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THE EFFECT OF SHELTERWOOD-CUT OAK FORESTRY PRACTICES ON BREEDING BIRD SUCCESS

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THE EFFECT OF SHELTERWOOD-CUT OAK
FORESTRY PRACTICES ON BREEDING BIRD SUCCESS

By

Patrick Lee Collins

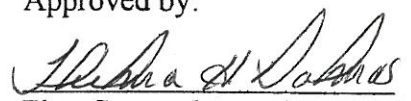
A Thesis Submitted to the Faculty of
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in Partial Fulfillment of the Requirements for the Degree of

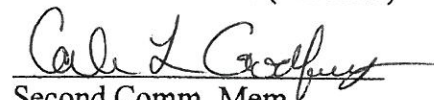
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ABSTRACT

THE EFFECT OF SHELTERWOOD-CUT OAK
FORESTRY PRACTICES ON BREEDING BIRD SUCCESS

Patrick Lee Collins

Mrs. Thelma Dalmas
Director

Populations of breeding birds were studied on two shelterwood-cut oak stands in Buckingham County, Virginia. These two tracts, Harris East and Harris West, were cut in 1996 and a Breeding Bird Census has been conducted on these tracts since 1997. This study is part of an ongoing effort to collect pre-burn data, and document the diversity of avian species utilizing this habitat. The changes in avian species present on the Harris East and Harris West plots is important to know so that the effects of shelterwood-cut forestry practices can be understood better. The data collected showed that, by changing the type of habitat from a mature closed canopy secondary growth forest to a shrub dominated open canopy forest, shelterwood-cut forestry practices have had a major impact on avian species present on the Harris East and Harris West plots. The shrub layer held over twice as many territories per acre than in the initial study conducted in 1997, increasing from 1.09 territories per acre to 3.54 territories per acre because of an increase in shrub height and density. Birds that are characteristic of forest habitats, such as the Eastern Wood-pewee (*Contopus virens*) and Wood Thrush (*Hylocichla mustelina*) were found on both plots along with an influx of species characteristic of shrub habitats.

Acknowledgements

I would like to take this opportunity to thank my partner, my committee and all of the volunteers who helped to conduct this study.

I would like to thank Sally Statham for being my partner in this study. Without her I would have had to do this study by myself. Thank you for your bright and shiny personality that helped to make those early mornings memorable. I would like to thank Mrs. Thelma Dalmas for being my thesis advisor. Thank you for all of your time and patience with this study and me.

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Introduction

The Breeding Bird Census data collected in this study represent the third year of study on the Harris East and Harris West plots located in Buckingham County, Virginia. The study was originally designed to determine the effects of shelterwood-cut forestry practices on breeding bird populations (McDonald 1997).

Shelterwood-cut forestry practices have been used for many years as an alternative to clear-cutting. It is normally used to keep the tract of forest on a cutting schedule to produce a forest that consists of mature trees of the same age and same size (Landowners Resource Centre 1999). The practice of shelterwood-cutting consists of three steps. First is the preparatory cut, which consists of removing small or unhealthy trees to allow the larger healthier trees to flourish (Landowner Resource Centre 1999). Second is the seed cut which removes half of the mature trees to allow sunlight to reach the forest floor to facilitate seed germination and growth (Landowner Resource Centre 1999). Third, and last, is the removal cut. This final cut removes all mature trees and is only conducted after the shrub layer has had enough time to grow (Landowner Resource Centre 1999).

The shelterwood-cut procedures described above have been followed for the Harris plots with a few additional steps. The shelterwood-cut project that was performed on the Harris plots is part of a study to determine if oak stands can be maintained as continuous timber production sites. This produced an interesting problem because of the slow growth rate of oak trees compared to other tree species such as the Red Maple (*Acer rubrum*) and the Tulip Poplar (*Liriodendron tulipifera*). Since oak species were the target species that were to be kept it was hypothesized that development of a prescribed burn

schedule five years after the initial cut would encourage their regeneration. This burn would effectively kill the Red Maple and Tulip Poplar present and give the oak species the ability to send up new saplings from existing rootstock. However, before this burn the growth of the shrub layer offers many bird species habitat suitable for nesting that was previously unavailable to them.

While the new areas were being utilized by many species of birds, it was unclear what changes in species density were occurring as the shrub layer matured. This problem was addressed three years ago when the Harris plots were designed to be Breeding Bird Census (BBC) sites.

Breeding Bird Census (BBC) techniques have been used since 1914 by the former United States Bureau of Biological Survey (McDonald 1997). After being run by the Biological Survey into the 1920s, control went to the National Audubon Society from 1937 - 1984 (USGS 1999). The Cornell Laboratory of Ornithology has administered the Breeding Bird Census following the Audubon Society. The results were not published for several years during the 1980s, but have appeared as a supplement to the Journal of Field Ornithology during the 1990s (USGS 1999).

While many different methods for ornithological data collection exist, such as the Breeding Bird Survey (BBS) and Christmas Counts, none offer the amount of information that can be obtained by the BBC. "Unlike the BBC, the BBS does not account for flyovers or birds merely visiting a plot. In addition, a BBC may note trends indicating the effects of forest fragmentation, where a BBS would not suggest such trends by examining data" (McDonald 1997). The most common use of the BBC method is to

determine population densities and breeding bird territories in a given homogeneous habitat.

Specific guidelines must be followed when running a BBC. First, the plot must have a minimal size of 10 to 40 hectares depending on the type of habitat (USGS 1999). Second, a vegetation study must be performed to document how bird populations interact with their surrounding habitat (McDonald 1997). Third, the surveyor must visit the plots no less than eight times during the breeding season. Fourth, the surveyor must know the common birds of the region by both sight and sound, and fifth, the surveyor must keep consistent data collection methods.

One of the more important criteria, next to the establishment of how breeding birds utilize the BBC plots, is the vegetational make up of the plots. It is essential to know what types of plant species are present in to determine what type of habitat is available for the birds. It is also important to know the vegetational composition because of the edge effects created by shelterwood-cutting. Shelterwood-cut practices, like clear-cutting, caused an edge effect by creating a change in environmental conditions from one type of habitat to another. This effect makes it necessary to understand how birds utilize the different habitats formed by the distribution of plant species from closed- to open-canopy forest. It is very important to understand what the effects of silvicultural practices have on avian populations (McDonald 1997).

Harris West was cut as an almost perfect parallelogram (Appendix I). Harris West is bordered on three sides by three different habitat structures and on the fourth by another shelterwood-cut (Harris East). Bordering the northwest side of Harris West is state route 614. Across 614 is a large tract of second growth mixed hardwood forest.

Located on the south/southwest side is another tract of extensive mixed hardwood second growth forest. On the north/northwest side of the plot is a powerline which is made up of many different food sources that are utilized by many species of bird. On the other side of the powerline cut is another small tract of mixed hardwood forest.

Harris East is located on the southeast side of Harris West (Appendix I). It is bordered on the south/southwest by the same tract of mixed hardwood forest as Harris West. Also, Harris East shares the same powerline cut on the north/northeast side until the powerline cut ends at a small tract of privately owned hardwood forest. State route 603 and a large agricultural field border the fourth side of Harris East.

The ultimate goal of this study, in the future, is to expand the number of plots being studied to eight paired plots with a control plot of uncut secondary forest. Beginning in 2000, prescribed burns will be conducted on one plot of each of the paired plots. The BBC data will be used to determine the effects of shelterwood-cut practices, both pre and post burn, on bird populations. In addition, the vegetation analysis will be useful in determining the effect of prescribed burning on oak regeneration.

During this study a Breeding Bird Census was performed to determine the effects of shelterwood-cut forestry practices on avian populations. The data collected was needed to show if avian populations are being adversely affected by shelterwood-cut practices and to better understand the relationship between avian species and their habitat. The data was also needed to see if shelterwood-cut practices cause an increase in nest predation by Brown-headed Cowbirds (*Molothrus ater*).

Methods

Plots were established using standard BBC surveying techniques. After establishing the borders of the plot and marking them with 30.48-centimeter wooden stakes, a point 25 meters from a corner was measured and marked. From this point, stakes were placed at 20-meter intervals on a line parallel to the border of the plot. This was the method for determining the exact location of the first row and at what degree it was running. According to McDonald (1997), state route 614 served as a guide for one border of the Harris West plot. The border was set 25 meters from the road with an azimuth of 55 degrees and served as the first row of the plot (McDonald 1997).

After the first row was completed, a parallel transect 50 meters further into the plot was marked with stakes. This process was repeated until a line was established 25 meters from the far border. According to McDonald (1997), this type of layout allows an observer to sufficiently detect birds in a forested habitat by keeping them within 25 meters of every point of the plot. This process was repeated for both Harris East and Harris West using wooded stakes.

In late spring the two Harris plots were visited to determine the locations of the rows. During this time it was necessary to place biodegradable flagging on vegetation found near the stakes. This was necessary because the shrub layer interfered with visibility and because many stakes had rotted.

Maps were drawn for both plots using a Reinhardt Redi Mapper. This device allows the surveyor to make accurate scale drawings of each site. The master maps were then photocopied to make field copies for the surveyor to use when conducting the BBC.

One new copy of the map was used for each plot census. Before each census, the name of the surveyor, the date, the start time and the start temperature were noted on the map. Also, the surveyor had to record sky and wind conditions as well. A point scale rated the sky conditions, and wind conditions were rated using the Beaufort Wind Force Scale (Appendix 5).

Censuses were conducted early in the mornings because of greater bird activity. According to McDonald (1997), 30 minutes after sunrise is a good time to start time. The census continued at a steady rate with stops occurring only when data are being recorded or when a bird is being viewed.

There were limitations that could prohibit a census from being performed. One was that a census was not conducted during heavy rainfall. Heavy rainfall kept most species from flying or singing. Another limitation was high wind. The BBC was not run if the wind force exceeded 3 on the Beaufort Scale. High wind decreases flying activity and causes songs to be masked by rustling leaves. High heat was another limiting factor. Many bird species stop singing if the temperature rises too high. Thick fog would also prevent census because of loss of visibility.

The minimum requirement for visits to a plot is eight. Harris East and Harris West were both visited nine times each for this part of the study. All data sheets have been reproduced and are located in Appendix 2. Either the author or Sally Statham performed censuses on the dates listed in Appendix 5. Each census was performed with the aid of binoculars and a field guide. The start point changed with each visit from corner to corner to reduce bias in the census.

Each time a bird was seen or heard on a census, it was entered as a "registration," and marked at the appropriate point on the map with a symbol used to designate that species. In previous censuses performed on Harris East and Harris West, symbols used to indicate each species of bird was the first two letters from both the genus and species name. For example, if a Tufted Titmouse, *Parus bicolor*, were sighted the corresponding symbol placed on the map was "Pabi". In 1999, however, the symbols consisted of the first two letters from the common name. For instance, instead of writing "Pabi" as the symbol for the Tufted Titmouse, the new symbol was written as "Tuti." This change was enacted because it was easier for the surveyor to remember and use the common name than it was to remember the scientific name. This system was also used because some of the scientific names had the same first two letters in the genus and species names.

Other symbols were used on the maps as well as the species indicator symbols. The sex of the bird was indicated on the maps in instances when the sex of the bird could be determined. Also indicated on the maps were the locations of nests, which were marked with the word "nest" and the species indicator symbol, if known. Another symbol used on the maps were lines indicating the flight path of flyovers or the flight path of a bird from one perch to another. A straight line is used to indicate the point of flight origin to the point of flight termination. Small circled numbers were placed under the species indicator symbol in instances where more than one of the same species were singing or were located in close proximity to each other.

After all the censuses were completed, territory maps were made for each species. This was accomplished by going through all of the census maps for each plot and finding where all occurrences of one species were located. The occurrences were then marked on

blank maps with an "X". After all occurrences of the species were transposed on the territory maps, groupings of three or more "X's" were circled and considered to be territories. Although it could not be determined with 100% accuracy that each sighting within a territory was the same individual it was presumed to be so because most male birds will not allow other males to enter their territories. In some cases, territories were located at the edges of the plot with sightings both on and off of the plot. In these cases, they were considered to be half territories. The territory maps have been reproduced and are located in Appendix 3.

Once the breeding season was over, a vegetation analysis was performed on both Harris East and Harris West. There were two reasons this vegetation analysis was performed. It was used to determine what species of shrub were the most dominant and to determine if there was a correlation between shrub height and the nesting habits of avian species. The study was performed using two 1-meter sticks, four engineer flags, two compasses, a 50-meter tape and an ocular tube. Ten random points were surveyed on each plot. Each point was then examined for estimated tree density, species frequency, basal area, shrub density, percent ground cover and percent canopy cover as described by McDonald (1997).

Following the procedure located in McDonald (1997), an 11.28-meter circle was measured around each point chosen. All data were taken from inside of the circles. The first data to be taken were the measurement of the diameter of all trees located within the circle. The diameter was taken by using the two meter sticks. One meter stick was placed against the tree and the other was used as a perpendicular line to the first to find the centimeter mark corresponding to the diameter of the tree. All trees with a diameter

at breast height (DBH) of 7 centimeters or greater were listed as trees. Any tree with a DBH less than 7 centimeters was considered to be of shrub size. DBH is considered to be 4.5 feet from the ground and was recorded on the data sheet along with the species of tree.

The shrub layer was also determined by using two meter sticks. The two sticks were held, with their ends touching each other, at breast height. Two transects were run through each circle. One running from north to south and the other running from east to west. The surveyor holding the sticks would then walk the transects and would call out the name of each species of shrub and the number encountered to the data collector.

Canopy cover and ground cover were the next measurements to be determined. These measurements were determined by using an ocular tube with a crosshair. The surveyor would walk along the same north/south and east/west transects established earlier and would stop at ten random points on each transect. At each point the surveyor would look up at the sky through the ocular tube. If green canopy was seen where the crosshairs met then it was recorded as a hit with a "+" sign. If the sky was observed through the ocular tube then a miss was recorded with a "-" sign. The numbers of hits recorded were later converted to percentages.

All of the vegetational data recorded from the plots were analyzed and converted into averages and percentages. These averages and percentages were found by first determining the relative density, relative dominance, relative frequency, total shrub stems, percent ground cover and percent canopy cover as described in McDonald (1997). The formulas used to determine these values are located in Appendix 5. Reproductions of the data sheets used for the vegetational analysis are located in Appendix 4.

Results

The number of registrations on Harris East and West during 1999 was 1525. There were 829 registrations on Harris West and 696 registrations on Harris East. A list of the species of birds seen and the corresponding number of registrations is reported in Table 1. Harris East had the most identified territories with a total of 98. Harris West had 79 identified territories. A list of species with the corresponding number of territories is reported in Table 2.

The total number of species with territories on both Harris East and Harris West was 27 (Table 2). Included in this number is the Brown-headed Cowbird even though it does not hold "traditional territories." Of these 26 species, 14 held territories on both plots. These species included: Eastern Wood-pewee (*Contopus virens*), Carolina Chickadee (*Parus carolinensis*), White-breasted Nuthatch (*Sitta carolinensis*), Carolina Wren (*Thryothorus ludovicianus*), Blue-gray Gnatcatcher (*Poliophtila caerulea*), Red-eyed Vireo (*Vireo olivaceus*), Prairie Warbler (*Dendroica discolor*), Yellow-breasted Chat (*Icteria virens*), Summer Tanager (*Piranga rubra*), Northern Cardinal (*Cardinalis cardinalis*), Indigo Bunting (*Passerina cyanea*), Rufous-sided Towhee (*Pipilo erythrophthalmus*), Field Sparrow (*Spizella pusilla*) and Brown-headed Cowbird (*Molothrus ater*) (Table 2).

The other 13 species held territories on only one of the plots. Species with territories only on Harris East were: Northern Bobwhite (*Colinus virginianus*), Tufted Titmouse (*Parus bicolor*), Wood Thrush (*Hylocichla mustelina*), Northern Mockingbird (*Mimus polyglottos*), Hooded Warbler (*Wilsonia citrina*) and Chipping Sparrow (*Spizella passerina*). Species with territories on Harris West only were: Red-tailed Hawk (*Buteo*

Table 1. Total Registrations Per Plot

Species	Abbreviation	Total Registrations	
		Harris West	Harris East
Red-tailed Hawk	RtHawk	1	0
Northern Bobwhite	NoBw	6	12
Mourning Dove	Modo	6	10
Yellow-billed Cuckoo	YBCu	4	2
Whip-poor-will	Whippoorwill	0	1
Red-headed Woodpecker	RhWp	1	1
Red-bellied Woodpecker	RbWp	5	5
Downy Woodpecker	DoWp	6	5
Hairy Woodpecker	HaWp	1	0
Pileated Woodpecker	PiWp	3	1
Eastern Wood-pewee	Pewee	33	35
Acadian Flycatcher	AcFl	0	1
Eastern Phoebe	Phoebe	0	2
Great-crested Flycatcher	GcFl	13	6
Blue Jay	Jay	6	5
American Crow	Crow	2	5
Carolina Chickadee	CaCh	22	13
Tufted Titmouse	TuTi	12	10
White-breasted Nuthatch	WbNu	20	14
Carolina Wren	CaWr	46	47
Blue-gray Gnatcatcher	BgGn	29	23
Wood Thrush	WoTh	17	11
Northern Mockingbird	Mock	0	7
Brown Thrasher	BrTh	11	2
Red-Eyed Vireo	ReVi	68	57
Prairie Warbler	PrWa	89	87
Ovenbird	Oven	7	0
Common Yellowthroat	CoYe	20	17
Hooded Warbler	HoWa	3	18
Yellow-breasted Chat	Yb Chat	27	24
Summer Tanager	SuTa	20	9
Scarlet Tanager	ScTa	24	7
Northern Cardinal	NoCa	13	9
Blue Grosbeak	BlGr	2	0
Indigo Bunting	InBu	156	117
Rufous-sided Towhee	RsTo	99	79
Chipping Sparrow	ChSp	0	2
Field Sparrow	FiSp	9	18
Grasshopper Sparrow	GrSp	0	2
Red-winged Blackbird	RWBl	0	1
Eastern Meadowlark	EaMe	0	3
Brown-headed Cowbird	BhCo	48	28

Table 2. List of Species with Their Corresponding Territories

Species	Scientific Name	Harris East	Harris West
Red-tailed Hawk	<i>Buteo jamaicensis</i>	0	1
Northern Bobwhite	<i>Colinus virginianus</i>	1	0
Downy Woodpecker	<i>Picoides pubescens</i>	0	1
Eastern Wood-pewee	<i>Contopus virens</i>	5	3
Great-crested Flycatcher	<i>Myiarchus crinitus</i>	0	2
Carolina Chickadee	<i>Parus carolinensis</i>	4	2
Tufted Titmouse	<i>Parus bicolor</i>	8	0
White-breasted Nuthatch	<i>Sitta carolinensis</i>	1	3
Carolina Wren	<i>Thryothorus ludovicianus</i>	11	4
Blue-gray Gnatcatcher	<i>Poliophtila caerulea</i>	3	4
Wood Thrush	<i>Hylocichla mustelina</i>	1	0
Northern Mockingbird	<i>Mimus polyglottos</i>	1	0
Brown Thrasher	<i>Toxostoma rufum</i>	0	1
Red-Eyed Vireo	<i>Vireo olivaceus</i>	5	4
Prarie Warbler	<i>Dendroica discolor</i>	13	7
Ovenbird	<i>Seiurus aurocappilus</i>	0	1
Common Yellowthroat	<i>Geothlypis trichas</i>	0	2
Hooded Warbler	<i>Wilsonia citrina</i>	3	0
Yellow-breasted Chat	<i>Icteria virens</i>	3	3
Summer Tanager	<i>Piranga rubra</i>	1	3
Scarlet Tanager	<i>Piranga olivacea</i>	0	3
Northern Cardinal	<i>Cardinalis cardinalis</i>	1	3
Blue Grosbeak	<i>Guiraca caerulea</i>	0	1
Indigo Bunting	<i>Passerina cyanea</i>	17	16
Rufous-sided Towhee	<i>Pipilo erythrophthalmus</i>	9	13
Chipping Sparrow	<i>Spizella passerina</i>	9	0
Field Sparrow	<i>Spizella pusilla</i>	2	2
Brown-headed Cowbird	<i>Molothrus ater</i>	x	x

jamaicensis), Downy Woodpecker (*Picoides pubescens*), Great-crested Flycatcher (*Myiarchus crinitus*), Brown Thrasher (*Toxostoma rufum*), Ovenbird (*Seiurus aurocappilus*), Common Yellowthroat (*Geothlypis trichas*) and Blue Grosbeak (*Guiraca caerulea*).

The vegetation analysis results show that there were 10 species of trees found on Harris East and Harris West (Tables 3 and 4). White Oaks (*Quercus alba*) had the highest relative density and relative dominance. Chestnut Oaks (*Quercus montana*), Red Maples (*Acer rubrum*) and Sour Gums (*Nyssa sylvatica sylvatica*) followed in abundance. The class size distribution for Harris East and West shows that the canopy trees with a DBH of 40+ centimeters are White Oaks, distantly followed by Chestnut Oaks. Other species of trees found on the plot with DBH over 7 centimeters are represented in Table 5 also. These three aspects of the vegetation analysis are of interest for this study because they show the two plots offered a homogenous habitat structure to be studied. It was important to have a homogenous habitat for study because if the habitats were different, the data would have possibly shown differences in bird species present.

Table 3. Relative Density on the Harris Plots

Species	Scientific Name	Harris West	Harris East
White Oak	<i>Quercus alba</i>	28.1	43
Chestnut Oak	<i>Quercus montana</i>	15.6	7.3
Red Oak	<i>Quercus rubra</i>	0	7.3
Pignut Hickory	<i>Carya glabra glabra</i>	9.3	2.4
Mockernut Hickory	<i>Carya tomentosa</i>	3.1	4.8
Red Maple	<i>Acer rubrum</i>	15.6	31
Sour Gum	<i>Nyssa sylvatica</i>	21.8	9.7
Red Cedar	<i>Juniperus virginiana</i>	3.1	0
Ironwood	<i>Carpinus caroliniana</i>	0	2.4
Tulip Poplar	<i>Liriodendron tulipifera</i>	3.1	0

Table 4. Relative Dominance on the Harris Plots

Species	Harris West	Harris East
White Oak	77	77.2
Chestnut Oak	11.8	5.7
Red Oak	0	1.4
Pignut Hickory	1.5	0.2
Mockernut Hickory	2.5	9.7
Red Maple	2.3	4.5
Sour Gum	3.1	0.8
Red Cedar	0.5	0
Ironwood	0	0.2

Table 5. Class Size Distribution

Harris West								
Species	3-6 cm	6-9 cm	9-15 cm	15-21 cm	21-27 cm	27-33 cm	33-40 cm	40+ cm
White Oak	0	0	0	0	0	1	0	8
Chestnut Oak	0	1	2	0	0	0	0	2
Pignut Hickory	0	1	1	1	0	0	0	0
Mock. Hickory	0	0	0	0	0	1	0	0
Red Maple	0	0	4	1	0	0	0	0
Sour Gum	0	1	6	0	0	0	0	0
Red Cedar	0	0	1	0	0	0	0	0
Tulip Poplar	0	0	0	1	0	0	0	0
Harris East								
Species	3-6 cm	6-9 cm	9-15 cm	15-21 cm	21-27 cm	27-33 cm	33-40 cm	40+ cm
White Oak	0	0	1	0	0	0	1	12
Red Oak	0	0	1	1	1	0	0	0
Chestnut Oak	0	1	1	0	0	0	0	1
Pignut Hickory	0	0	1	0	0	0	0	0
Mock. Hickory	0	0	0	0	0	0	0	2
Red Maple	0	3	9	0	0	0	1	0
Sour Gum	0	2	1	1	0	0	0	0
Ironwood	0	0	1	0	0	0	0	0

Discussion

The BBC conducted this past summer and reported here was performed as the third year study on the Harris plots. They were conducted to determine the effects of the shelterwood-cut oak stands on breeding bird populations after three years of succession. Compared to the past two years of data on Harris East and West, higher bird counts were found (Figure 1). This may have been caused by the increase in the shrub layer (Figure 2). The increase in the shrub layer possibly offered more habitats for nesting sites as well as increased food production.

Many species of birds defended territories on Harris East and Harris West. One that seems to have fluctuated over the past few years is the Eastern Wood-pewee (*Contopus virens*). In the initial study, pewees held 5.5 and 7 territories on Harris East and Harris West respectively. The next year, however, the number of territories fell to 3.5 and 4. In 1999 the number went back up to 5 territories on Harris East but fell again on Harris West to 3 territories (Figure 3). These fluctuations are probably due to the natural fluctuations in population size that all species go through. According to McDonald (1997) this may be true for flycatchers in general.

The vireos are another group of bird that has been found on the Harris plots. The initial study in 1997 showed that both Harris East and Harris West were visited by the vireos. Both plots had territories defended by Yellow-throated Vireo (*Vireo flavifrons*). In 1997 the total number of territories held by Yellow-throated Vireos were 0.5 on Harris East and 3.5 on Harris West. The next year, in 1998, the number seemed to have stabilized at 2 territories each on Harris East and Harris West. However, in 1999 no territories were held on either plot.

Figure 1. Registration Comparisons

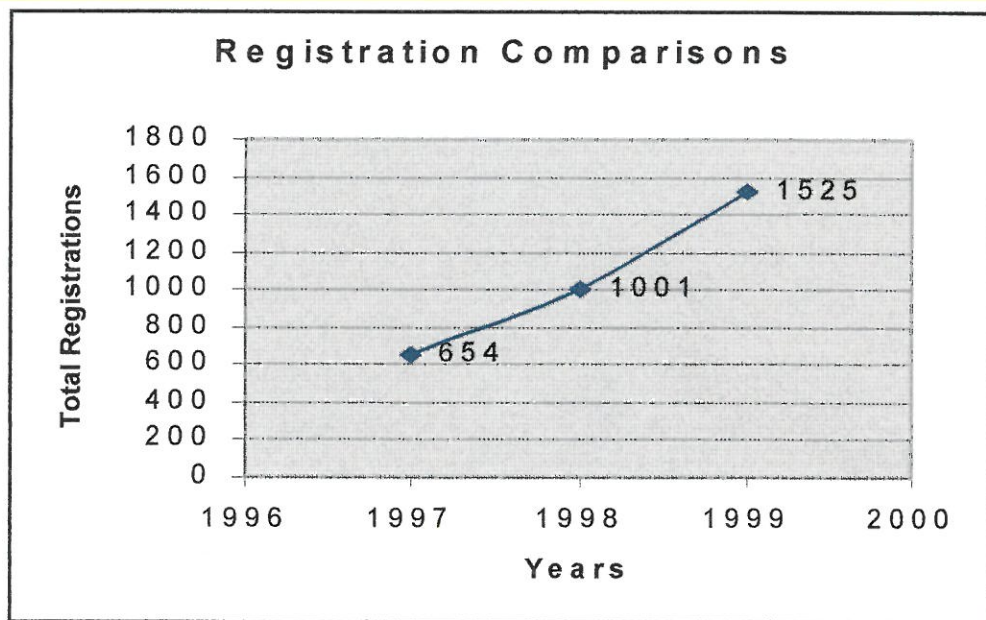


Figure 2. Change in Shrub Cover

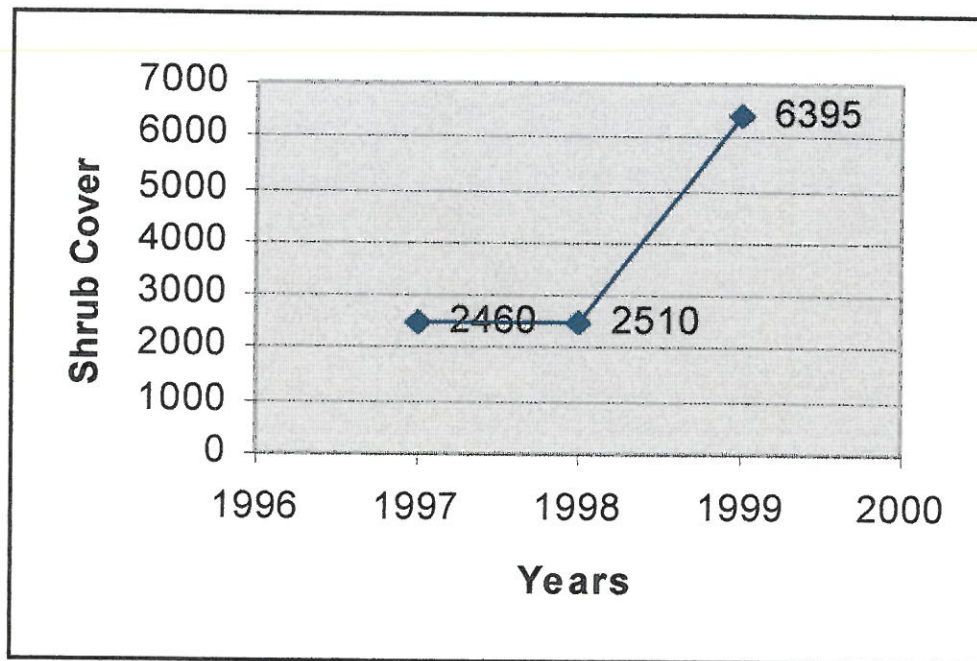
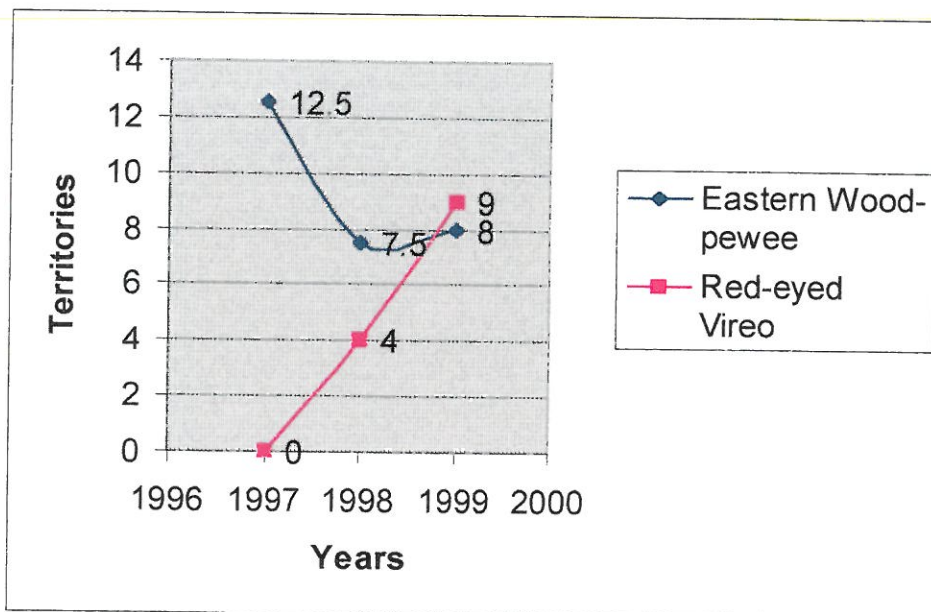


Figure 3. Territory Changes in Eastern Wood-pewees and Red-eyed Vireos



The reverse is true for the Red-eyed Vireo (*Vireo olivaceus*). In 1997, the Red-eyed Vireo did not hold any territories on either Harris East or Harris West. Over the next two years, however, the number of territories increased. The counts went to 2 territories each on both Harris plots in 1998 to 5 and 4 territories in 1999 (Figure 3). This increase in territories may have been because of the filling in of the shrub layer.

According to Harrison (1975), Red-eyed Vireos build their nests from 2 - 60 feet (0.6 - 18.3 meters) above ground with an average height above ground at 5 - 10 feet (1.5 - 3.0 meters). According to Bull and Farrand Jr. (1996), there are millions of Red-eyed Vireo in North America, making them one of the most abundant birds found here.

Another group of birds that seems to have been able to utilize the Harris plots is the warblers. Warblers are a very diverse group that "have their greatest diversity in deciduous forests, collectively utilizing all vegetation levels from the ground to the upper canopy of the tallest trees to glean insects and spiders" (McDonald 1997). Five species of warblers were found to hold territories on the Harris plots. They were Ovenbird (*Seiurus aurocappilus*), Common Yellowthroat (*Geothlypis trichas*), Hooded Warbler (*Wilsonia citrina*), Yellowbreasted Chat (*Icteria virens*) and Prairie Warbler (*Dendroica discolor*). The latter two held territories on both Harris East and Harris West, while the others held territories on only one plot.

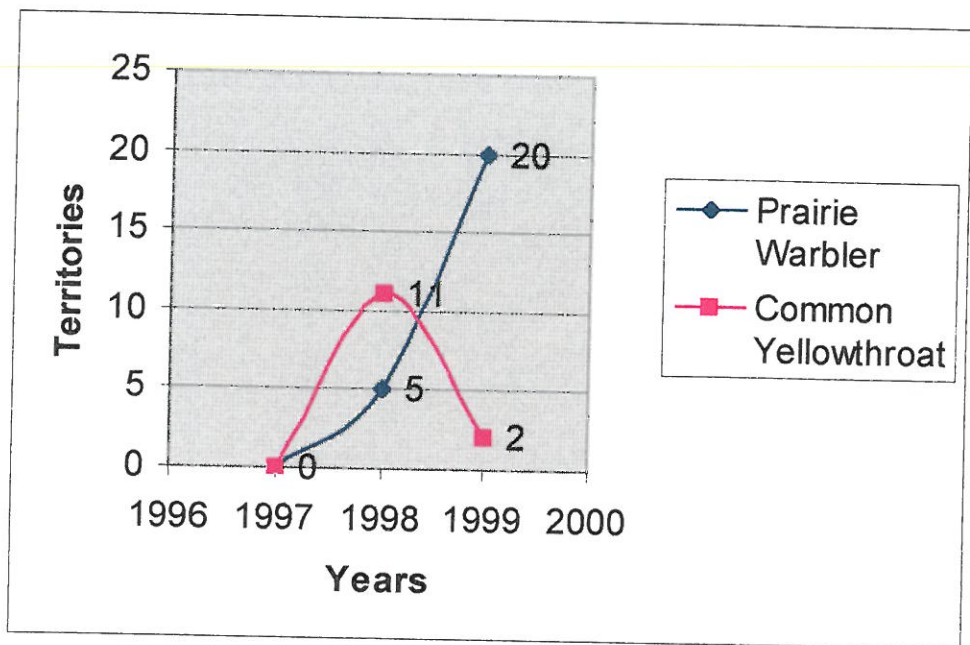
The changes in territorial utilization of the Harris plots, over the past three years, are of particular interest. In 1997, only the Ovenbird held a territory on either of the Harris plots. Since then the number of territories held by the Ovenbird has fluctuated little. On average they have held at least one territory on the plot.

The other four species listed above have begun to hold territories in greater numbers. According to McDonald (1997), these four species were either not seen or were rare visitors to the plots. However, as the shrub layer has grown so have the occurrences of the Common Yellowthroats, Hooded Warblers, Yellow-breasted Chats and Prairie Warblers. Of these four, only three of them, the Prairie Warbler, the Hooded Warbler and the Yellow-breasted Chat, have expanded their territorial holdings on the Harris plots. Over the past three years the number of territories held by the Hooded Warbler has gone from no territories on either plot to having 3 territories on Harris East and a frequent visitor on Harris West. The number of territories held by the Yellowbreasted Chat has been steadily increasing on both Harris East and Harris West. Their numbers have gone from no territories on either plot to 3 on each. However, the Prairie Warbler has had the greatest increase of territories on the Harris plots. They have also gone from holding no territories in 1997 to holding 13 and 7 territories on Harris East and Harris West respectively (Figure 4).

One alarming trend in these warbler species concerns the Common Yellowthroat. At first, they gained territories in great numbers. From 1997 to 1998 they gained 5 territories on Harris East and 6 on Harris West. In 1999, however, the numbers have dropped to 0 territories on Harris East and 2 on Harris West (Figure 4). The cause of this may have been caused by natural population fluctuations.

The Indigo Bunting (*Passerina cyanea*) is another species of bird that seems to have effectively utilized the effects of the shelterwood-cut practices. Due to their use of the shrub layer as nesting sites, the Indigo Buntings have gone from holding only partial territories on the edges of the plots to utilizing both the edges and the interior of the plots

Figure 4. Territory Changes in Prairie Warblers and Common Yellowthroats



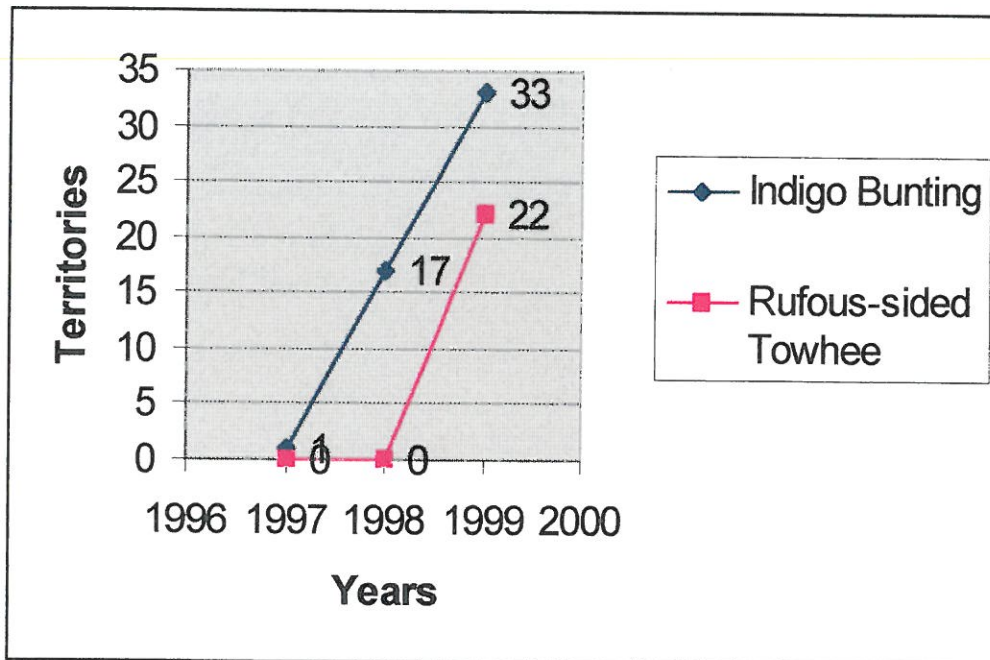
as well. The territories defended by Indigo Buntings have doubled from 0.5 territories each on Harris East and Harris West in 1997 to 8 on Harris East and 9 on Harris West in 1998. This trend was again repeated in 1999 as the territories defended rose to 17 on Harris East and 16 on Harris West (Figure 5).

Another species of bird that has been able to utilize the growth of the shrub layer on the Harris plots is the Rufous-sided Towhee (*Pipilo erythrophthalmus*). They, like the Indigo Bunting, were found in great numbers on the plots (Figure 5). The movement of the Rufous-sided Towhee onto the Harris plots did not occur until 1999 and may be indicative of an increase in the shrub layer.

Brown-headed Cowbird (*Molothrus ater*) parasitism is prevalent on Harris East and Harris West. Cowbirds, while a songbird, do not defend territories as other songbirds do. In 1998, the number of individuals found on the Harris plots decreased in number. In 1999 the number of individuals sighted increased. There is probably nest parasitism occurring on these plots but it is uncertain which species are being affected. "This may be compared to the finding that a high relative abundance of Brown-headed Cowbirds in the clear-cut and shelterwood-cut treatments may have been due to the high density of breeding birds found there because cowbirds may select habitats with high host densities" (McDonald 1997).

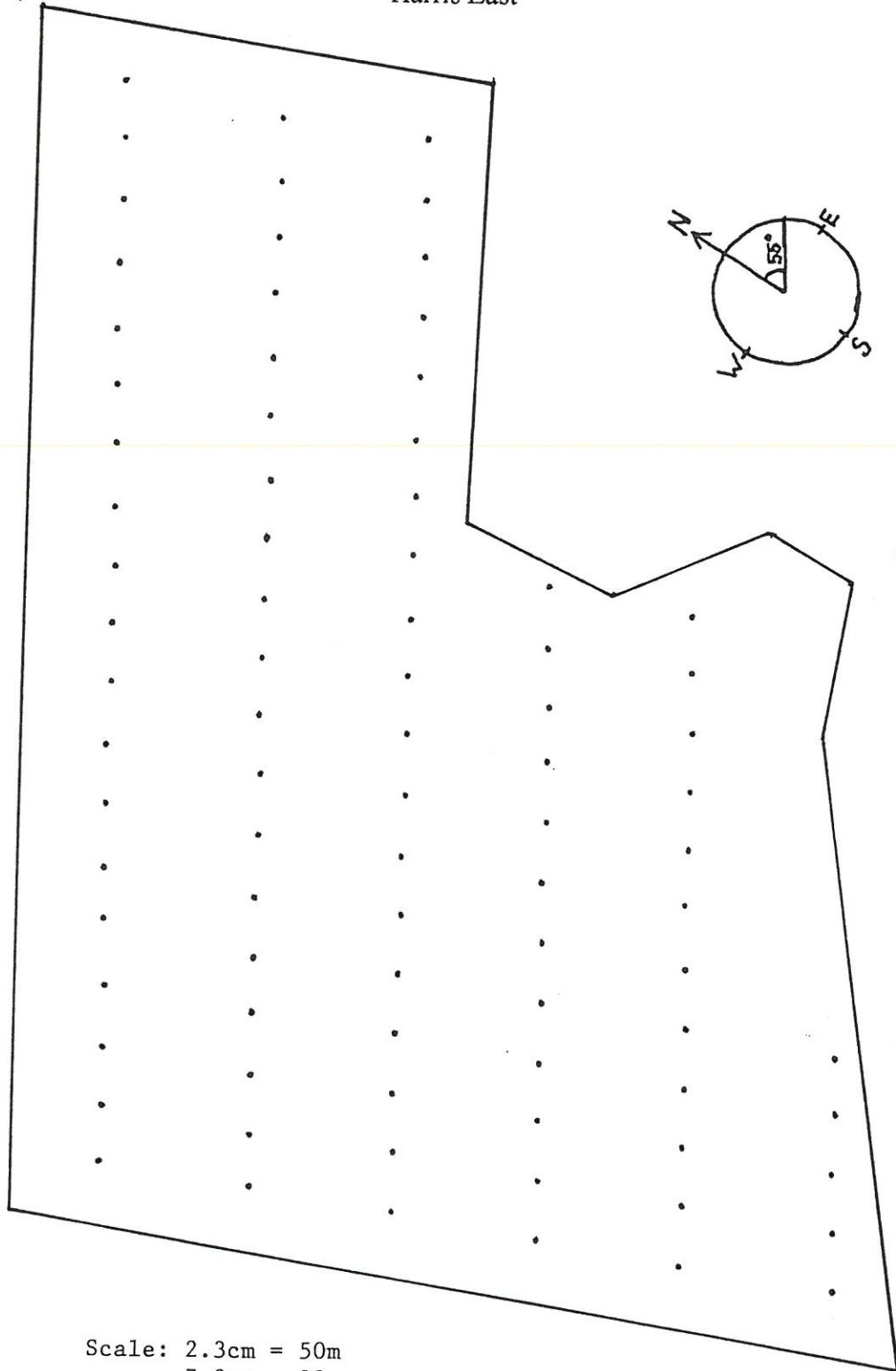
The continued BBC study of the Harris plots is crucial in understanding how shelterwood-cut forestry practices affect breeding bird distribution. It is needed to develop a foundation of baseline data to compare pre and post burn habitat utilization. They are also needed to compare and contrast the data found between a burned plot and an unburned one. All of the results for 1999 were needed to determine what relationships

Figure 5. Territory Changes in Indigo Buntings and Rufous-sided Towhees



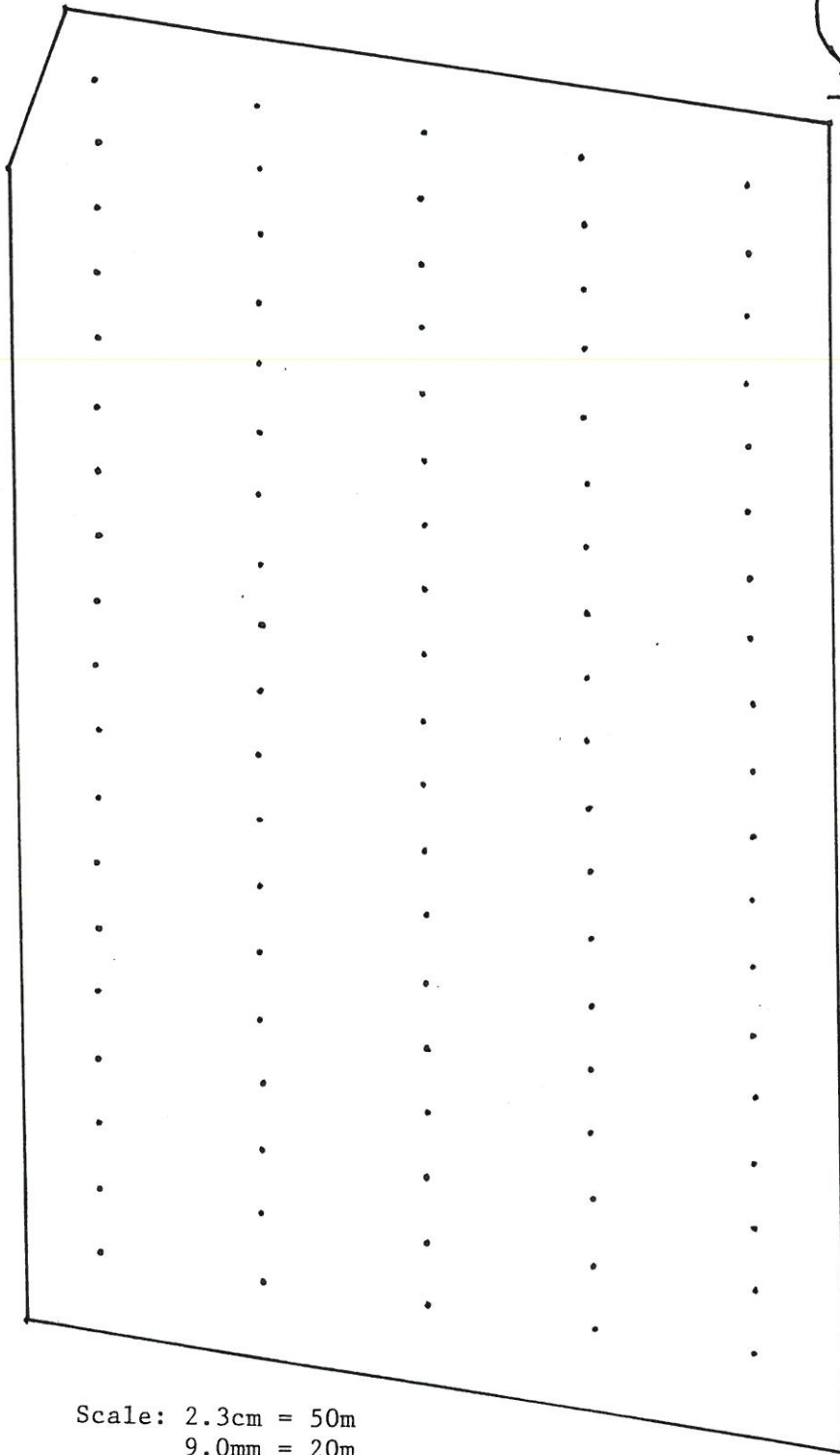
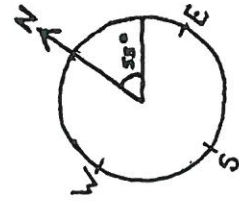
exist between shelterwood-cut forestry practices and avian species. The study performed in 1999 has advanced our understanding of these relationships by showing that shelterwood-cut forestry practices can probably offer self-sustaining timber production while also offering avian species suitable nesting habitat.

Maps of Harris East and Harris West.



Scale: 2.3cm = 50m
7.0mm = 20m

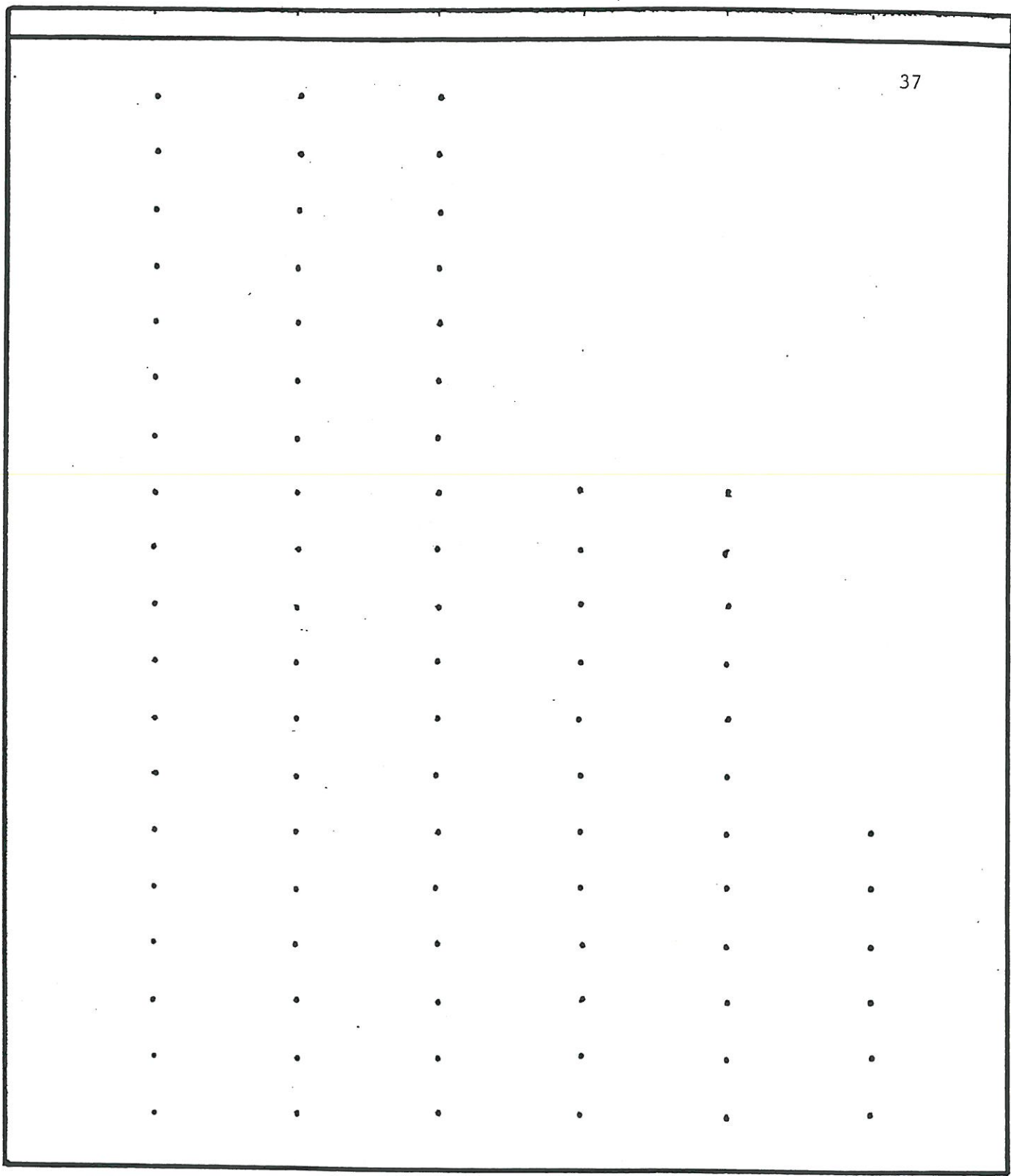
Harris West



Scale: 2.3cm = 50m
9.0mm = 20m

Appendix II

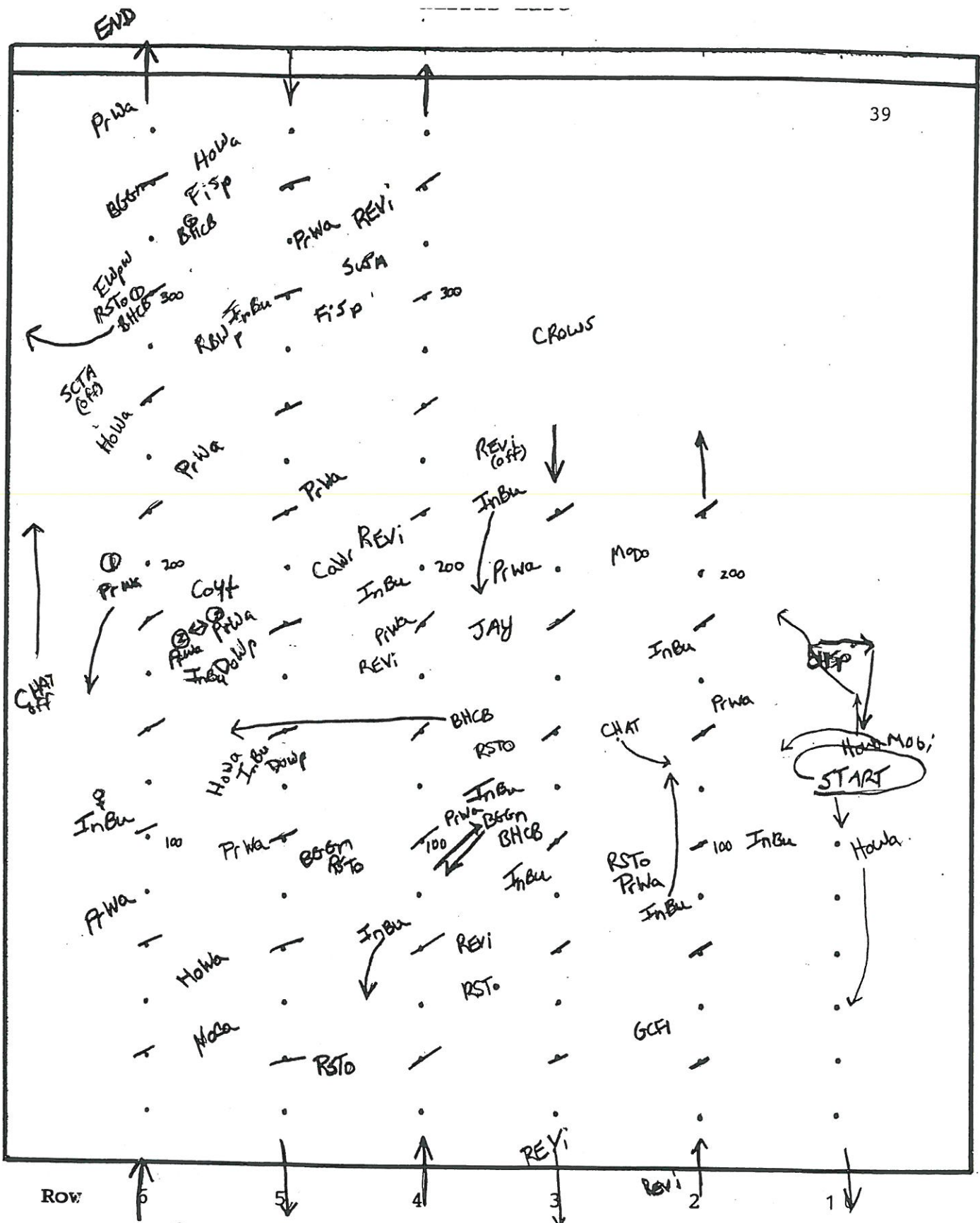
This appendix contains copies of the field data sheets from the 1999 breeding season. The 9 maps presented first are from Harris East, followed by the 9 maps from Harris East. All maps are in chronological order.



Row 6 5 4 3 2 1

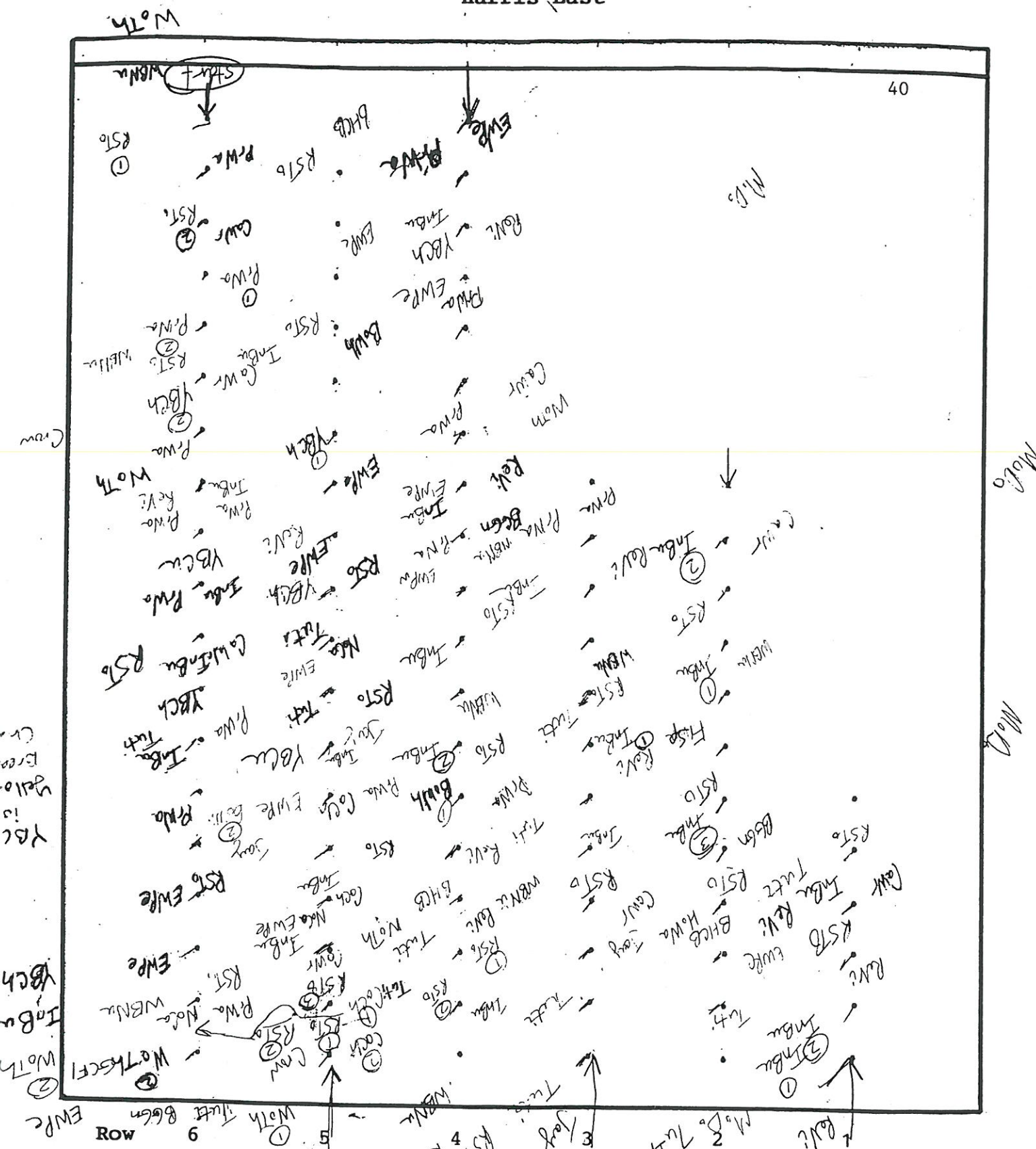
Observer _____
 Date _____
 Start Time _____
 Start Temp _____
 Sky _____
 Wind _____
 End Time _____
 End Temp _____

Scale
 1 in. = 50 m
 1 cm = 20 m



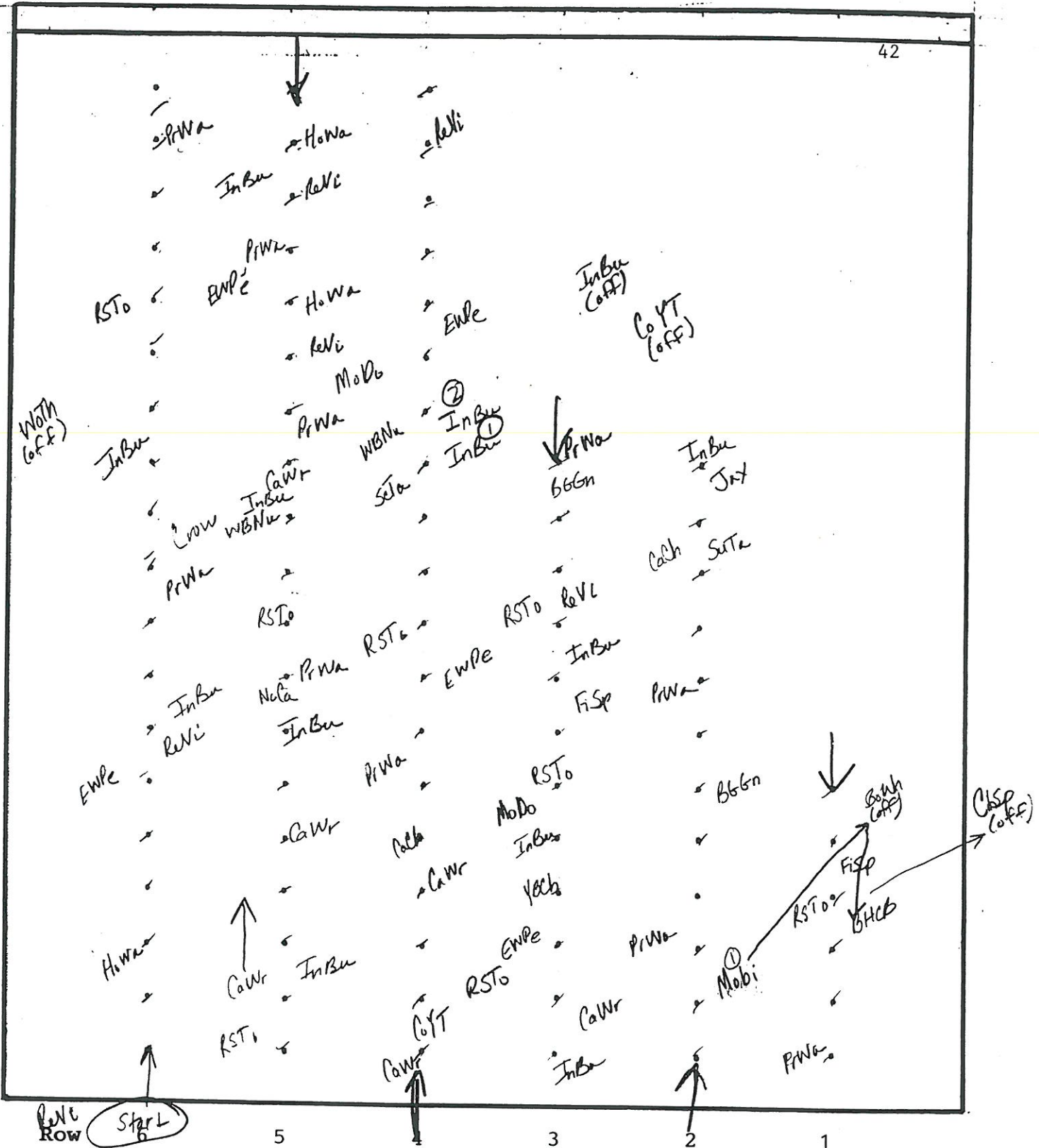
Observer Patrick
 Date 6-2-99
 Start Time 6:35
 Start Temp 14°C
 Sky 2
 Wind 2
 End Time 8:20
 End Temp 25°C

Scale
 1 in. = 50 m
 1 cm = 20 m



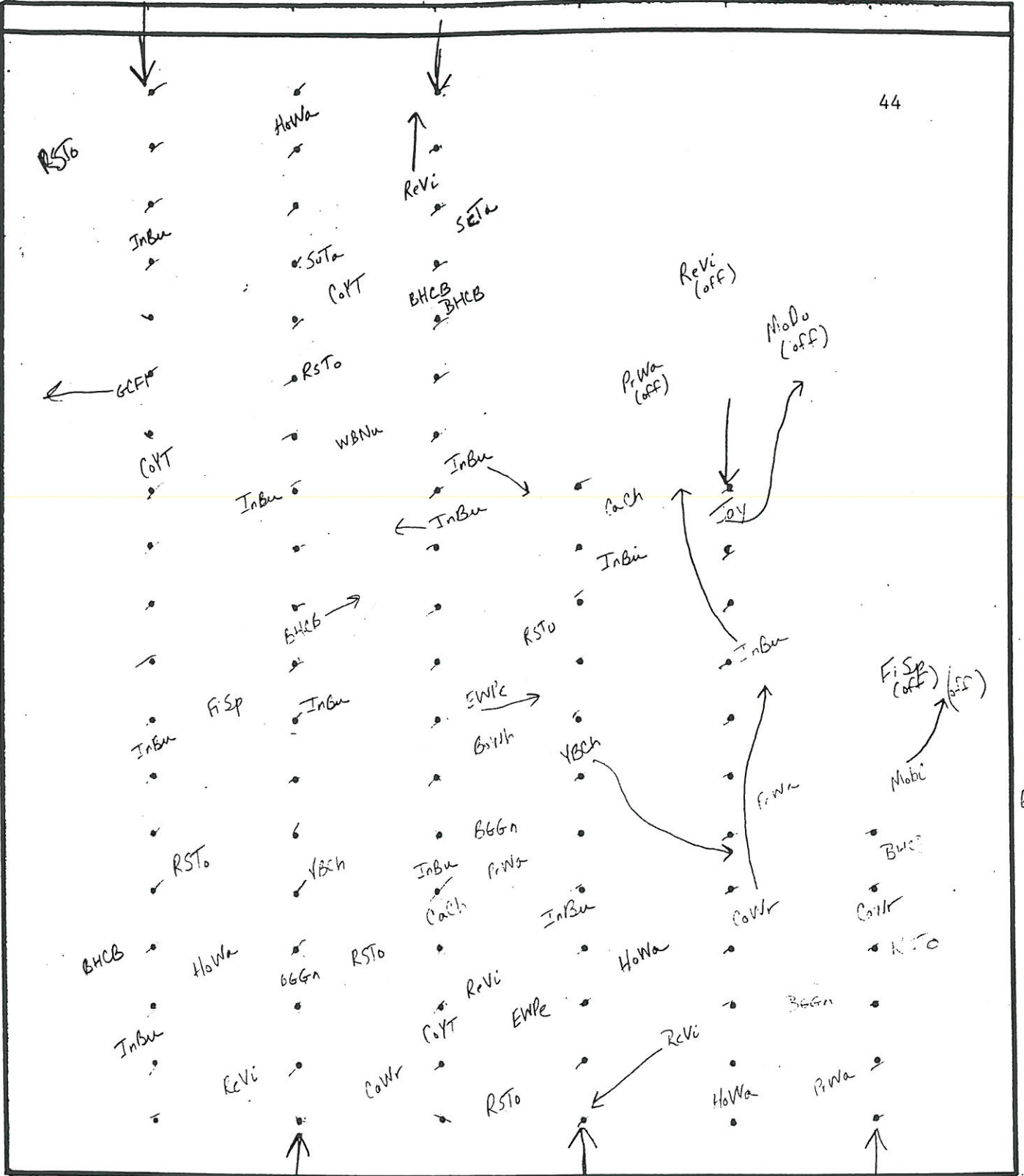
Observer Sally
 Date 6/3/99
 Start Time 6:15
 Start Temp 17°C
 Sky 0
 Wind 1
 End Time 8:45
 End Temp 25°C

Scale
 1 in. = 50 m
 1 cm = 20 m



Observer Sally
 Date 6/16/99
 Start Time 6:15 AM
 Start Temp 15°C
 Sky 0
 Wind 2
 End Time 8:10 AM
 End Temp 25°C

Scale
 1 in. = 50 m
 1 cm = 20 m



Row 6 5 4 3 2

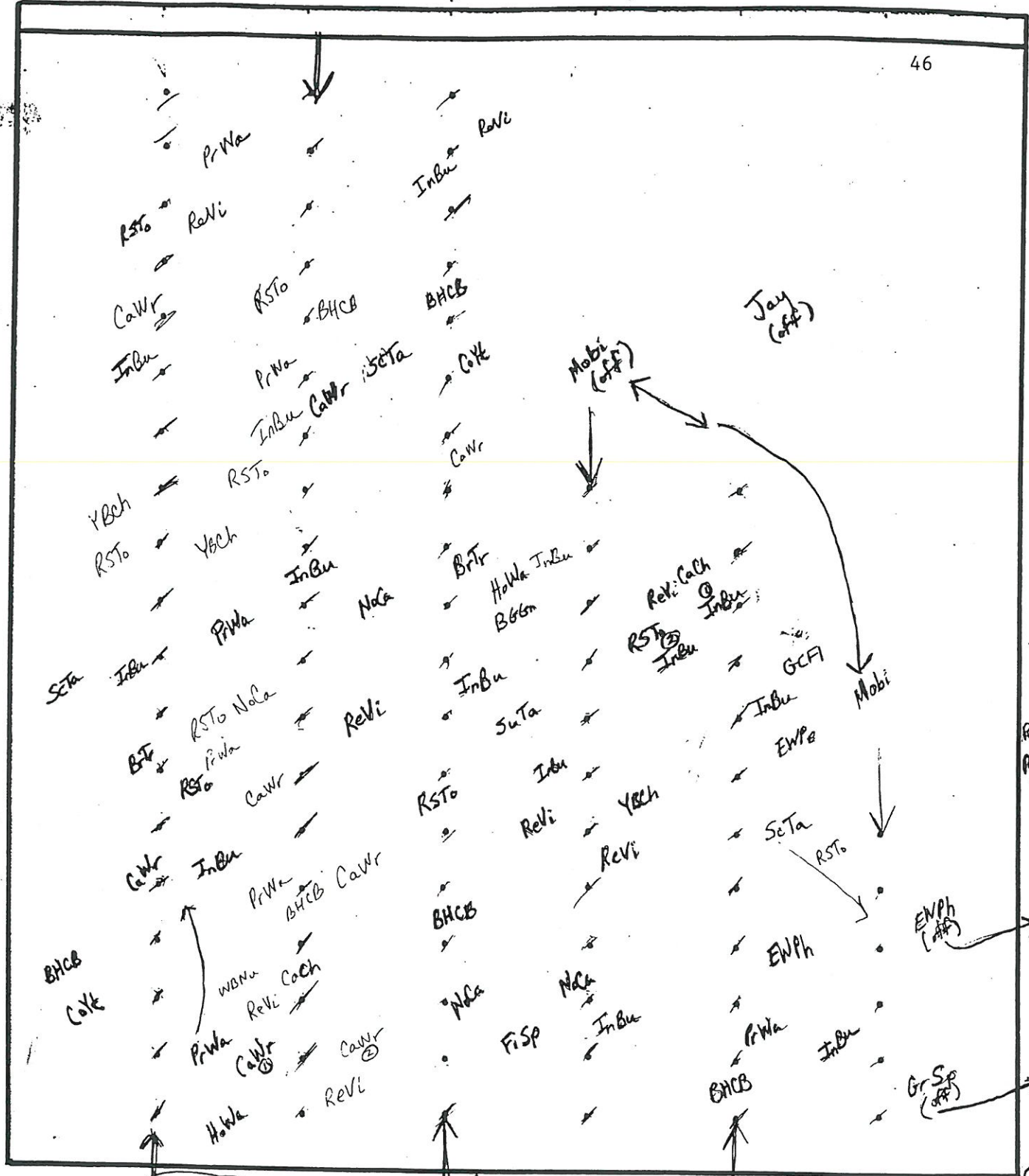
Observer Sally
 Date 6/29/99
 Start Time 6:20AM
 Start Temp 21°C
 Sky 1
 Wind 2
 End Time 8:40AM
 End Temp 27°C

Scale

1 in. = 50 m
 1 cm = 20 m

EM

W080



RWBB
Red-wb
Black
Bird
Coff

ENPh
(off)

Gr Sp
(off)

Gr Sp
Grass
spar

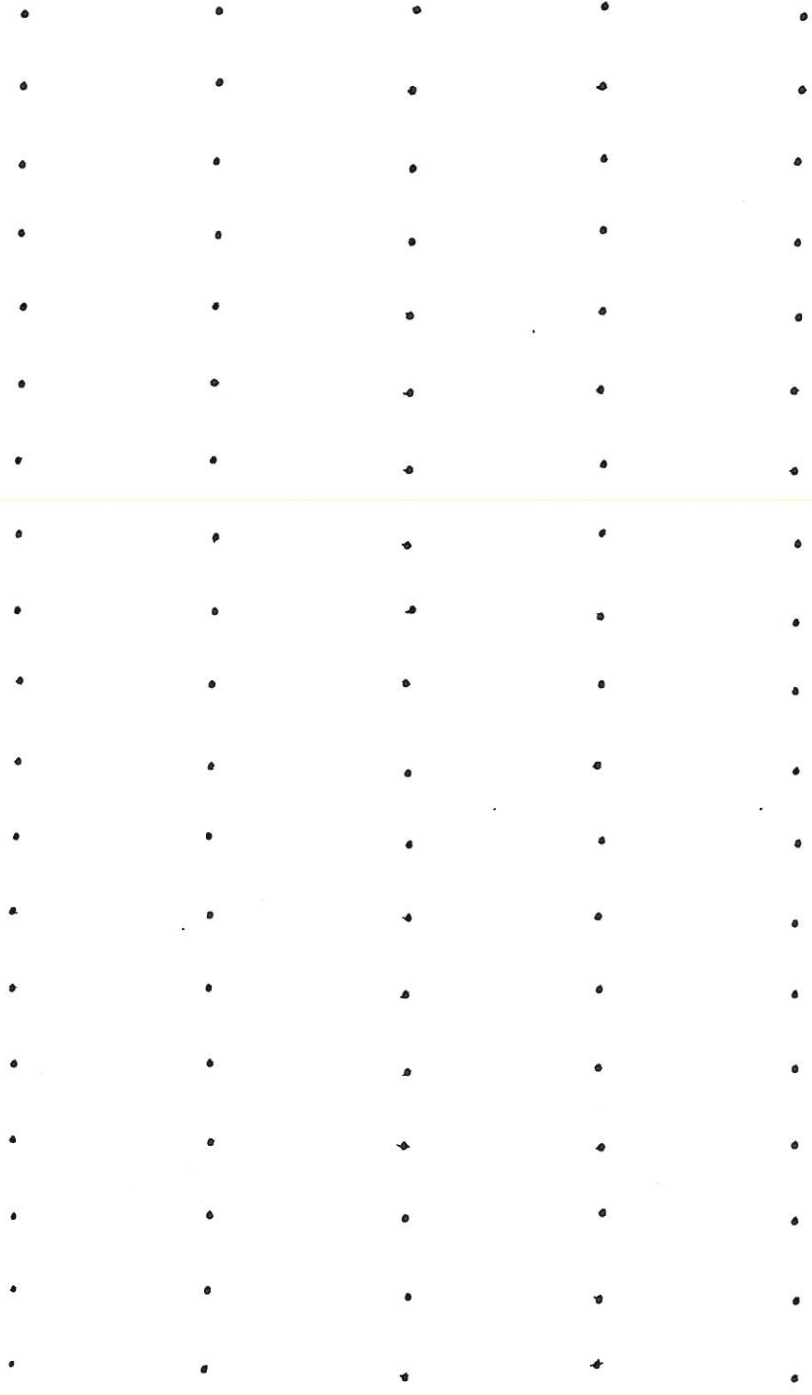
Row 6 Start 5 W080 4 ReLi 3 2 1

Observer Sally
 Date 7/1/99
 Start Time 6:30AM
 Start Temp 22°C
 Sky 3
 Wind 1
 End Time 9:30AM
 End Temp 27°C

Scale
 1 in. = 50 m
 1 cm = 20 m

Harris West

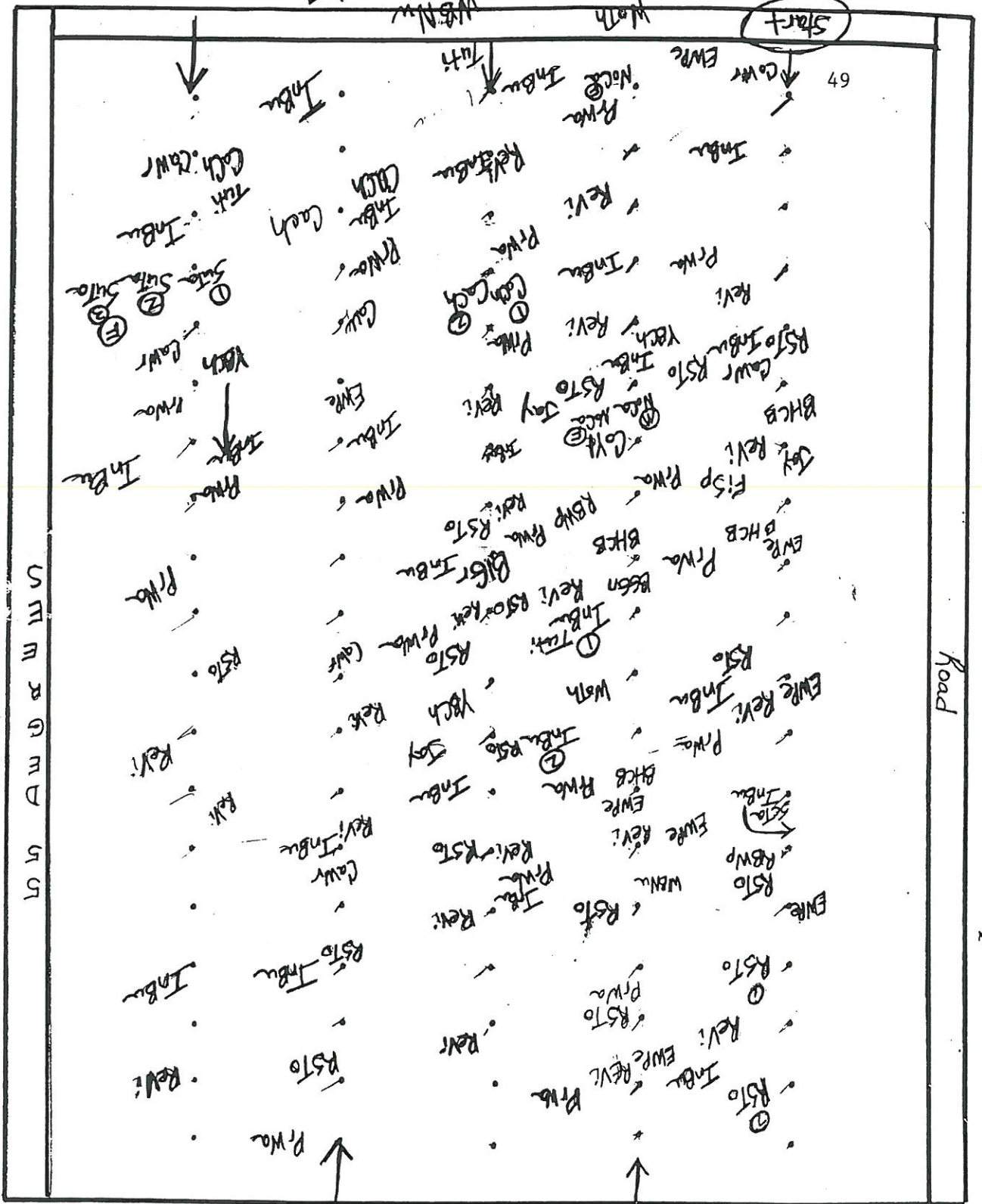
47



Row 5 4 3 2 1

Observer _____
Date _____
Start Time _____
Start Temp _____
Sky _____
Wind _____
End Time _____
End Temp _____

Scale
1 in. = 50 m
1 cm = 20 m



Observer Sally
 Date 6/2/99
 Start Time 6:25 AM
 Start Temp 12°C
 Sky |
 Wind |
 End Time 9:00 AM
 End Temp 22°C

(Power line)

Scale
 1 in. = 50 m
 1 cm = 20 m

Red wrong

Grassbreak
 Blue
 15
 Big

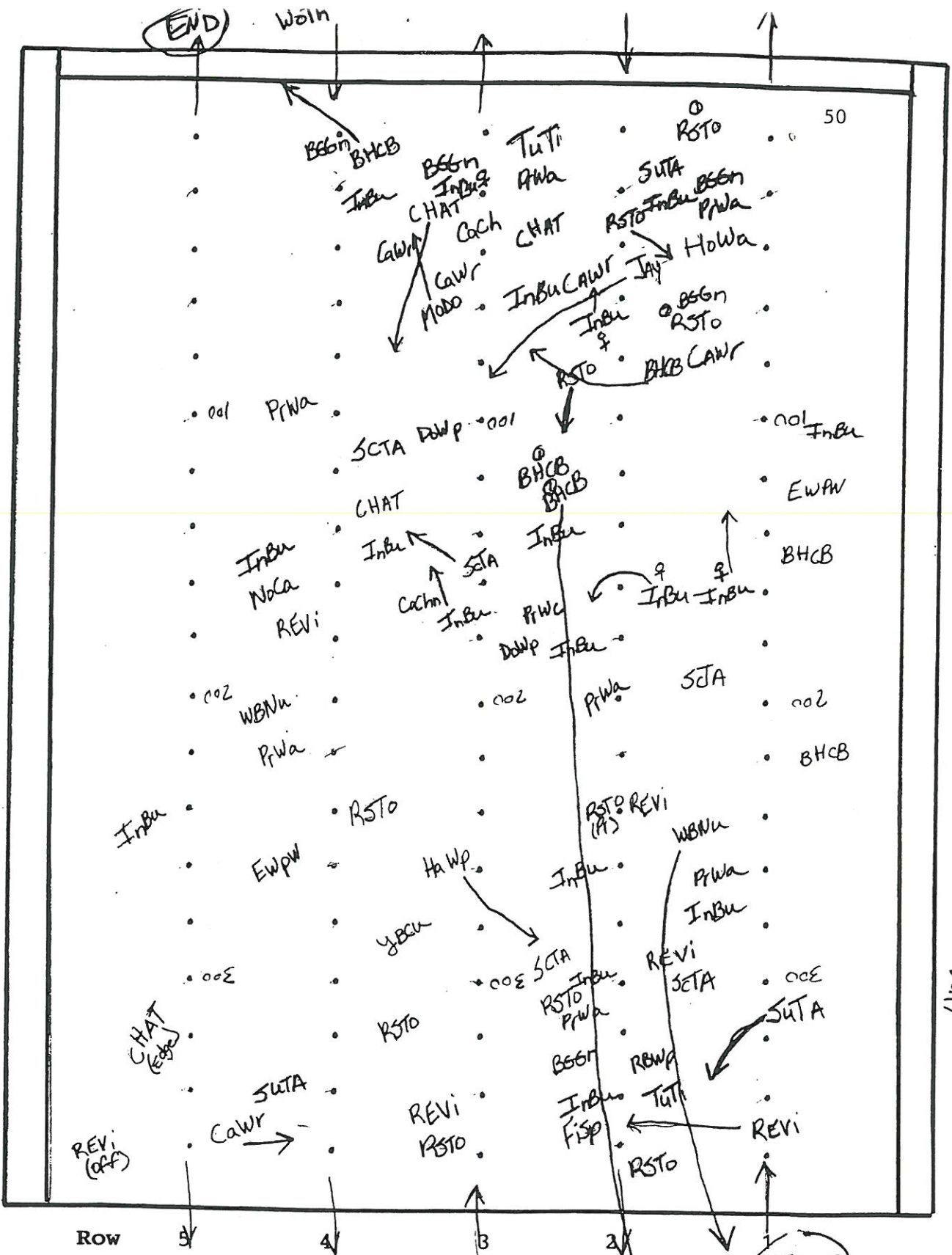
S
E
F
E
R
B
G
E
D
S
S

Row 5
4
3
2
1

Road

49

Start

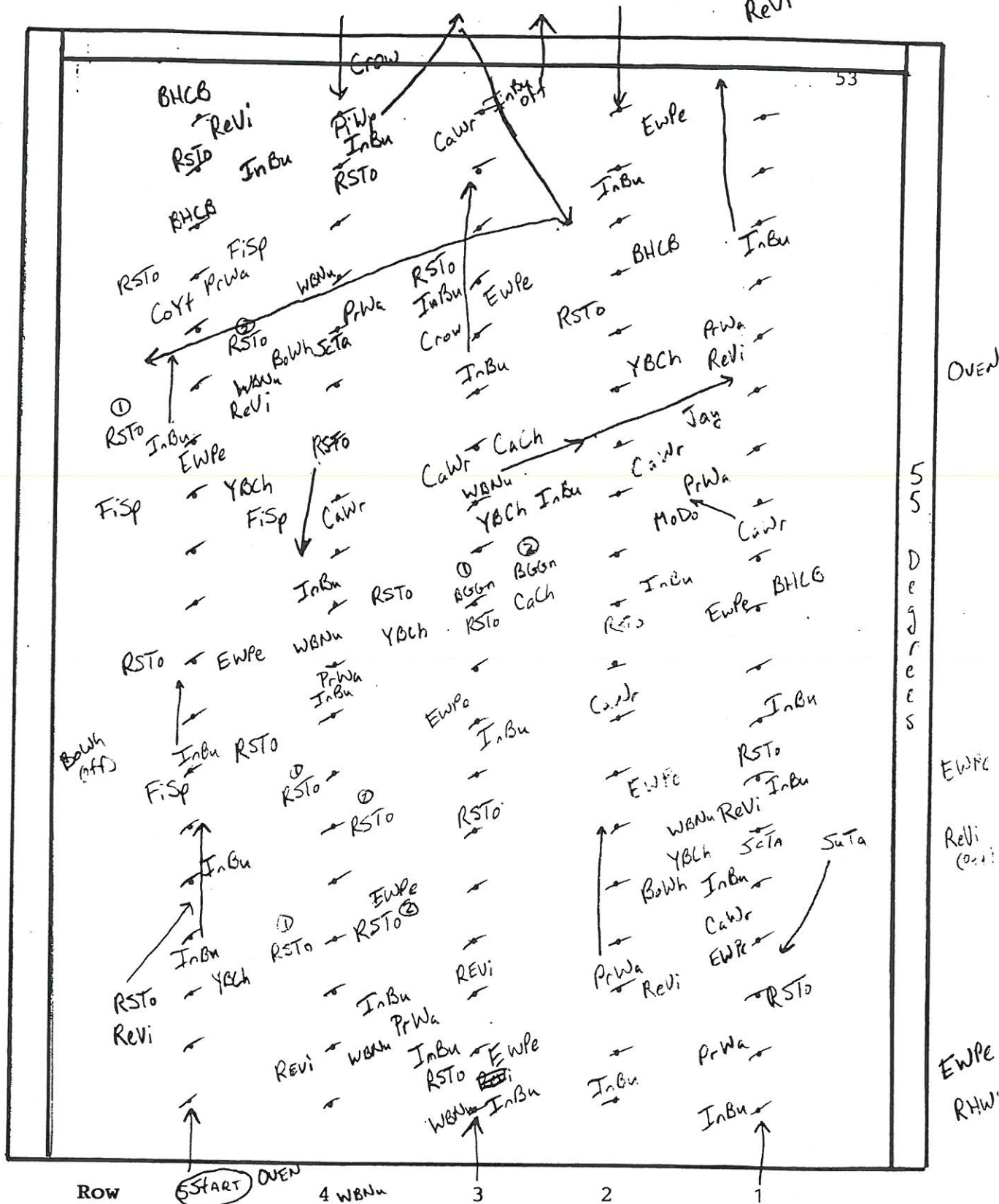


Observer Patrick
 Date June 3
 Start Time 6:10
 Start Temp 17°C
 Sky 0
 Wind 1
 End Time 8:10
 End Temp 25°C

(Powerline)

Scale
 1 in. = 50 m
 1 cm = 20 m

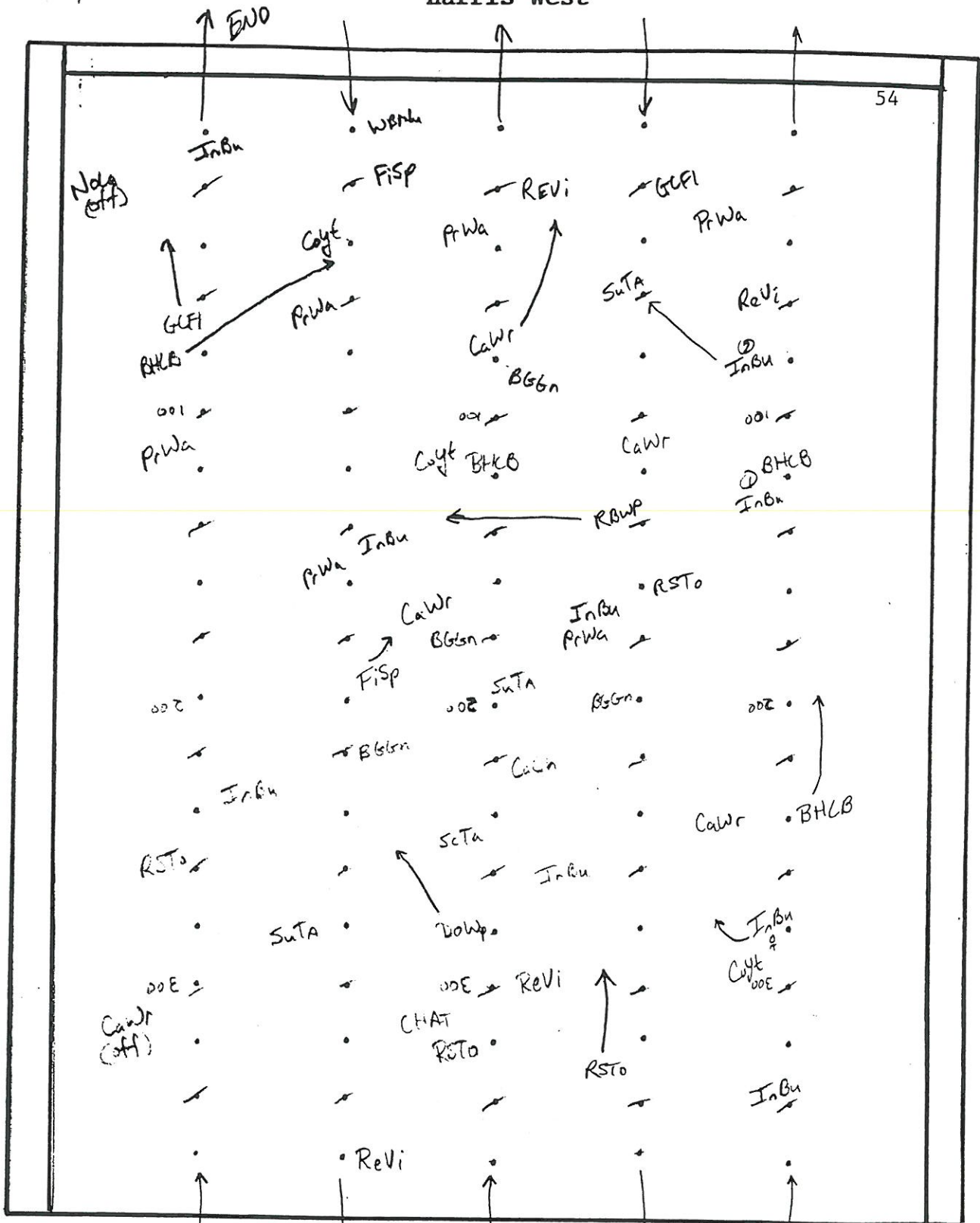
YBCW (off)



Observer Sally
 Date 6/22/99
 Start Time 6:15 AM
 Start Temp 18°C
 Sky 4
 Wind 2
 End Time 8:05 AM
 End Temp 21°C

Scale
 1 in. = 50 m
 1 cm = 20 m

Harris West



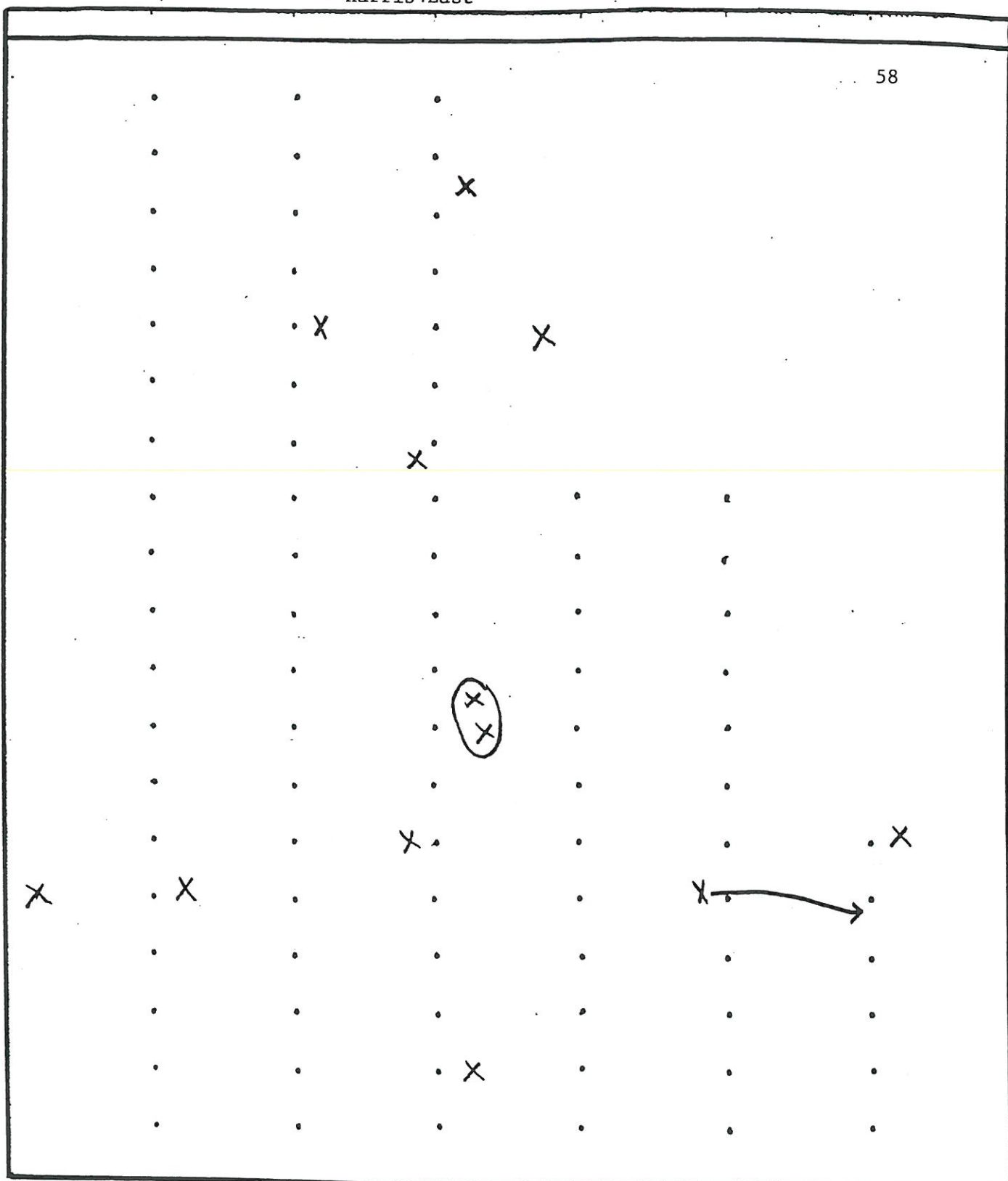
Observer PATRICK
 Date 6/29/99
 Start Time 6:20
 Start Temp 21°C
 Sky 1
 Wind 2
 End Time 8:05
 End Temp 26°C

Scale
 1 in. = 50 m
 1 cm = 20 m

Appendix III

57

This appendix contains copies of all territory maps for the Harris plots. The maps for Harris East are given first and then those for Harris West are given.

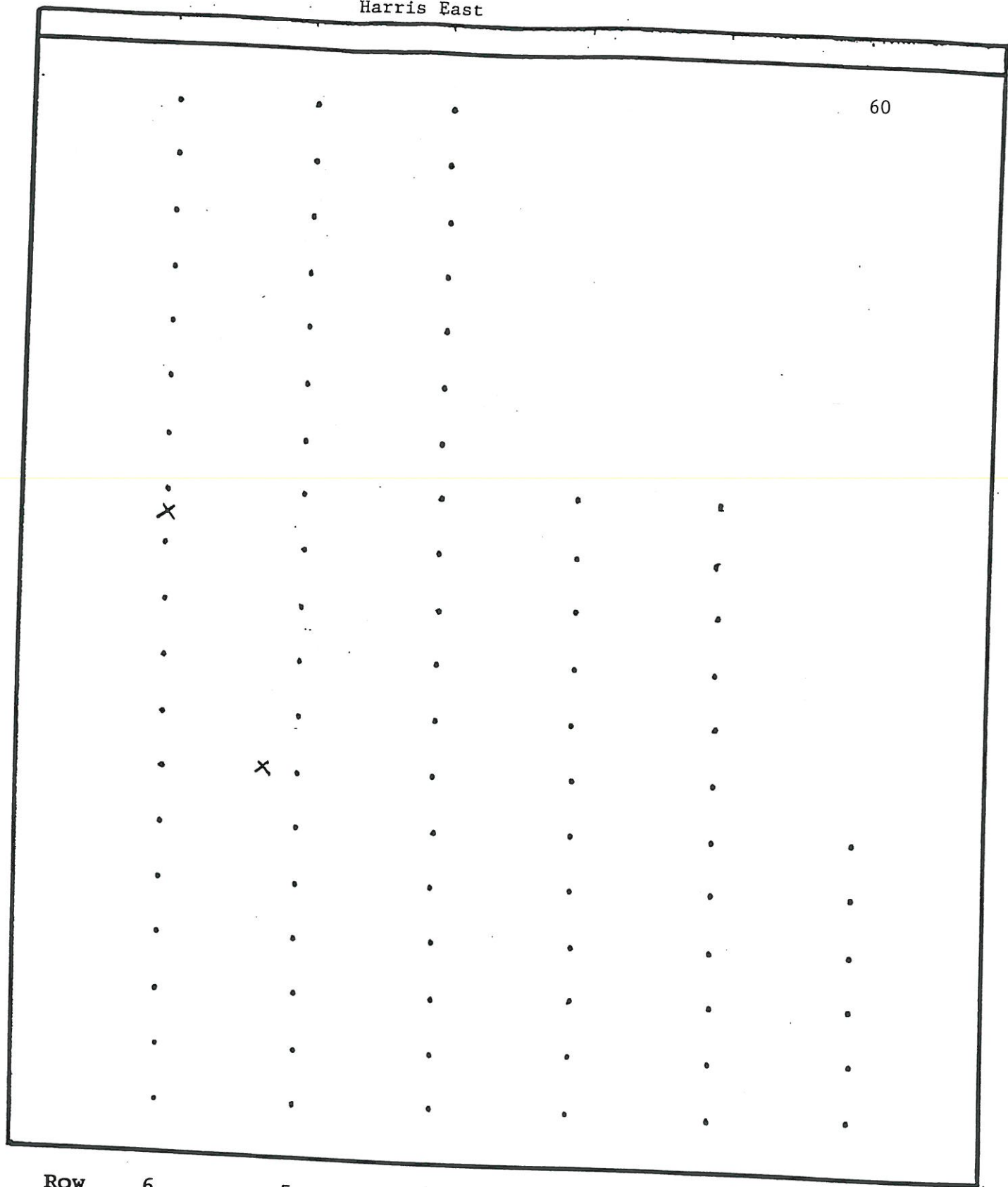


Row 6 5 4 3 2 1

Northern Bobwhite

Scale

1 in. = 50 m
1 cm = 20 m



Row

6

5

4

3

2

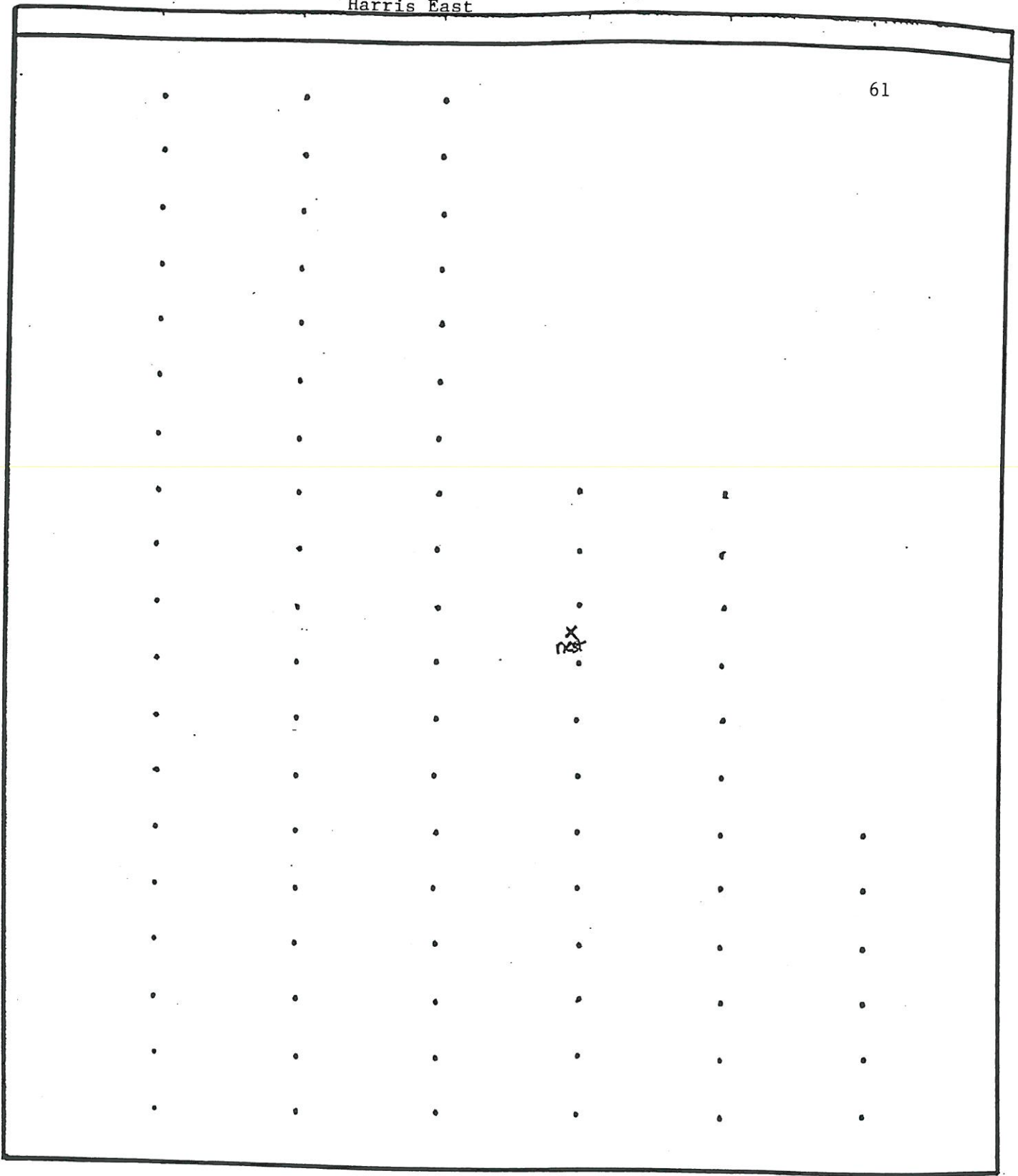
1

Yellow-billed Cuckoo

Scale

1 in. = 50 m

1 cm = 20 m

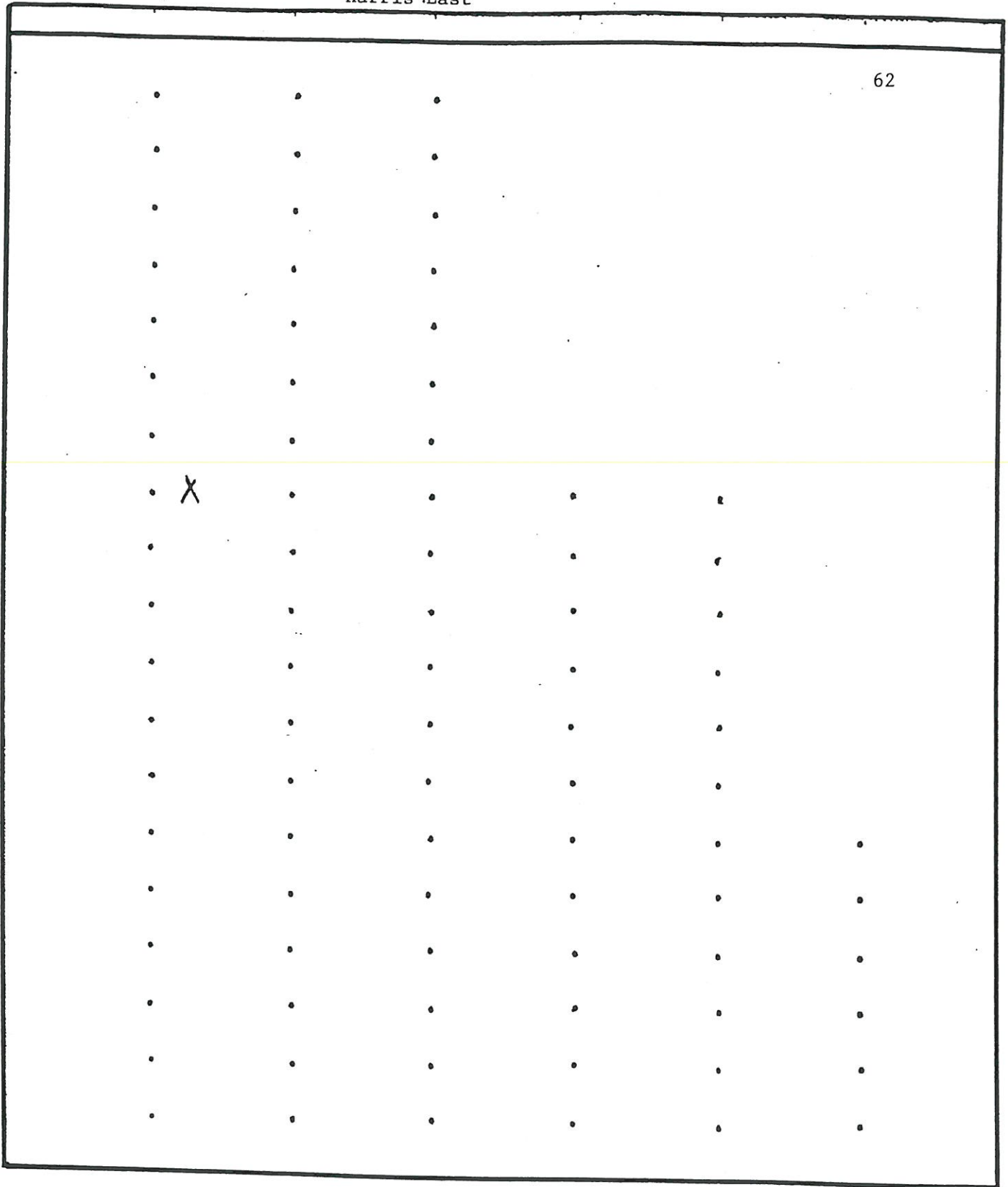


Row 6 5 4 3 2 1

Whip-poor-will

Scale

1 in. = 50 m
1 cm = 20 m

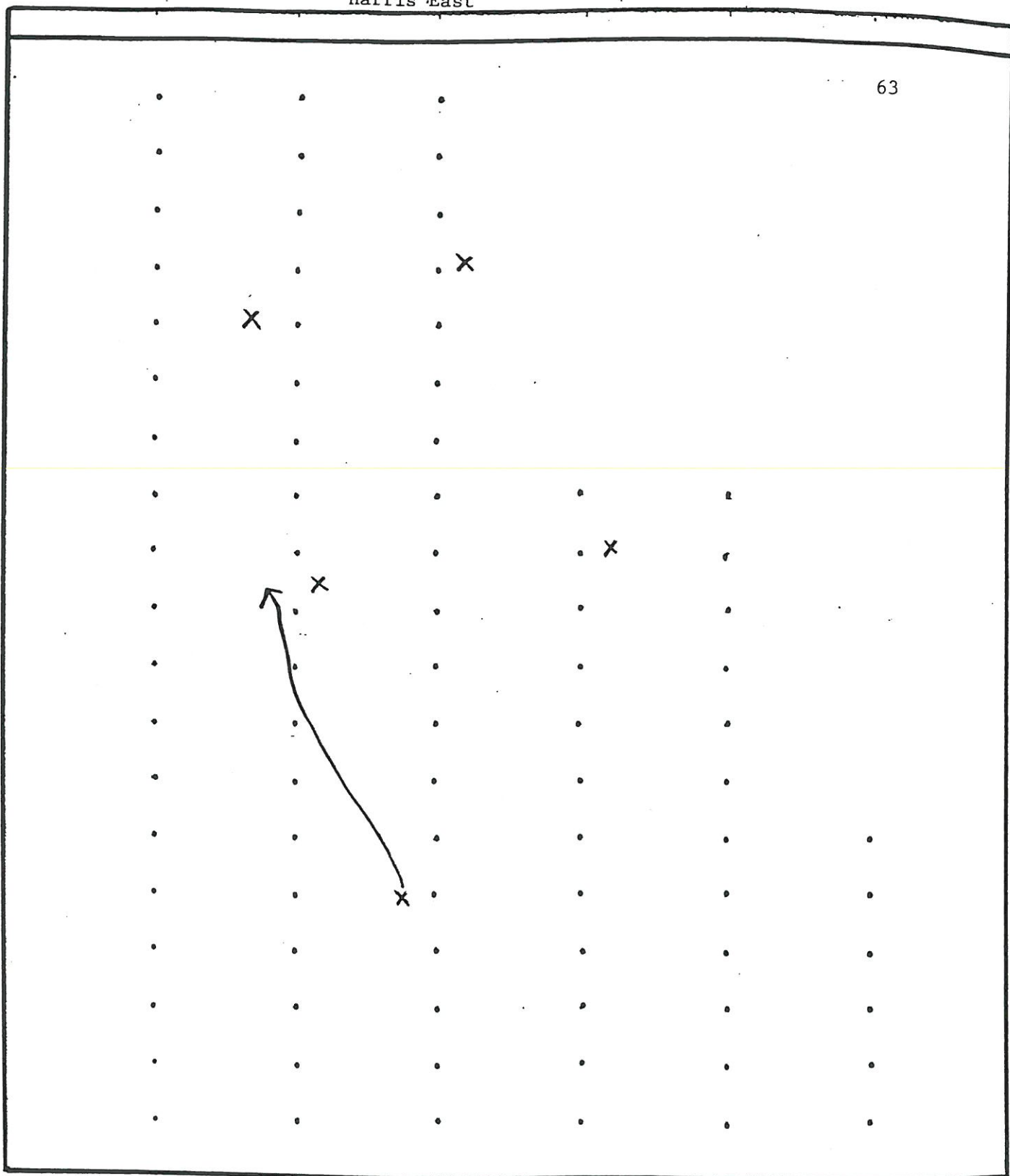


Row 6 5 4 3 2 1

Red-headed Woodpecker

Scale

1 in. = 50 m
1 cm = 20 m

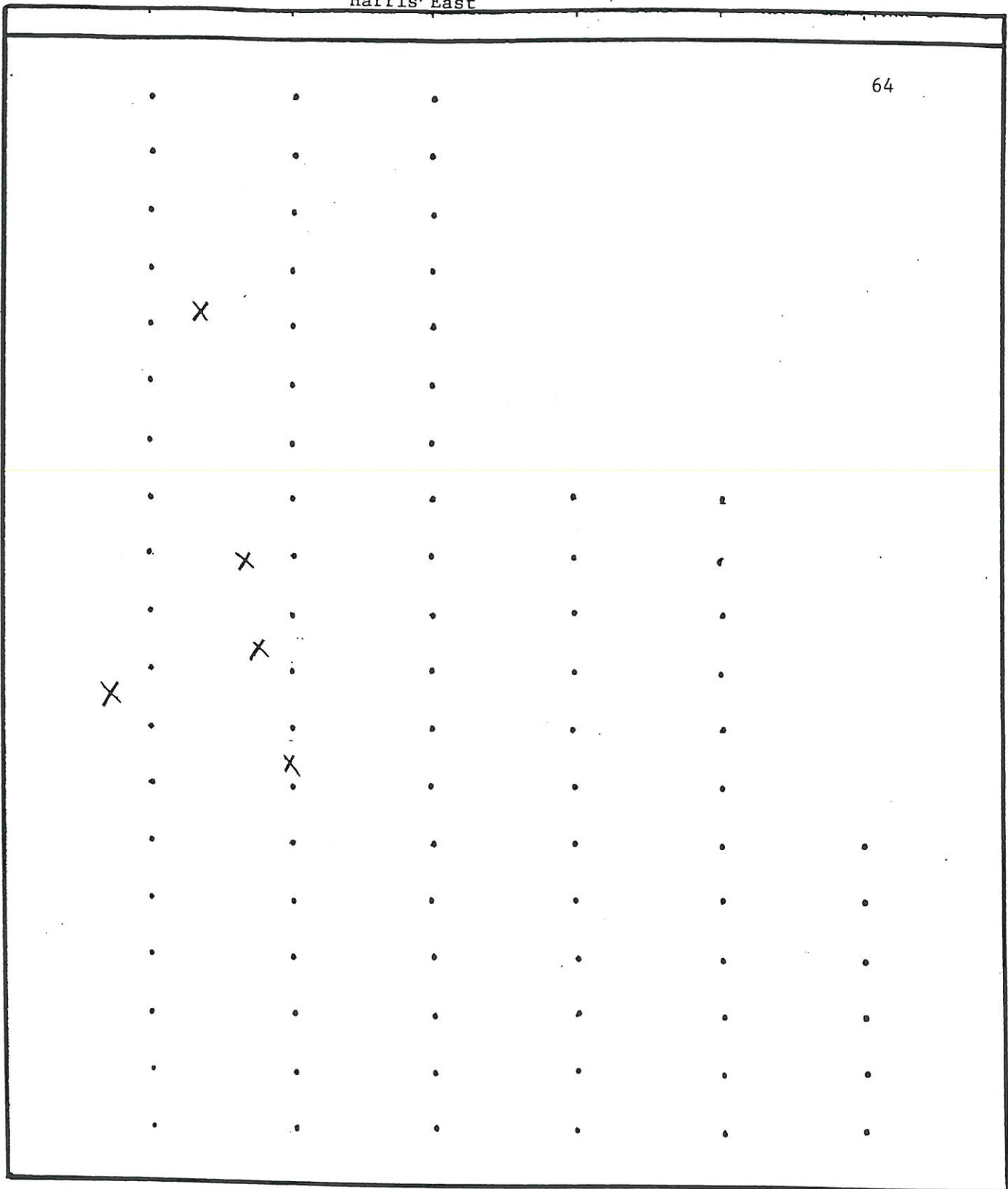


Row 6 5 4 3 2 1

Red-bellied Woodpecker

Scale

1 in. = 50 m
1 cm = 20 m

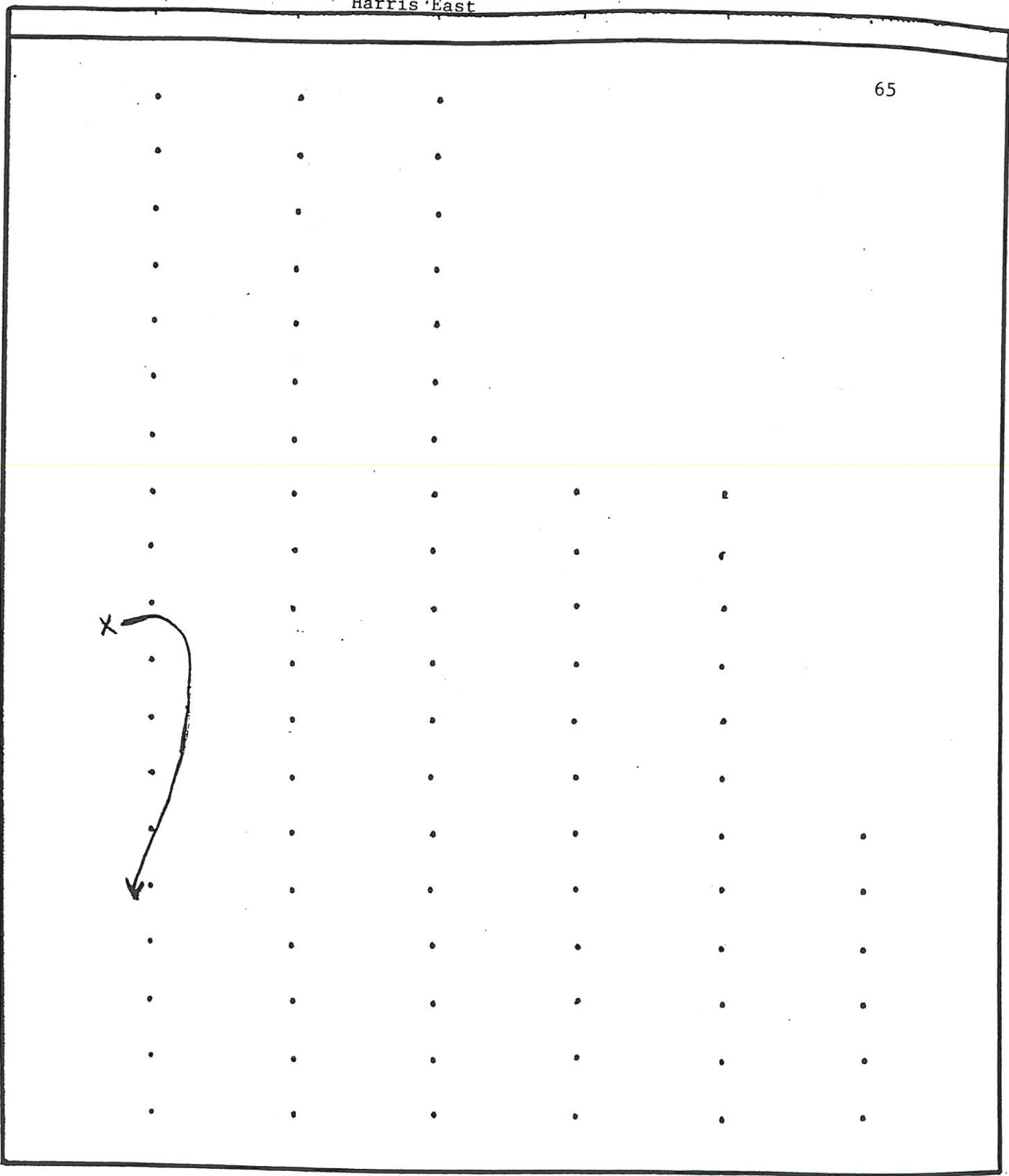


Row 6 5 4 3 2 1

Downy Woodpecker

Scale

1 in. = 50 m
1 cm = 20 m

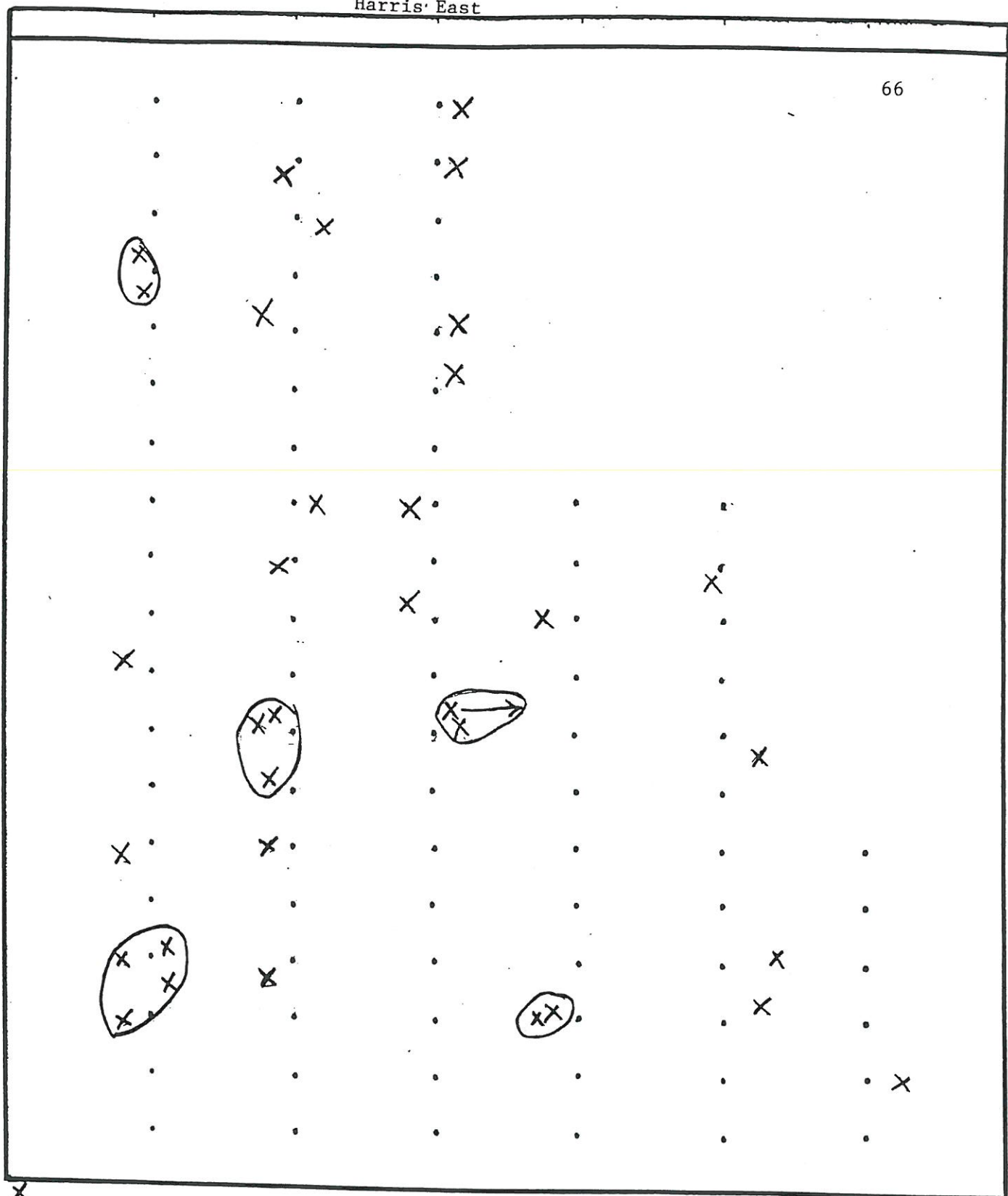


Row 6 5 4 3 2 1

Pileated Woodpecker

Scale

1 in. = 50 m
1 cm = 20 m

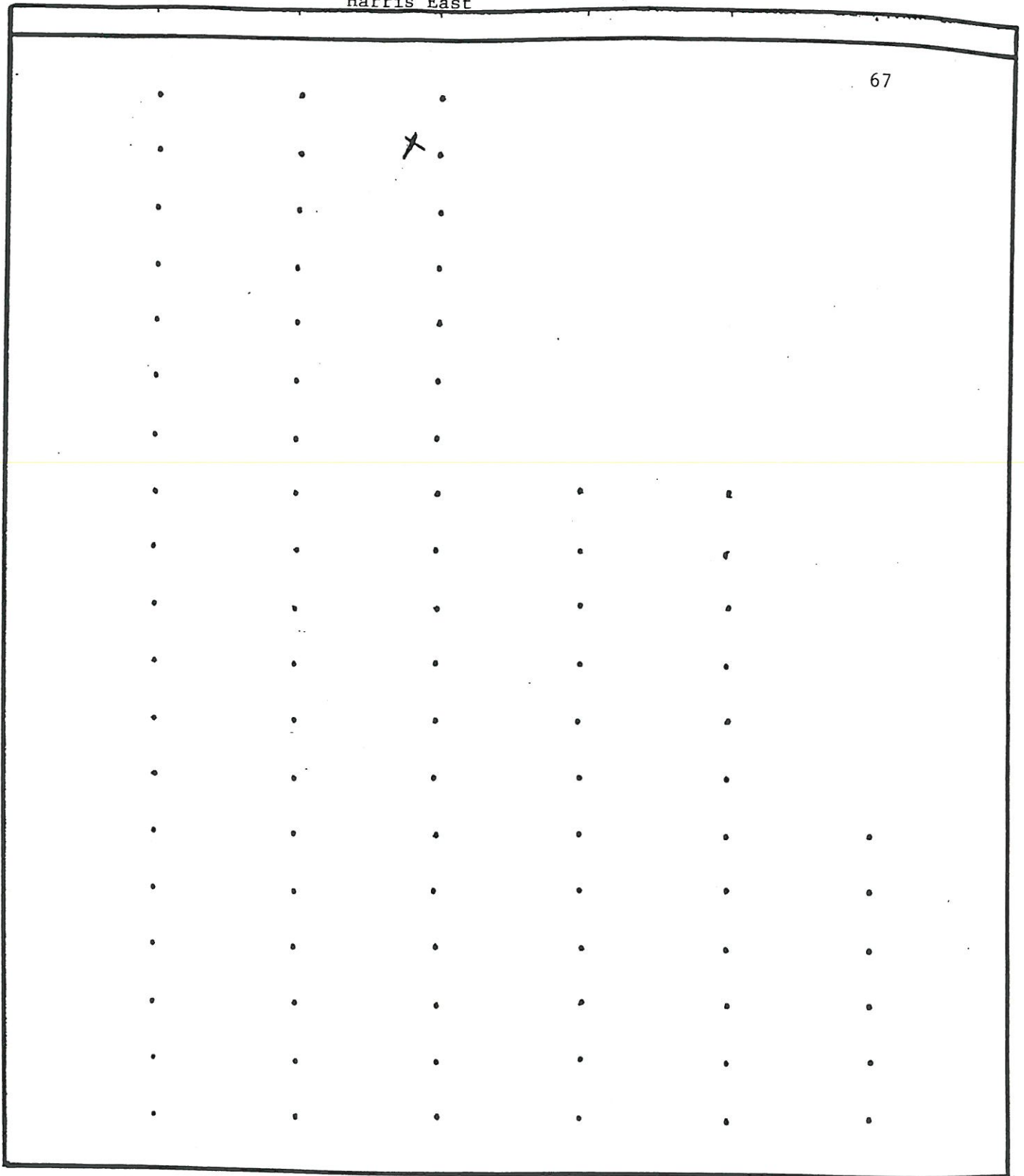


X
 Row 6 5 4 3 2 1

Eastern Wood-pewee

Scale

1 in. = 50 m
 1 cm = 20 m

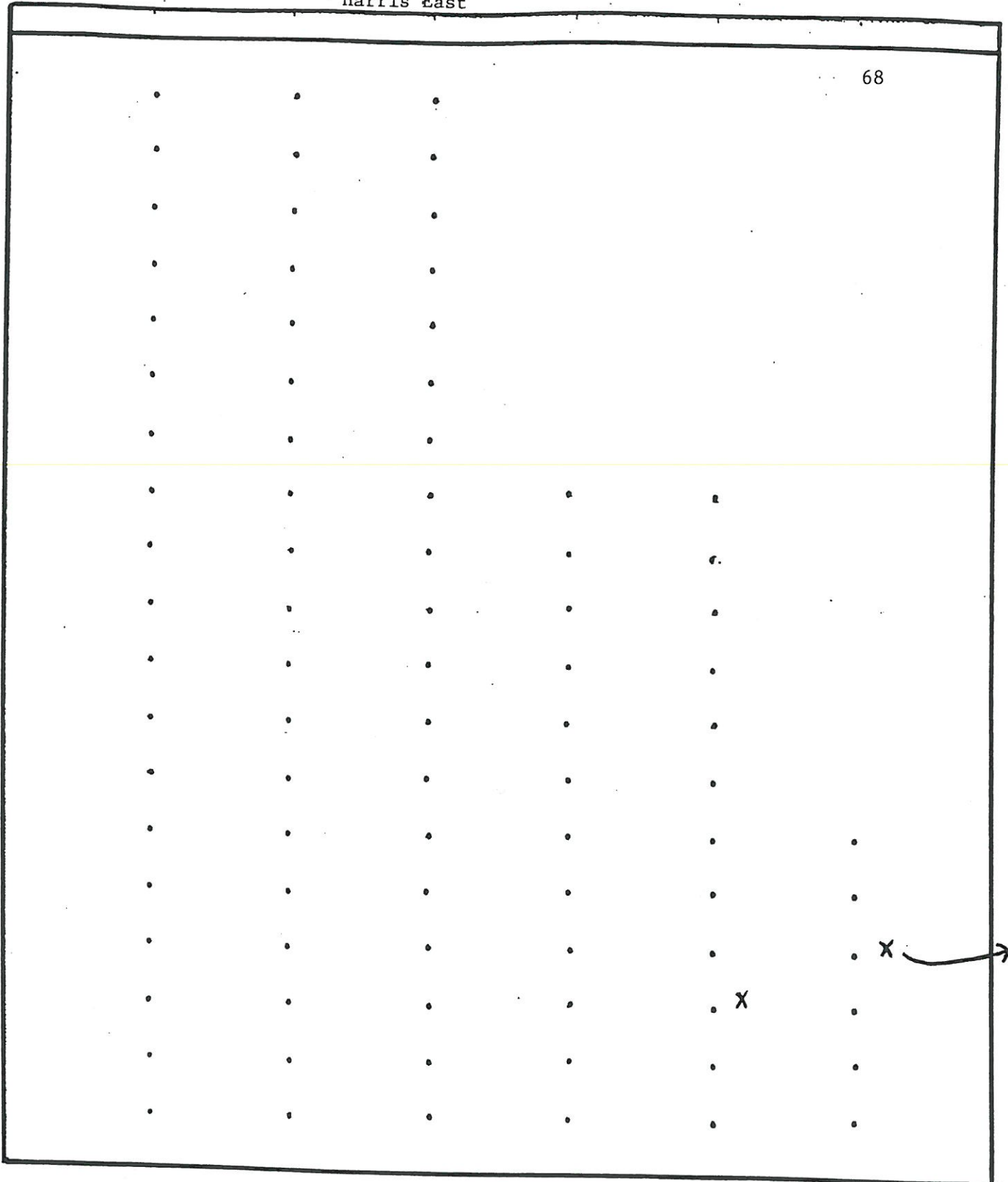


Row 6 5 4 3 2 1

Acadian Flycatcher

Scale

1 in. = 50 m
1 cm = 20 m

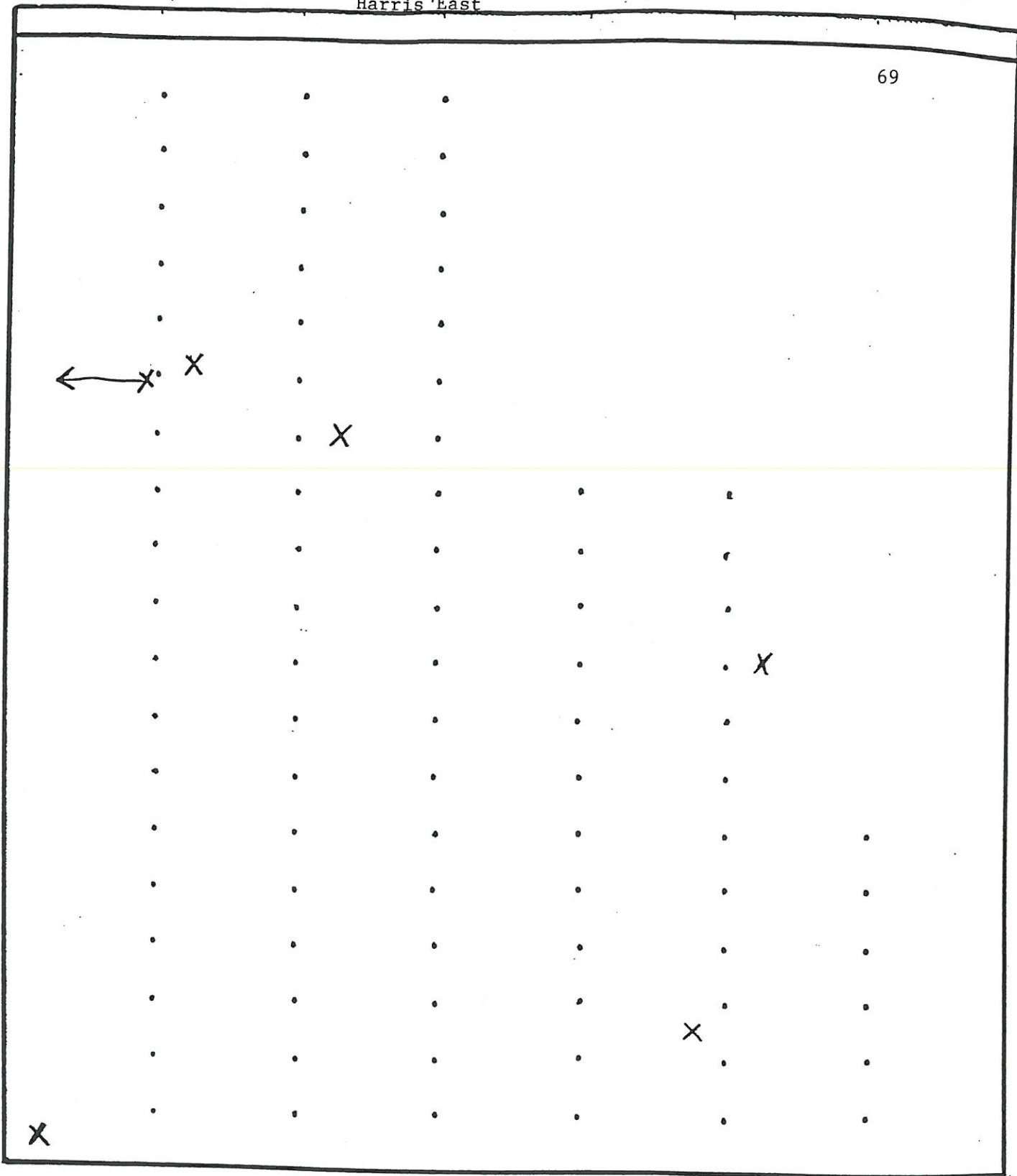


Row 6 5 4 3 2 1

Eastern Phoebe

Scale

1 in. = 50 m
1 cm = 20 m



Row

6

5

4

3

2

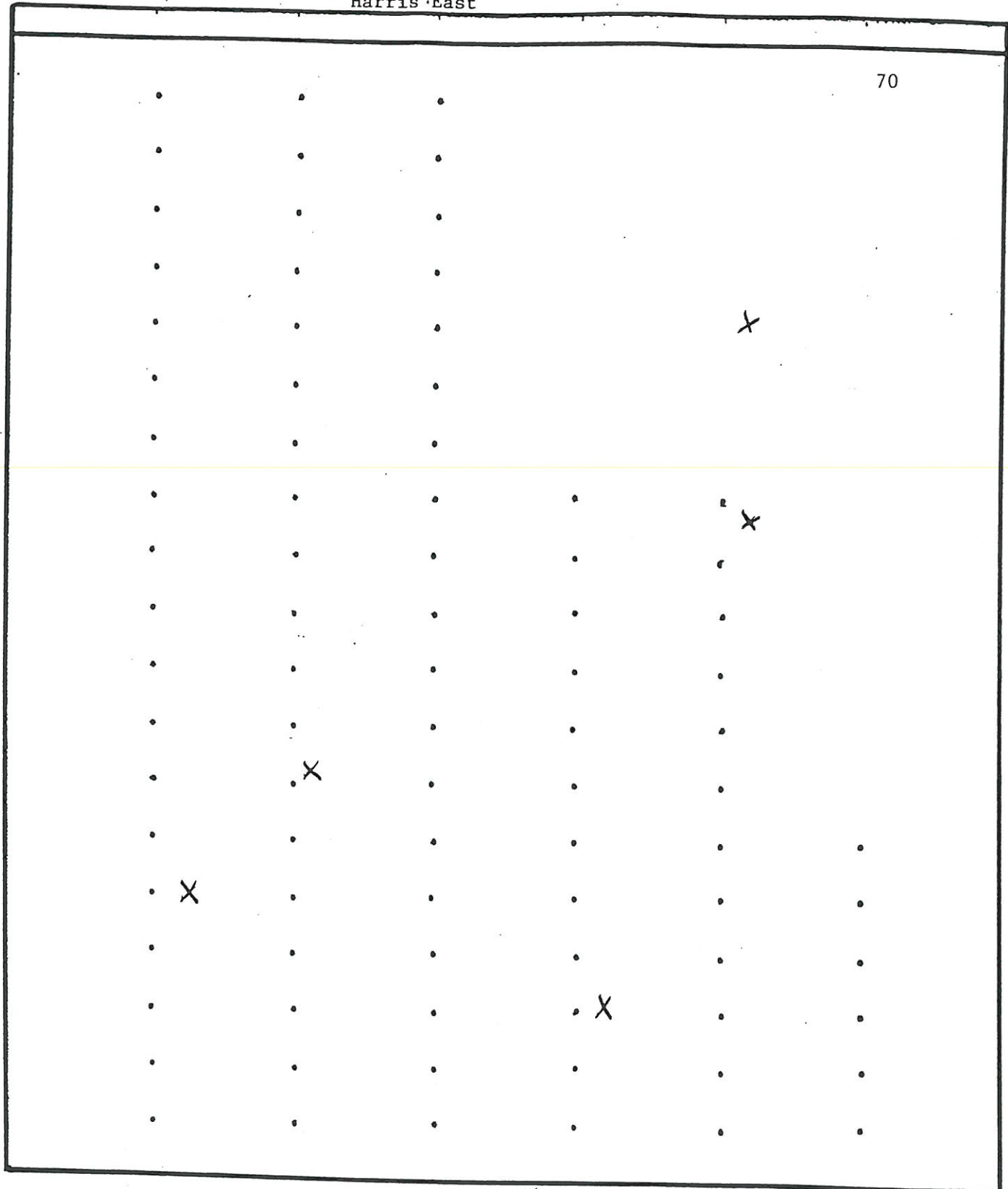
1

Great Crested Flycatcher

Scale

1 in. = 50 m

1 cm = 20 m



Row 6 5 4 3 2 1

Blue Jay

Scale

1 in. = 50 m
1 cm = 20 m

X

X

X

X

X

Row

6

5

4

3

2

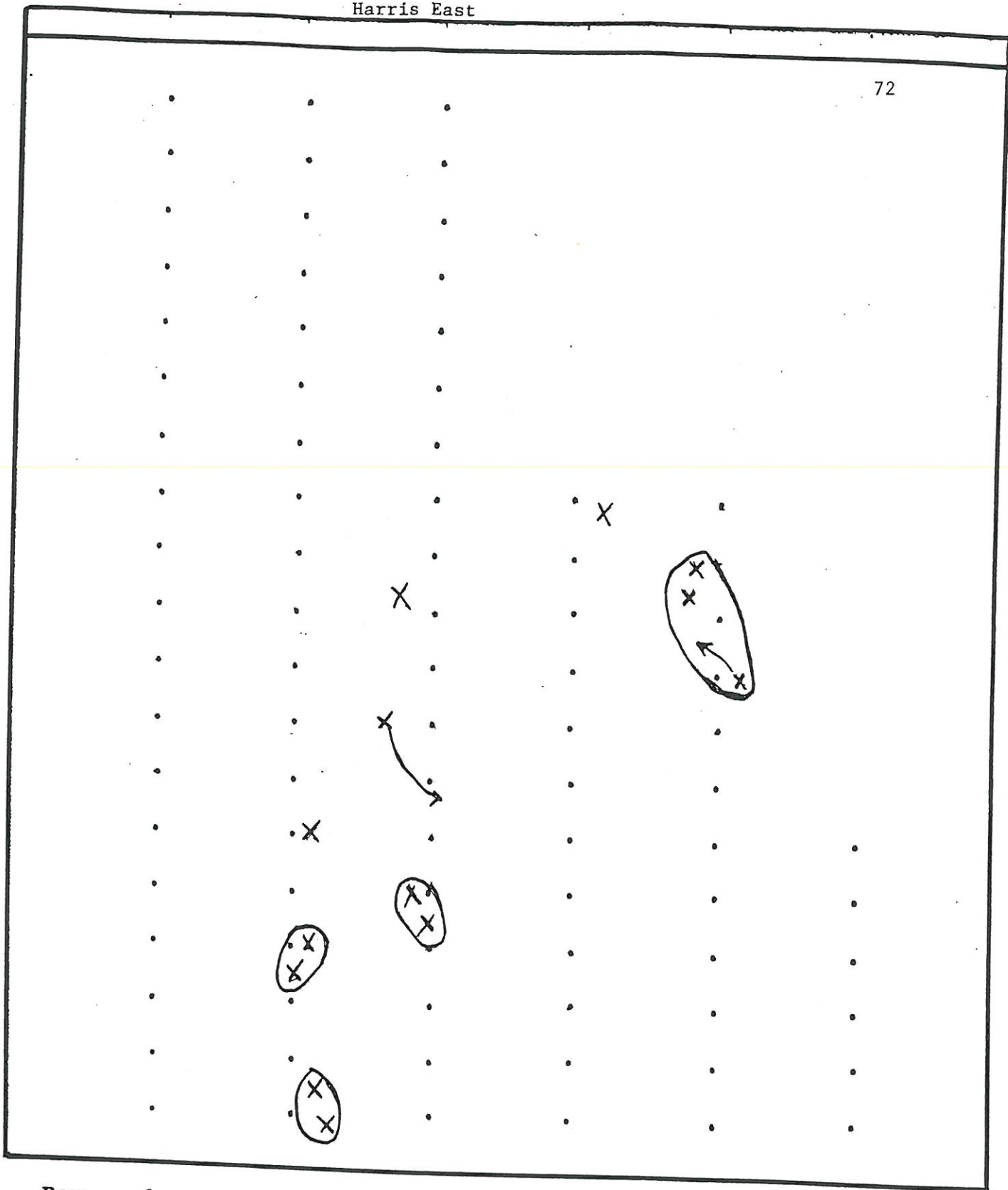
1

American Crow

Scale

1 in. = 50 m

1 cm = 20 m



Row

6

5

4

3

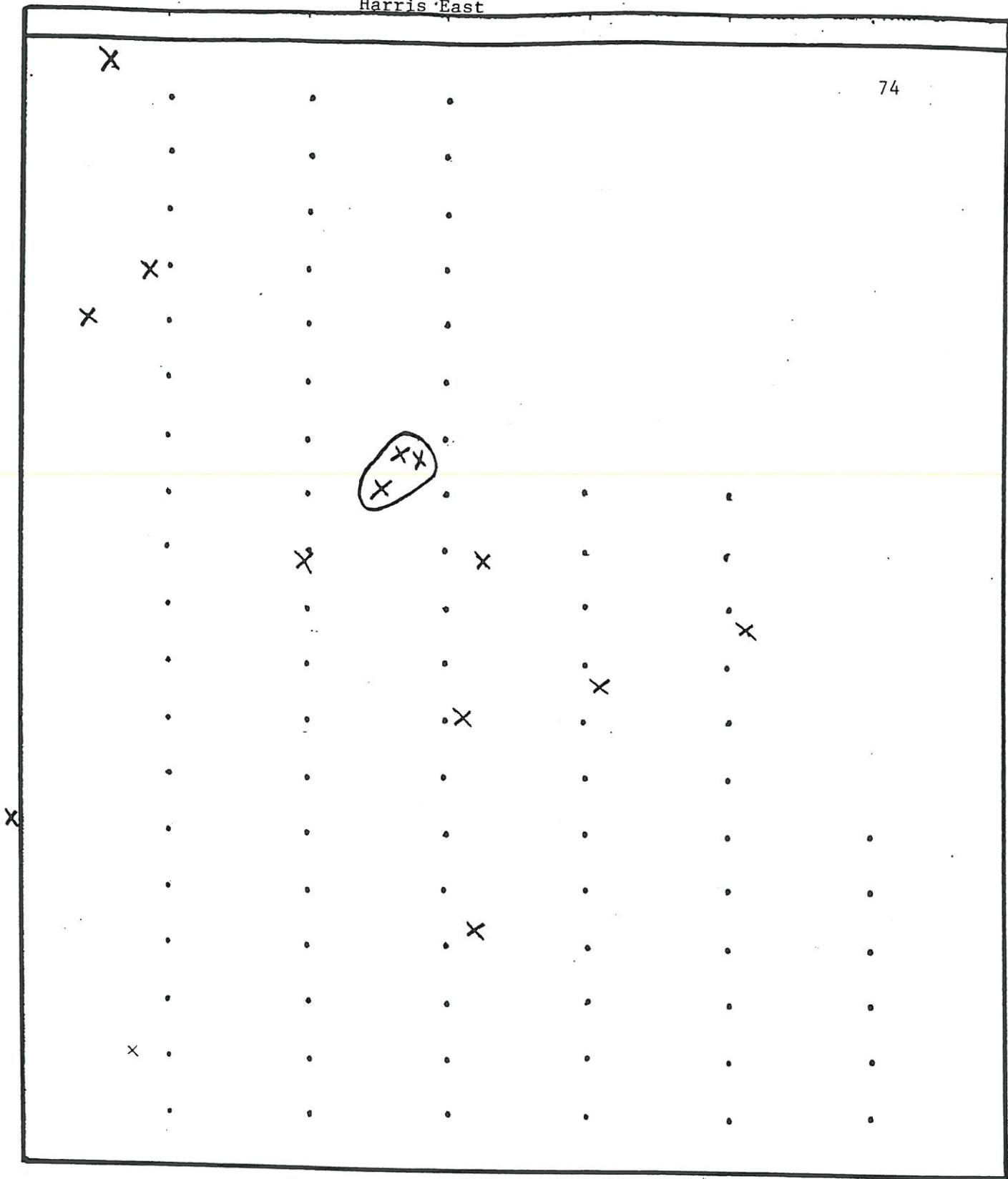
2

1

Carolina Chickadee

Scale

1 in. = 50 m
1 cm = 20 m



Row

6

5

4

3

2

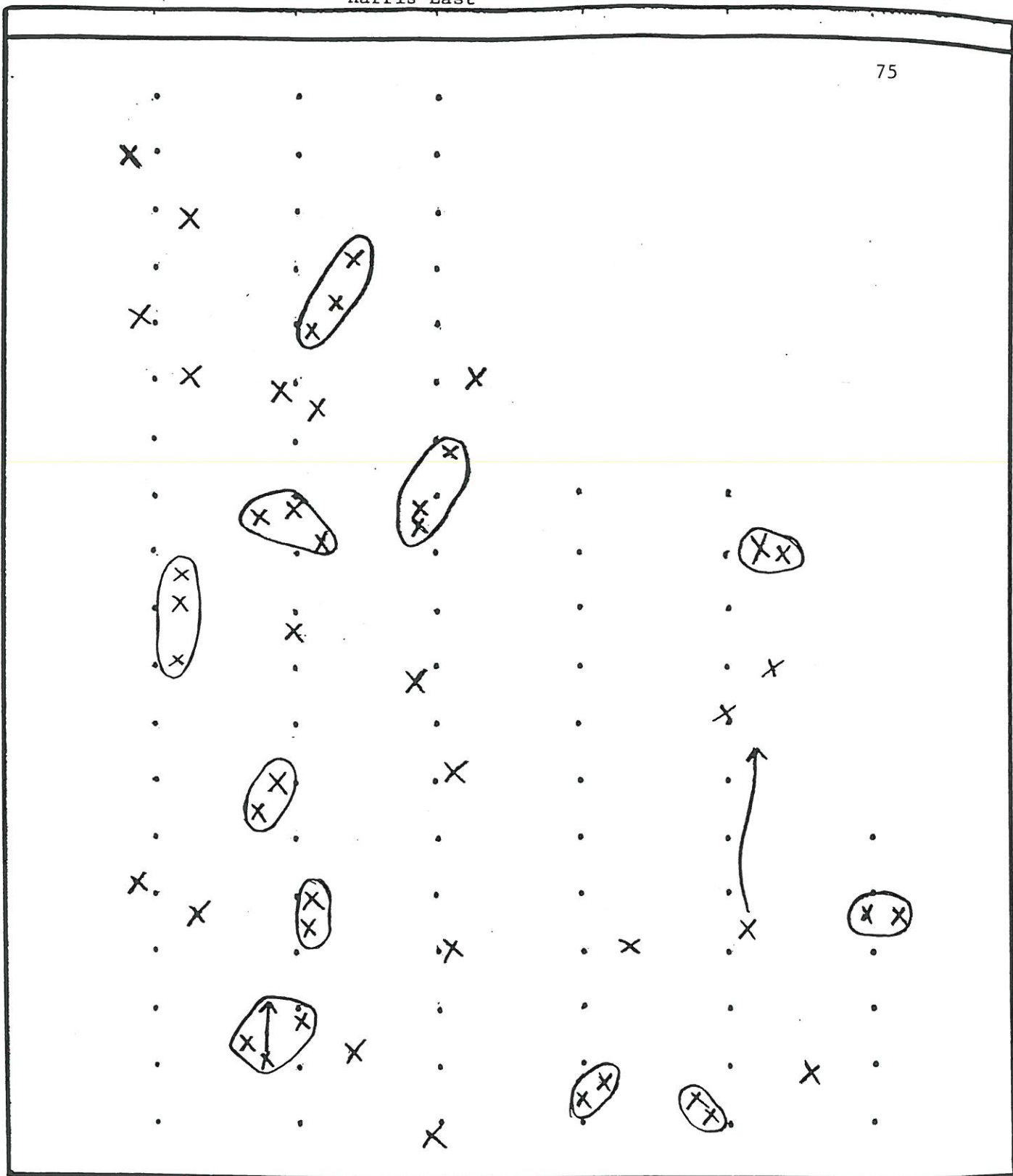
1

White-breasted Nuthatch

Scale

1 in. = 50 m

1 cm = 20 m

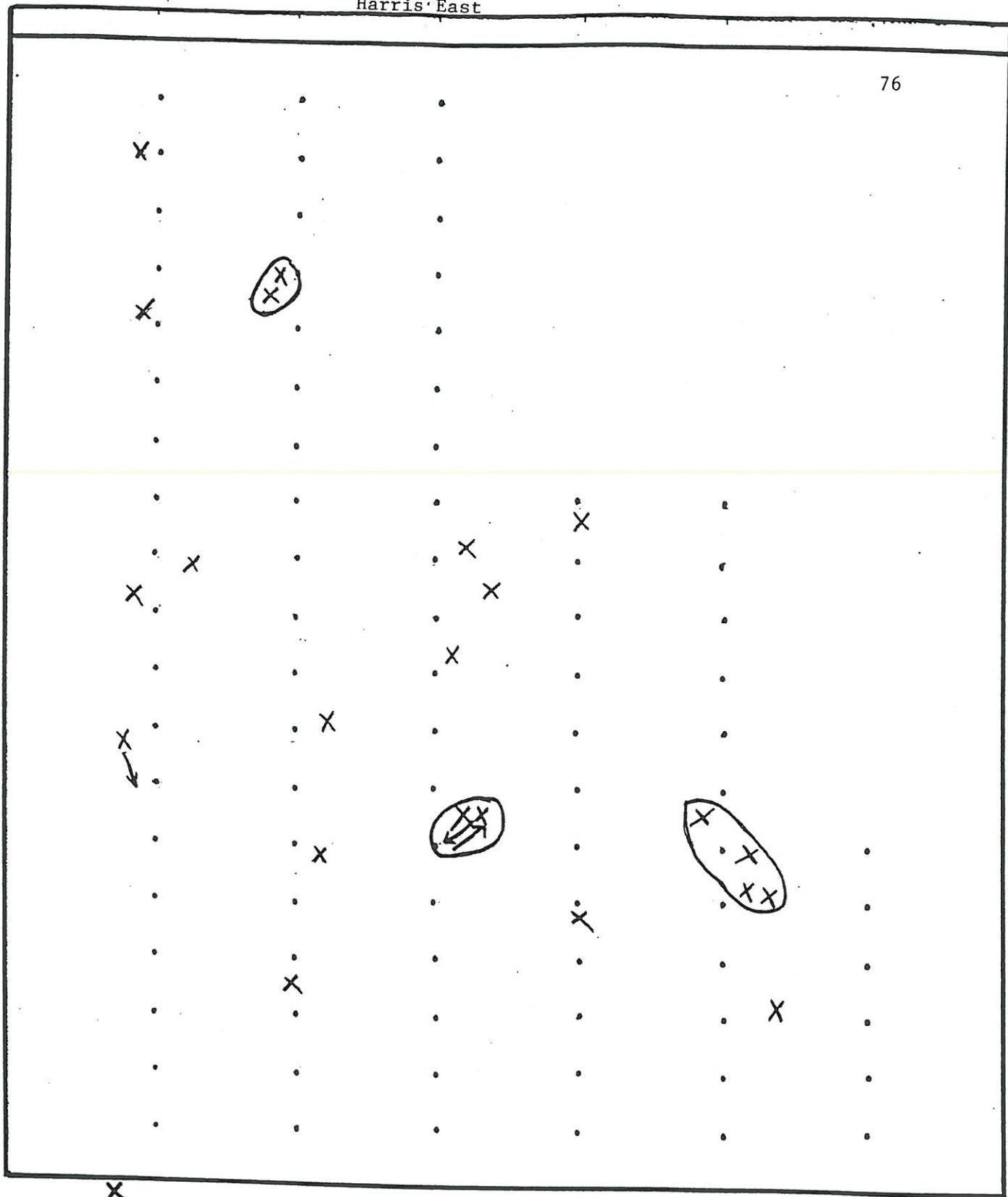


Row 6 5 4 3 2 1

Carolina Wren

Scale

1 in. = 50 m
1 cm = 20 m

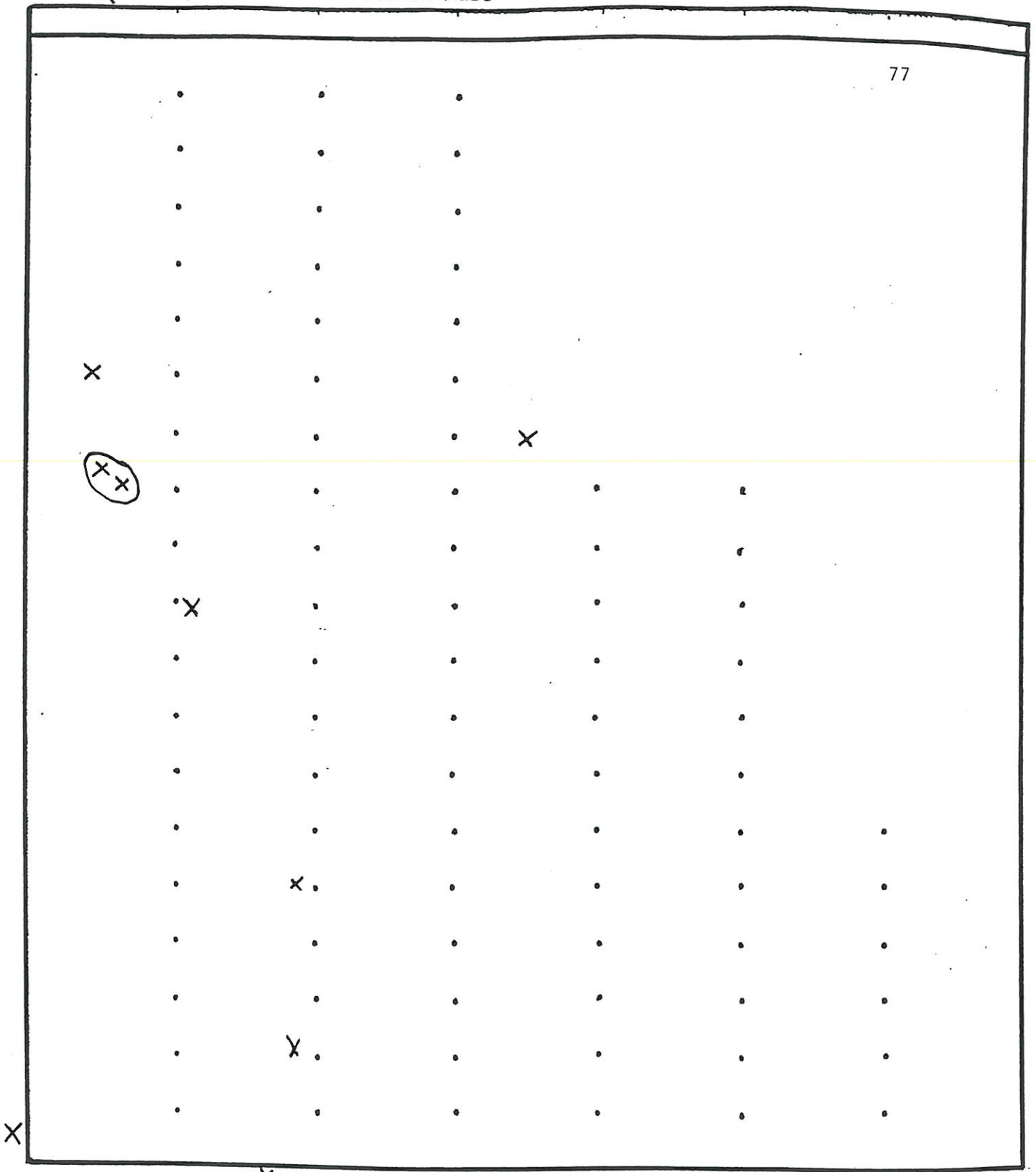


Row X 6 5 4 3 2 1

Blue-grey Gnatcatcher

Scale

1 in. = 50 m
1 cm = 20 m



Row

6

X

5

X

4

3

2

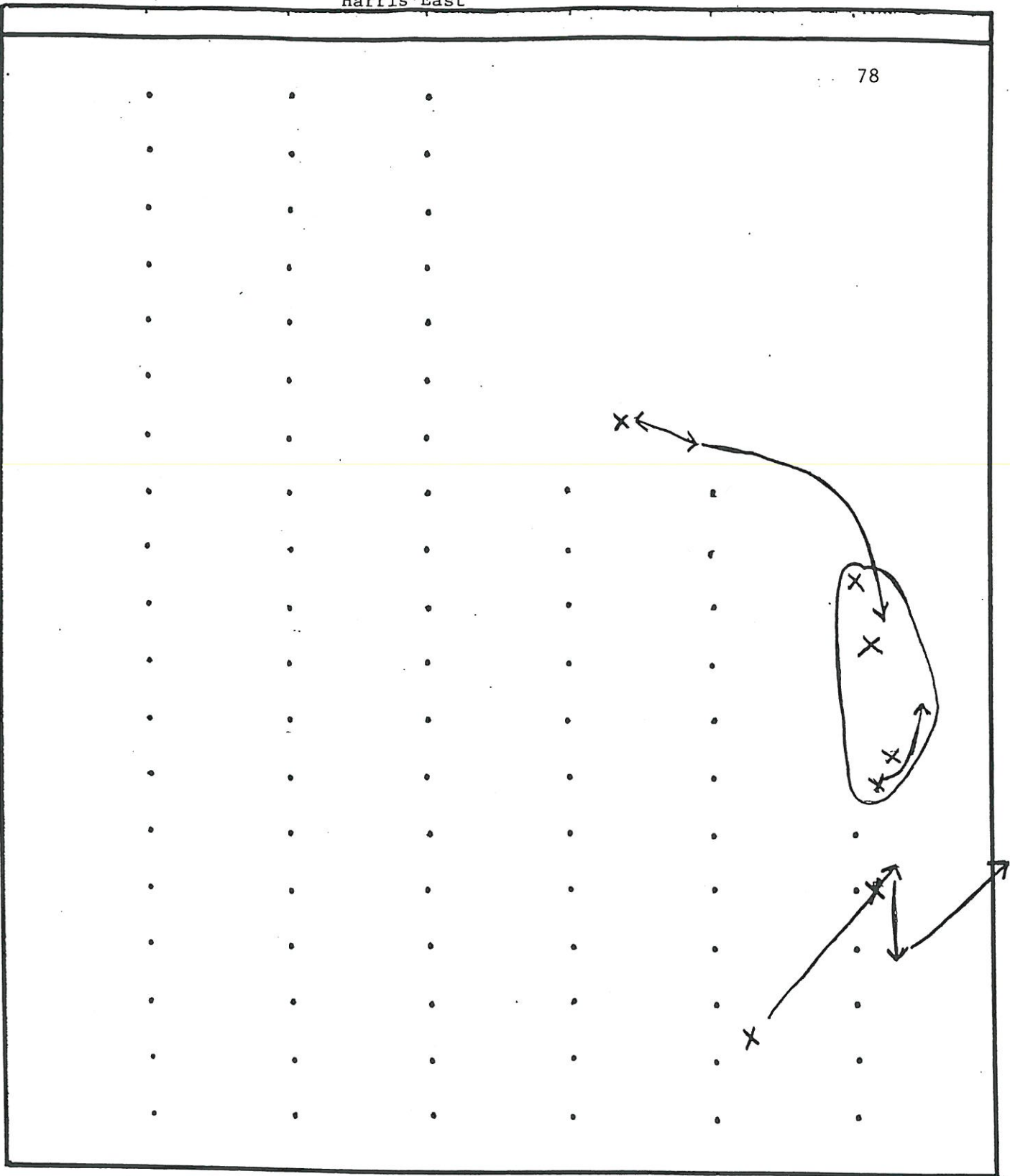
1

Wood Thrush

Scale

1 in. = 50 m

1 cm = 20 m



Row

6

5

4

3

2

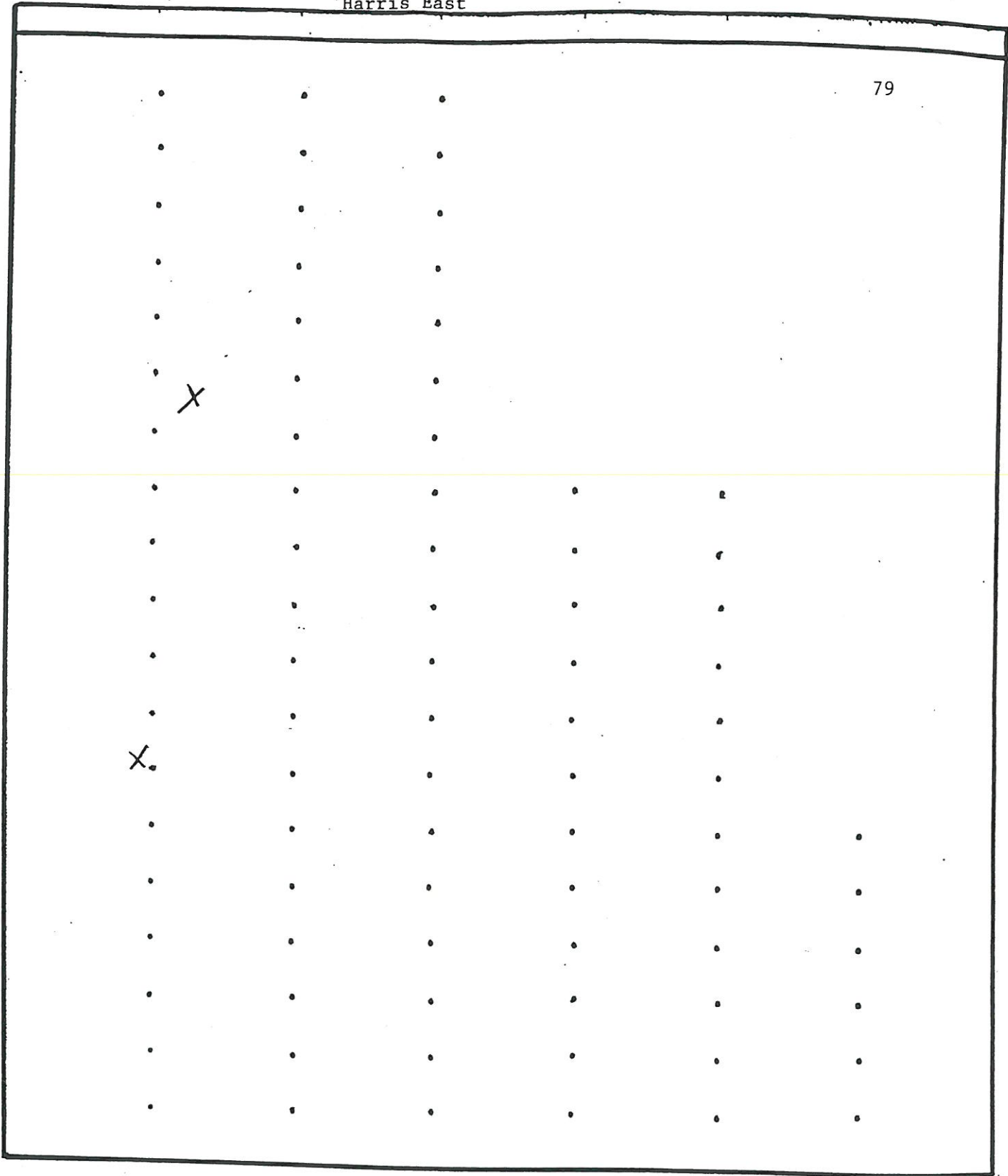
1

Mockingbird

Scale

1 in. = 50 m

1 cm = 20 m



Row

6

5

4

3

2

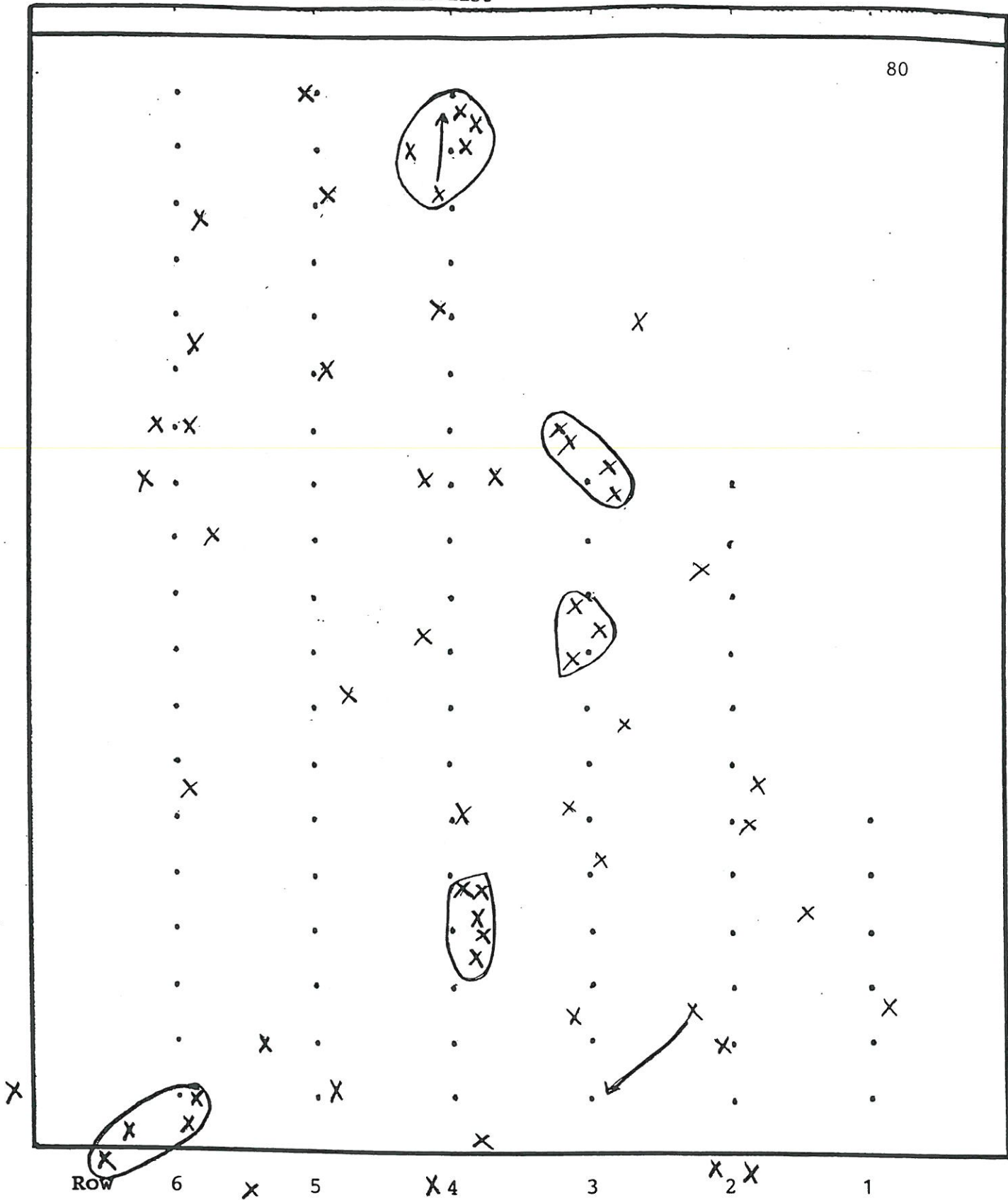
1

Brown Thrasher

Scale

1 in. = 50 m

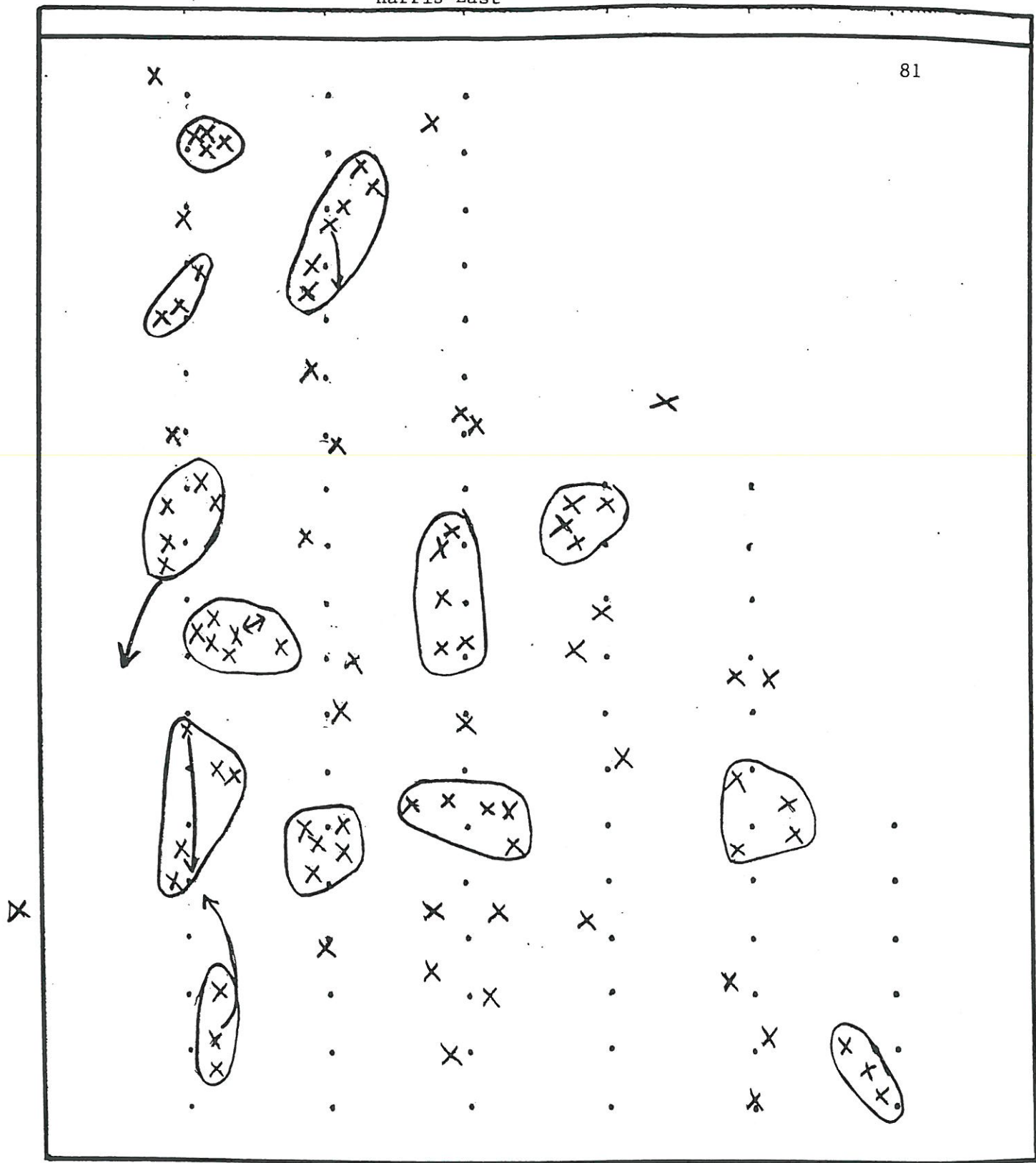
1 cm = 20 m



Red-eyed Vireo

Scale

1 in. = 50 m
1 cm = 20 m



Row

6

5

4

3

2

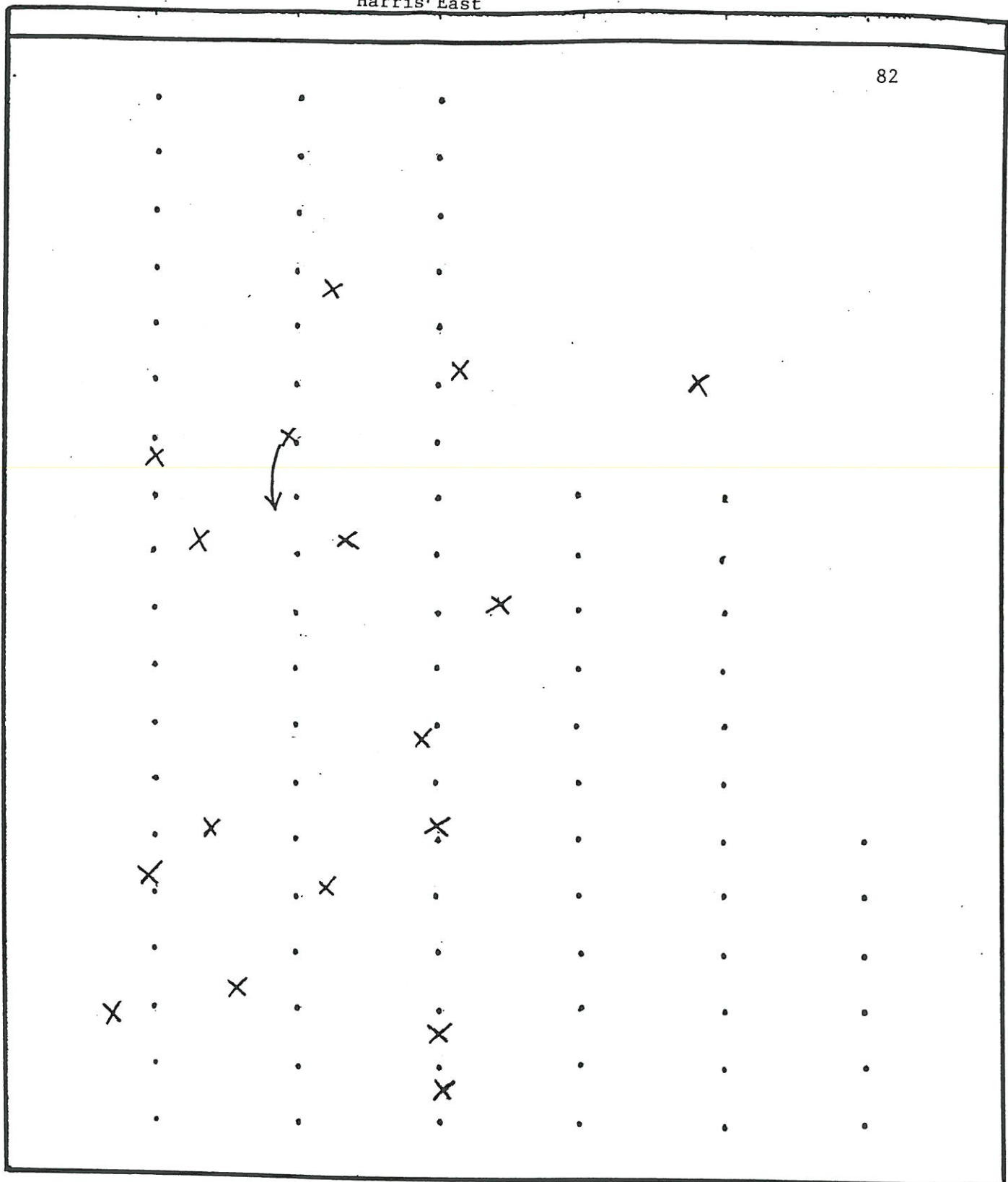
1

Prairie Warbler

Scale

1 in. = 50 m

1 cm = 20 m



Row

6

5

4

3

2

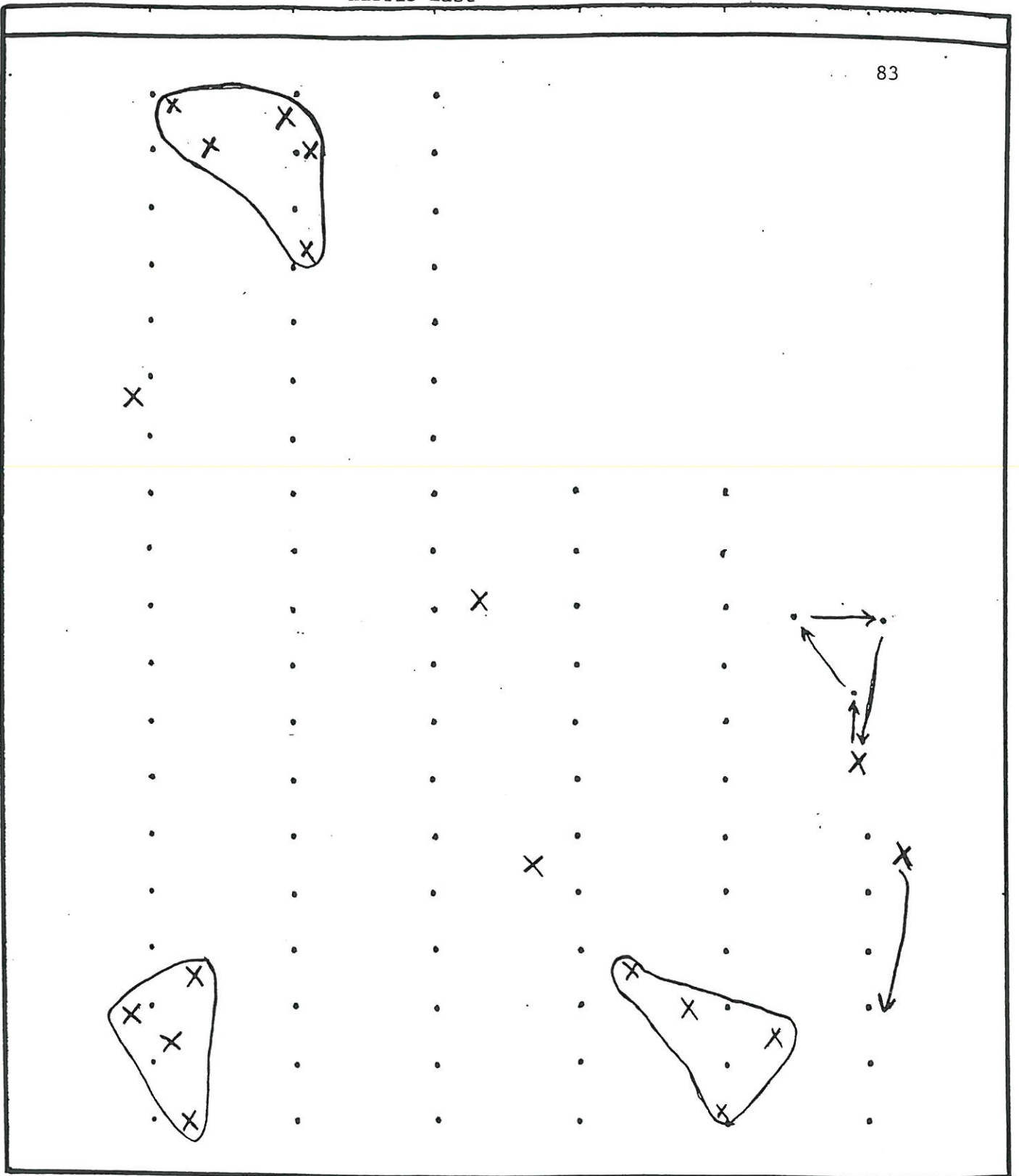
1

Common Yellowthroat

Scale

1 in. = 50 m

1 cm = 20 m



Row

6

5

4

3

2

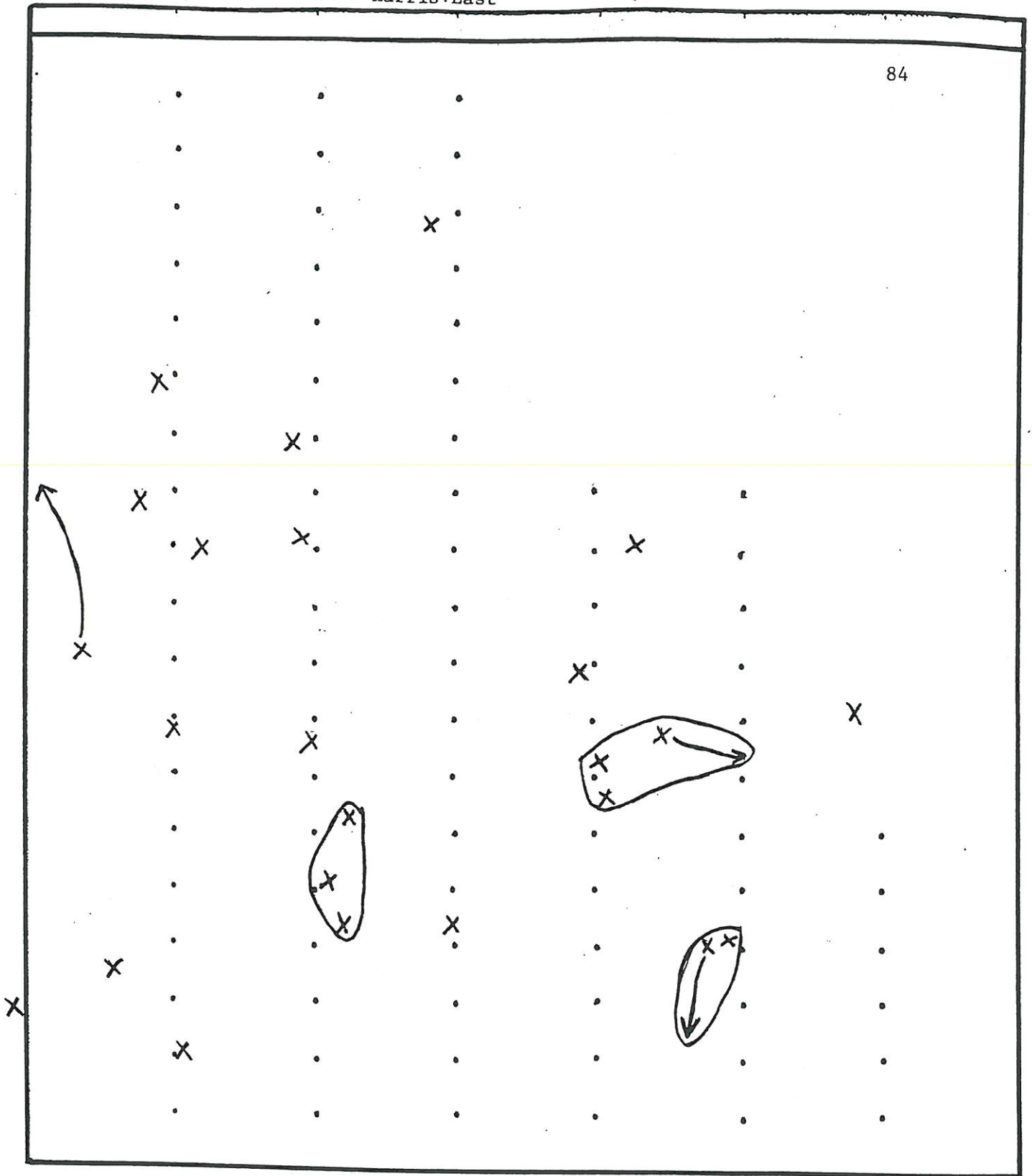
1

Hooded Warbler

Scale

1 in. = 50 m

1 cm = 20 m

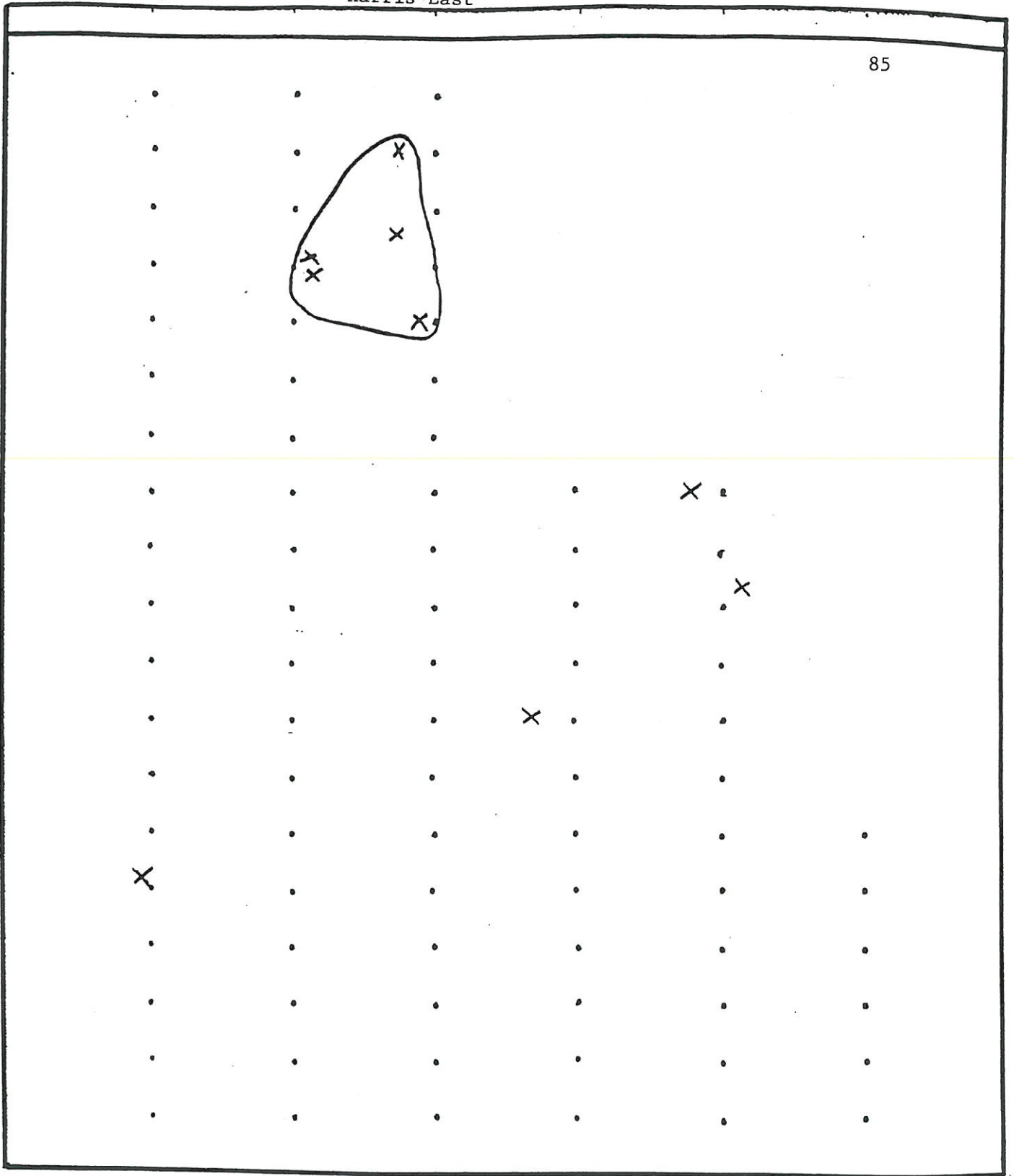


Row 6 5 4 3 2 1

Yellow-breasted Chat

Scale

1 in. = 50 m
1 cm = 20 m



Row

6

5

4

3

2

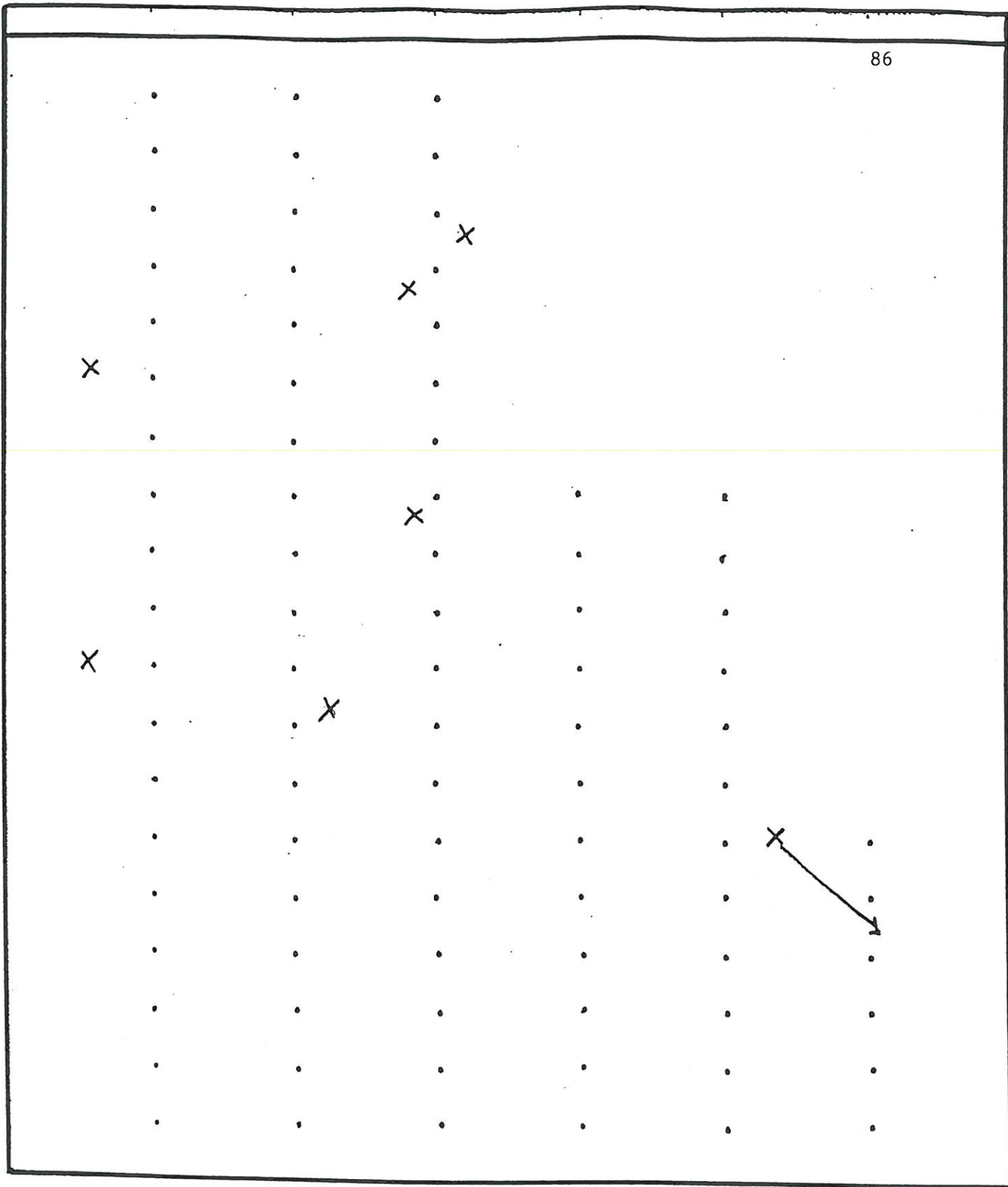
1

Summer Tanager

Scale

1 in. = 50 m

1 cm = 20 m

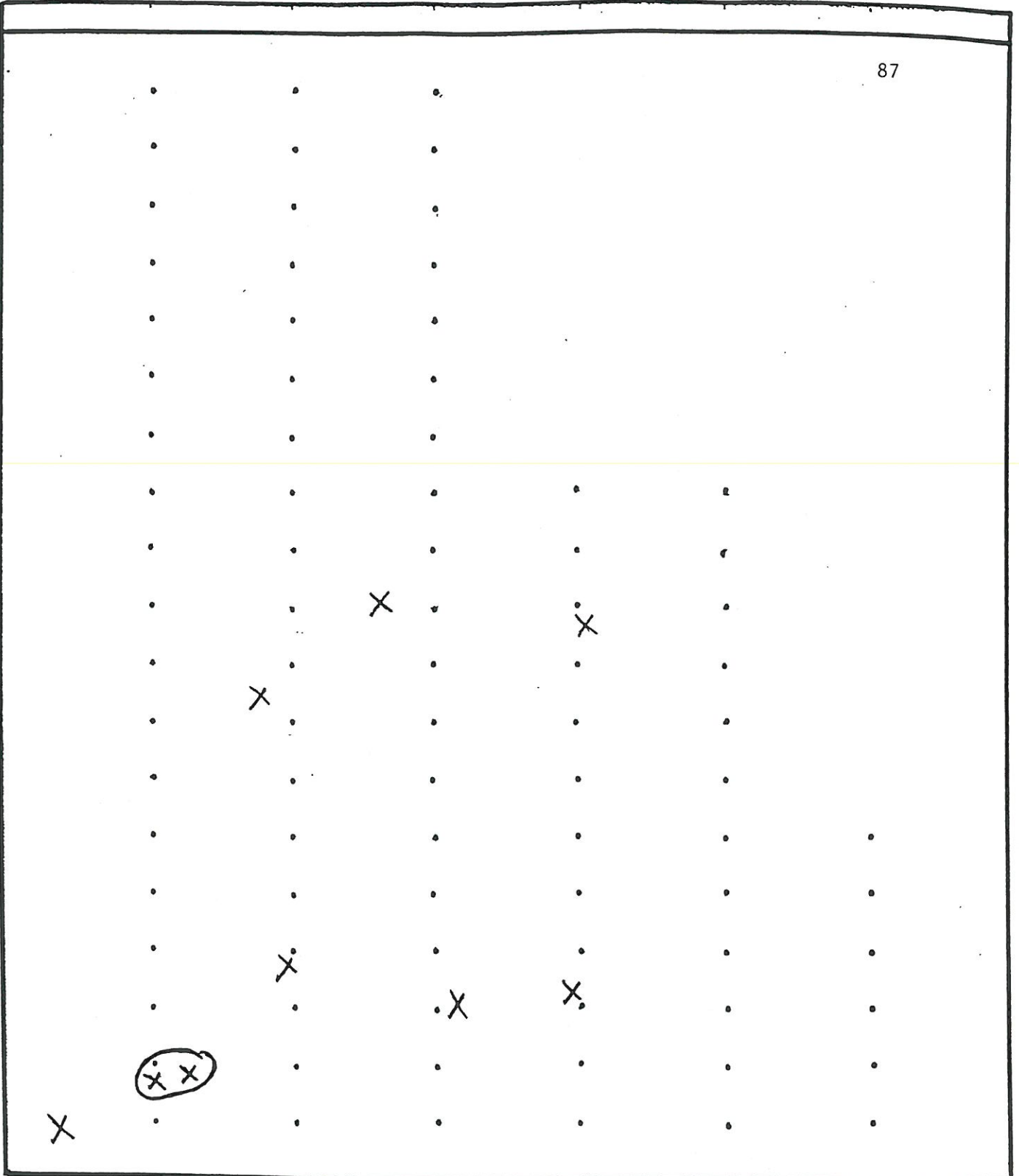


Row 6 5 4 3 2 1

Scarlet Tanager

Scale

1 in. = 50 m
1 cm = 20 m



Row

6

5

4

3

2

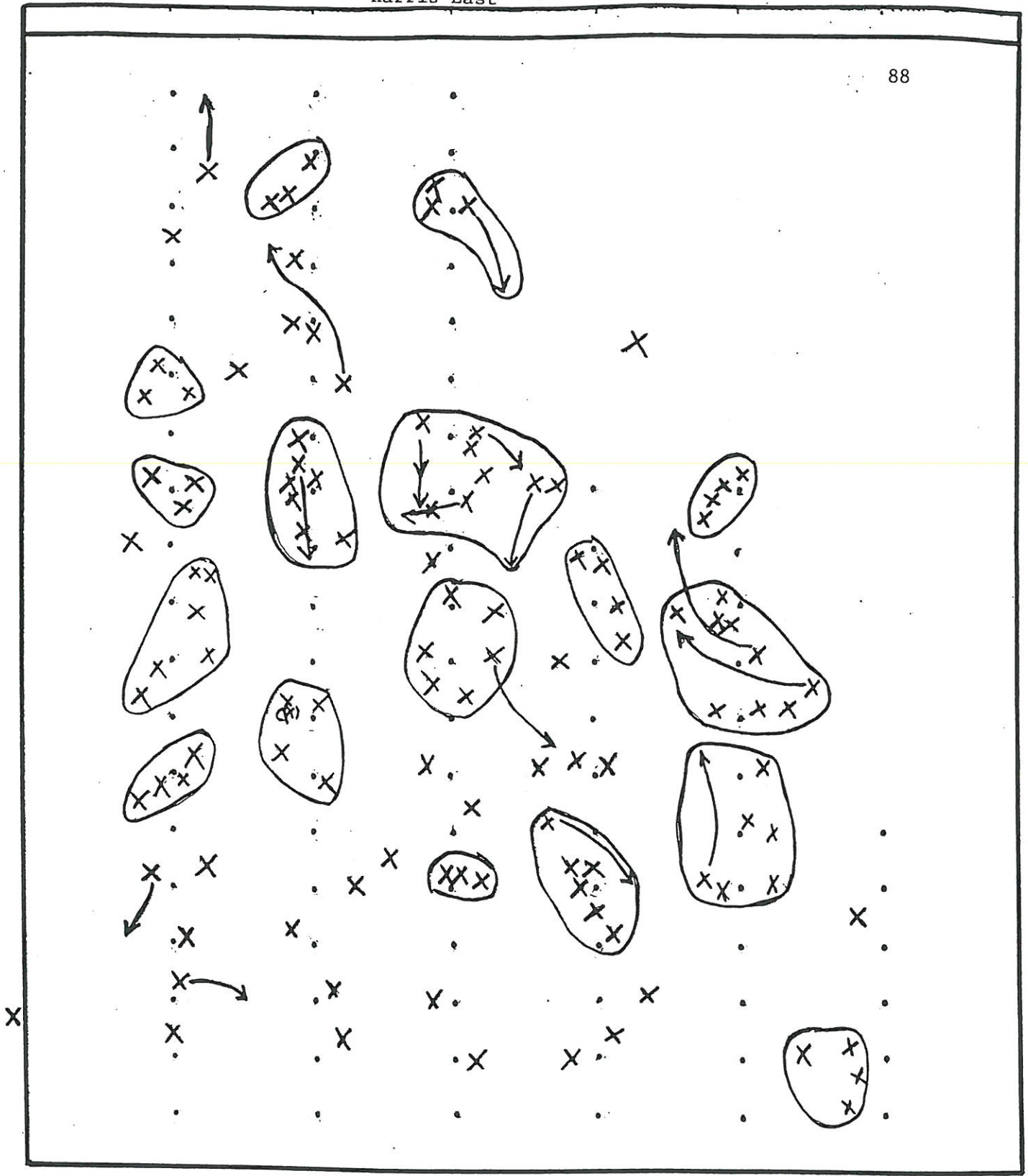
1

Northern Cardinal

Scale

1 in. = 50 m

1 cm = 20 m



Row

6

5

4

3

2

X

1

Indigo Bunting

Scale

1 in. = 50 m

1 cm = 20 m



Row

6

5

4 X

3

2

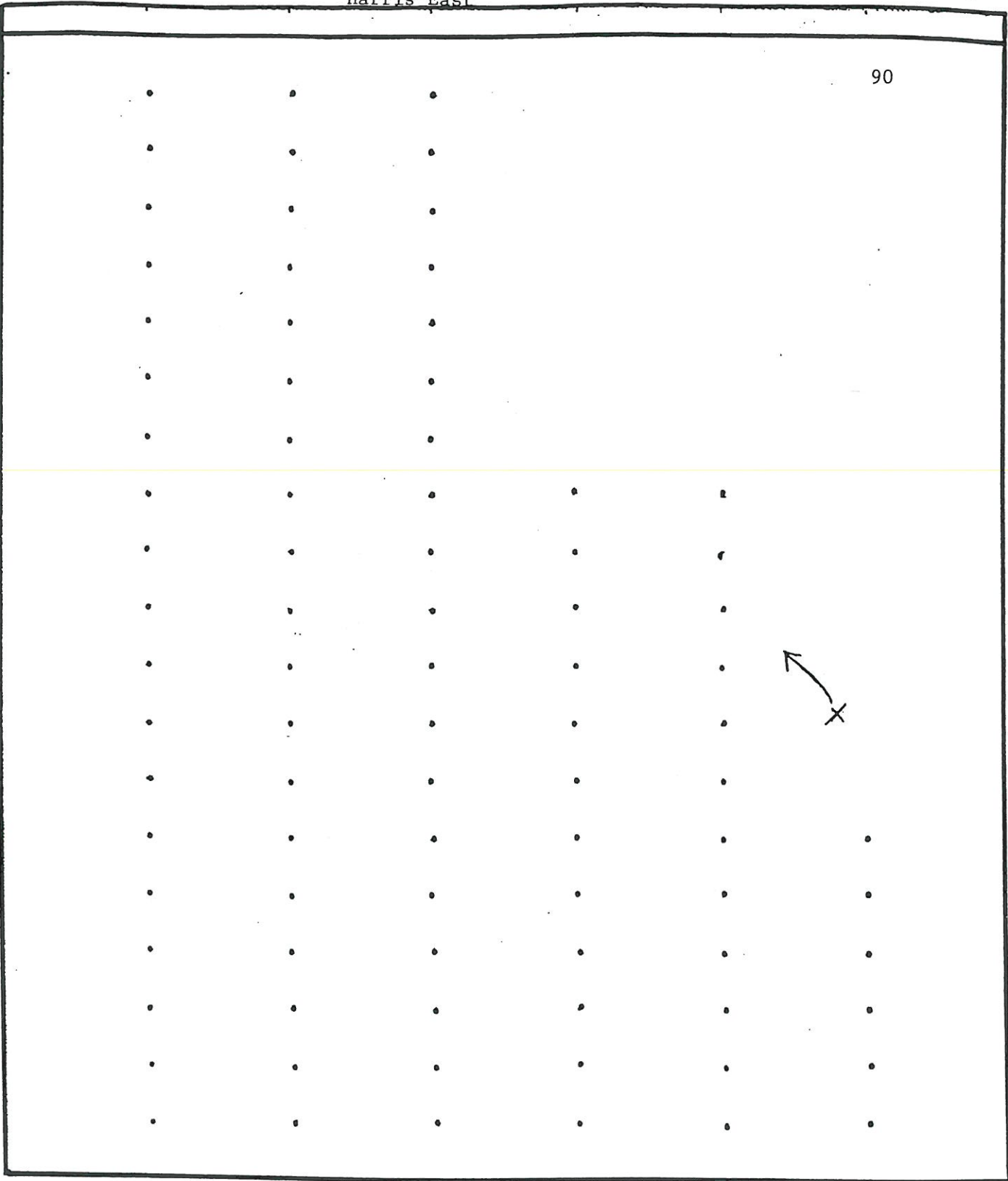
1

Rufous-sided Towhee

Scale

1 in. = 50 m

1 cm = 20 m



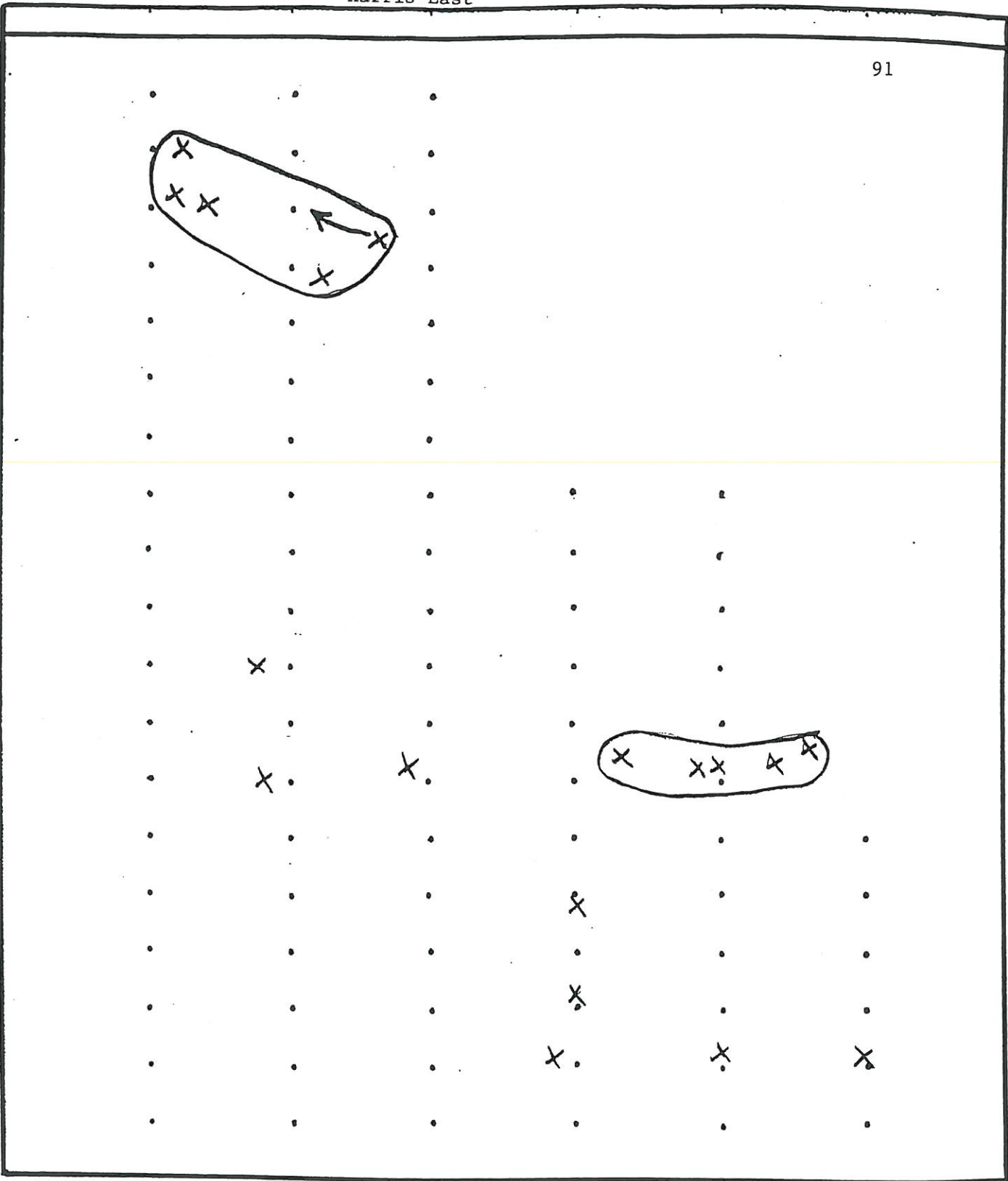
Row 6 5 4 3 2 1

Chipping Sparrow

Scale

1 in. = 50 m

1 cm = 20 m

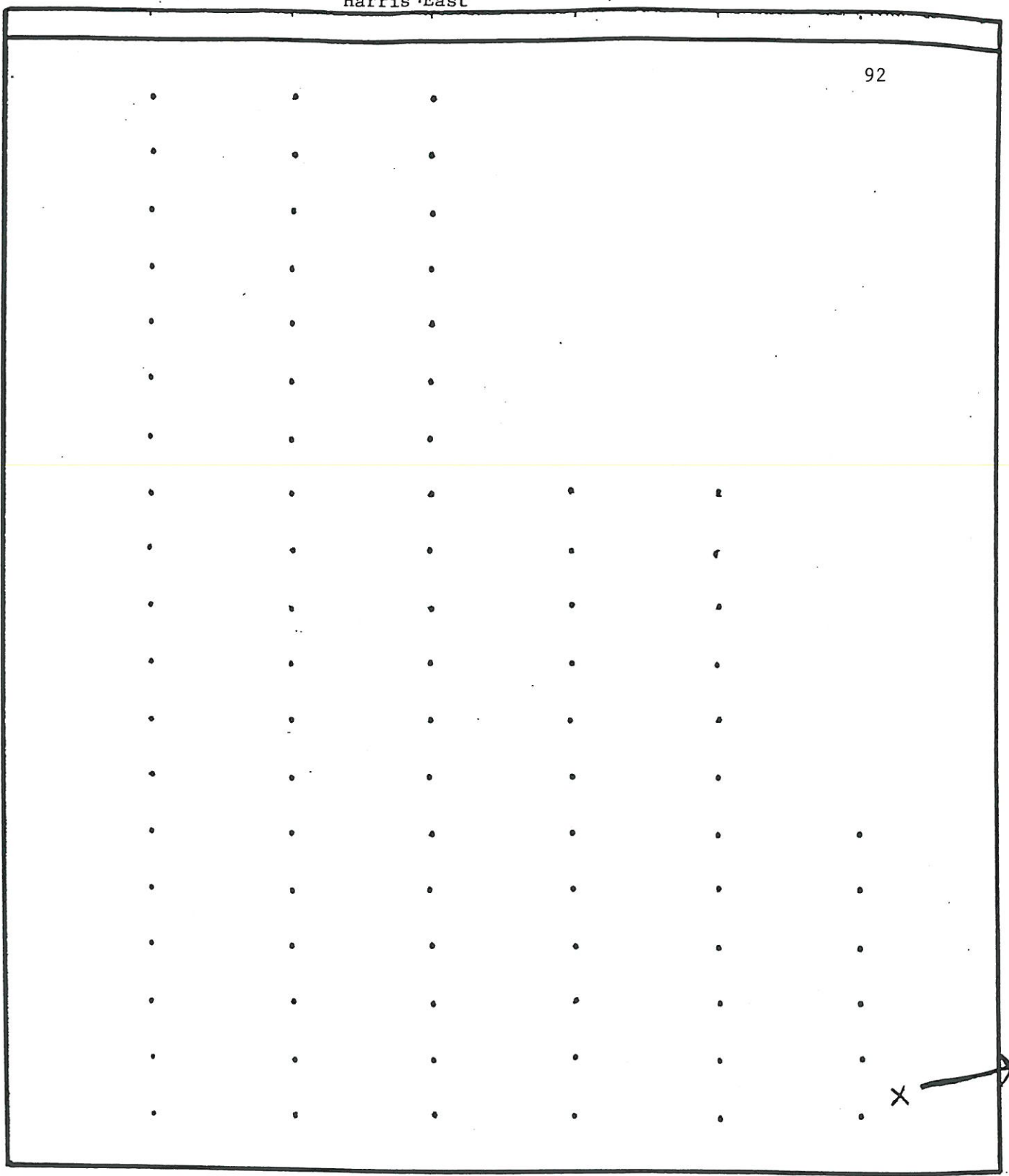


Row 6 5 4 3 2 1

Field Sparrow

Scale

1 in. = 50 m
1 cm = 20 m

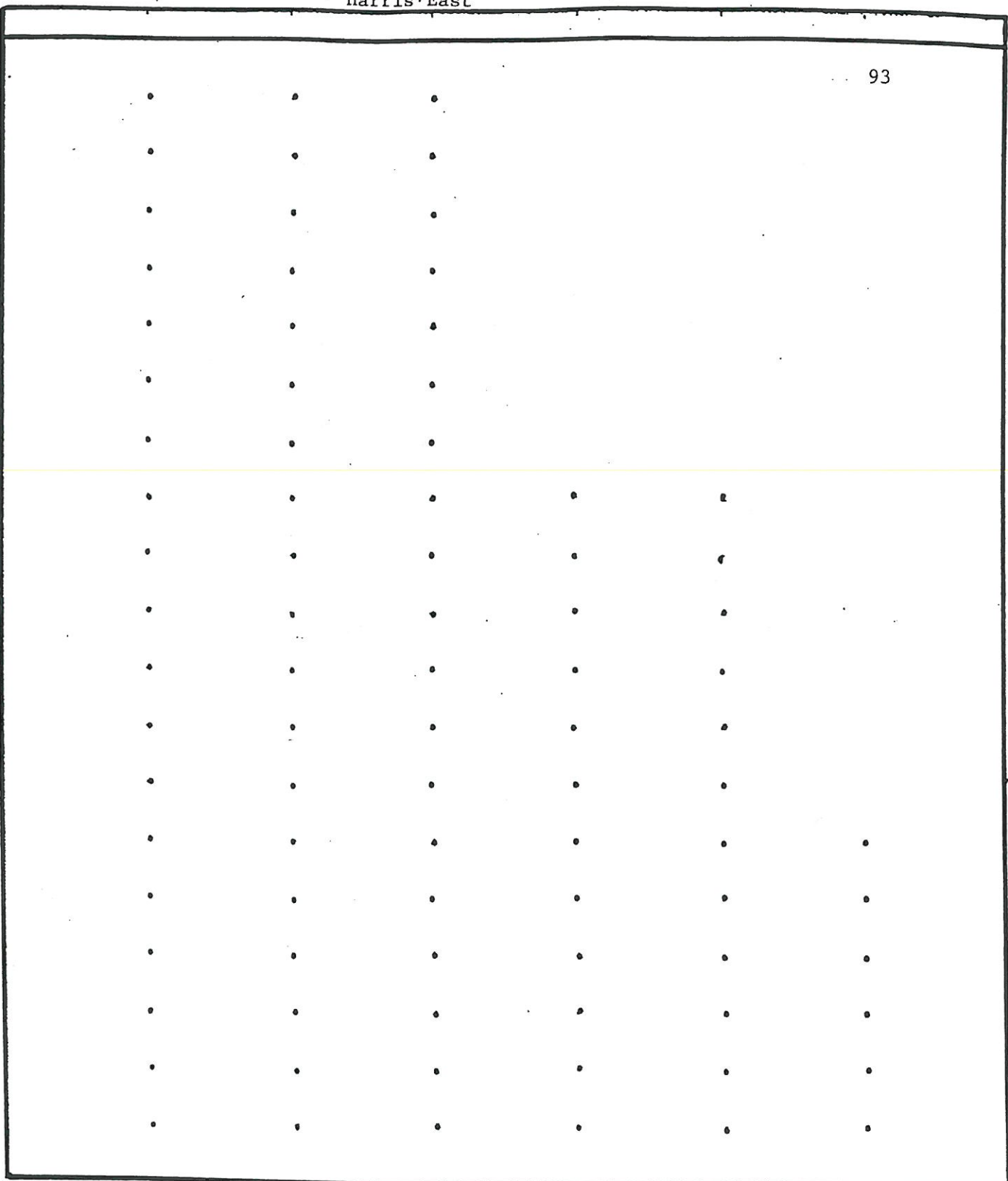


Row 6 5 4 3 2 1

Grasshopper Sparrow

Scale

1 in. = 50 m
1 cm = 20 m



X

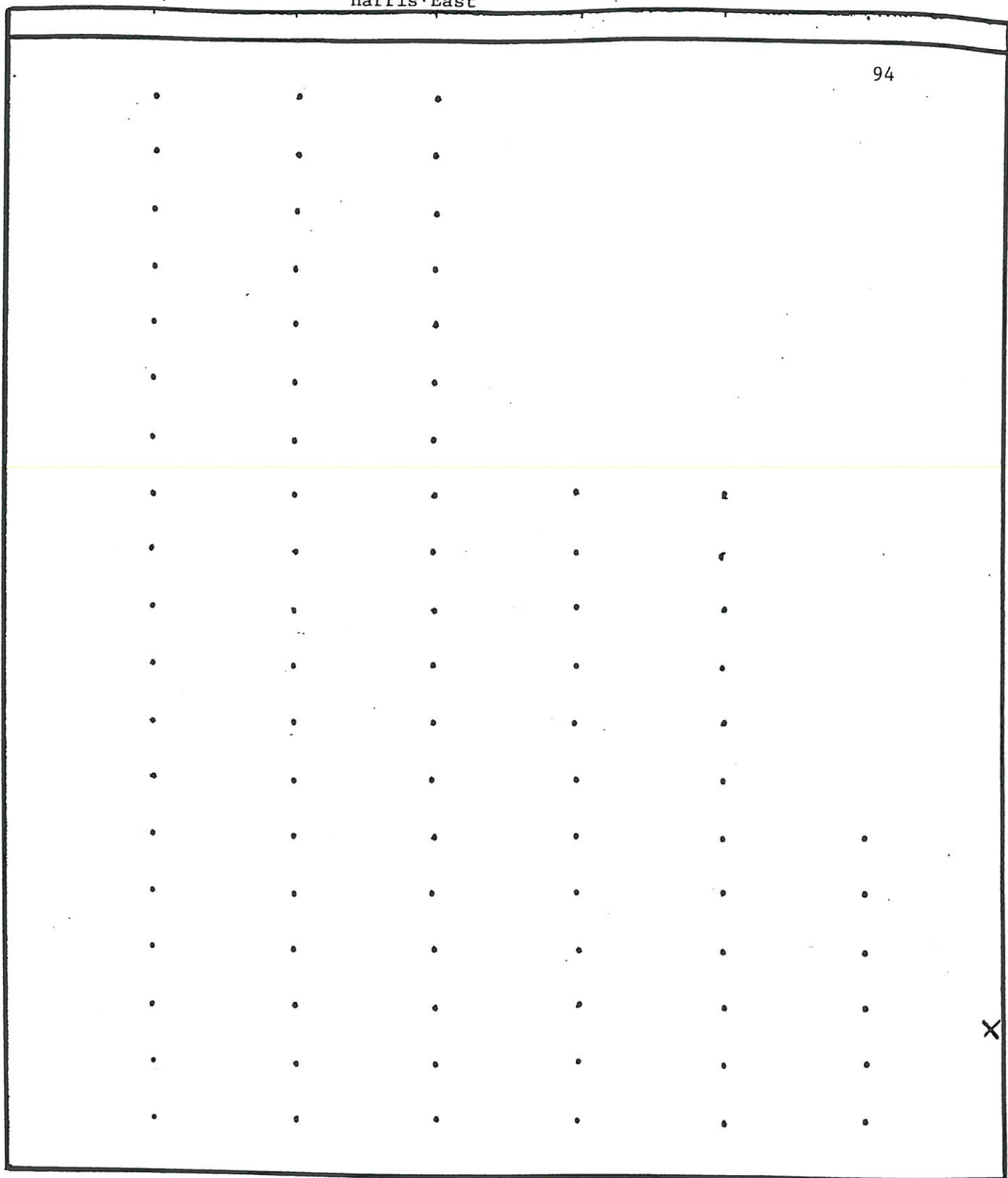
Row 6 5 4 3 2 1

Red-winged Blackbird

Scale

1 in. = 50 m

1 cm = 20 m



XX

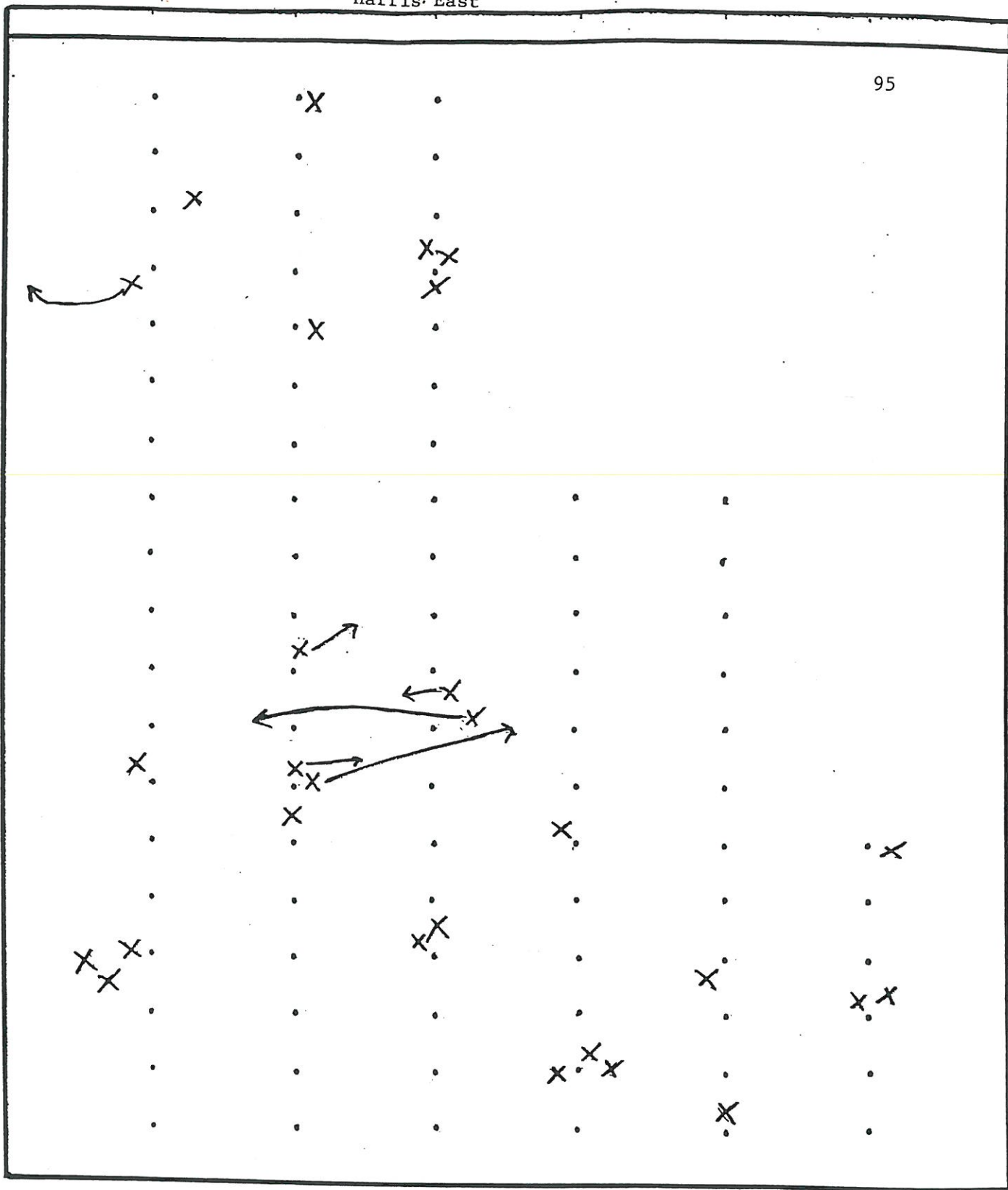
X

Row 6 5 4 3 2 1

Eastern Meadowlark

Scale

1 in. = 50 m
1 cm = 20 m



Row

6

5

4

3

2

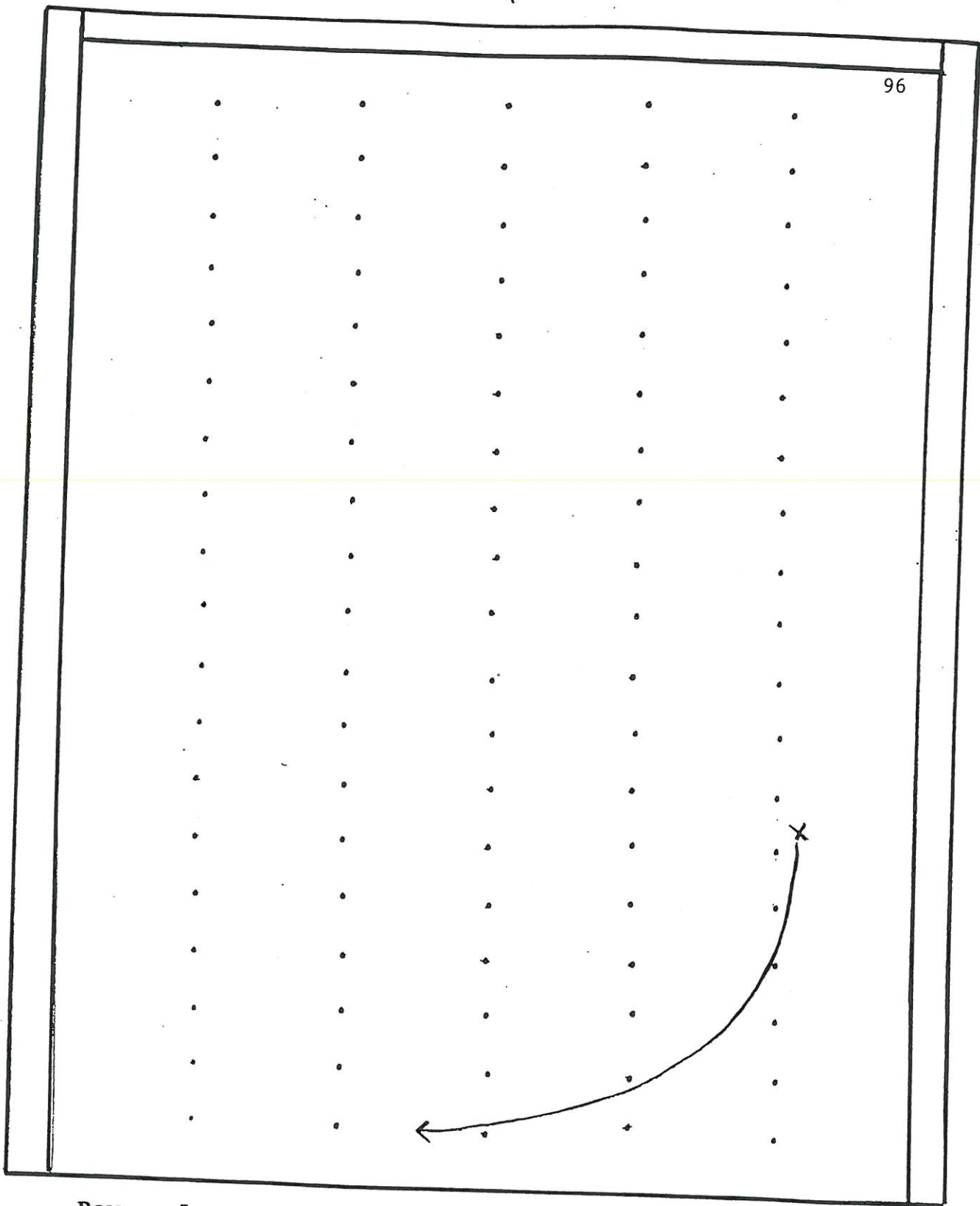
1

Brown-headed Cowbird

Scale

1 in. = 50 m

1 cm = 20 m

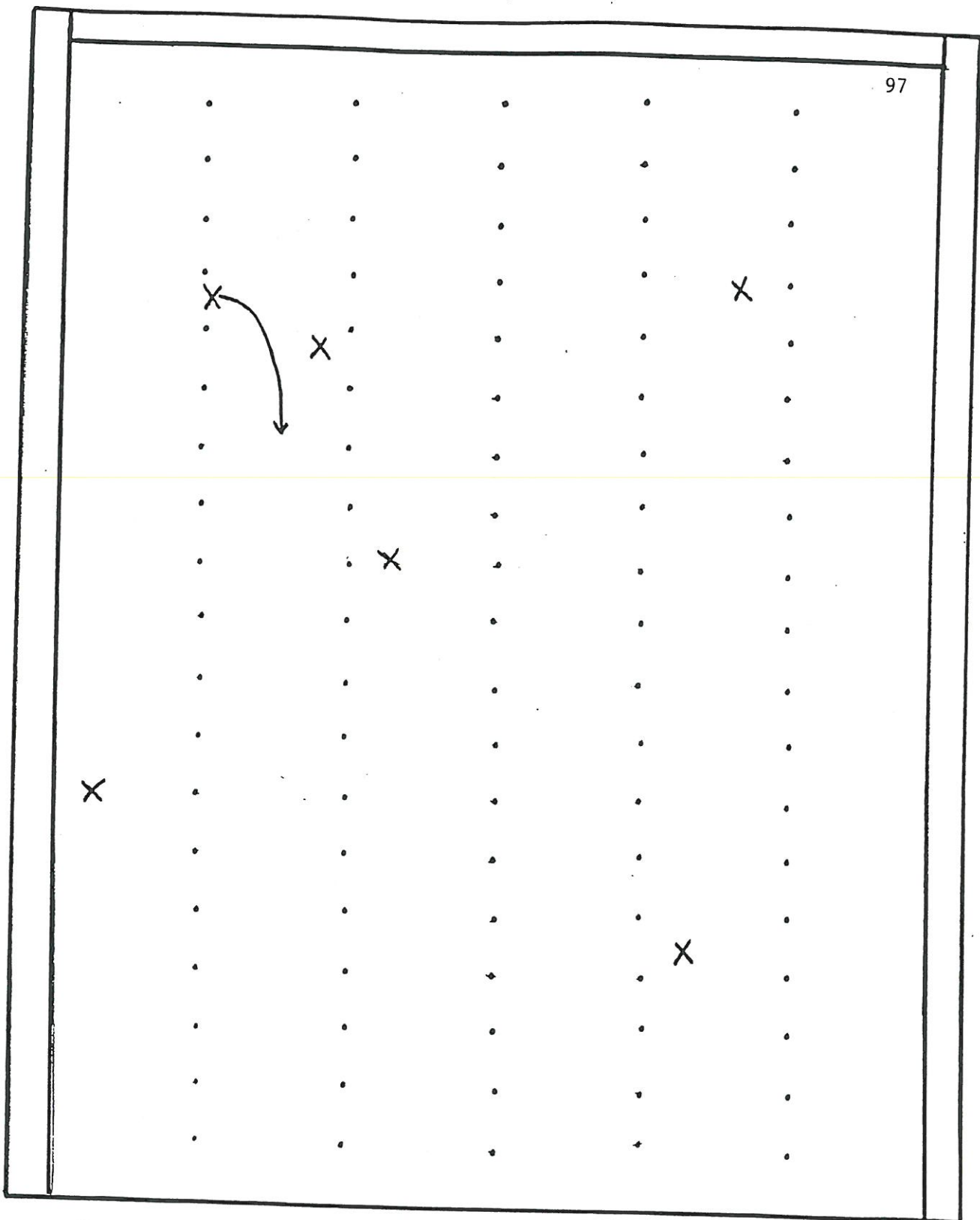


Row 5 4 3 2 1

Red-tailed Hawk

Scale

1 in. = 50 m
1 cm = 20 m



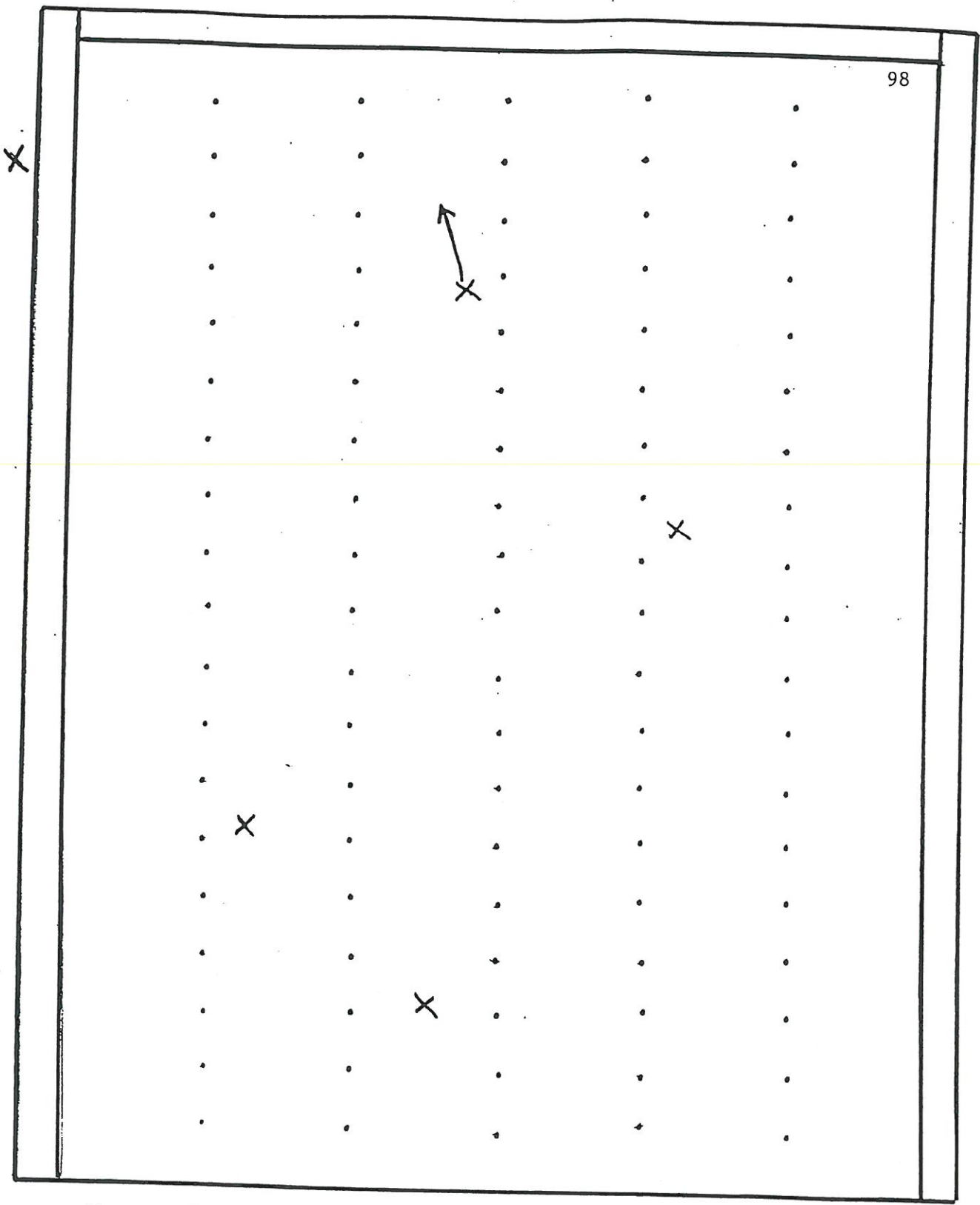
Row 5 4 3 2 1

Northern Bobwhite

Scale

1 in. = 50 m
1 cm = 20 m

X

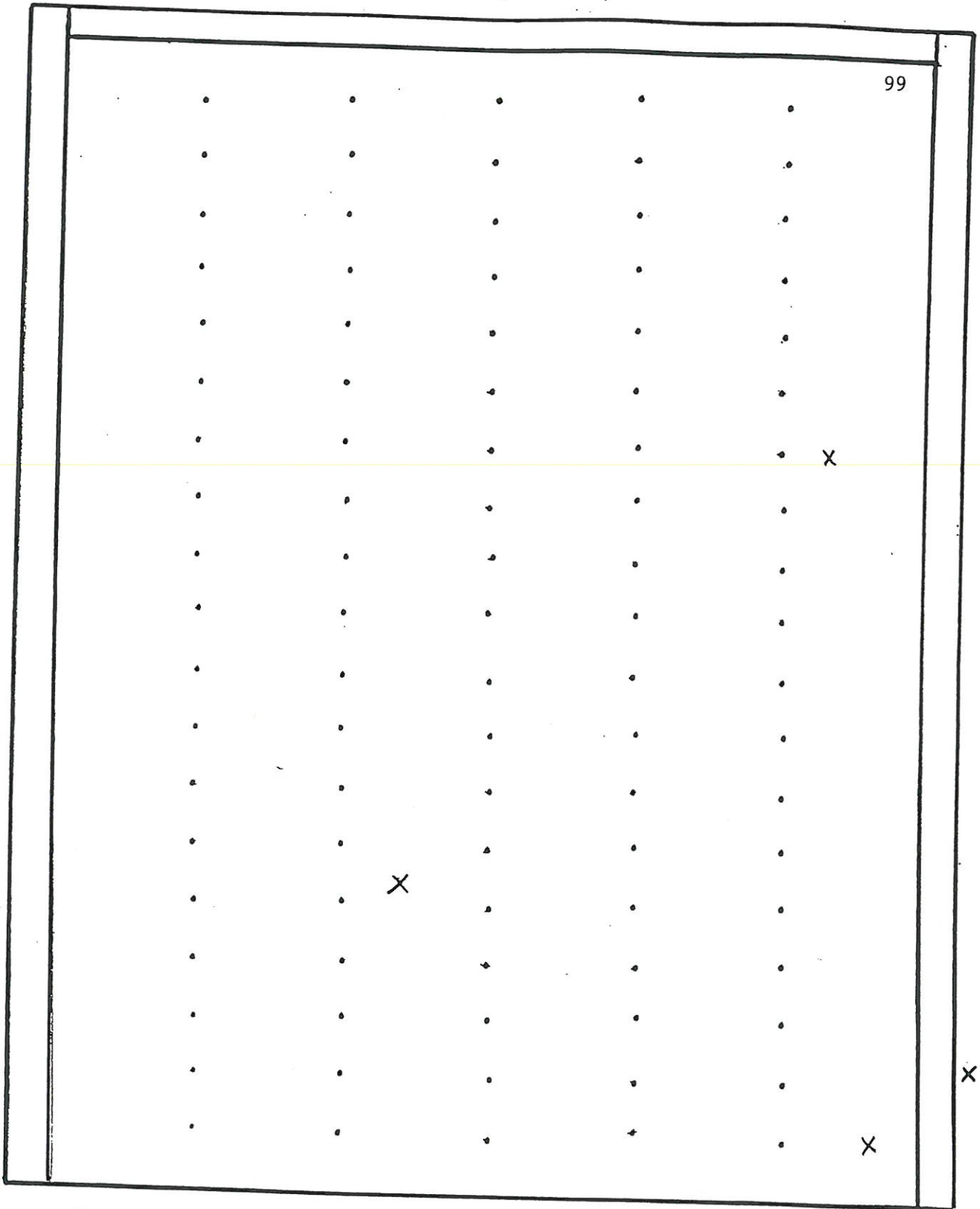


Row 5 4 3 2 1

Mourning Dove

Scale

1 in. = 50 m
1 cm = 20 m

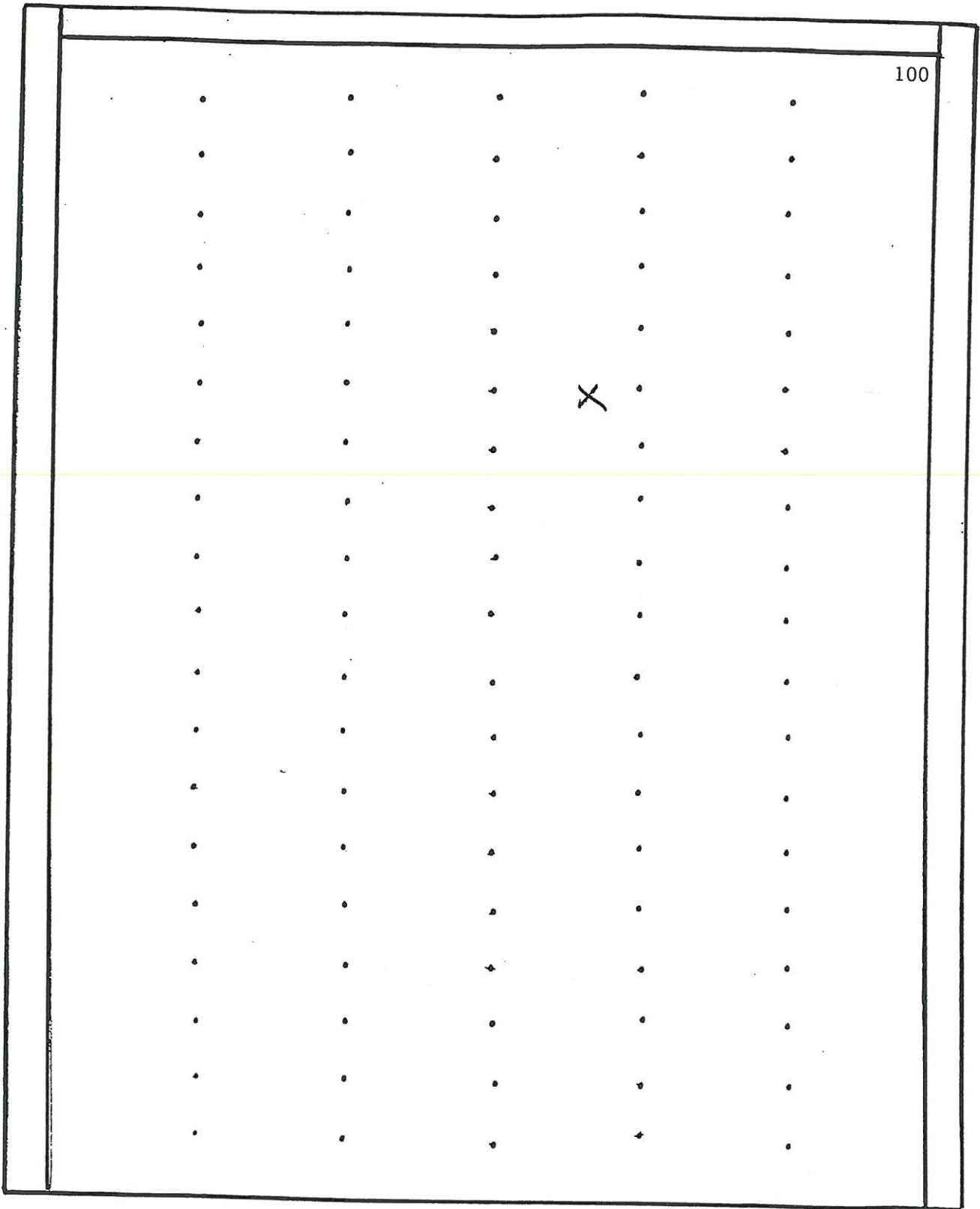


Row 5 4 3 2 1

Yellow-billed Cuckoo

Scale

1 in. = 50 m
1 cm = 20 m

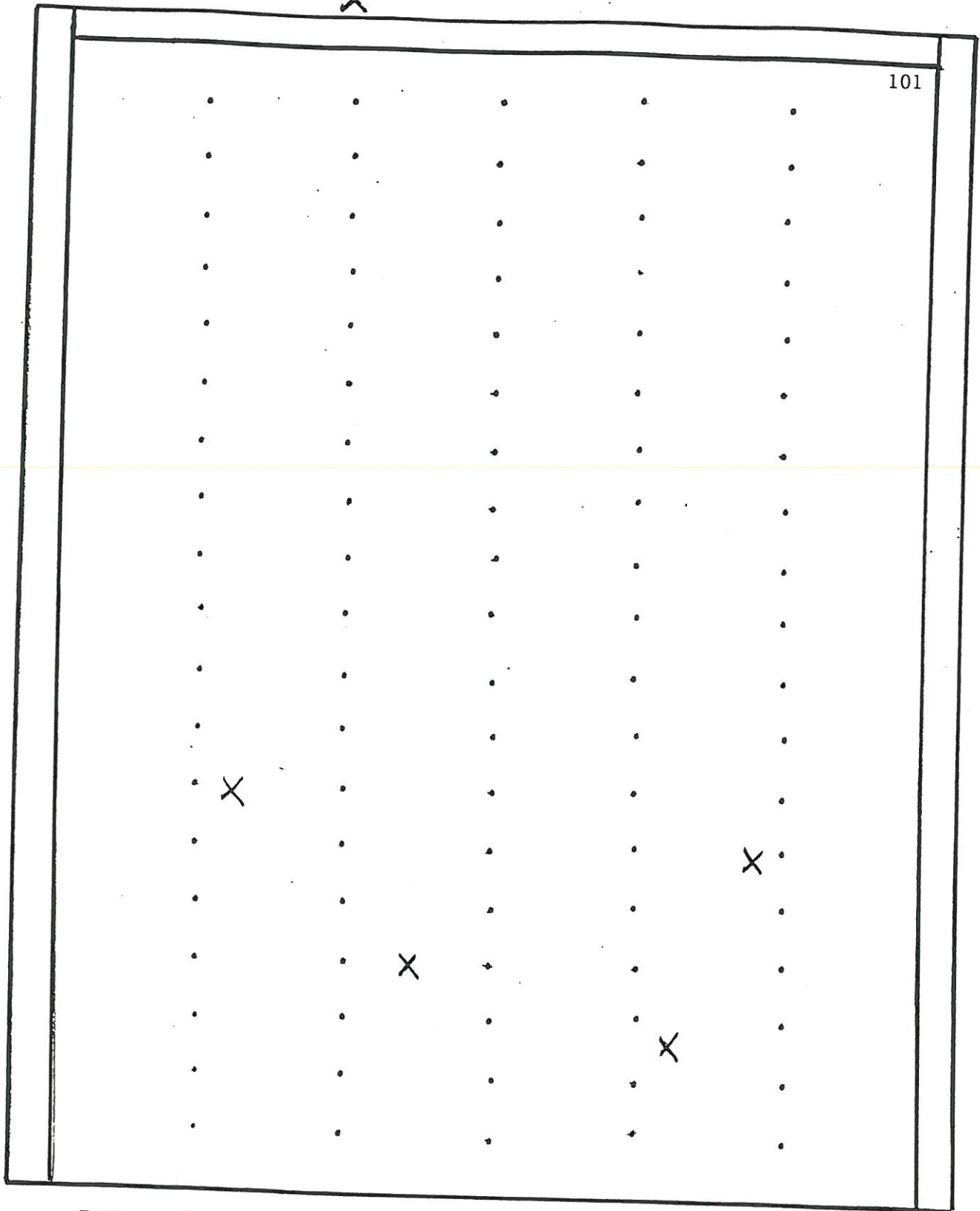


Row 5 4 3 2 1

Ruby-throated Hummingbird

Scale

1 in. = 50 m
1 cm = 20 m

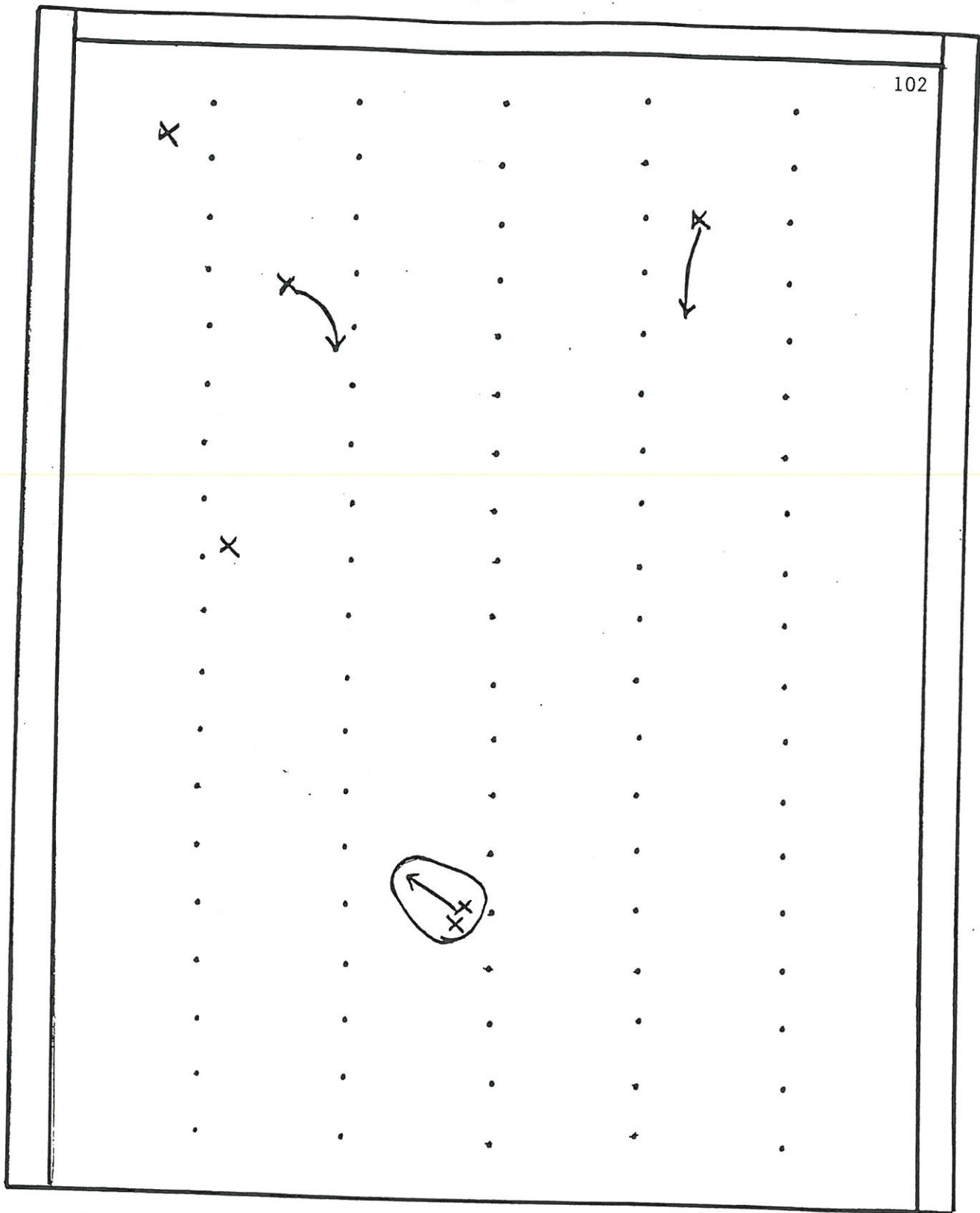


Row 5 4 3 2 1

Red-bellied Woodpecker

Scale

1 in. = 50 m
1 cm = 20 m

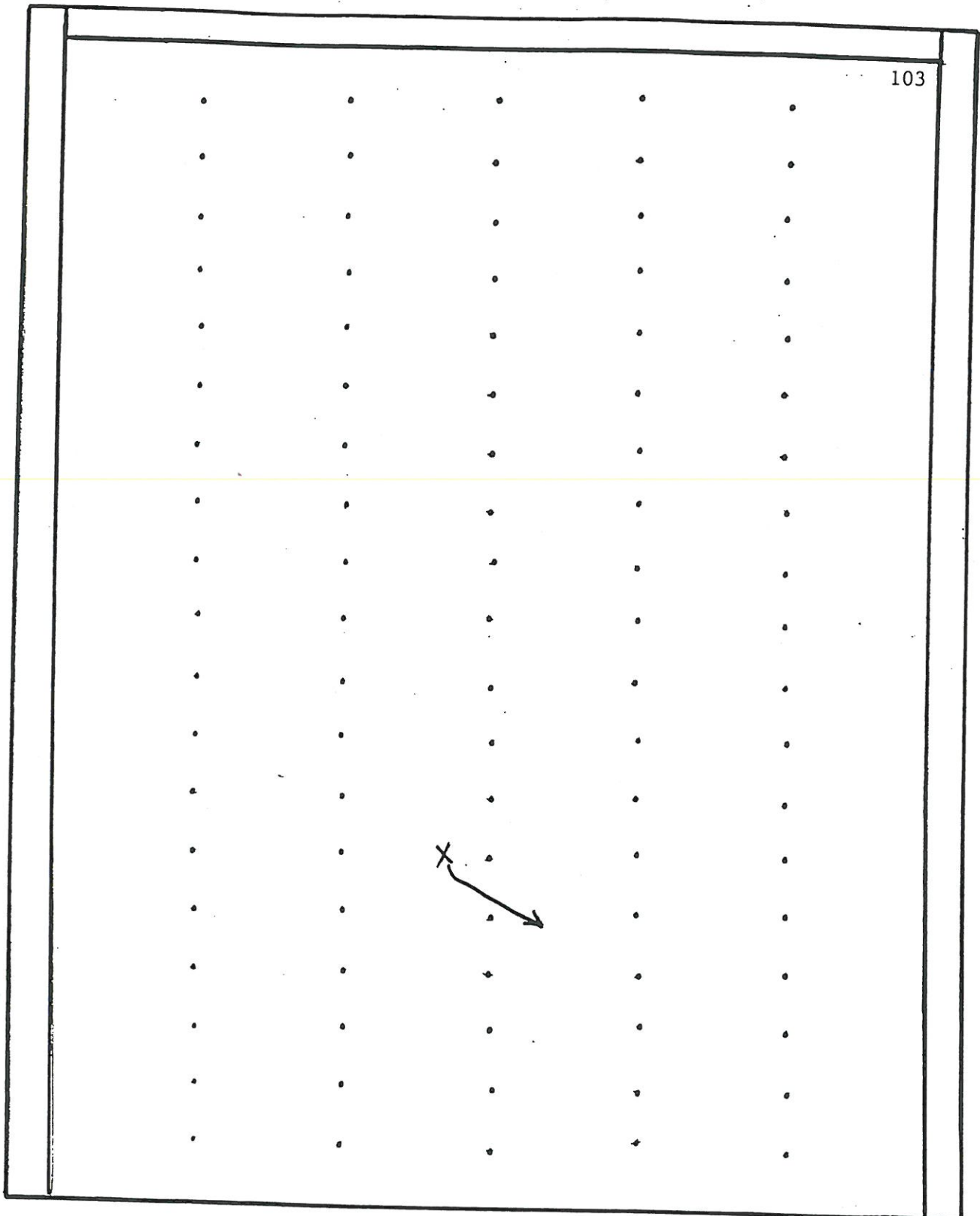


Row 5 4 3 2 1

Downy Woodpecker

Scale

1 in. = 50 m
1 cm = 20 m

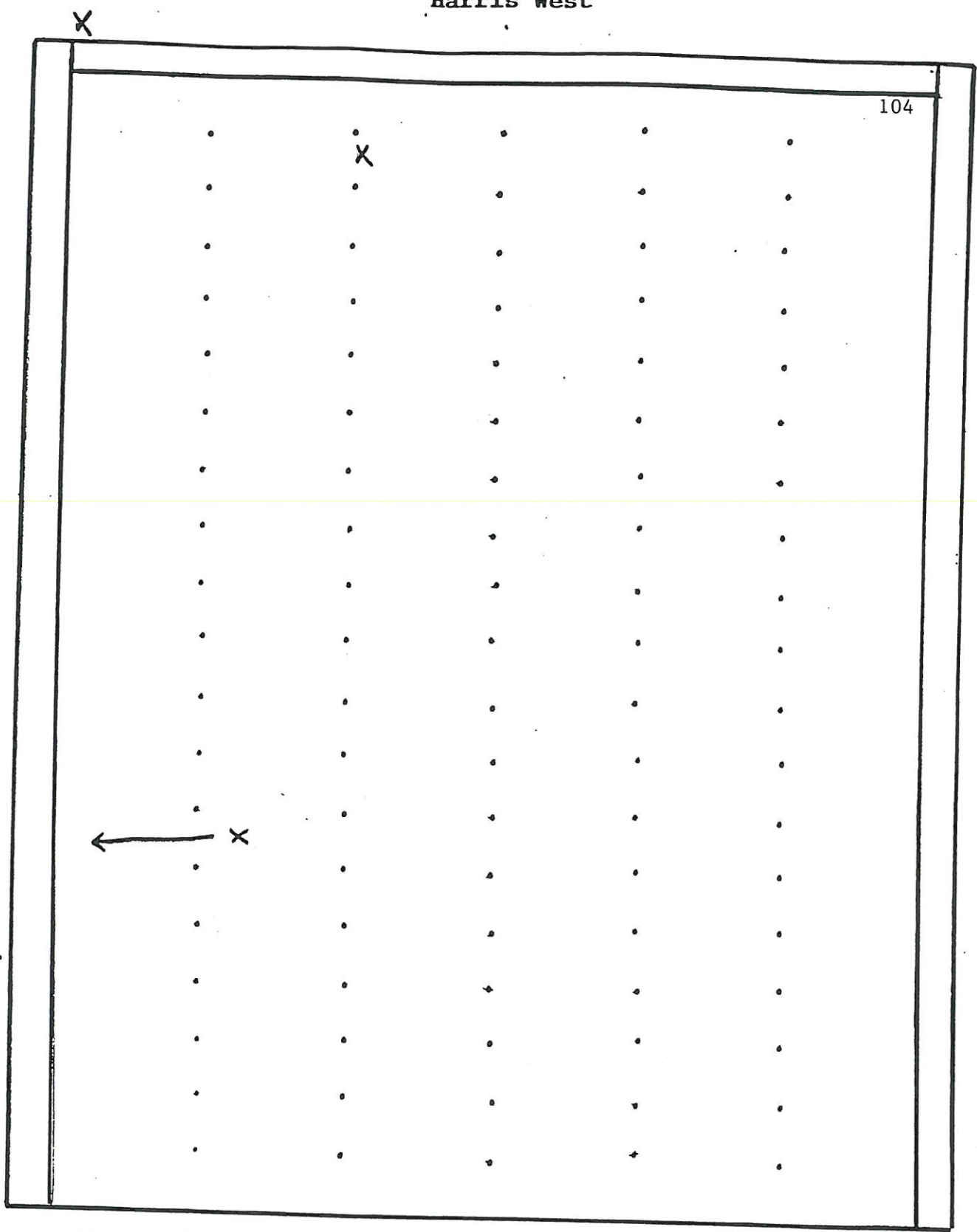


Row 5 4 3 2 1

Hairy Woodpecker

Scale

1 in. = 50 m
1 cm = 20 m

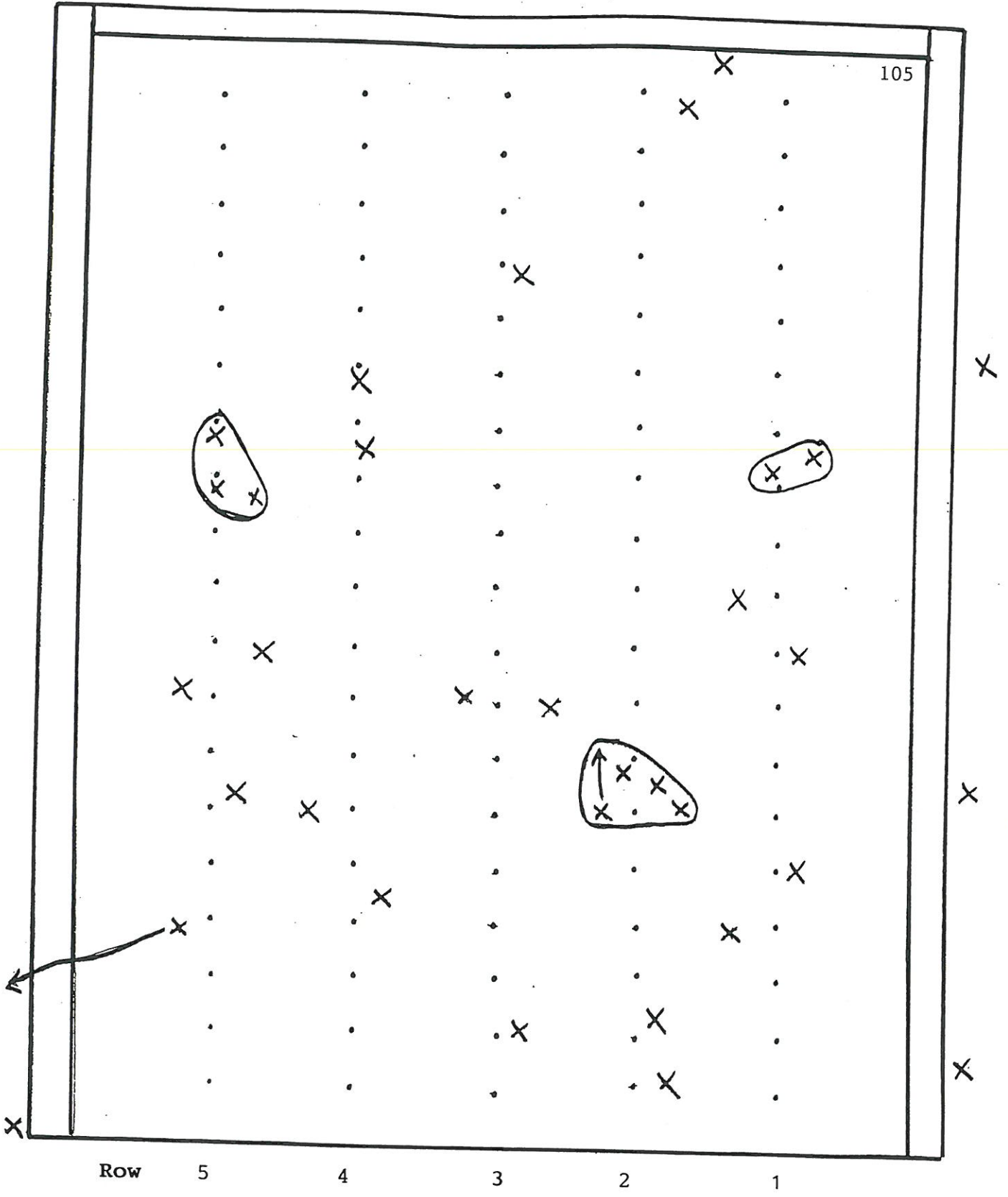


Row 5 4 3 2 1

Pileated Woodpecker

Scale

1 in. = 50 m
1 cm = 20 m

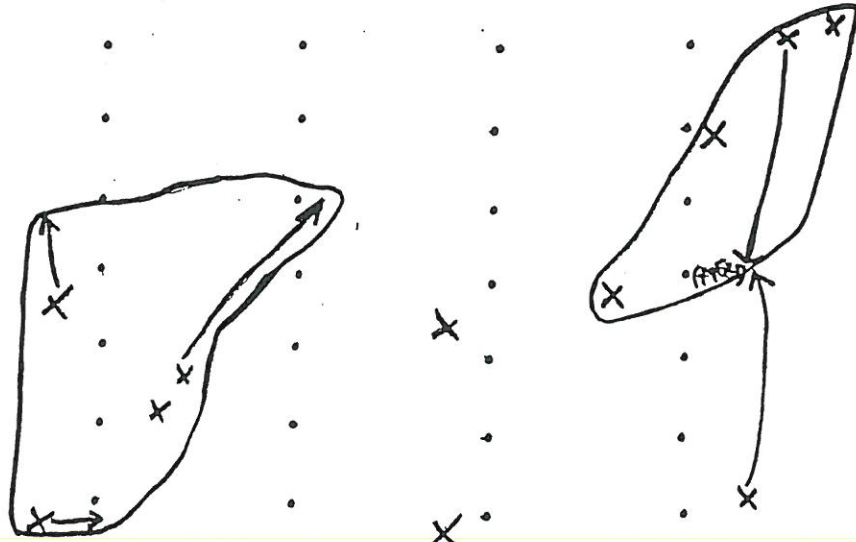


Row 5 4 3 2 1

Eastern Wood-pewee

Scale

1 in. = 50 m
1 cm = 20 m

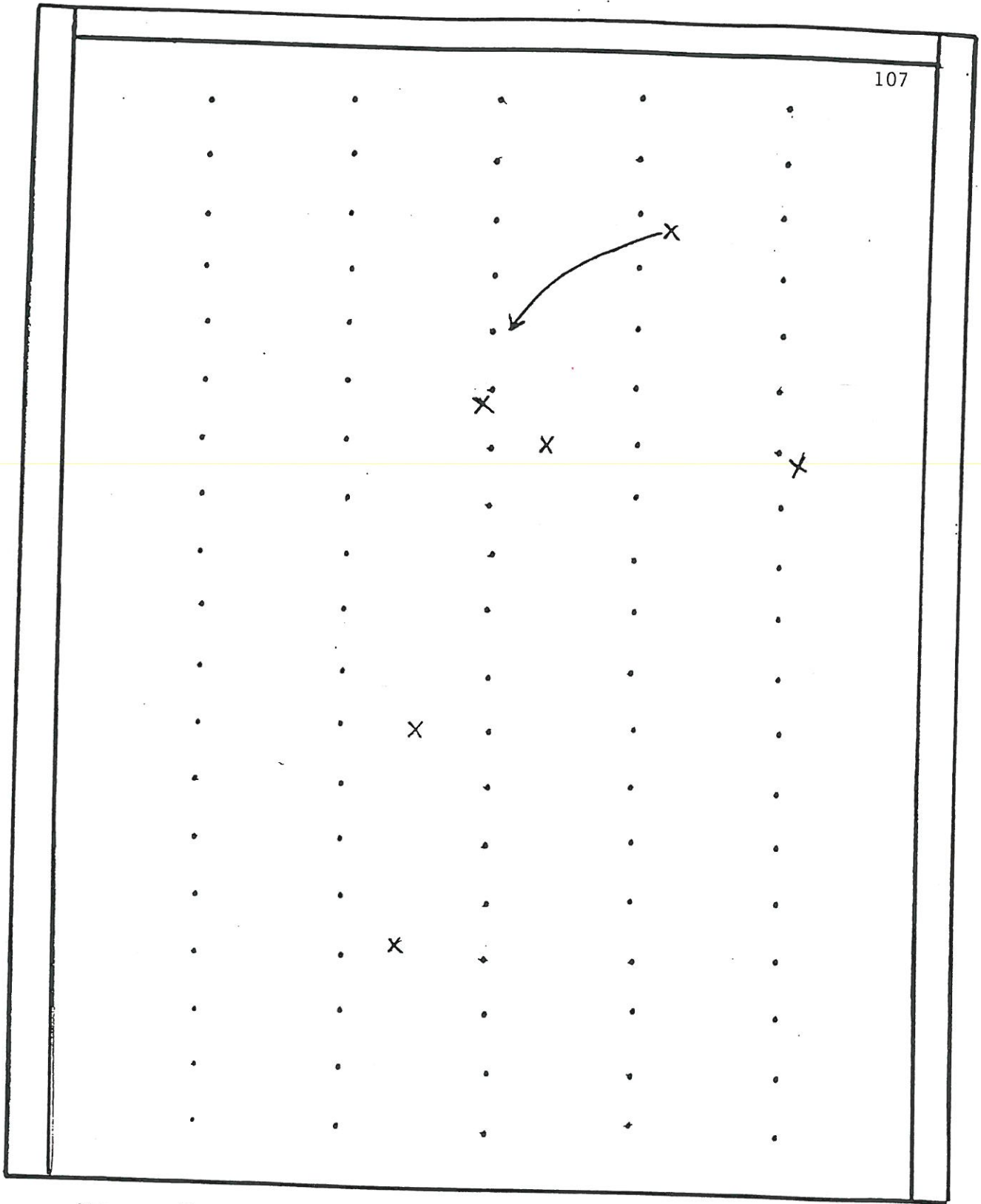


Row 5 4 3 X 2 1

Great-crested Flycatcher

Scale

1 in. = 50 m
1 cm = 20 m

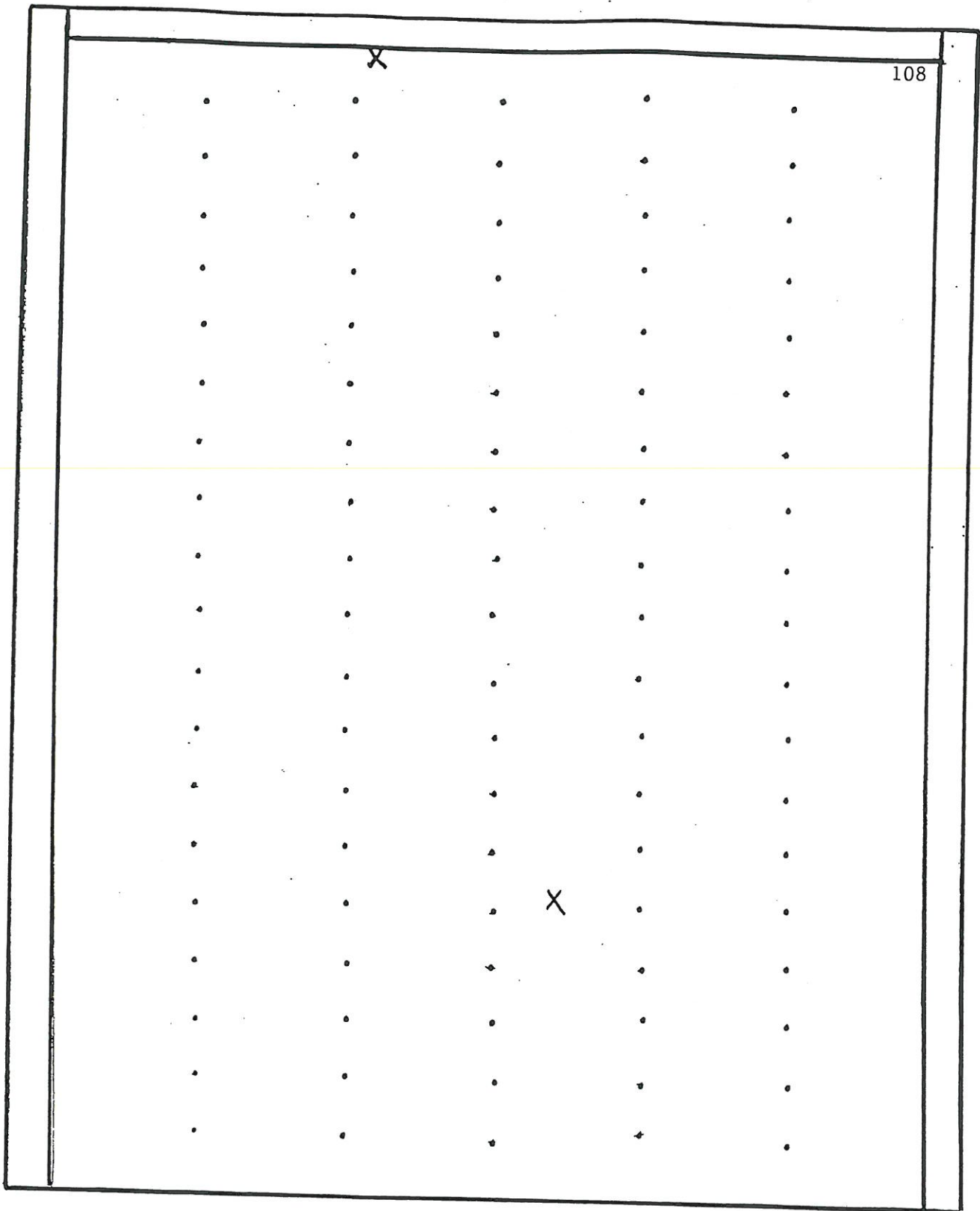


Row 5 4 3 2 1

Blue Jay

Scale

1 in. = 50 m
1 cm = 20 m

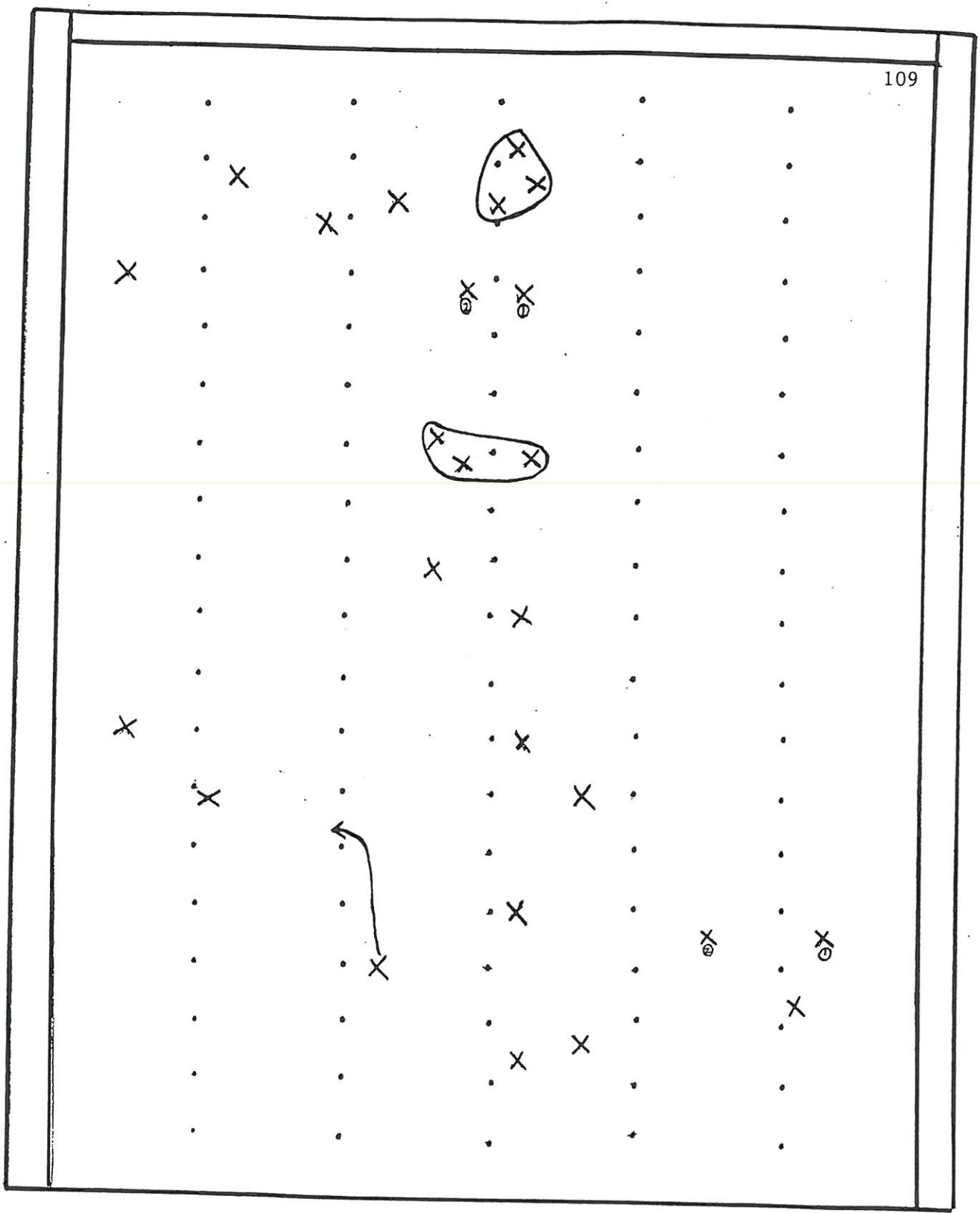


Row 5 4 3 2 1

American Crow

Scale

1 in. = 50 m
1 cm = 20 m



Row 5 4 3 2 1

Carolina Chickadee

Scale

1 in. = 50 m
 1 cm = 20 m

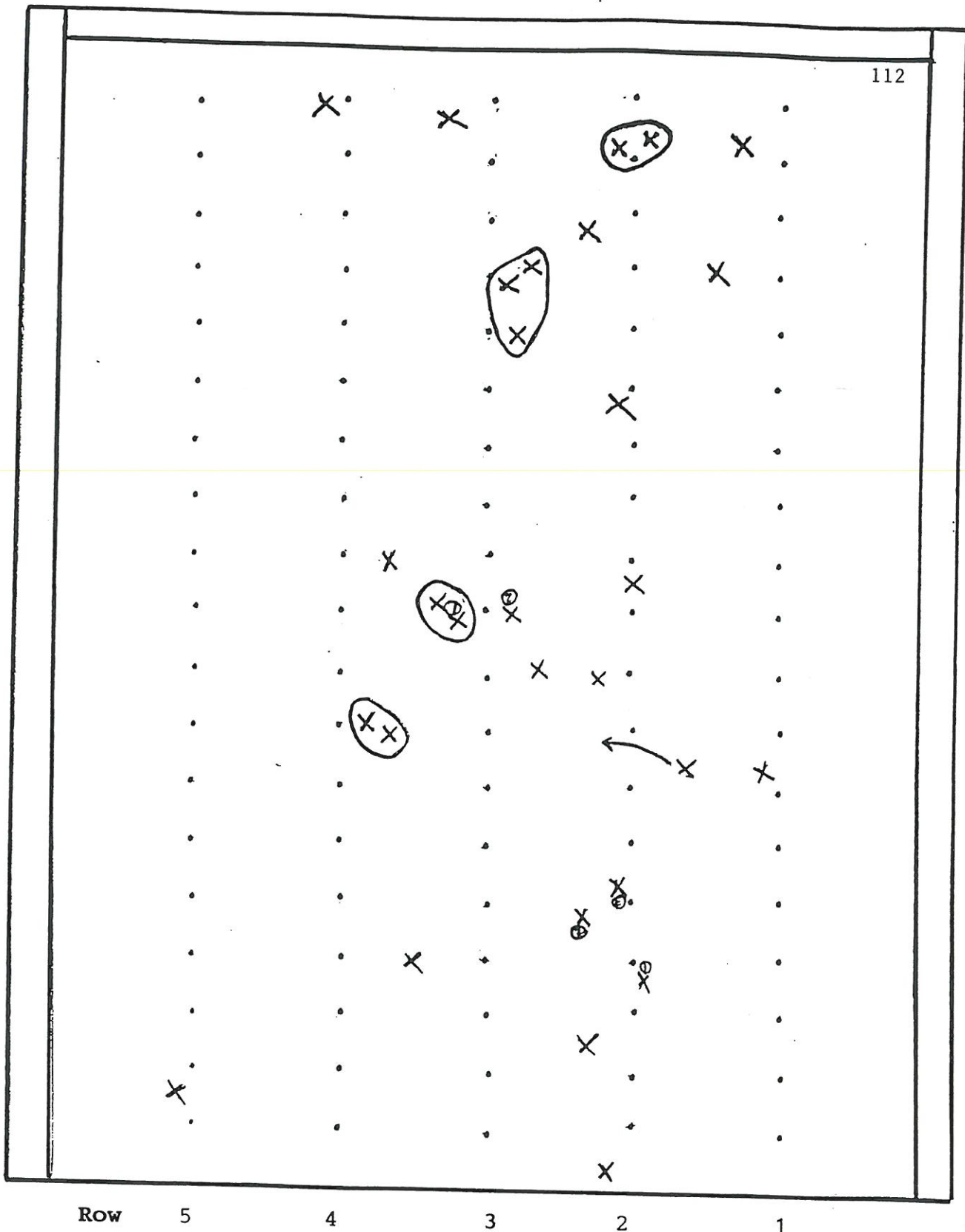


Row 5 4 3 2 1

Carolina Wren

Scale

1 in. = 50 m
1 cm = 20 m



Row

5

4

3

2

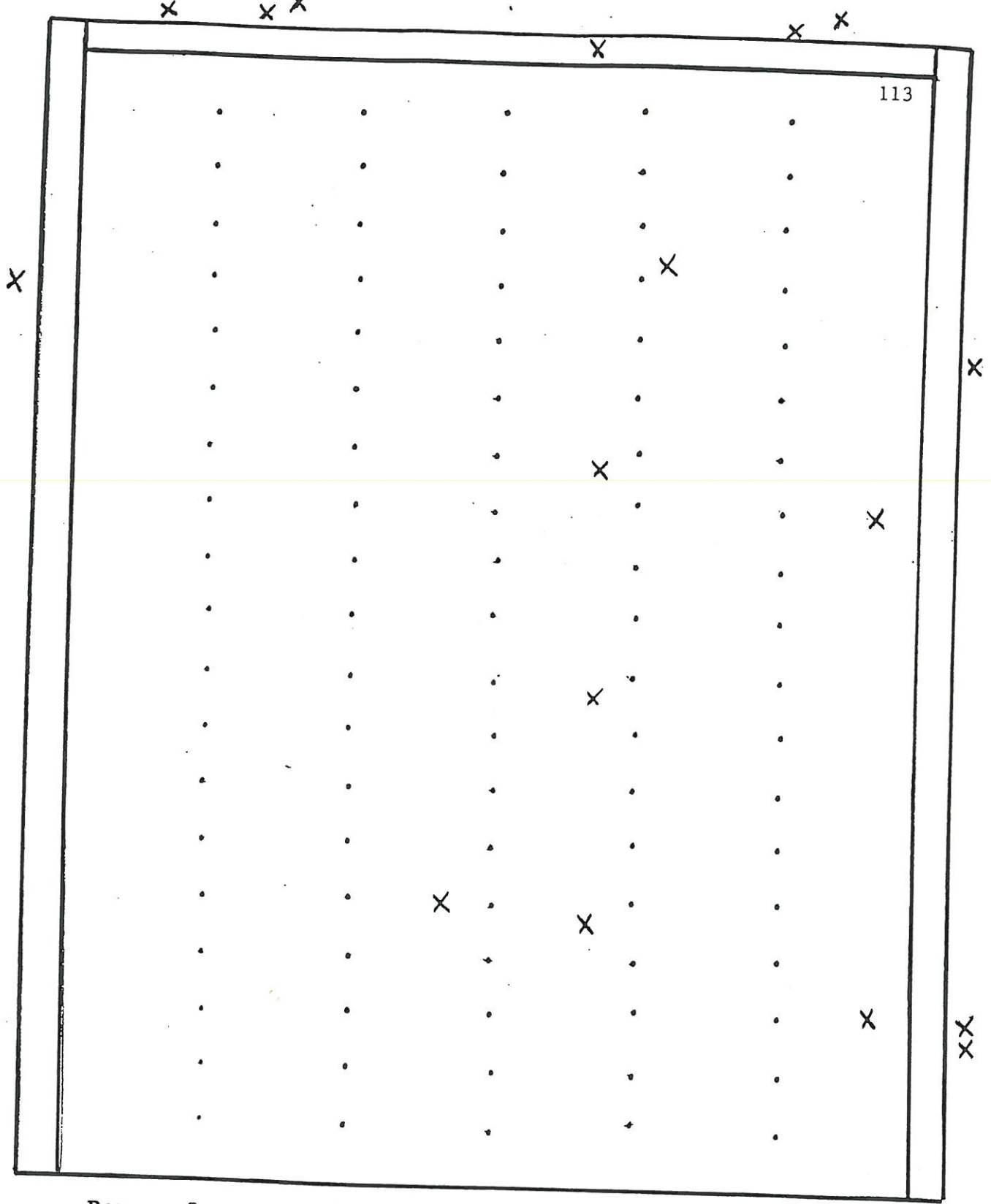
1

Blue-grey Gnatcatcher

Scale

1 in. = 50 m

1 cm = 20 m

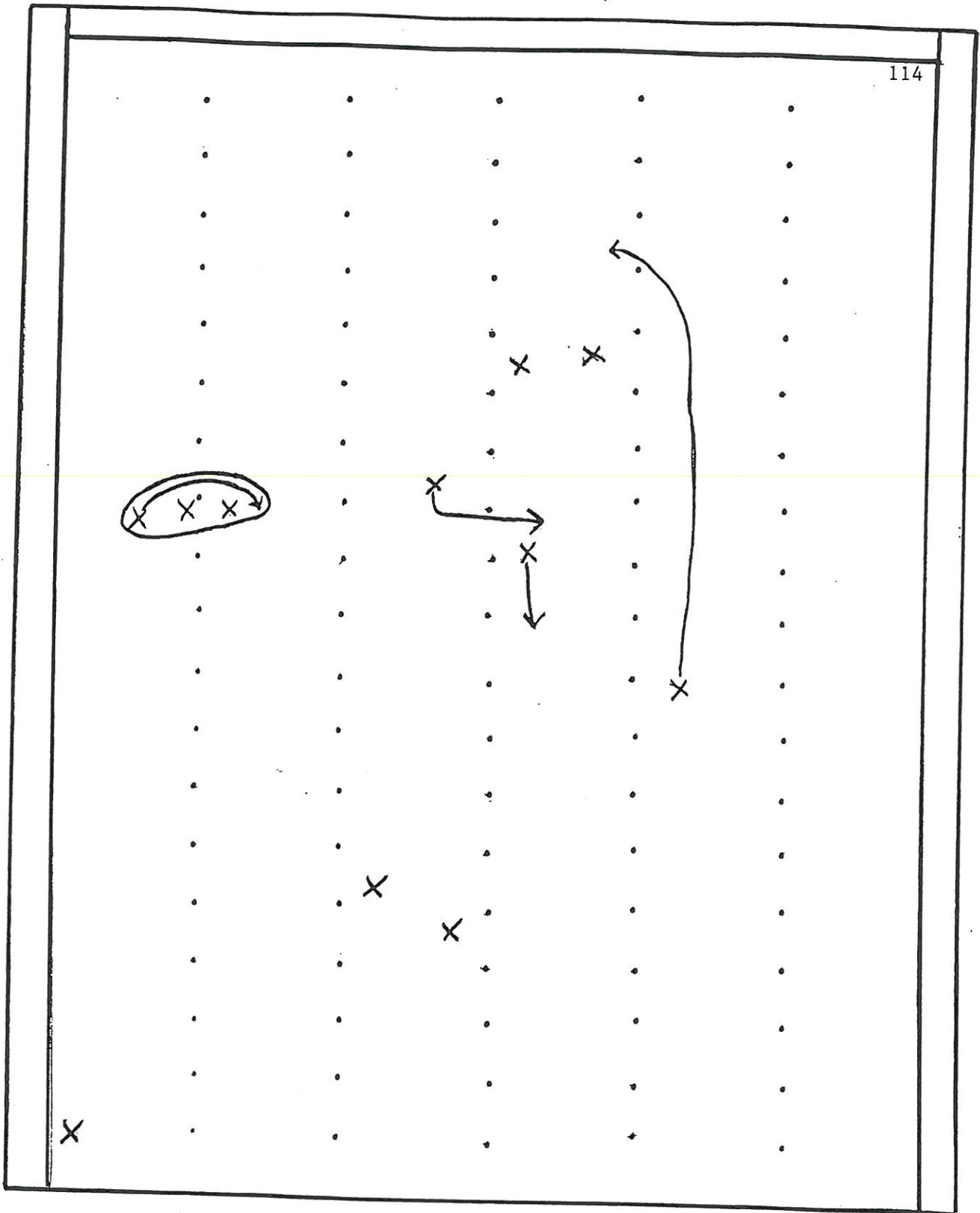


Row 5 4 3 2 1

Wood Thrush

Scale

1 in. = 50 m
 1 cm = 20 m



Row

5

4

3

2

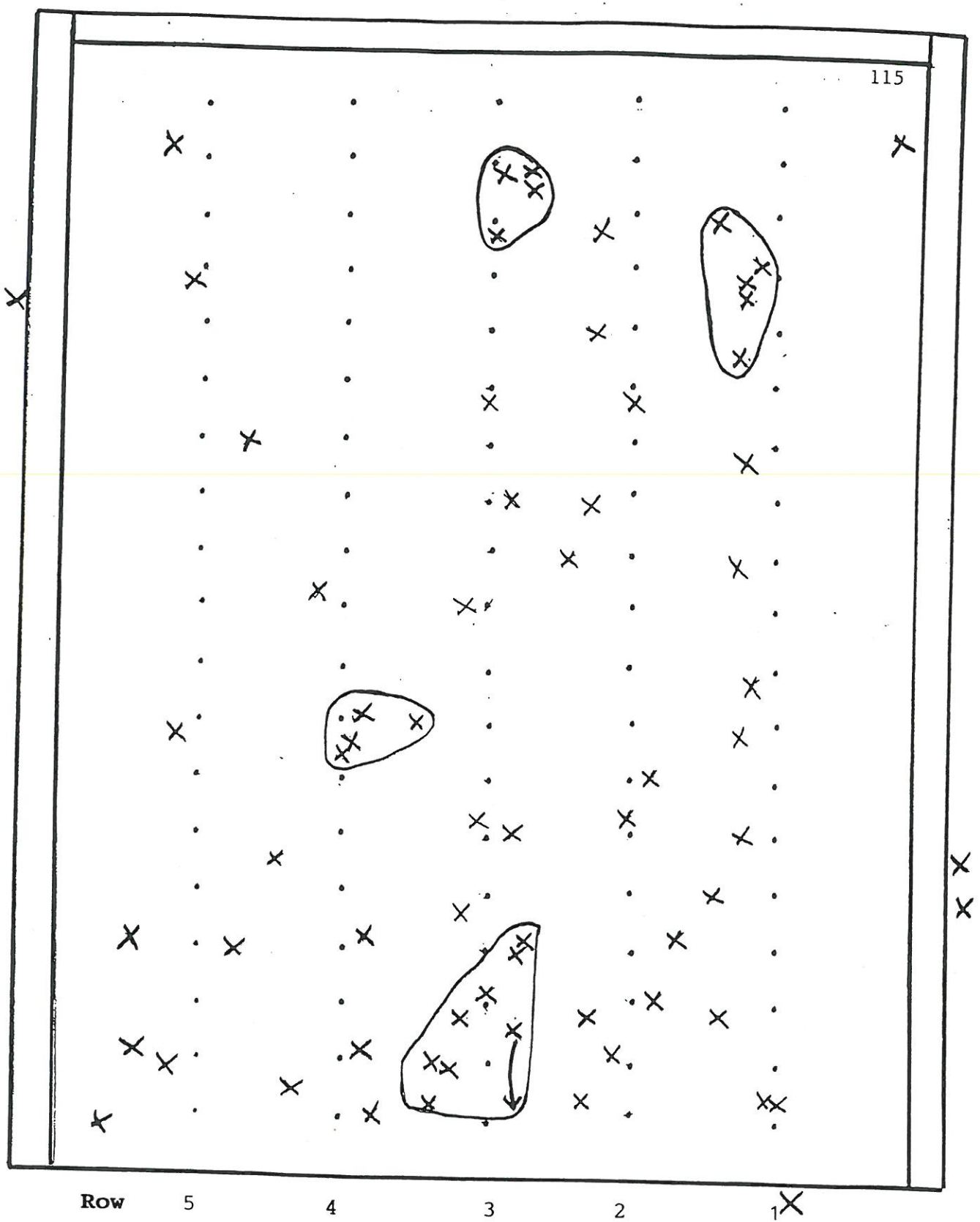
1

Brown Thrasher

Scale

1 in. = 50 m

1 cm = 20 m

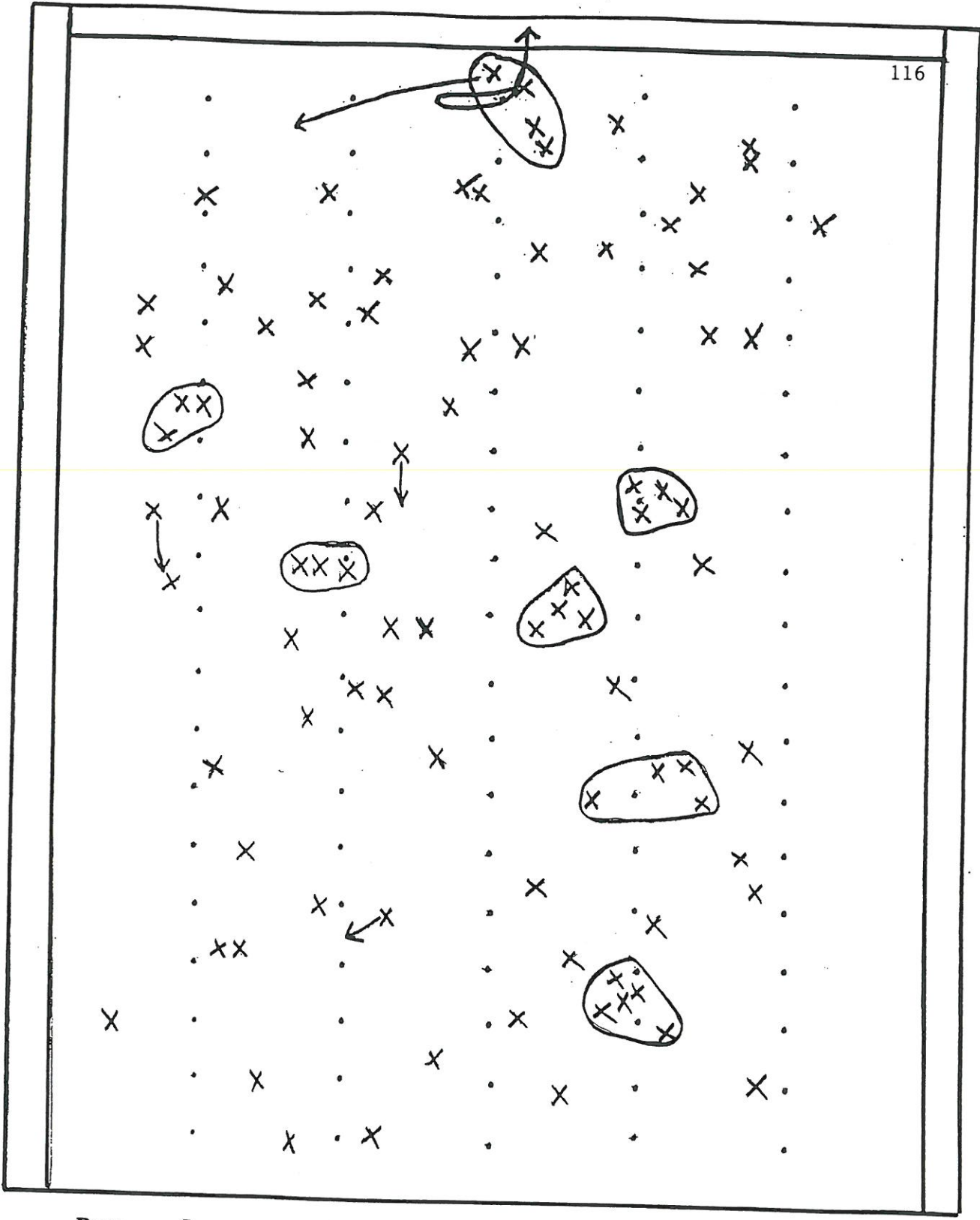


Row 5 4 3 2 1

Red-eyed Vireo

Scale

1 in. = 50 m
1 cm = 20 m



Row 5 4 3 2 1

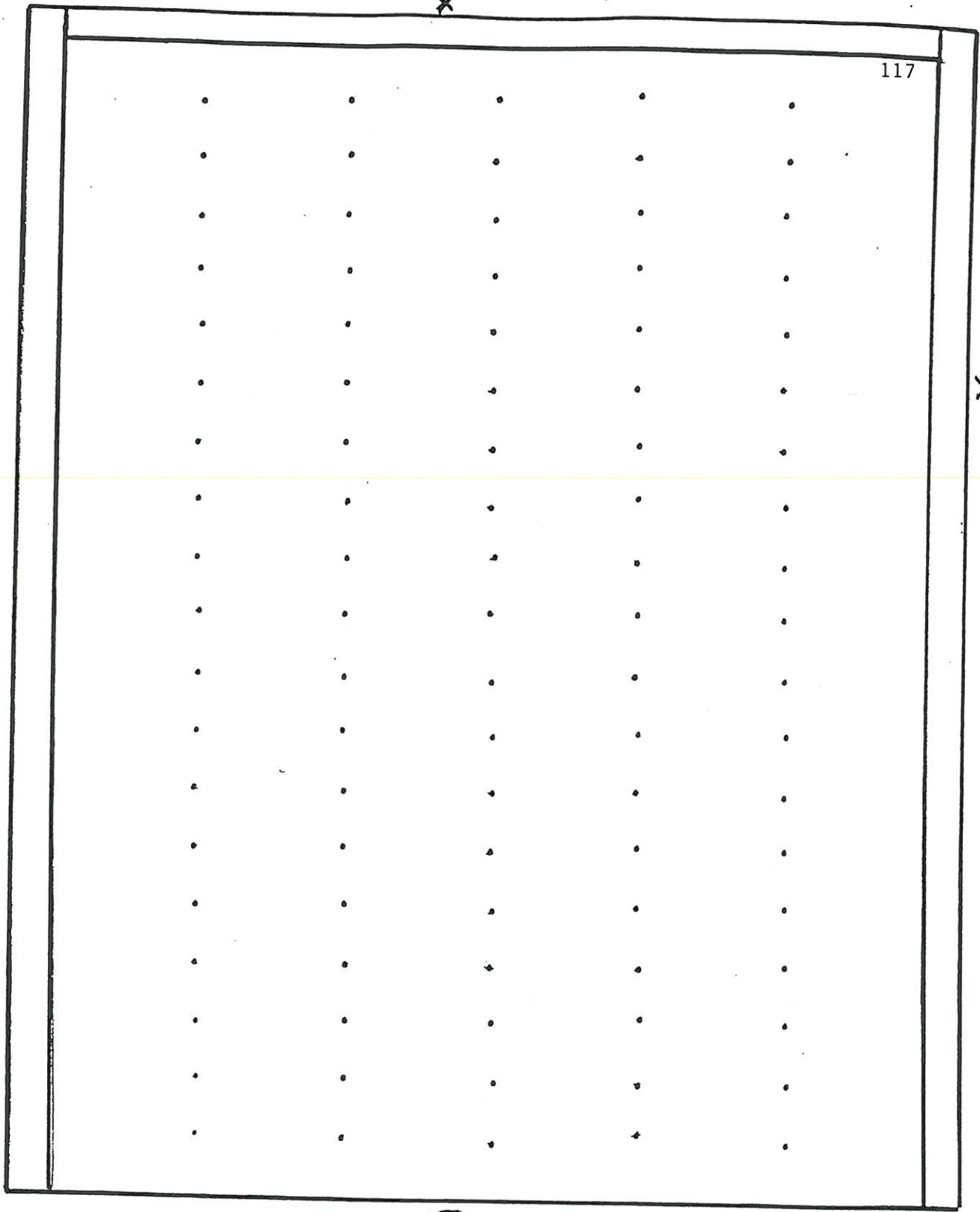
Prairie Warbler

Scale

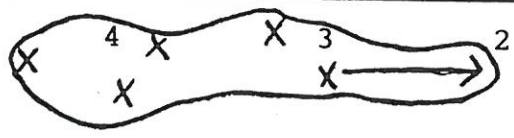
1 in. = 50 m
1 cm = 20 m

X

117



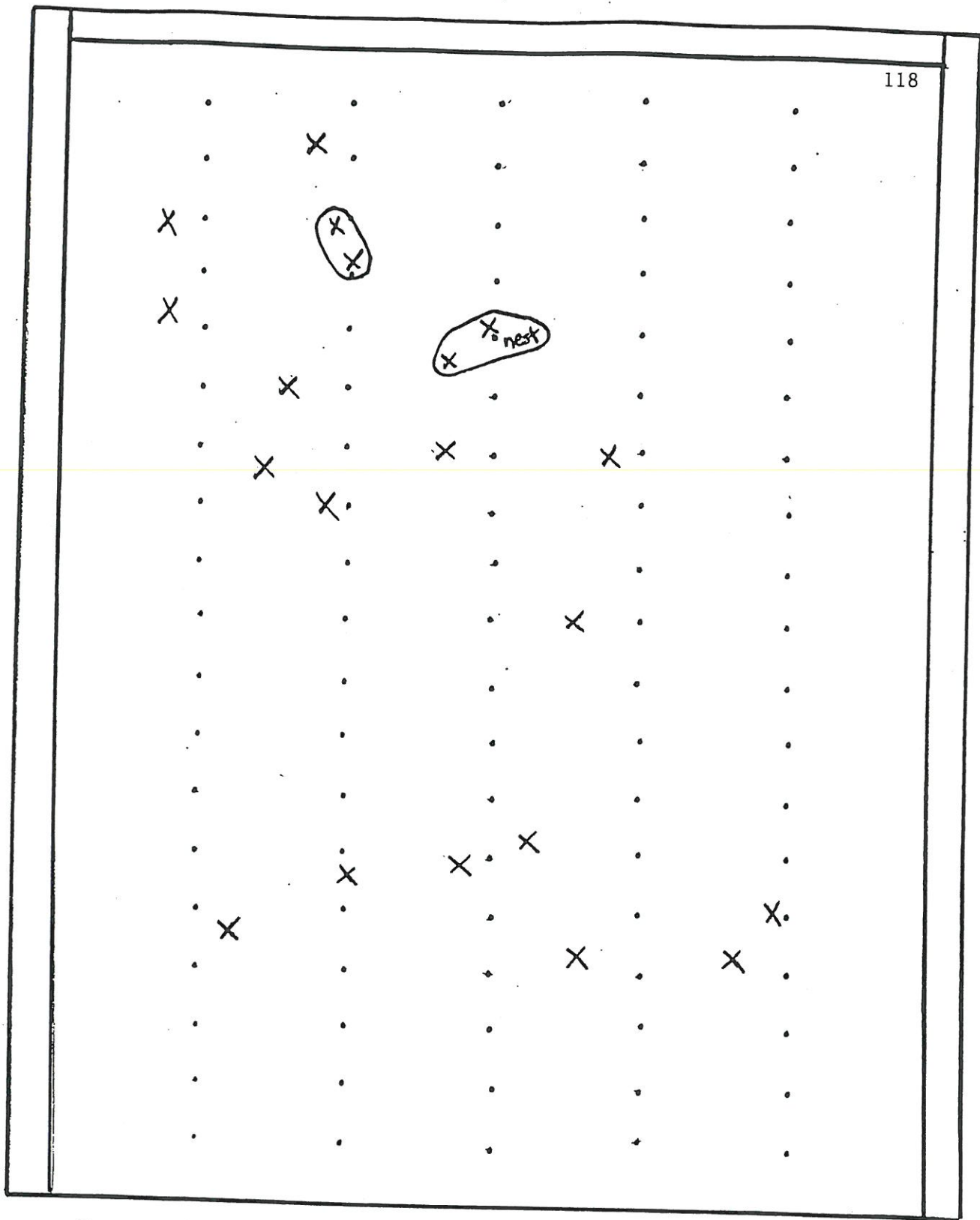
Row 5



Ovenbird

Scale

1 in. = 50 m
1 cm = 20 m

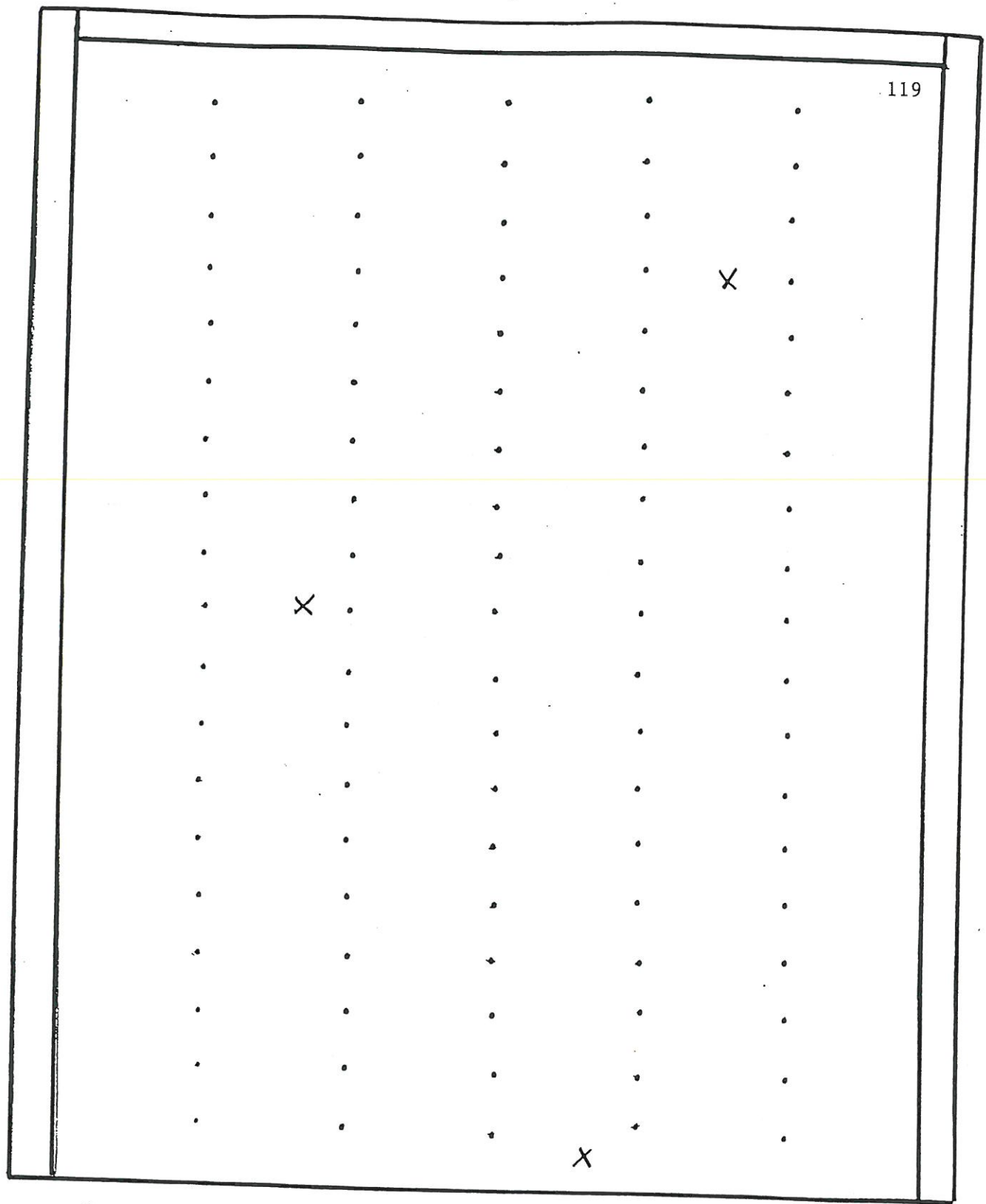


Row 5 4 3 2 1

Common Yellowthroat

Scale

1 in. = 50 m
1 cm = 20 m

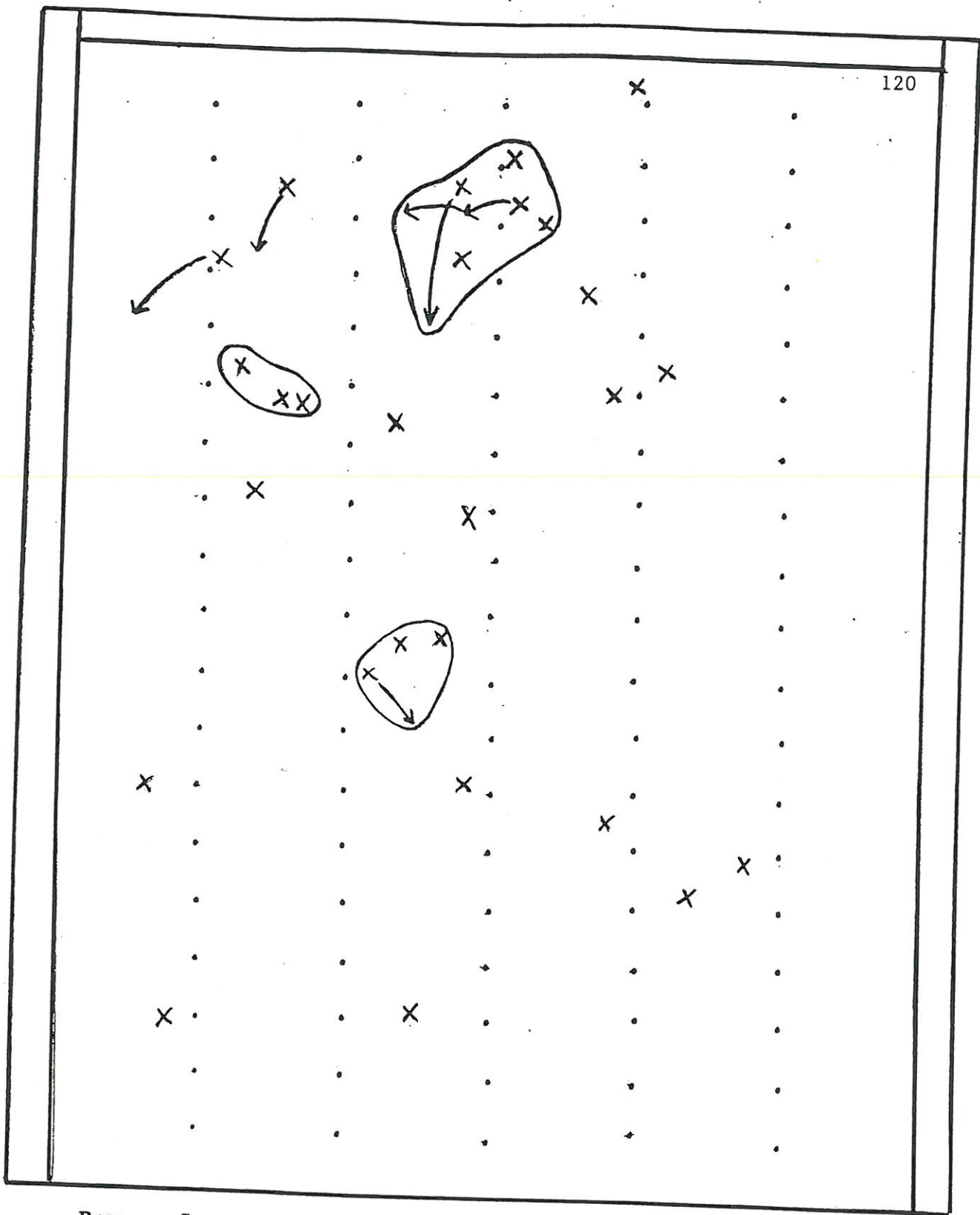


Row 5 4 3 2 1

Hooded Warbler

Scale

1 in. = 50 m
1 cm = 20 m

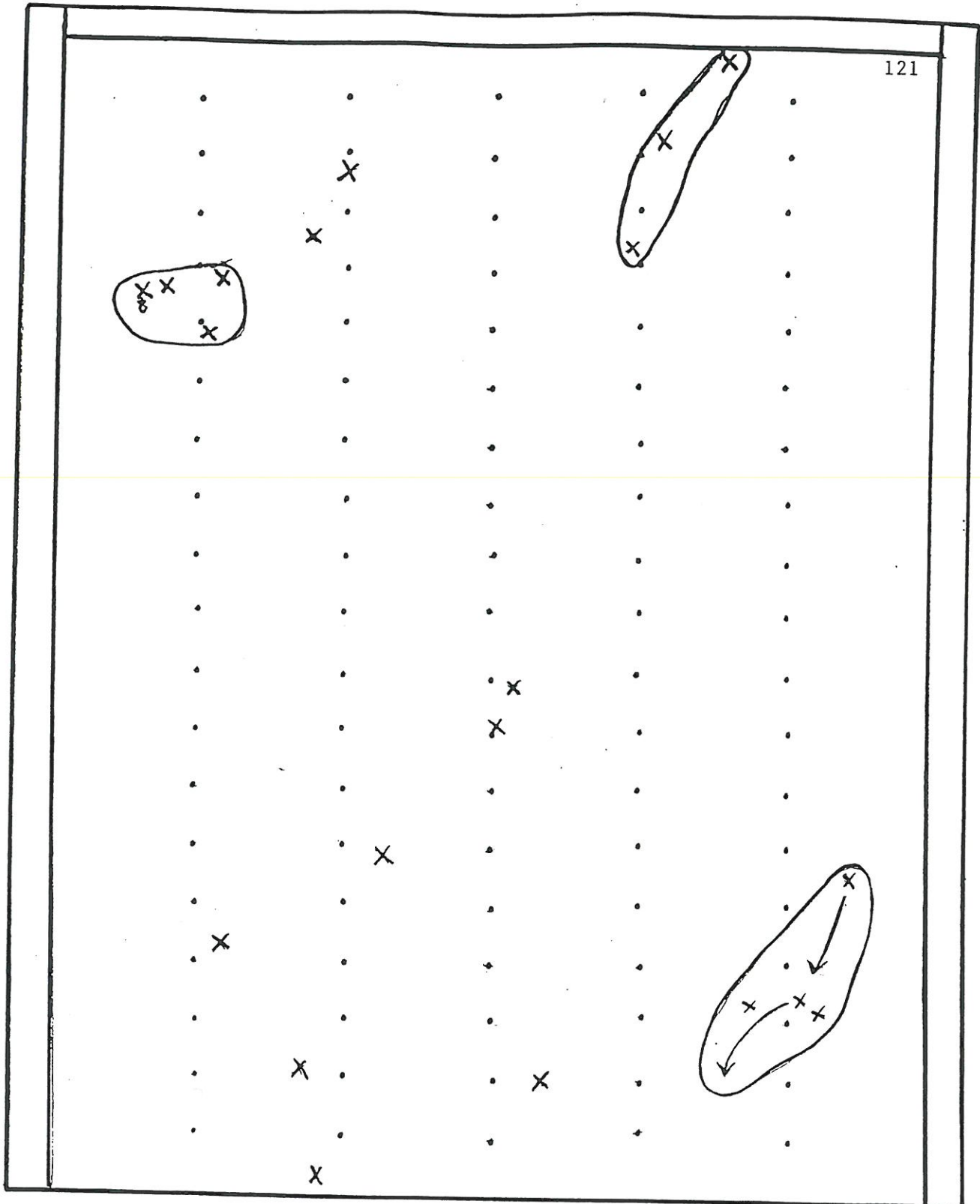


Row 5 4 3 2 1

Yellow-breasted Chat

Scale

1 in. = 50 m
1 cm = 20 m

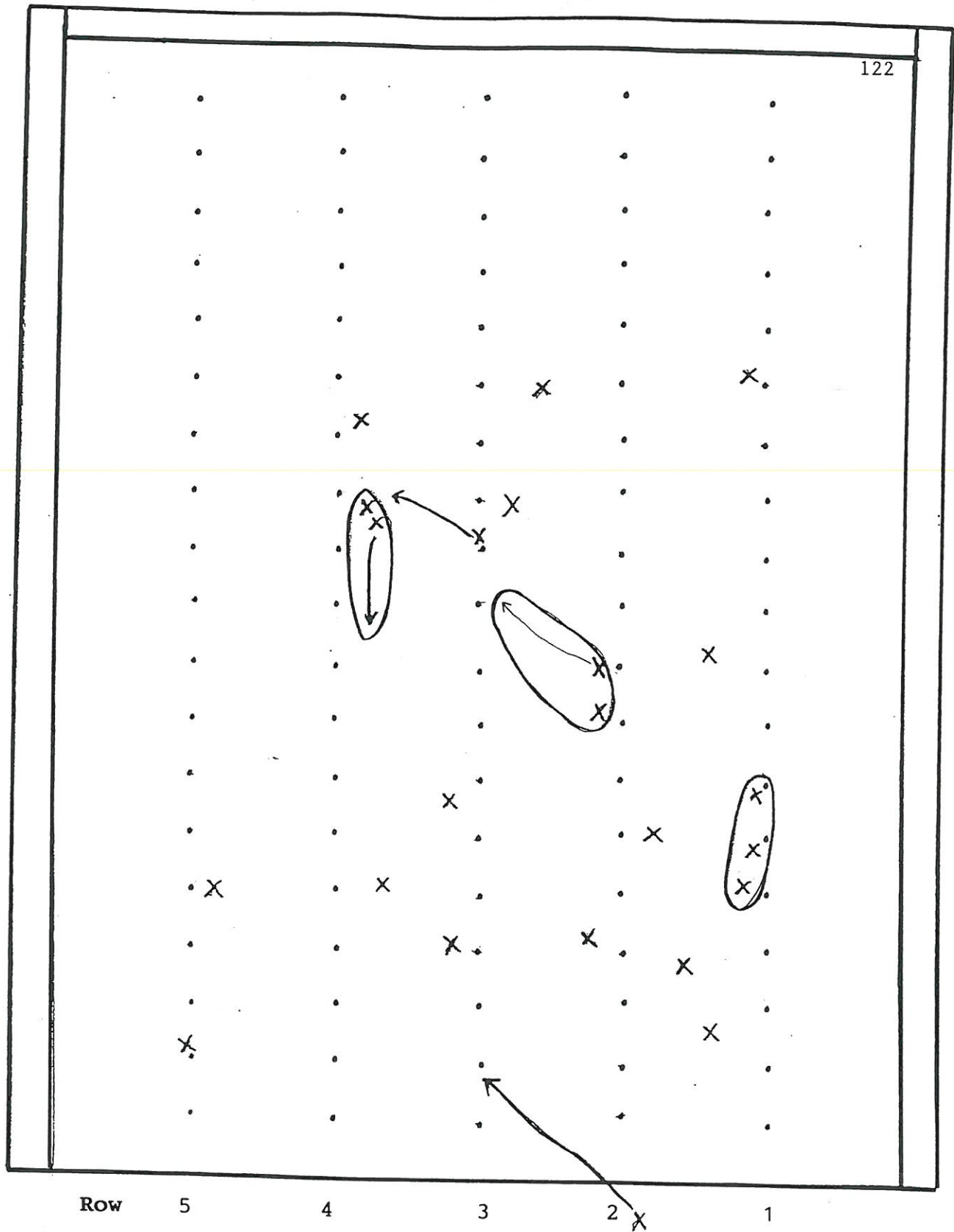


Row 5 4 3 2 1

Summer Tanager

Scale

1 in. = .50 m
1 cm = 20 m



Row

5

4

3

2

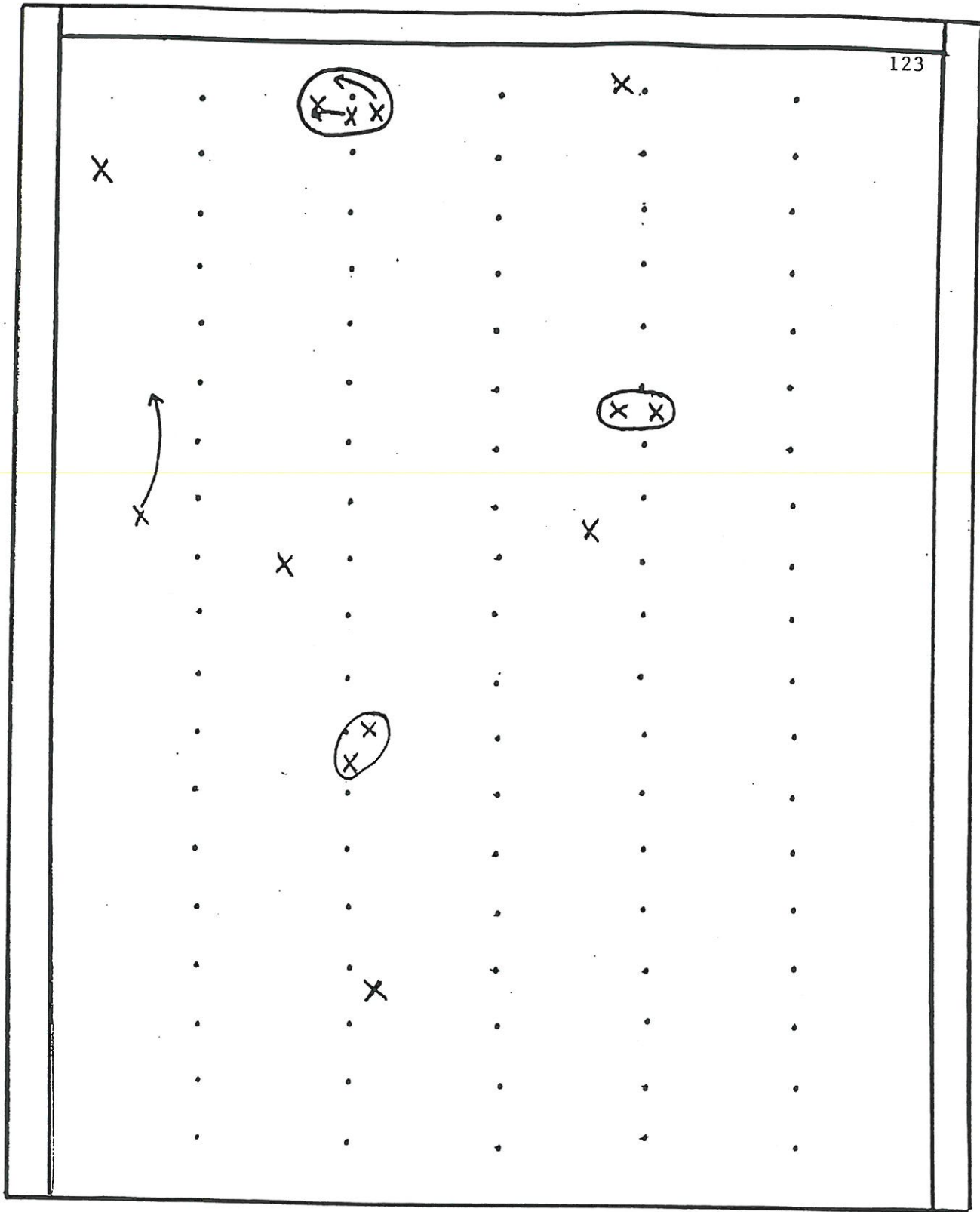
1

Scarlet Tanager

Scale

1 in. = 50 m

1 cm = 20 m

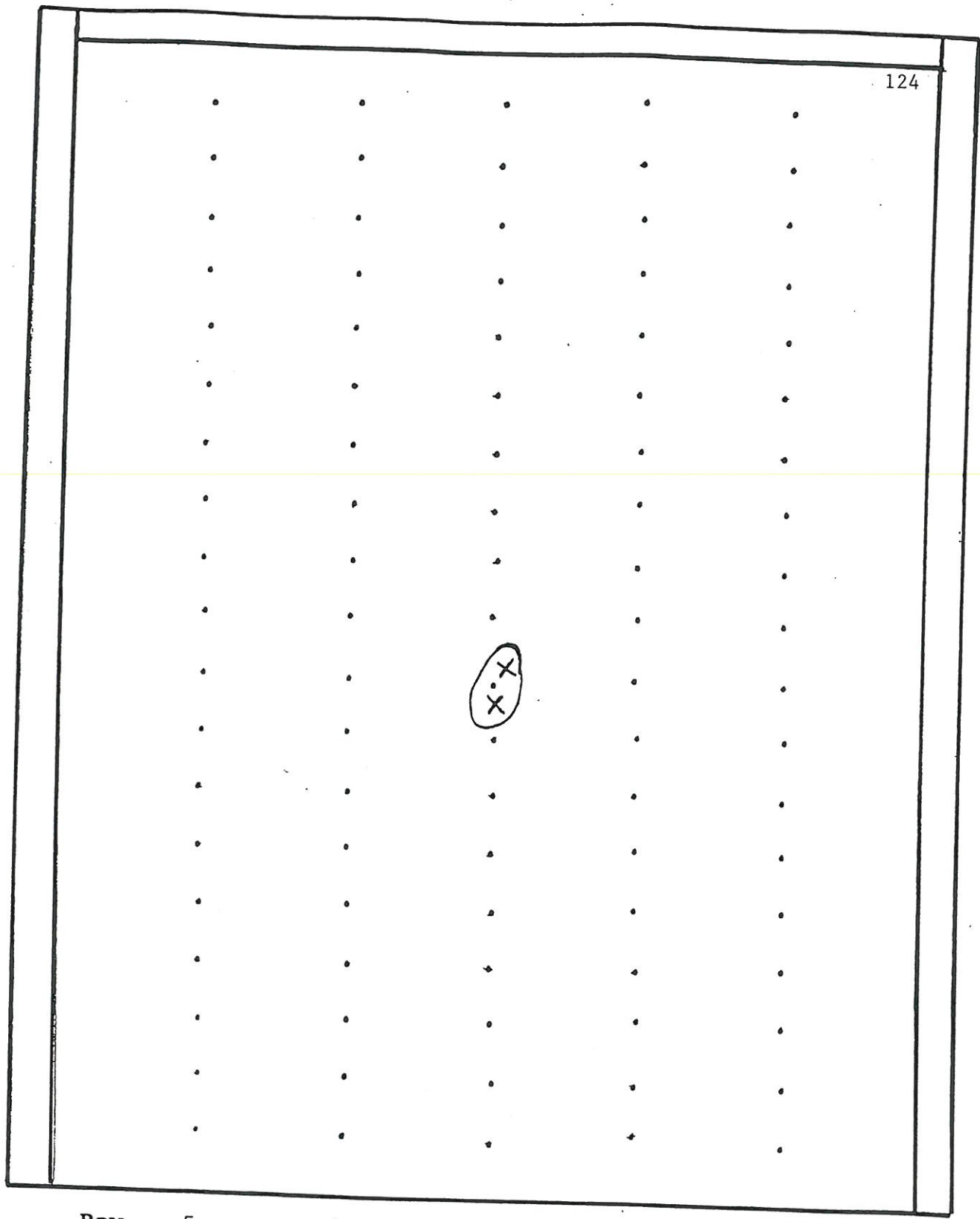


Row 5 4 3 2 1

Northern Cardinal

Scale

1 in. = 50 m
1 cm = 20 m

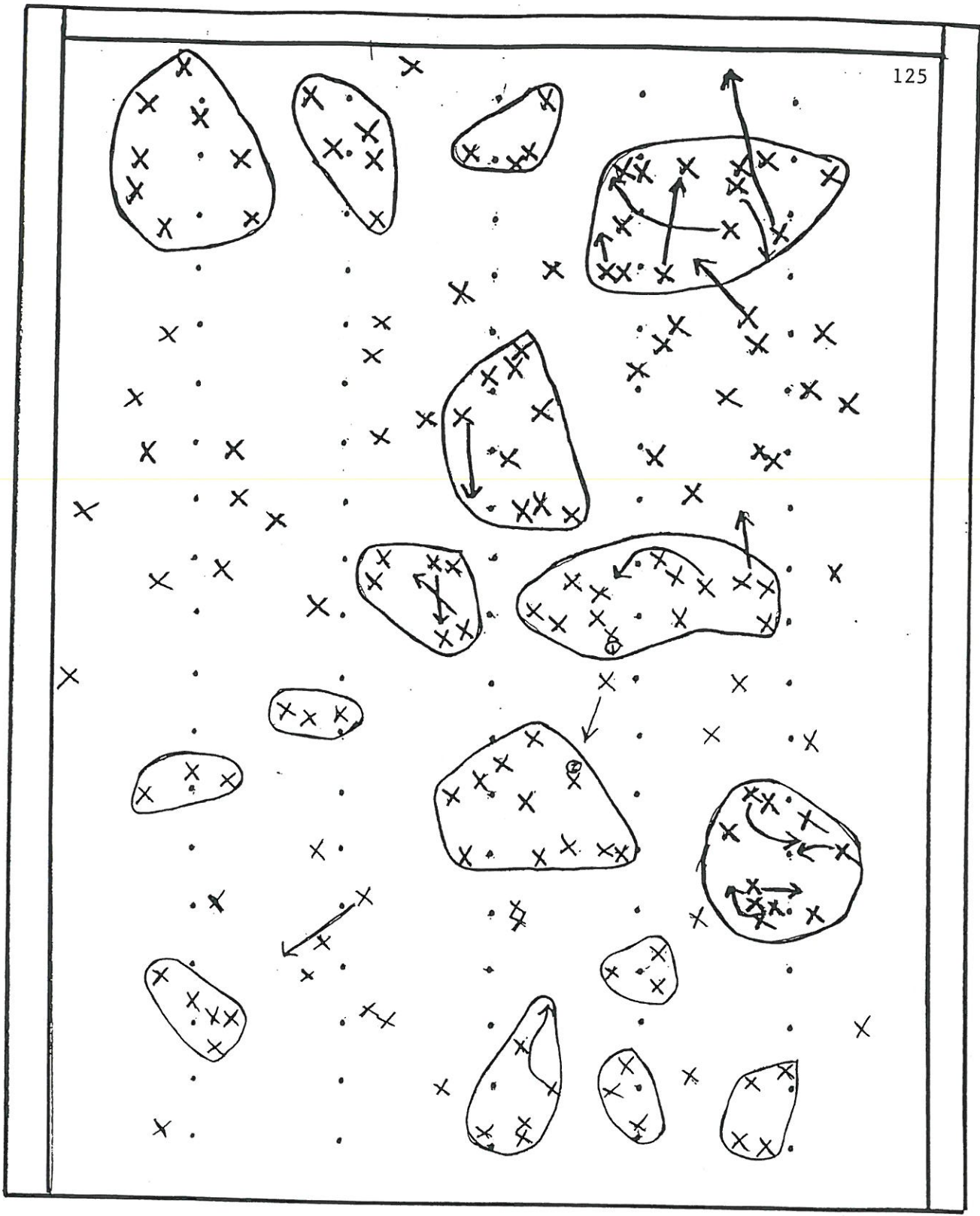


Row 5 4 3 2 1

Blue Grosbeak

Scale

1 in. = 50 m
1 cm = 20 m



Row 5 4 3 2 1

Indigo Bunting

Scale

1 in. = 50 m
1 cm = 20 m

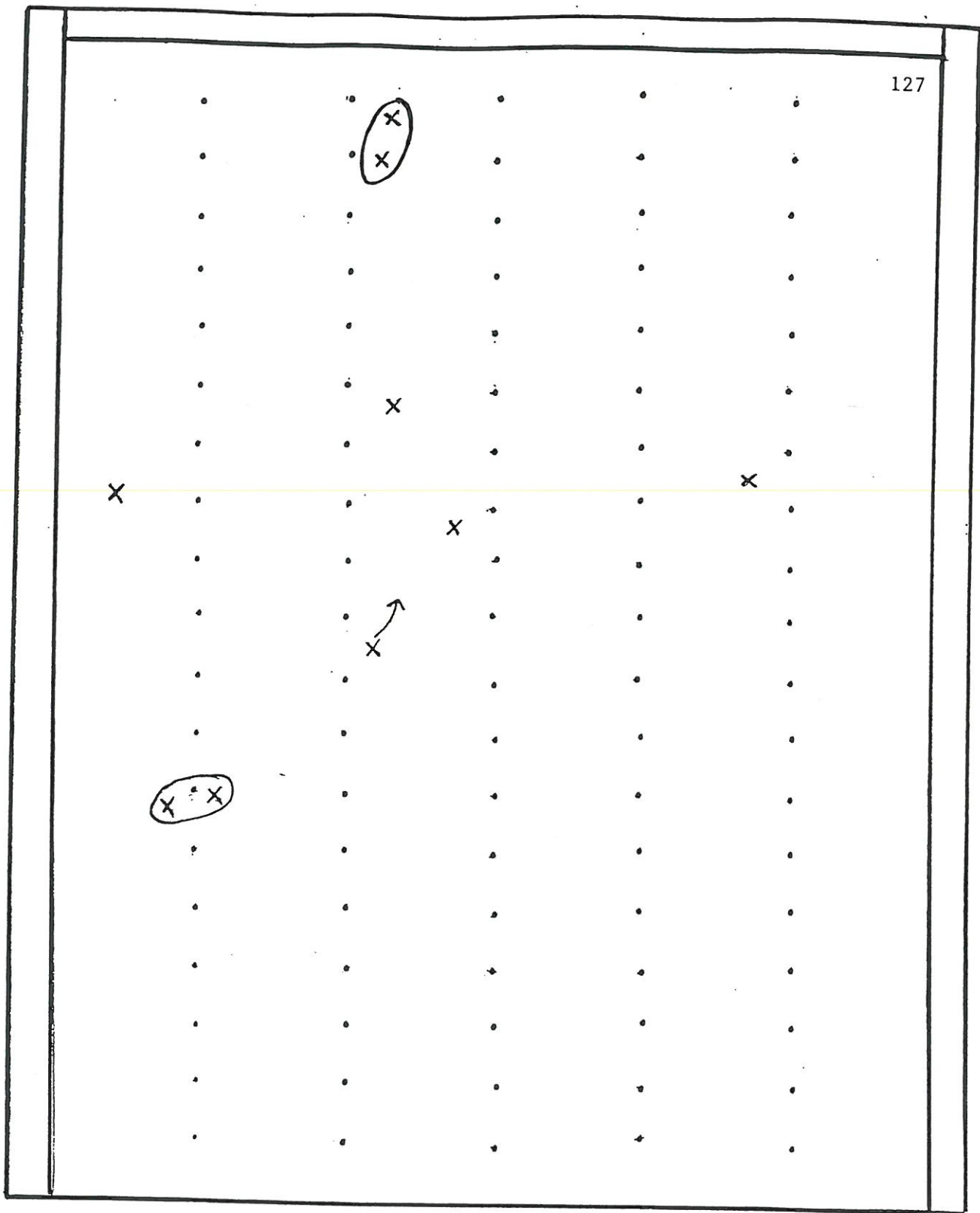


Row 5 4 3 2 1

Rufous-sided Towhee

Scale

1 in. = 50 m
 1 cm = 20 m

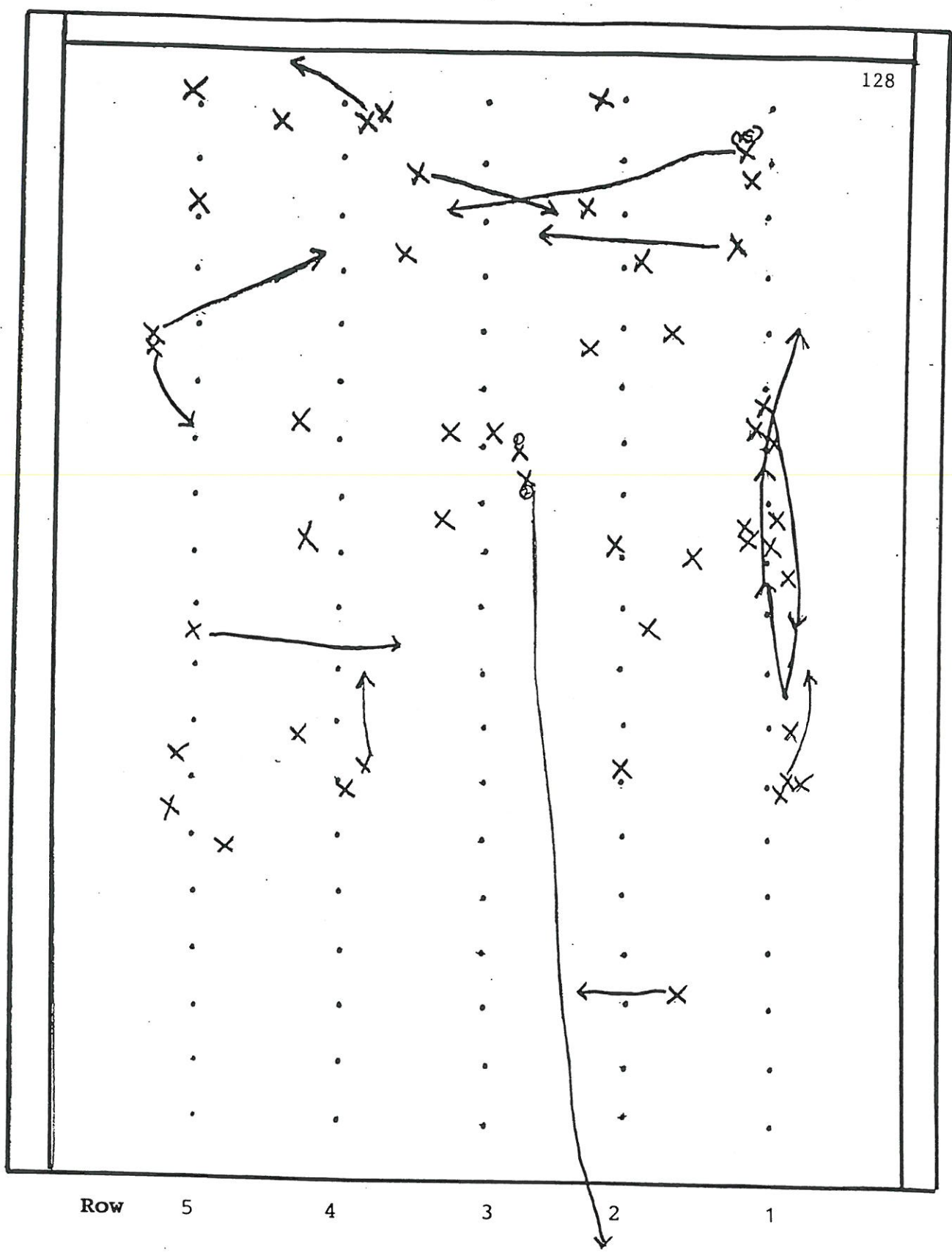


Row 5 4 3 2 1

Field Sparrow

Scale

1 in. = 50 m
1 cm = 20 m



Row

5

4

3

2

1

Brown-headed Cowbird

Scale

1 in. = 50 m

1 cm = 20 m

Appendix IV

Contained within this appendix are the Vegetation Analysis Data Sheets. Given first are the maps from Harris East and then those from Harris West are given.

Vegetation Data Sheet

Plot Location: Harris East Surveyor's Name: Sally / Patrick / Pam

Date: 9/21/99

Circle Center Location: Row 3, 100M

Tree Identification

Species	Diameter in (cm)									
1. Chestnut Oak										
2.										
3.										
4.										
5.										
6.										
7.										
8.										
9.										
10.										
11.										

Shrub Identification-Woody stems less than 7 cm

Species	Transect #1	Total	Transect #2	Total
1. Red Maple		9		1111
2. Tulip Poplar		25		42
3. American Beech		1		0
4. Red Oak		1		1
5. Winged Sumac		1		0
6. Chestnut Oak		0		4
7. Pignut Hickory		0		1
8. Sour Gum		0		3
9.				
10.				

Ground Cover		Canopy Cover	
Transect #1	Transect #2	Transect #1	Transect #2
+++++	+++++	- - - - -	- - - - -

Vegetation Data Sheet

Plot Location: Harris East Surveyor's Name: Sally Patrick/Pam

Date: 9/21/99

Circle Center Location: Row 4, 240M

Species	Tree Identification		Diameter in (cm)	
	Count	Count	Count	Count
1. Red Maple			15	
2. Sour Gum			19	
3. White Oak			90	59
4. Red Oak			22	
5. Chestnut Oak			9	
6.				
7.				
8.				
9.				
10.				
11.				

Shrub Identification-Woody Stems less than 7 cm

Species	Transect #1		Transect #2		Total
	Count	Count	Count	Count	
1. Red Maple	###	####			4
2. Dogwood					0
3. Pignut Hickory					0
4. Chestnut Oak					0
5. Tulip Poplar	###	###	###	###	12
6. White Oak					0
7. American Beech					0
8. Sourwood					0
9. Red Oak					0
10. Sour gum					0
Ground Cover					
Canopy Cover					

Transect #1	Transect #2	Transect #1	Transect #2
+++++	+++++	+++++	+++++

Vegetation Data Sheet

Plot Location: Harris East Surveyor's Name: Sally Patrick Peam

Date: 9/21/99

Circle Center Location: Row 5, 340M

Tree Identification

Species	Diameter in (cm)			
1. Red Maple	15	7	15	
2. Sour Gum	9	7		
3. White Oak	48			
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				

Shrub Identification-Woody Stems less than 7 cm

Species	Transsect #1	Total	Transsect #2	Total
1. Red Oak	1	1	1	1
2. Red Maple		28		42
3. American Beech	1	1		0
4. Dogwood/Sweet Cherry	1	10	0/	93
5. Post Oak		3		3
6. Sour Gum		4		7
7. White Oak	1	0		6
8. Mockernut Hicory	1	1	1	0
9. Black Oak/Tulip Poplar	1/	1/3	1/	18
10. Chestnut Oak	1	1	1	1
Ground Cover				
Transsect #1	Transsect #2	Transsect #1	Transsect #2	Canopy Cover
+++++	+++++	+++++	-----	-----

Vegetation Data Sheet

Plot Location: Harris East Surveyor's Name: Sally / Patrick / Paul

Date: 9/21/99

Circle Center Location: Row 5, 120M

Tree Identification

Species	Diameter in (cm)																			
1. White Oak	61	74																		
2. Red Oak	18																			
3. Pinet Hickory	12																			
4.																				
5.																				
6.																				
7.																				
8.																				
9.																				
10.																				
11.																				

Shrub Identification-Woody Stems less than 7 cm

Species	Transect #1	Total	Transect #2	Total
1: Chestnut Oak	+++ 11	7	+++ 1	6
2. Red Maple	+++ 1111	9	+++ 1111 11	12
3. American Beech		0	1	1
4. Ash		0	1	1
5. Tulip Poplar	+++	5	1111	4
6. Sour Gum		0	1	1
7. Mockernut Hickory	1	1		0
8.				
9.				
10.				

Ground Cover		Canopy Cover	
Transect #1	Transect #2	Transect #1	Transect #2
+++++	+++++	-----	+++++

Vegetation Data Sheet

Plot Location: Harris East
 Date: 9/21/99
 Surveyor's Name: Sally / Patrick / Pam

Circle Center Location: Row 6, 240M

Species	Tree Identification				Diameter in (cm)
	1	2	3	4	
1. Red Maple	11	8	12	11	13
2. White Oak		72	36	78	
3. Mockernut Hickory			57		
4. Sour Gum			10		
5.					
6.					
7.					
8.					
9.					
10.					
11.					

Shrub Identification-Woody Stems less than 7 cm

Species	Transect #1		Total	Transect #2		Total
	1	2		1	2	
1. Mockernut Hickory	+++	llll	9			9
2. Red Maple	+++	+++	17	++	ll	0
3. Tulip Poplar	ll		2			1
4. Sour Gum	+++	l	6			0
5. Cherry			0	+++	ll	7
6. Red Bud	llll		4	ll		2
7.						
8.						
9.						
10.						

Ground Cover

Canopy Cover

Transect #1	Transect #2	Transect #1	Transect #2
++-++-++-++-	++++++-++-	++-++-++-++-	++++++-++-

Vegetation Data Sheet

Plot Location: Harris East Surveyor's Name: Sally / Patrick / Pam
 Date: 9/21/99

Circle Center Location: Row 4, 100m

Species	Tree Identification		Diameter in (cm)				
1. Red Maple		8					
2. White Oak		72	53				
3. Red Oak		13					
4. Ironwood		14					
5. Mockernut-Hickory		56					
6.							
7.							
8.							
9.							
10.							
11.							

Shrub Identification-Woody Stems less than 7 cm

Species	Transect #1		Total	Transect #2		Total
	#	##		#	##	
1. Red Maple	###	###	56	###	###	12
2. Tulip Poplar	###	###	17	##	##	2
3. Red Oak	###	##	7	##	##	1
4. Dogwood	##	##	1			0
5. White Oak	##	##	2			0
6. Sour Gum	##	##	1			0
7.						
8.						
9.						
10.						

Ground Cover

Canopy Cover

Transect #1	Transect #2	Transect #1	Transect #2
+++++ +- ++	- - - - + + + + + + + +	- - - - + + + + + + + +	+++++ +- ++

Vegetation Data Sheet

Plot Location: Harris East Surveyor's Name: Sally Patrick Pam

Date: 9/21/99

Circle Center Location: Row 2, 120M

Species	Tree Identification		Diameter in (cm)				
1. White Oak		53					
2. Chestnut Oak		60					
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							

Shrub Identification-Woody Stems less than 7 cm

Species	Transect #1		Total	Transect #2		Total
1. Red Maple			17			25
2. Chestnut Oak			2			6
3. White Oak			1			0
4. Tulip Poplar			3			0
5. Dogwood			2			1
6. Black Oak			0			1
7. Red Oak			2			1
8.						
9.						
10.						

Ground Cover

Canopy Cover

Transect #1	Transect #2	Transect #1	Transect #2
+ - - + - - + + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +	+ - - - - - - - - - -

Vegetation Data Sheet

Plot Location: Harris West

Surveyor's Name: Pam / Patrick

Date: 9/22/99

Circle Center Location: Row 5, 140M

Tree Identification

Species	Diameter in (cm)								
1. Pinus Hickory	16								
2. Sycamore	14								
3. Red Maple	13								
4.									
5.									
6.									
7.									
8.									
9.									
10.									
11.									

Shrub Identification-Woody Stems less than 7 cm

Species	Transect #1	Total	Transect #2	Total
1. Red Maple		24		14
2. Mochernut Hickory		0		1
3. Tulip Poplar		0		26
4. Black Oak		0		1
5. Chestnut Oak		0		1
6. Sour Gum		0		3
7. Dogwood		2		1
8. American Beech		2		0
9.				
10.				

Ground Cover

Canopy Cover

Transect #1	Transect #2	Transect #1	Transect #2
+++++--+	-+-+----+	+++++--	-----+++++

Vegetation Data Sheet

Plot Location: Harris West
 Date: 9/22/99

Surveyor's Name: Sally/Greg

Circle Center Location: Row 3 100M

Species	Tree Identification		Diameter in (cm)				
1. Tulip Poplar		18					
2. White Oak		51	41				
3. Red Maple		14					
4. Sour Gum		8	13				
5. Pignut Hickory		9					
6.							
7.							
8.							
9.							
10.							
11.							

Shrub Identification-Woody Stems less than 7 cm

Species	Transect #1		Total	Transect #2		Total
1. Pignut Hickory	+++		3			2
2. Tulip Poplar	+++	+	4	+++		8
3. Red Maple	+++	+	4	+++	+	5
4. Mockernut Hickory			3			3
5. Sour Gum			4			2
6.						
7.						
8.						
9.						
10.						

Ground Cover

Canopy Cover

Transect #1	Transect #2	Transect #1	Transect #2
+++++	+++++	-----	-----

Vegetation Data Sheet

Plot Location: Harris West

Surveyor's Name: Sally / Greg

Date: 9/22/99

Circle Center Location: Row 2 40M

Tree Identification

Species	Tree Identification		Diameter in (cm)	
1. White Oak			51	46
2. Chestnut Oak			9	
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				

Shrub Identification-Woody Stems less than 7 cm

Species	Transect #1	Total	Transect #2	Total
1. Red Maple	+++ +	16	+++ +	12
2. Red Oak	1	1		2
3. Chestnut Oak	+++ 1	6	1	6
4. Tulip Poplar		0	+++ 1	6
5. Mockernut Hickory		0	1	1
6.				
7.				
8.				
9.				
10.				

Ground Cover

Canopy Cover

Transect #1	Transect #2	Transect #1	Transect #2
+++++	++++ -	+++ - - -	++++ - - -

Vegetation Data Sheet

Plot Location: Harris West

Surveyor's Name: Pam Patrick

Date: 9/22/99

Circle Center Location: Row 4, 220M

Species Tree Identification

Species	Diameter in (cm)									
1. Sour Gum	15	13								
2. White Oak	56									
3.										
4.										
5.										
6.										
7.										
8.										
9.										
10.										
11.										

Shrub Identification-Woody Stems less than 7 cm

Species	Transect #1	Total	Transect #2	Total
1. Sour Gum	1	1	1111	4
2. Red Maple	1111 1111 1111 1111	38	1111 1111 1111	13
3. Tulip Poplar	1111 11	7	24 + 1111 1111 1	31
4. Sweet Cherry		0		1
5. American Beech	1	1		0
6.				
7.				
8.				
9.				
10.				

Ground Cover

Canopy Cover

Transect #1	Transect #2	Transect #1	Transect #2
+++++	+++++	-----	-----

Vegetation Data Sheet

Plot Location: Harris West

Surveyor's Name: Pam Patrick

Date: 9/22/99

Circle Center Location: Row 5, 120M

Species

Tree Identification

Diameter in (cm)

1. <u>Peanut Hickory</u>	15	14	.																	
2. <u>Red Maple</u>	12	14																		
3. <u>Red Cedar</u>	14																			
4.																				
5.																				
6.																				
7.																				
8.																				
9.																				
10.																				
11.																				

Shrub Identification-Woody Stems less than 7 cm

Species	Transect #1	Total	Transect #2	Total
1. <u>Tulip Poplar</u>		4		4
2. <u>Red Maple</u>		1		8
3. <u>Red Oak</u>		4		1
4. <u>Sourgum</u>		3		14
5.				
6.				
7.				
8.				
9.				
10.				

Ground Cover

Canopy Cover

Transect #1	Transect #2	Transect #1	Transect #2
-++- -++- -	- -+- -++- ++	++++ - - -+-	++++ + + + + - - -

Vegetation Data Sheet

Plot Location: Harris West Surveyor's Name: Saou, Patrick

Date: 9/22/99

Circle Center Location: Row 1, 240M

Species	Tree Identification										Diameter In (cm)
1. Chestnut Oak											45
2. Sour Gum											11
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											
11.											

Shrub Identification-Woody Stems less than 7 cm

Species	Transect #1	Total	Transect #2	Total
1. Tulip Poplar	HHH /	10	1	1
2. Sour Gum	1	1		0
3. Red Maple	III	3	III	3
4. Diamond	1	1		1
5. Chestnut Oak	1	1		1
6.				
7.				
8.				
9.				
10.				

Ground Cover

Canopy Cover

Transect #1	Transect #2	Transect #1	Transect #2
+++++	++	++	++

Vegetation Data Sheet

Plot Location: Harris West

Surveyor's Name: Sam Patrick

Date: 9/22/99

Circle Center Location: Row 4, 160M

Tree Identification

Species	Tree Identification		Diameter in (cm)																
1. White Oak		62																	
2.																			
3.																			
4.																			
5.																			
6.																			
7.																			
8.																			
9.																			
10.																			
11.																			

Shrub Identification-Woody Stems less than 7 cm

Species	Transect #1	Total	Transect #2	Total
1. Sour Gum	+++	17		2
2. Pignut Hickory		3		0
3. Red Oak		1		0
4. Dogwood		1	+++	18
5. Tupelo		3	+++	19
6. Red Maple		2		1
7. Red Cedar				
8.				
9.				
10.				

Ground Cover

Canopy Cover

Transect #1	Transect #2	Transect #1	Transect #2
+++++ - ++ -	+++++ +++++	+- - + + + - - -	- - - - - - - - -

Appendix V

This appendix contains copies of the equations used for the vegetation analysis, census dates and the Beaufort Wind Force Scale.

Equations Used for the Vegetation Analysis

1. **Density** is the number per unit area.
 - 20 if 5 circles
 - 16 if 6 circles
2. Total trees counted by X
 - 14 if 7 circles
 - 13 if 8 circles
 - 11 if 9 circles
 - 10 if 10 circles
3. Relative density is the percent of the total number of trees which are the species in question:

$$\frac{\text{Number of trees of the species}}{\text{Total number of trees of all species}}$$
4. Circumference was determined by:

$$C = \text{diameter}^2 (.7854) \text{ for each tree species}$$
5. **Basal Area** is the cross sectional area of the trunk of a tree 4.5 feet (DBH)
6. Add the total circumference of each size class to give the basal area for each tree's size class.
7.
$$\frac{\text{Total basal area of the species}}{\text{Total basal area of all species}}$$
8. **Frequency** indicates the evenness of distribution of a species
9.
$$\frac{\text{Number of circles in which the species occurred}}{\text{Total number of circles}}$$
10. **Shrubs:** Total shrub stems in all transects (2 per circle) x 100, divided by the number of transects.
11. **Ground Cover:** Total pluses (+) recorded (20 sightings per circle) x 100, divided by the total number of sightings = % ground cover.
12. **Canopy Cover:** Total pluses (+) recorded (20 sightings per circle) x 100, divided by the total number of sightings = % canopy cover.

Census Dates**Harris East**

1 June 1999
2 June 1999
3 June 1999
9 June 1999
16 June 1999
22 June 1999
29 June 1999
30 June 1999
1 July 1999

Harris West

1 June 1999
2 June 1999
3 June 1999
9 June 1999
16 June 1999
22 June 1999
29 June 1999
30 June 1999
1 July 1999

Beaufort Wind Force Scale

<u>Beaufort Number</u>	<u>Wind Speed</u>	<u>Description</u>
0	<1	Calm: Still: Smoke will rise vertically
1	1 - 3	Light Air: Rising smoke drifts
2	4 - 7	Light Breeze: Leaves rustle, wind can be felt on face.
3	8 - 12	Gentle Breeze: Leaves rustle and twigs move around.
4	13 - 18	Moderate Breeze: Moves thin branches
5	19 - 24	Fresh Breeze: Small trees sway
6	25 - 31	Strong Breeze: Large tree branches move
7	32 - 38	Moderate Gale: Large trees sway
8	39 - 46	Fresh Gale: Twigs and small branches are broken from trees
9	47 - 54	Strong Gale: Slight damage occurs to buildings
10	55 - 63	Whole Gale: Large trees are uprooted
11	64 - 72	Storm: Extensive widespread damage
12	>73	Hurricane: Extreme destruction

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