12	-1	1.2	17.4	32.8	0.1	0	1	N	-1
C 21	11	1.1	-1	17.4	32.8	0.1	0	1	N	-1
C 22	13	1.0	-1	17.4	32.8	0.1	0	1	N	-1
C 23	10	1.1	-1	17.4	32.8	0.1	0	1	N	-1
C 24	16	1.0	-1	14.9	31.1	3.3	0	1	N	-1
C 25	10	0.6	-1	-1	-1	0.1	0	0	N	-1
C 26	17	-1	3.2	-1	-1	16.5	0	1	N	-1

Appendix Table 1. Data set (continued).

S #		A	H	D	X	Y	N	R	Sa	Sl	Di
C	27	83	-1	66.9	47.0	43.7	11.0	1	1	W	-1
C	28	18	-1	8.1	57.3	54.8	7.0	0	1	N	-1
C	29	9	0.5	-1	55.4	46.5	7.0	0	0	N	-1
C	30	11	-1	4.0	56.4	69.8	0.1	0	1	N	-1
C	31	10	1.2	-1	56.4	69.8	0.1	0	1	N	-1
C	32	11	1.0	-1	56.4	69.8	0.1	0	1	N	-1
C	33	7	0.5	-1	56.4	69.8	0.1	0	0	N	-1
C	34	8	0.6	-1	61.0	10.9	0.1	0	0	W	-1
C	35	19	-1	14.8	66.1	2.3	11.0	1	1	W	-1
C	36	32	-1	21.6	11.9	13.6	11.0	1	1	N	-1
C	37	-1	1.2	-1	-1	38.4	5.0	0	1	N	-1
C	38	-1	0.4	-1	22.8	34.0	6.0	0	0	N	-1
C	39	-1	0.3	-1	56.0	54.8	1.3	0	0	N	-1
D	1	74	-1	48.0	16.5	17.2	7.0	1	1	W	3.5
D	2	32	-1	21.5	41.0	2.5	15.0	1	1	W	10.5
D	3	77	-1	47.2	26.6	1.5	15.0	1	1	W	15.9
D	4	12	-1	5.8	62.5	6.6	24.0	0	1	W	1.0
D	5	20	-1	17.0	1.3	29.6	14.0	0	1	N	3.5
D	6	26	-1	13.0	16.6	24.0	3.0	0	1	N	2.9
D	7	21	-1	12.0	14.1	26.8	3.0	0	1	N	4.8
D	8	23	-1	15.1	14.5	32.3	7.0	1	1	N	9.9
D	9	10	-1	3.2	8.3	35.5	7.0	0	1	N	11.8
D	10	10	1.0	-1	2.9	45.5	7.0	0	1	N	19.7
D	11	24	-1	14.9	12.1	51.0	12.5	1	1	N	27.7
D	12	14	-1	3.2	13.6	38.7	12.5	0	1	N	15.9
D	13	10	-1	1.9	9.5	64.1	13.0	0	1	N	37.3
D	14	27	1.0	-1	42.5	67.0	3.8	0	1	N	49.4
D	15	17	1.0	-1	46.2	67.0	3.8	0	1	N	51.0
D	16	22	-1	5.0	28.7	24.5	2.7	0	1	N	70.1
D	17	17	-1	7.0	28.7	27.2	2.7	0	1	N	9.6
D	18	22	-1	7.8	27.9	32.1	0.4	0	1	N	13.7
D	19	17	-1	7.5	28.2	32.1	0.4	0	1	N	14.0
D	20	23	-1	14.3	22.3	39.9	1.7	0	1	N	20.1
D	21	14	-1	1.1	22.7	41.1	1.7	0	1	N	21.7
D	22	24	-1	10.3	25.9	40.8	3.6	0	1	N	21.7
D	23	31	-1	11.4	19.7	43.1	4.0	0	1	N	22.3
D	24	23	-1	10.7	25.3	47.2	3.5	0	1	N	28.0
D	25	24	-1	10.4	28.9	46.3	3.5	0	1	N	28.3
D	26	22	-1	7.0	25.5	52.7	0.5	0	1	N	33.1
D	27	21	-1	7.4	26.0	52.7	0.5	0	1	N	33.1
D	28	24	-1	7.4	31.5	48.5	3.2	0	1	N	30.9
D	29	15	-1	6.0	33.3	47.7	3.2	0	1	N	30.9
D	30	14	-1	4.7	36.9	45.0	1.0	0	1	N	29.6
D	31	19	-1	7.7	36.9	45.0	1.2	0	1	N	29.6
D	32	10	-1	1.2	37.6	45.0	-1	0	0	N	29.6
D	33	10	-1	1.2	37.6	45.0	-1	0	0	N	29.6
D	34	10	-1	1.2	37.6	45.0	-1	0	0	N	29.6
D	35	10	-1	1.2	37.6	45.0	-1	0	0	N	29.6

Appendix Table 1. Data set (continued).

S #	A	H	D	X	Y	N	R	Sa	Sl	Di
D 36	10	-1	1.2	37.6	45.0	-1	0	0	N	29.6
D 37	13	<.5	-1	43.8	44.5	0.8	0	1	N	30.9
D 38	21	-1	10.5	43.0	44.5	0.8	0	1	N	30.6
D 39	21	-1	11.7	31.8	42.2	2.3	0	1	N	25.2
D 40	15	-1	4.2	36.6	44.0	0.2	0	1	N	28.3
D 41	11	-1	0.5	36.9	44.0	0.3	0	0	N	28.3
D 42	15	-1	2.5	36.9	43.7	0.3	0	1	N	28.0
D 43	20	-1	7.0	37.9	42.3	1.3	0	1	N	27.4
D 44	23	-1	11.5	36.9	42.3	1.7	0	1	N	26.8
D 45	28	-1	5.8	34.8	43.4	2.3	0	1	N	27.1
D 46	14	-1	5.7	31.8	37.6	1.3	0	1	N	20.4
D 47	15	-1	6.5	33.3	38.1	2.0	0	1	N	21.3
D 48	16	-1	7.5	32.8	36.6	2.0	0	1	N	19.7
D 49	18	-1	7.8	35.1	36.0	2.7	0	1	N	20.1
D 50	9	1.0	-1	37.8	37.0	1.0	0	0	N	21.7
D 51	14	-1	1.2	39.2	37.7	1.0	0	1	N	22.9
D 52	20	-1	13.1	39.8	40.6	3.4	0	1	N	25.5
D 53	19	-1	4.3	45.1	40.8	2.7	0	1	N	27.4
D 54	15	-1	3.9	47.6	41.3	2.7	0	1	N	28.7
D 55	30	-1	9.4	49.4	42.8	2.7	0	1	N	30.6
D 56	23	-1	9.5	66.0	36.0	5.1	0	1	N	29.6
D 57	21	-1	13.5	67.1	31.1	5.1	0	1	N	25.2
D 58	16	-1	7.4	61.3	37.8	4.3	0	1	N	29.6
D 59	20	-1	14.8	57.3	37.0	3.8	0	1	N	27.7
D 60	16	-1	7.2	57.9	34.6	3.8	0	1	N	25.5
D 61	31	-1	13.2	58.4	30.1	1.0	0	1	N	21.3
D 62	24	-1	8.6	57.5	29.7	1.0	0	1	N	20.4
D 63	15	-1	3.7	55.2	28.2	3.1	0	1	N	18.5
D 64	16	-1	6.5	49.1	33.5	5.0	0	1	N	21.7
D 65	22	1.0	-1	50.7	29.7	5.0	0	1	N	18.5
D 66	26	-1	11.2	52.1	26.7	4.3	1	1	N	15.9
D 67	31	-1	15.4	43.6	30.1	1.2	0	1	N	16.6
D 68	13	<.5	-1	42.2	30.1	1.3	0	0	N	16.2
D 69	12	-1	3.0	41.7	30.6	1.3	0	1	N	16.6
D 70	27	-1	8.2	40.8	33.9	1.9	0	1	N	19.7
D 71	16	-1	5.8	39.0	32.9	1.9	0	1	N	17.8
D 72	21	-1	9.7	33.3	33.3	3.7	0	1	N	16.9
D 73	29	-1	8.9	36.4	32.5	1.3	0	1	N	16.9
D 74	71	-1	23.2	33.6	28.4	2.6	1	1	N	11.8
D 75	76	-1	43.4	33.5	26.1	2.6	1	1	N	9.6
D 76	78	-1	38.2	42.0	21.3	9.0	1	1	N	8.0
D 77	-1	1.0	-1	30.2	44.7	-1	0	0	N	27.1
D 78	-1	1.0	-1	30.2	44.7	-1	0	0	N	27.7

1. X and Y are map coordinates as measured in meters from a grid pattern established at each site.