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Site fidelity and return rates of Grasshopper Sparrows at three sand prairies in Northwest Illinois

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Introduction

Prairie habitats once stretched for over 20 million acres in Illinois. These native grasslands have been largely replaced with agricultural fields. Initially, farms were diverse and included a variety of crops and pastures, and the loss of prairie was offset somewhat by non-native grasslands such as hayfields and grain crops. These surrogate grasslands provided some habitat for grassland birds. Over the past two decades, however, farming in Illinois has become increasingly dominated by industrial agriculture focusing on monocultures on a vast scale. The shift from diversified to industrial farming was accompanied by a loss of non-native surrogate grasslands and widespread declines in many species of grassland birds (Herkert 1991, 1995, 1997). With the loss of surrogate grasslands, native prairie remnants are among the last and best hope for retaining grassland birds in Illinois.

In northwestern Illinois a series of sand prairies near the Mississippi River have been protected by state and federal agencies (see study sites below). These areas contain the largest prairie remnants in the state, numerous state-listed threatened and endangered species, and large populations of many rare or declining grassland species. Thus far management of these areas has focused on habitat protection and restoration. Studies on species of management concern should help refine restoration and management efforts.

Grassland birds have been the focus of several studies to develop management guidelines to halt and reverse well-documented population declines. Much of the work has been on habitat preferences (e.g. Wenny and Symstad 2002) and several studies have examined reproductive success (Winter 1999, Herkert et al. 2003). Few studies have examined population dynamics in terms of site fidelity over several years. In this study, I captured and banded grasshopper sparrows to answer the following questions: 1) What proportion of the population present in one year returns to that same site? 2) Do return rates differ among sites or years? 3) Do individual birds return to the same territory? 4) Do individuals have the same mates in subsequent years? 5) do return rates depend on mating status and previous reproductive success? and 6) Do young birds return?

Study Sites

This study was conducted in May through early August 2000-2002 at three sites in northwest Illinois. At each site a 10-ha study area was selected based on similar vegetation structure and the presence of grasshopper sparrows. Lost Mound is a proposed National Wildlife Refuge in Carroll and JoDaviess counties. This 9,411-acre site is part of the former Savanna Army Depot that was closed in March 2000. The site contains the largest remaining sand prairie in Illinois and is dominated by little bluestem (*Schizachyrium scoparium*). Other common plant species include Indian grass (*Sorghastrum nutans*), smooth brome (*Bromus inermis*), aromatic sumac (*Rhus aromatica*), red cedar (*Juniperus virginiana*) and horse milkweed (*Asclepias verticillata*) (Robertson et al. 1997). Lost Mound was grazed by cattle annually during the growing season until October 1999. Since then no grazing or burning has occurred. The specific site at Lost Mound is referred to here as Whitton.

Ayers Sand Prairie State Nature Preserve is a 110-ha native prairie in Carroll County. Little bluestem is the dominant grass and common forbs include spiderwort (*Tradescantia ohiensis*), prairie coreopsis (*Coreopsis palmata*), poppy mallow (*Callirhoe involucrate*), and *Rhus aromatica*. Cattle grazed this site until the 1970's when the property was purchased by the

state. Since then prescribed burns have been conducted periodically. The study area was not burned during this study except for a small portion on the southeast corner of the plot that was burned in alternate years in April. This project was started at Ayers in 1999 and expanded to the other sites in 2000.

Thomson Natural Area in Carroll County is part of the Upper Mississippi Wildlife Refuge. It is also a formerly grazed sand prairie remnant. Little bluestem is the dominant grass but Indian grass and switch grass (*Panicum virgatum*) are also common. Other common plants include (*Liatris aspera*), prickly-pear cactus (*Opuntia humifusa*), and (*Juniperus virginiana*).

Methods

Intensive mist-netting and spot-mapping were used to delineate territories. Mist-netting was conducted approximately 2 days each week at each site from mid-May through July. Each bird captured was given a unique combination of a numbered aluminum band and three plastic color bands. Approximately 95% of the males and 80% of the females were captured and banded at each site. Spot-mapping was done 8-10 times at each site on days when mist netting was not conducted. Spot-mapping focused on (1) delineating the territories of singing males following standard methods (Bibby et al. 2000), and (2) determining breeding status based on behavioral cues (Vickery et al. 1992). Because only two people were working on this study nest-searching was impractical. Therefore, we were not able to determine reproductive success for all the birds present. Instead we used mating status as a measure that indicates some level of success (compared to birds that did not have mates) for virtually all birds and reproductive success for birds whenever possible. A male was considered mated if seen in non-antagonistic association with the same female on two or more occasions, if observed carrying food, or if he approached the net chipping while a female was captured within the territory. Breeding success was determined similarly by association of either banded adult with hatch-year birds.

Results

Return rates - Over the entire study 244 birds were captured and banded including 119 males, 80 females, and 45 hatch year (HY) birds. Of the 205 birds from 1999-2001, 51 (25%) were recaptured or resighted in one or more subsequent years (2000-2002). Overall, 35 (17%) birds returned the year after they were banded, 8 (7%) returned in both the first and second years after banding, and 8 (7%) returned the second year after banding but not the first. No birds returned three years after capture at Ayers, the only site with 4 years of banding data (Table 1).

Return rates were higher for males than for females (Chi-squared test: $\chi^2 = 11.2$, df = 1, P < 0.001) and were higher for adults than for fledglings ($\chi^2 = 6.63$, df = 1, P = 0.01). Of the 35 birds that returned one year later, 28 (80%) were male and 7 (20%) were female. All the birds that returned two years consecutively were male and 7 of 8 (88%) that returned in year 2 but not year 1 were male. Of 36 birds captured as fledglings (HY) in 1999-2001 two (11%) returned: one 1 year after banding and one 2 years after banding (Table 1). Both of these HY birds that returned as adults were male.

Return rates differed significantly among the three sites ($\chi^2 = 9.95$, df = 2, P < 0.01). Ayers had lower return rates and Thomson had higher return rates than expected if all three sites had equal rates. Return rates varied significantly among years ($\chi^2 = 7.4$, df = 2, P < 0.05) with

rates from 1999 (Ayers only) lower and from 2000 higher than expected if all three years were equal. Excluding the 1999 data, return rates did not differ among the remaining years ($\chi^2 = 2.13$, df = 1, $P > 0.05$) but still differed among sites with Thomson have higher return rates than Ayers or Whitton ($\chi^2 = 6.4$, df = 2, $P < 0.05$).

In a given year 9-38% of the adults present are birds that were present in the previous year and up to 54% of the birds present had returned from the previous two years combined (Tables 2, 3, and 4). The proportion of the population that returned from previous years did not differ among the sites ($\chi^2 = 1.15$, df = 2, $P > 0.05$) or among years ($\chi^2 = 3.97$, df = 2, $P > 0.05$).

Birds were more likely to return after a successful than unsuccessful year ($\chi^2 = 10.8$, df = 1, $P < 0.001$; Figure 1). Similarly, return rates were higher for mated than unmated birds ($\chi^2 = 7.3$, df = 1, $P = 0.007$; Figure 2). A higher proportion of birds were mated at Ayers and Whitton than at Thomson ($\chi^2 = 7.8$, df = 2, $P < 0.05$; Figure 3) and reproductive success was lower than expected at Thomson than the other two sites ($\chi^2 = 10.4$, df = 2, $P = 0.006$).

Dispersal distance - Males tended to return to the same territory held the previous year, while females tended to be in a different territory (see territory maps in Appendix I). In two cases both members of a mated pair returned to the same site. In one case the pair stayed together and had the same territory. In the other both birds had new mates and were in adjacent territories. In all other returns only one member of a pair returned. The within-site dispersal distance was greater for females than for males (excluding the 2 HY birds that returned, see below). The distance between territory centers from one year to the next averaged 66±45 meters for males and 103±65 meters for females (Mann-Whitney U test; $P = 0.04$; Figure 4). Within-site dispersal distance did not differ with past mating status or reproductive success nor did the distance dispersed influence mating status or reproductive success in the year after dispersal. The distances from the natal territory for the two fledglings that returned as adult males were 229 and 265 meters. No bird captured at one site was observed or captured at any other site.

Dispersal distances differed among the sites (ANOVA $F = 3.3$; df = 2, 52; $P = 0.043$). Returning birds dispersed farther at Thomson than at Ayers ($P = 0.031$) or Whitton ($P = 0.027$) while dispersal distances at Ayers and Whitton were similar (Figure 4). Dispersal distances did not differ among the years ($F = 0.9$, df = 2, 52, $P = 0.4$).

Discussion

Return rates

Migratory birds often return to the same breeding site year after year (Greewood 1982). The decision to return appears to be part instinct and part decision. The decision is based in part on individual reproductive success and the success of neighbors (Haas 1998). Thus, while birds that had successful nests may be more likely to return to the same breeding site, prior success may not be the only criterion. Many species show a general tendency to return to the same site (Greewood 1982).

Higher return rates at Thomson than Ayers and Whitton may be misleading. Rather than suggesting Thomson is better habitat, mating status and reproductive success indicate that Thomson is a population sink while Ayers and Whitton are sources. Ayers and Whitton had both a higher proportion of males mated, and a larger number of unmated males than Thomson. Thus,

the apparently high return rates at Thomson may be a result of fewer new birds colonizing that site and the majority of the population composed of older birds returning from previous years.

The relatively large number of unmated males at Ayers and Whitton probably reflect conspecific attraction to a productive breeding area. A large number of singing males is more likely to be indicative of suitable nesting habitat for territorial passerine birds than a small number of males. Competition for mates is intense based on the skewed sex ratio among grasshopper sparrows and the apparent higher survival of males than females (see below). Many males probably assess the possibility of finding a mate and move to another site. Indeed, at Whitton and Ayers especially, we captured many males in late May and early June that were never observed again. Thus, the lower return rates at Ayers and Whitton may be a result of more birds attracted to the site that then leave because they cannot find mates and because all suitable areas are occupied.

Survival

The overall return rates suggest maximum survival for grasshopper sparrows of about 3 years. This estimate corresponds closely with the maximum longevity estimated from recoveries of banded birds (Klimkiewicz and Futcher 1987). On the other hand, only one of the three sites in this study has data from 4 years and the return rates of birds banded at Ayers in 1999 were lower than for other years. Thus, additional data on 3-year return rates from other sites is needed.

These patterns of return rates are similar to other passerine birds and suggest higher survival of males than females and higher survival of adults than first year birds. The general explanation for higher male than female survival is that the cost of egg-laying for females is higher than the cost of territorial defense for males (Greewood 1982) but differential survival in the non-breeding season is also possible (Marra et al. 1998). Natal returns (birds returning to the area where they were hatched) of about 1% in grasshopper sparrows is similar to other passerine species .

Management recommendations

The results suggest Thomson is a population sink while Ayers and Whitton are stable. The main difference between these sites is the presence of pines trees at Thomson but not the other sites. All three sites have some encroachment of woody vegetation in the prairie but only Thomson has the stands of large pines separating the grassland units and spreading into the prairie. Thus, Thomson may be less suitable habitat for grasshopper sparrows and other grassland species than Ayers or Whitton. These pines have the effects of (1) making Thomson a smaller site than it could be by placing a barrier between units, (2) providing habitat for non-grassland birds, some of which are competitors for food or are nest predators, (3) providing habitat for mammalian nest predators, and (4) facilitating nest parasitism by cowbirds. During spot mapping I never observed a grasshopper sparrow travel through the pine trees although they would perch in the smaller isolated pines in the prairie. Data from summer point count surveys at these sites indicate more species of nongrassland birds at Thomson than at Ayers (Wenny and Symstad 2002).

Additional questions

The lack of dispersal between study sites raises the questions of where the new birds arriving at these sites originate from and how far the birds from these study sites disperse? Ayers is approximately 25 k south of Whitton and Thomson is about 12 k south of Ayres. Thus, the

maximum dispersal distance possible in this study was about 40k. Do dispersing birds go farther than that, and if so how far? Alternatively, a small portion of each study area was included in this study and perhaps birds disperse within 1-2 k but beyond the specific study sites. No studies of this type exist that I know of, and such a study would be difficult because of the scale necessary to answer this question. Nevertheless, with so few suitable sites for grasshopper sparrows in the area (Wenny and Symstad 2002) it may be possible to examine the smaller range of dispersal possibilities with increased banding effort at the three sites used in this study.

Another question raised by this study is what factors are important in differences in return rates among forest and grassland birds. Return rates of forest birds appear to be higher than for grasshopper sparrows reported in this study. One possible explanation is a higher propensity to disperse among grassland species because of more rapid successional changes in grassland than forest. A mature forest is likely to remain so for many years barring catastrophic disturbance. In contrast, studies of grassland bird habitat selection suggest a relatively narrow window of habitat suitability. If this window of habitat availability is shorter than the lifespan of the species then selection would favor increased dispersal. Following this logic, shrubland species may also have lower return rates than forest species, perhaps even lower than some grassland species. If so, the propensity to disperse may explain the general lack of area sensitivity among shrubland species (Brawn et al. 2001) and the lower area requirements of grassland birds than forest birds (Wenny et al. 1993, Herkert 1994).

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Table 1. Summary of the number of grasshopper sparrows banded in each year at each of three study sites in northwestern Illinois. The columns under each study year list the number of birds banded in that year and previous years. For example, in 2002 14 banded male grasshopper sparrows were present at Ayers: 6 banded in 2002, 3 from 2001, 5 from 2000 and none from 1999. The Grand total column is the sum of new birds banded each year rather than the sum of total birds present each year. Except were noted (*), birds returning from previous years were originally banded as adults.

Study Site	Study Year	1999	2000			2001				2002					Grand Total
	Yr Banded	99	99	00	Tot	99	00	01	Tot	99	00	01	02	Tot	
Ayers	Male	23	2	18	20	2	4	8	14	0	5	3	6	14	55
	Female	19	1	6	7	0	0	13	13	0	0	0	3	3	41
	HY	5	-	4	4	-	-	7	7	-	-	-	1	1	17
	Total	47	3	28	31	2	4	28	34	0	5	3	10	18	113
Thomson	Male	-	-	9	9	-	3	10	13	-	3	9*	3	15	22
	Female	-	-	5	5	-	2	7	9	-	1	1	1	3	13
	HY	-	-	3	3	-	-	8	8	-	-	-	4	4	15
	Total	-	-	17	17	-	5	25	30	-	4	10	8	22	50
Whitton	Male	-	-	17	17	-	6	13	19	-	5	3*	12	20	42
	Female	-	-	9	9	-	2	12	14	-	0	3	5	8	26
	HY	-	-	5	5	-	-	4	4	-	-	-	4	4	13
	Total	-	-	31	31	-	8	29	37	-	5	6	21	32	81
Grand Total		47	3	76	79	2	17	82	101	0	14	19	39	72	244

*Including one bird banded HY in previous year

Table 2. Summary of grasshopper sparrow banding at Ayers State Nature Preserve. For each year of the study the number of birds that returned in subsequent years is shown. Also, the number of unbanded birds (based on spot mapping) is listed along with the number of birds present that were banded in previous years. In the last two columns the numbers in parentheses refer to the number and percentage of birds that returned from the year immediately preceding the study year (rather than all previous years of the study).

Year	Age-Sex	Banded birds present	Returned in subsequent years		Unbanded birds present	Total adults present	Returned from previous years	
			#	%			#	%
1999	AHY-M	23	4	17	0	23		
	AHY-F	19	1	5	0	19		
	Adults	42	5	12	0	42		
	HY-U	5	0	0				
	Total	47	5	11				
2000	AHY-M	20	6	30	0	20	2	10
	AHY-F	7	0	0	7	14	1	7
	Adults	27	6	22	7	34	3	9
	HY-U	4	0	0				
	Total	31	6	19				
2001	AHY-M	14	3	21	4	18	7 (5)	39 (28)
	AHY-F	13	0	0	1	14	0	0
	Adults	27	3	11	5	32	7 (5)	22 (16)
	HY-U	7	0	0				
	Total	34	3	3				
2002	AHY-M	14			1	15	8 (3)	53 (20)
	AHY-F	3			6	9	0	0
	Adults	17			7	24	8 (3)	33 (13)
	HY-U	1						
	Total	18						
Total	AHY-M	57	13	23	5	53	17 (10)	32 (19)
	AHY-F	38	1	3	14	37	1	3
	Adults	79	14	18	21	90	18 (11)	20 (12)
	HY-U	16	0	0				
	Total	95	14	15				

Table 3. Summary of grasshopper sparrow banding at Thomson section of Upper Mississippi Wildlife and Fish Refuge. For each year of the study the number of birds that returned in subsequent years is shown. Also, the number of unbanded birds (based on spot mapping) is listed along with the number of birds present that were banded in previous years. In the last two columns the numbers in parentheses refer to the number and percentage of birds that returned from the year immediately preceding the study year (rather than all previous years of the study).

Year	Age-Sex	Banded birds present	Returned in subsequent years		Unbanded birds present	Total adults present	Returned from previous years	
			#	%			#	%
2000	AHY-M	9	5	56	0	9		
	AHY-F	5	3	60	0	5		
	Adults	14	8	57	0	14		
	HY-U	3	0	0				
	Total	17	8	47				
2001	AHY-M	13	9	69	1	14	3	21
	AHY-F	9	0	0	3	12	2	17
	Adults	22	9	41	4	26	5	19
	HY-U	8	1	12				
	Total	29	10	34				
2002	AHY-M	15			1	16	12 (9)	75 (56)
	AHY-F	3			7	10	2 (1)	20 (10)
	Adults	18			8	26	14 (10)	54 (38)
	HY-U	4						
	Total	22						
Total	AHY-M	22	14	64	2	30	15 (12)	50 (40)
	AHY-F	14	3	21	10	22	4 (3)	18 (14)
	Adults	36	17	47	12	52	19 (15)	37 (29)
	HY-U	11	1	7				
	Total	51	18	35				

Table 4. Summary of grasshopper sparrow banding at Whitton Gate area of the proposed Lost Mound National Wildlife Refuge. For each year of the study the number of birds that returned in subsequent years is shown. Also, the number of unbanded birds (based on spot mapping) is listed along with the number of birds present that were banded in previous years. In the last two columns the numbers in parentheses refer to the number and percentage of birds that returned from the year immediately preceding the study year (rather than all previous years of the study).

Year	Age-Sex	Banded birds present	Returned in subsequent years		Unbanded birds present	Total adults present	Returned from previous years	
			#	%			#	%
2000	AHY-M	17	7	41	3	20		
	AHY-F	9	2	22	4	13		
	Adults	26	9	35	7	33		
	HY-U	5	0	0				
	Total	31	9	29				
2001	AHY-M	19	4	21	0	19	6	32
	AHY-F	14	3	21	1	15	2	13
	Adults	33	7	21	1	34	8	24
	HY-U	4	1	25				
	Total	37	8	22				
2002	AHY-M	20			0	20	9 (4)	45 (20)
	AHY-F	8			2	10	3 (3)	30 (30)
	Adults	28			2	30	12 (7)	40 (23)
	HY-U	4						
	Total	32						
Total	AHY-M	36	11	31	3	39	15 (10)	38 (26)
	AHY-F	23	5	22	7	25	5	20
	Adults	59	16	27	10	64	20 (15)	31 (23)
	HY-U	9	1	11				
	Total	68	17	25				

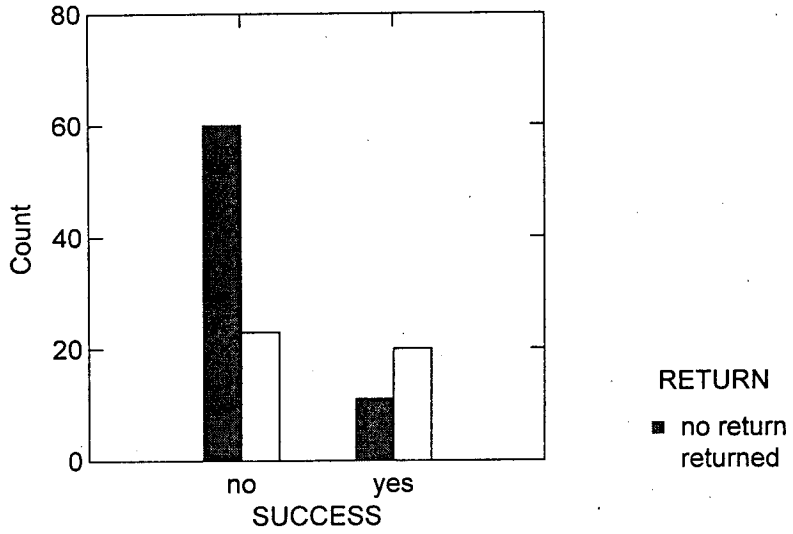


Figure 1. Number of birds that returned or did not return after a year with reproductive success or no success.

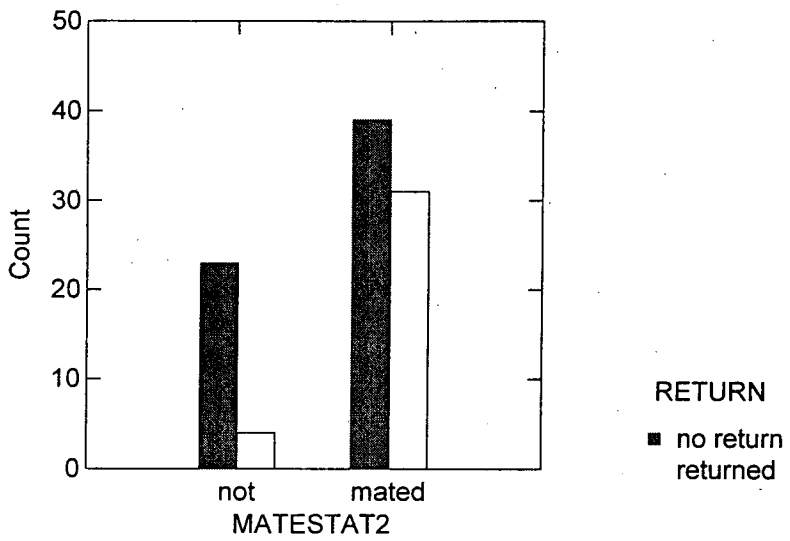


Figure 2. Number of birds that returned or did not return after a year in which they were mated or not mated.

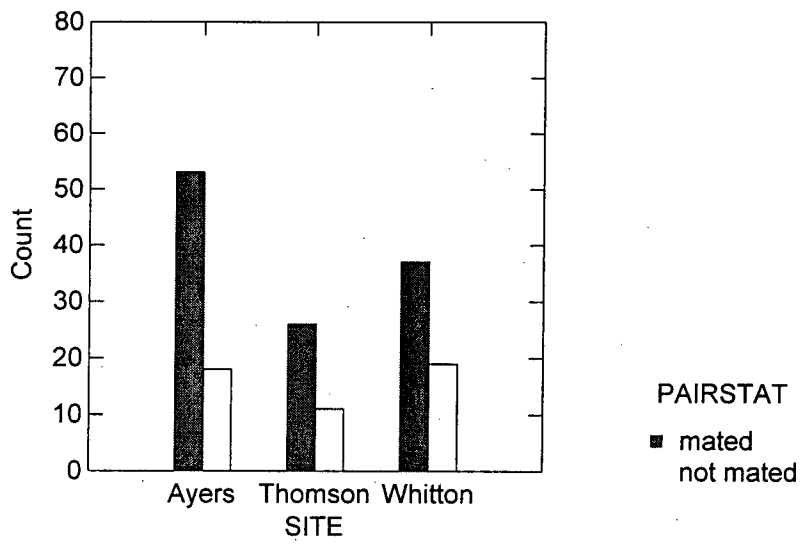


Figure 3. Mating status of grasshopper sparrows at the three study sites.

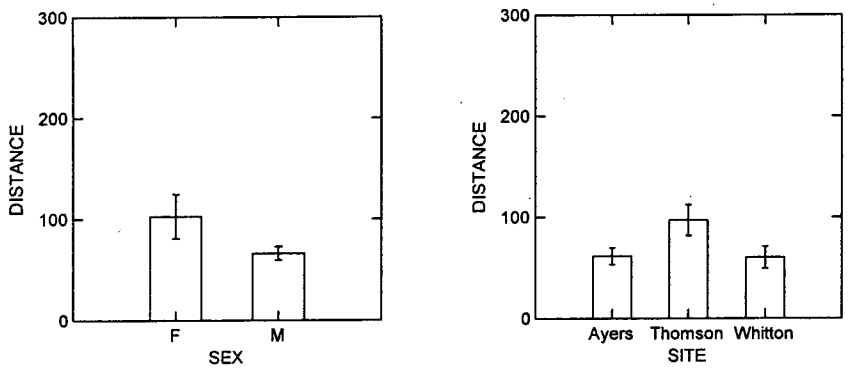
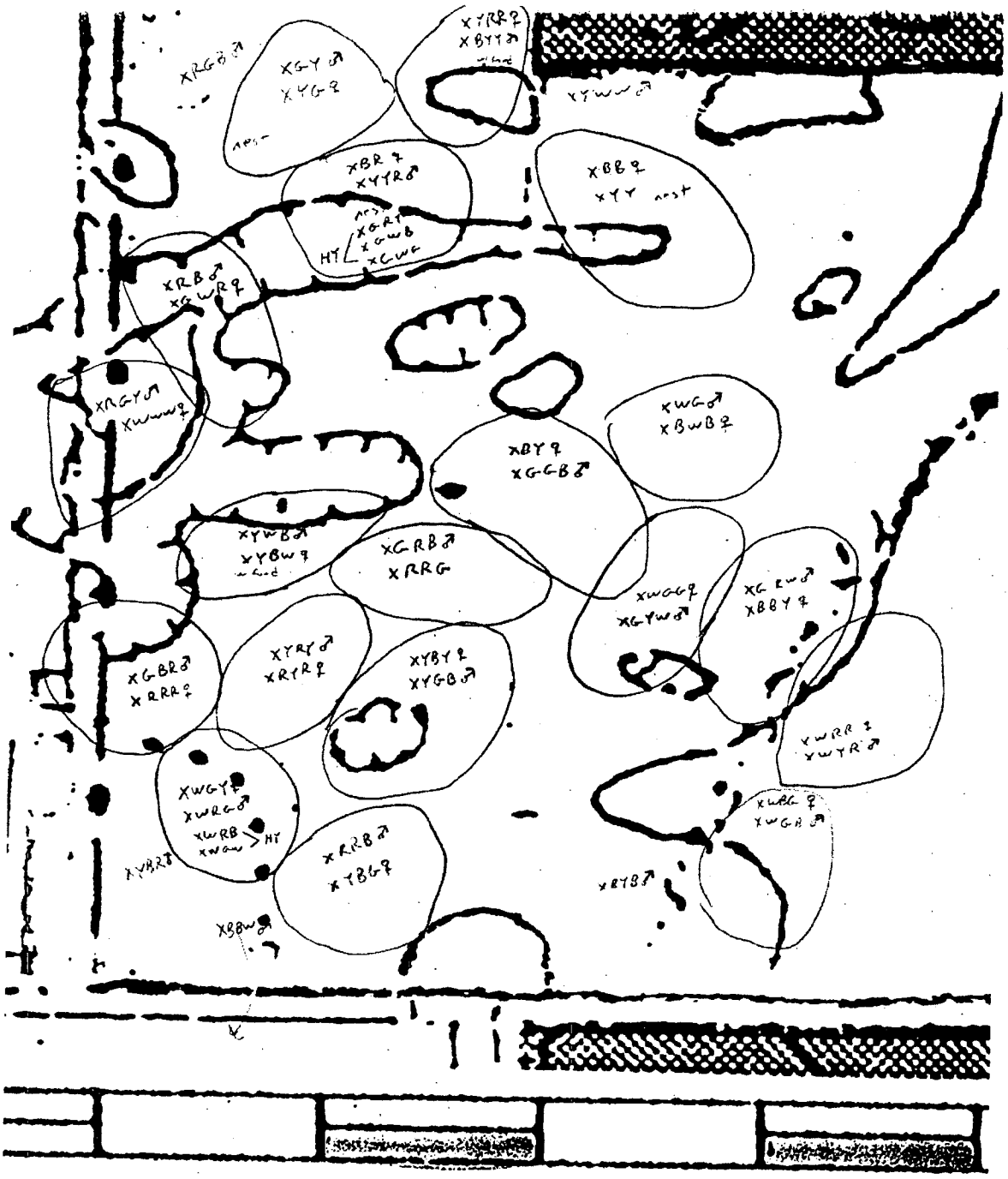
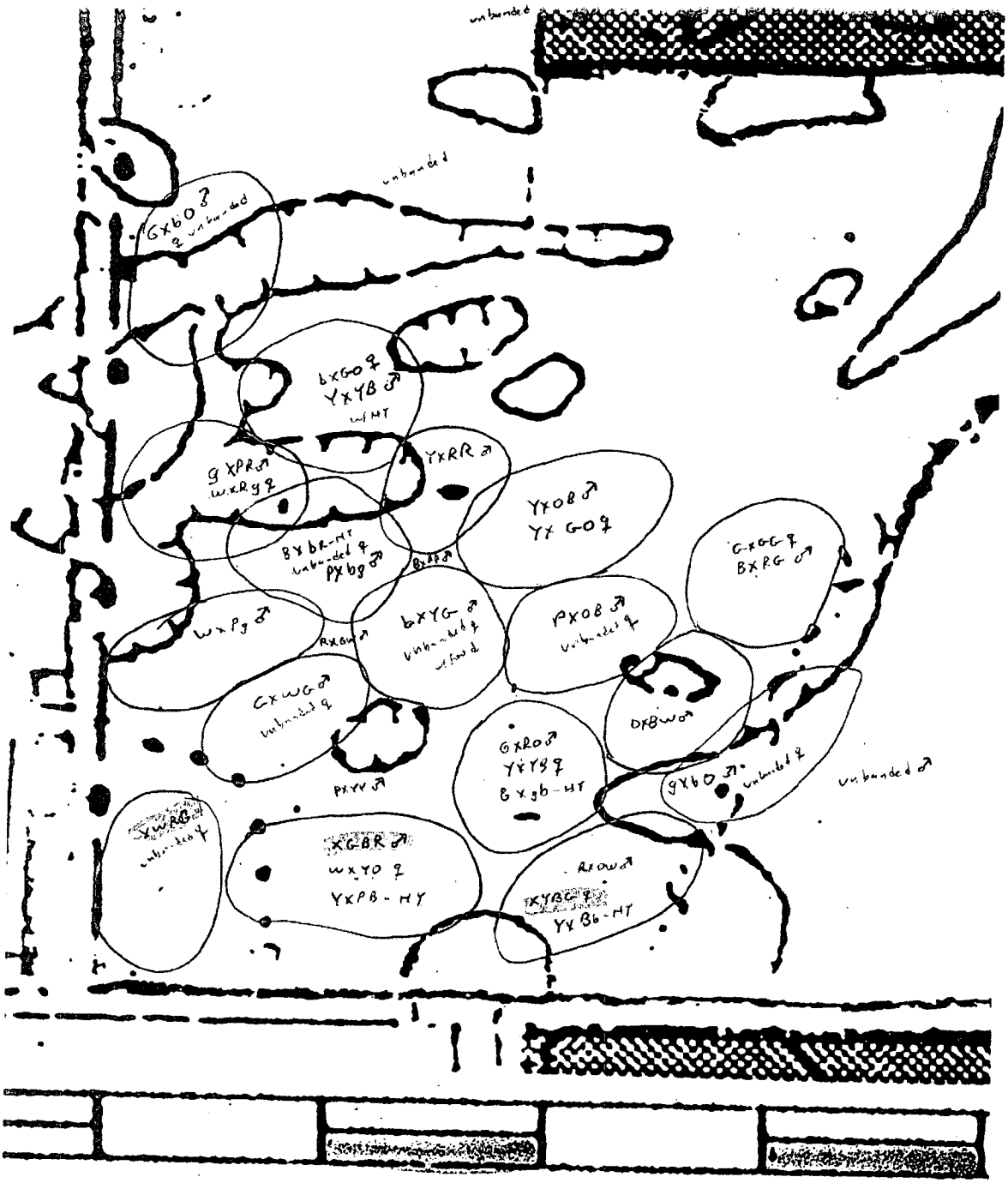


Figure 4. Average distance between territory centers in subsequent years for each bird that returned to a site one year later. Graphs show dispersal distances compared between the sexes (left) and among the three sites (right).

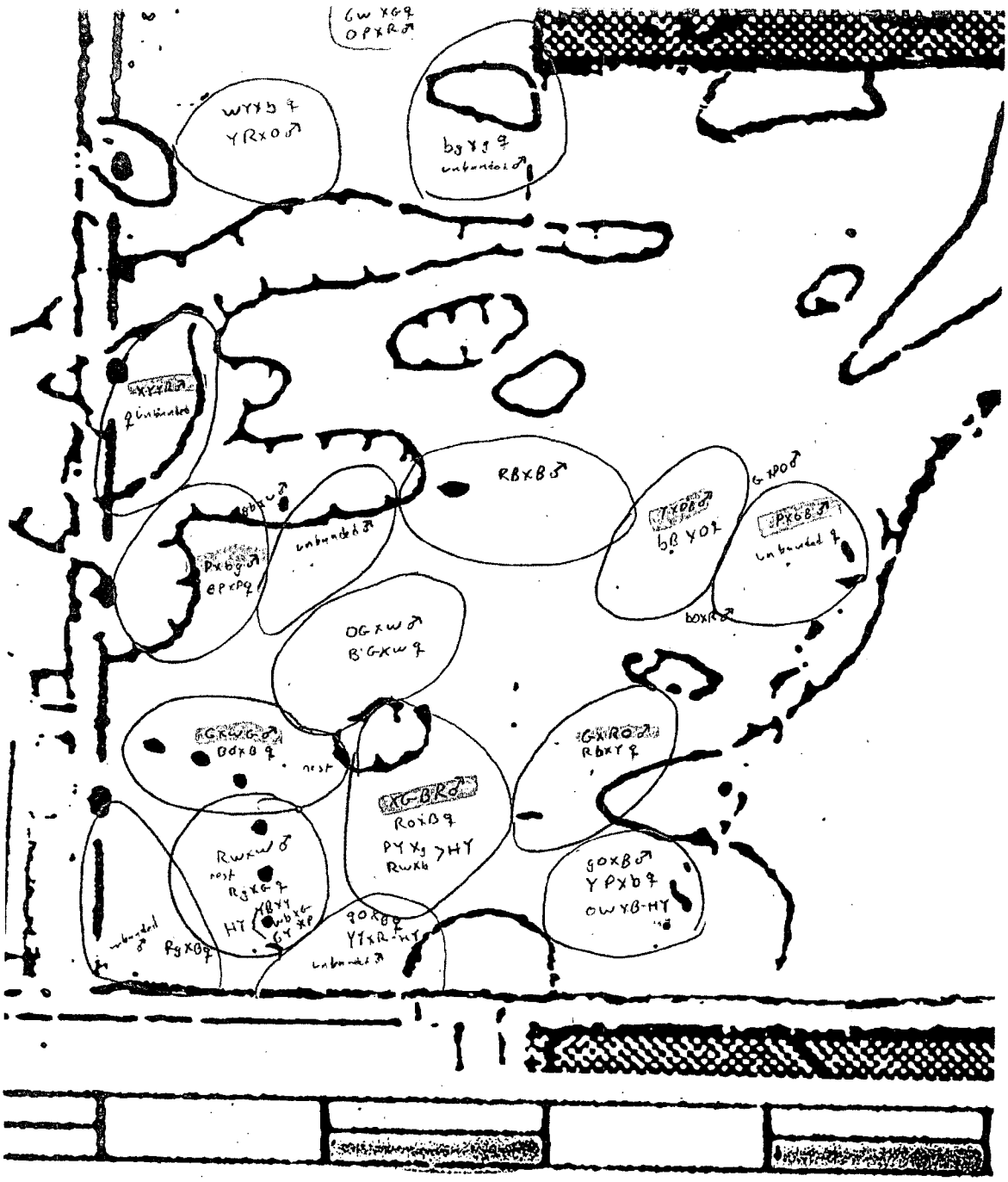
Appendix I a-j. Maps of each study site for each year showing approximate locations of Grasshopper Sparrow territories (or banding location for individuals without territories). Scale on edge of each map is in 100m segments. Each bird is identified by its colorband combination (X=aluminum band, B=dark blue, b=light blue, G-dark green, g=light green, O=orange, P=purple, R=red, W=white, Y-yellow). Birds that returned to the same study site are highlighted.



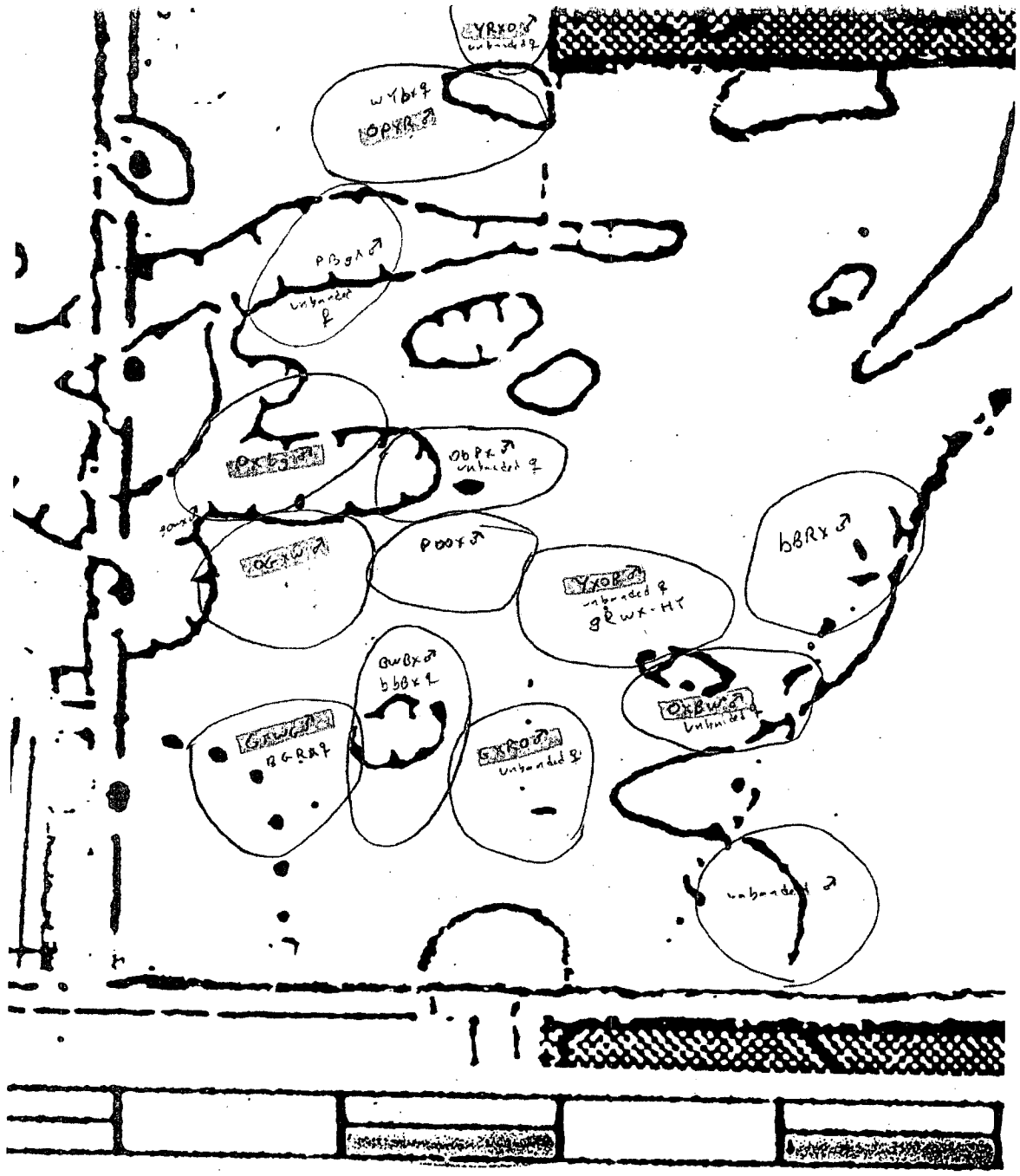
Appendix I a. Grasshopper sparrow territories at Ayers Sand Prairie State Nature Preserve in 1999. Scale at bottom is in 100m segments.



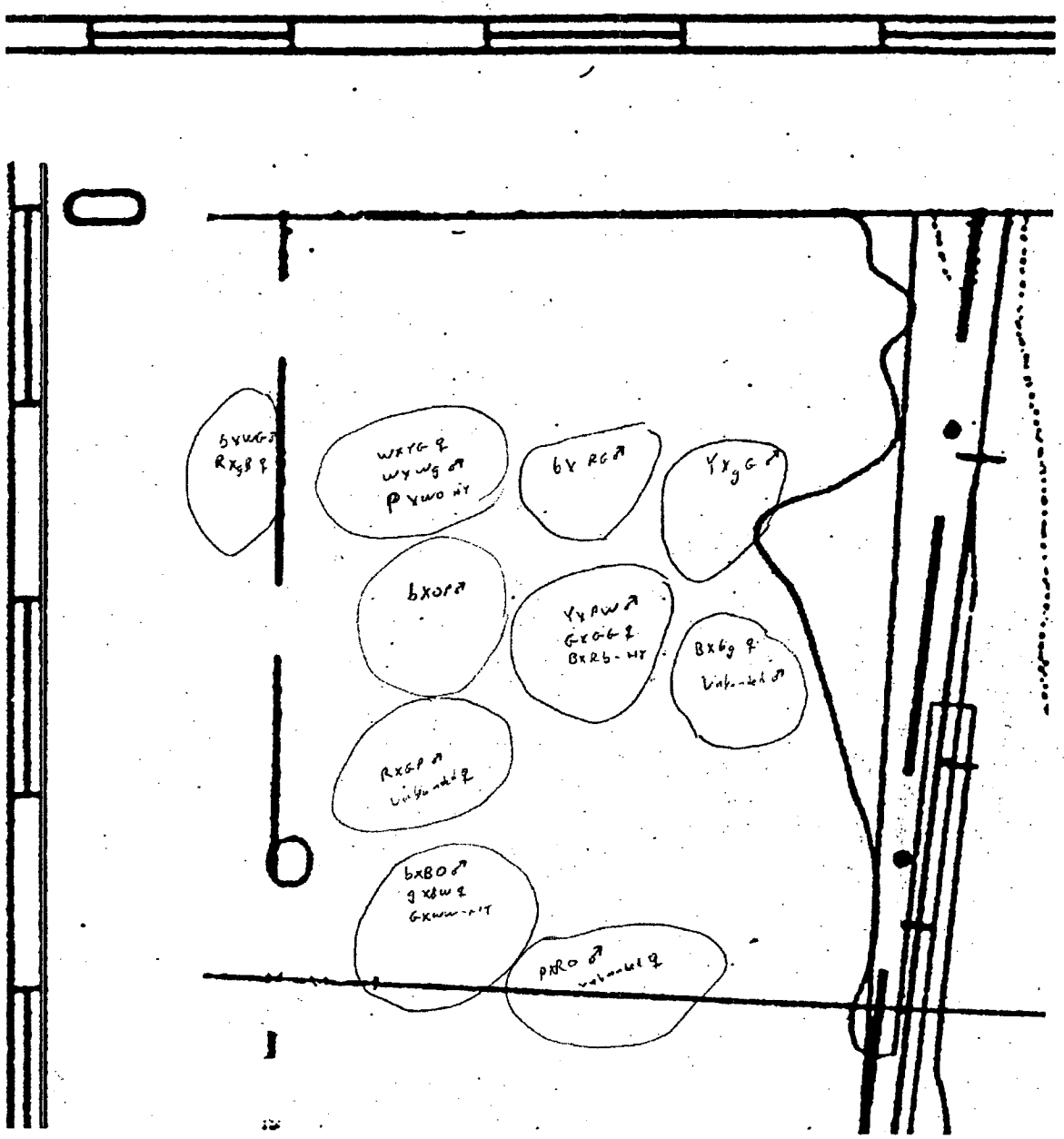
Appendix I b. Grasshopper sparrow territories at Ayers Sand Prairie State Nature Preserve in 2000. Scale at bottom is in 100m segments. Birds highlighted in blue were banded in 1999.



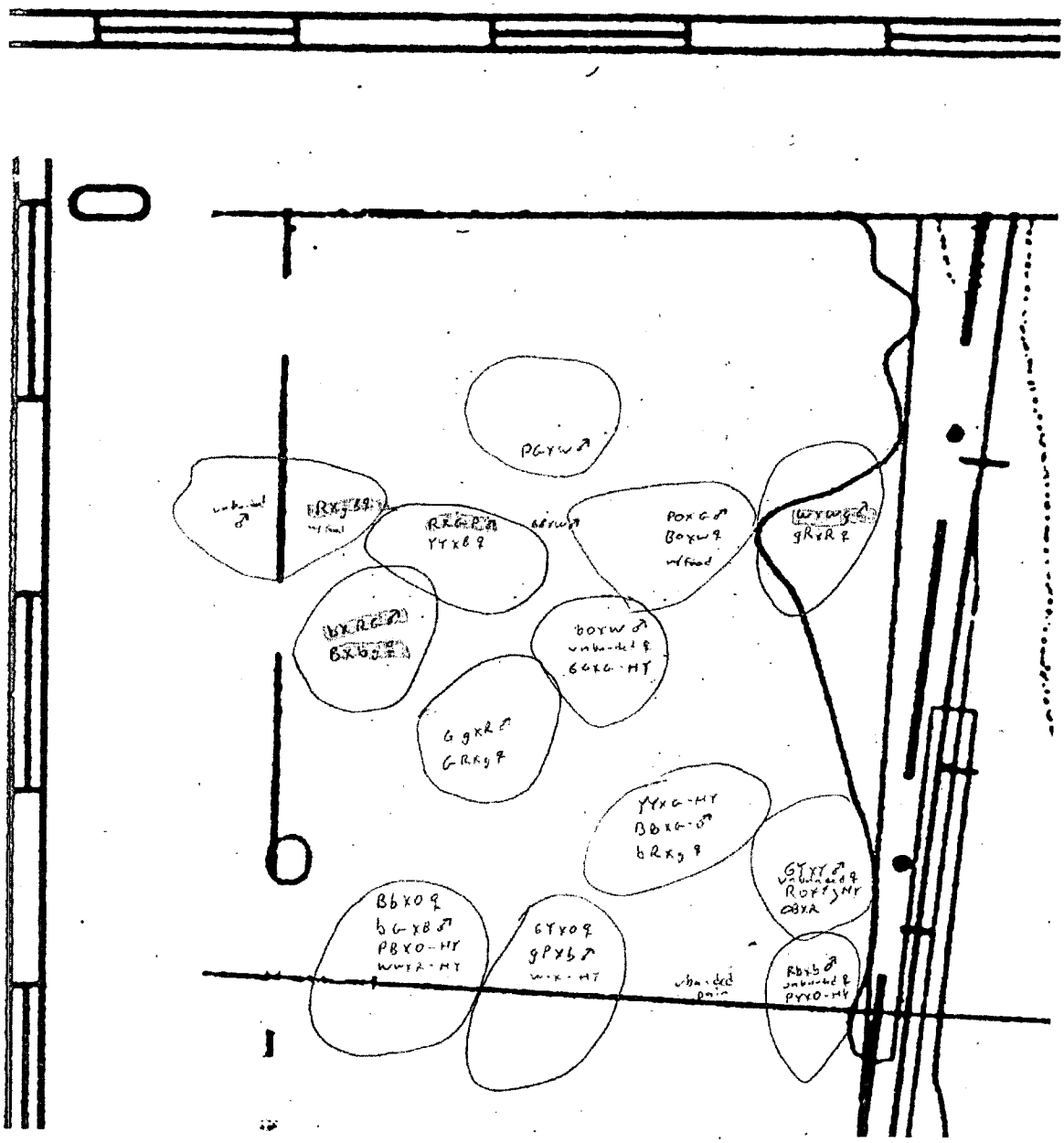
Appendix 1c. Grasshopper sparrow territories at Ayers Sand Prairie State Nature Preserve in 2001. Scale at bottom is in 100m segments. Highlighted birds were originally banded in 1999 (pink) or 2000 (blue).



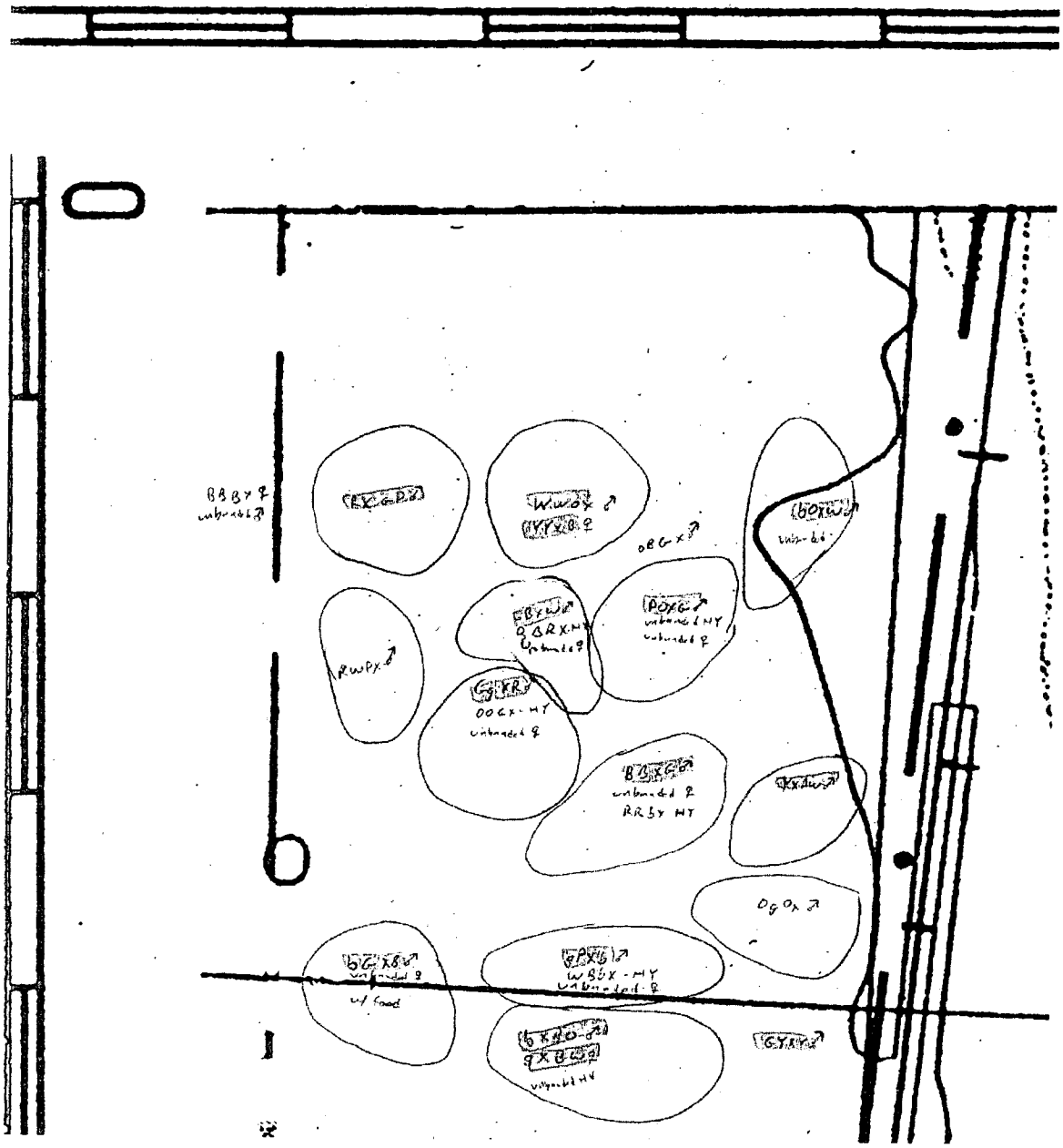
Appendix 1d. Grasshopper sparrow territories at Ayers Sand Prairie State Nature Preserve in 2002. Scale at bottom is in 100m segments. Highlighted birds were originally banded in 2000 (pink) or 2001 (blue).



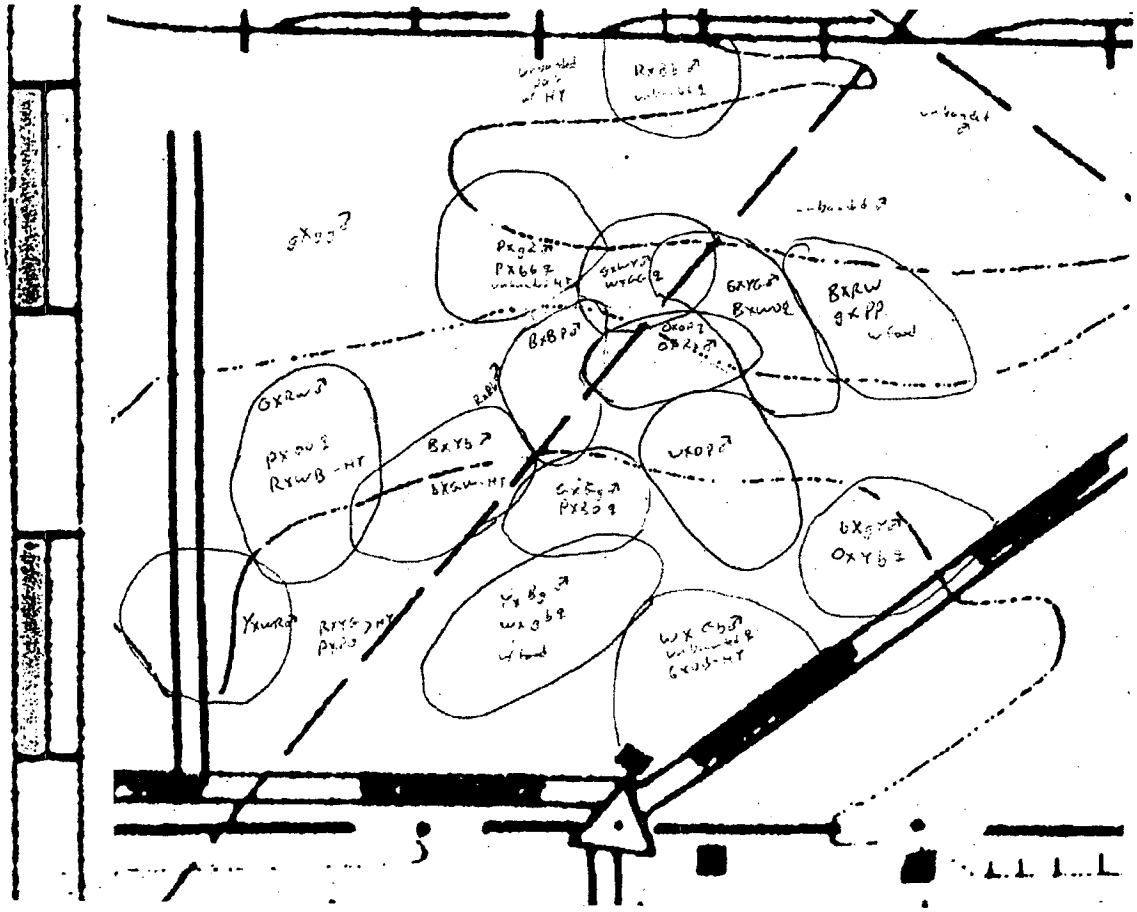
Appendix 1e. Grasshopper sparrow territories at Thomson Natural Area of the Upper Mississippi River National Fish and Wildlife Refuge in 2000. Scales are in 100m segments.



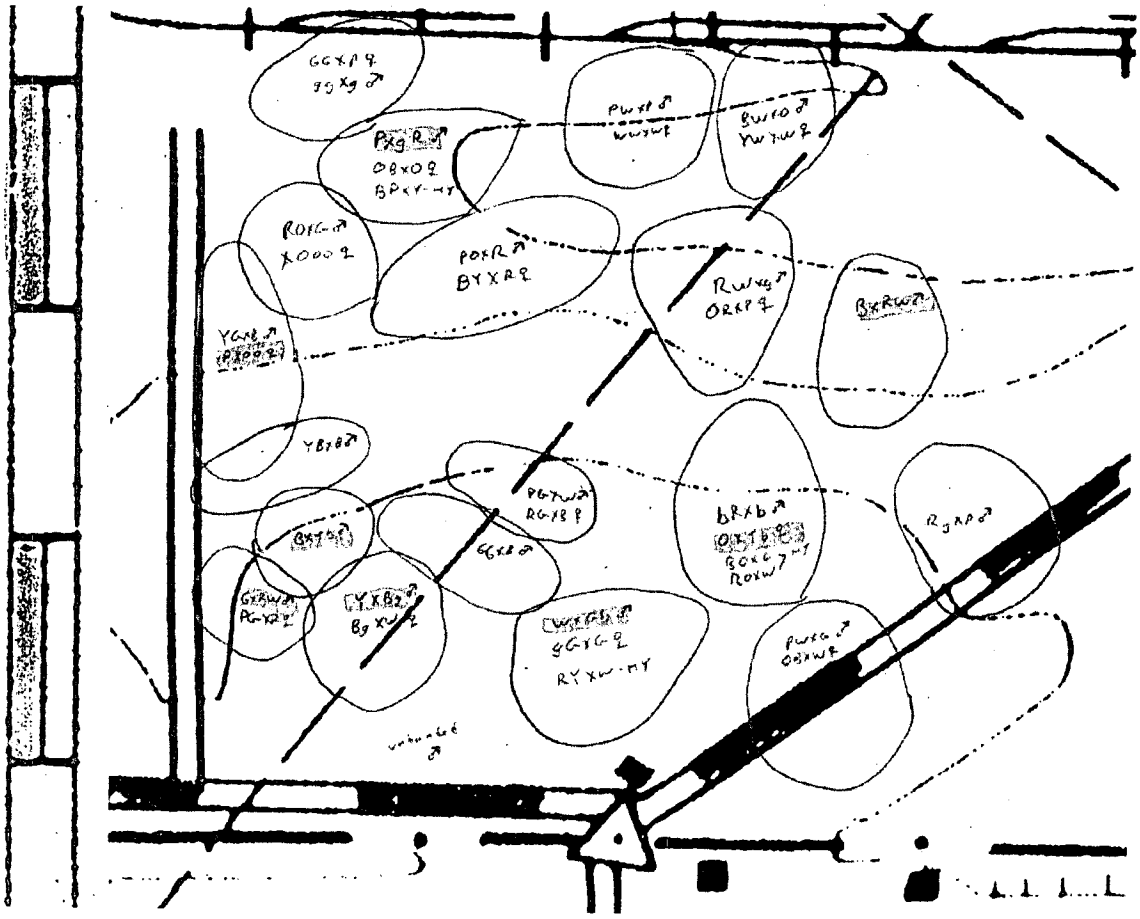
Appendix 1f. Grasshopper sparrow territories at Thomson Natural Area of the Upper Mississippi River National Fish and Wildlife Refuge in 2001. Scales are in 100m segments. Birds highlighted in blue were banded in 1999.



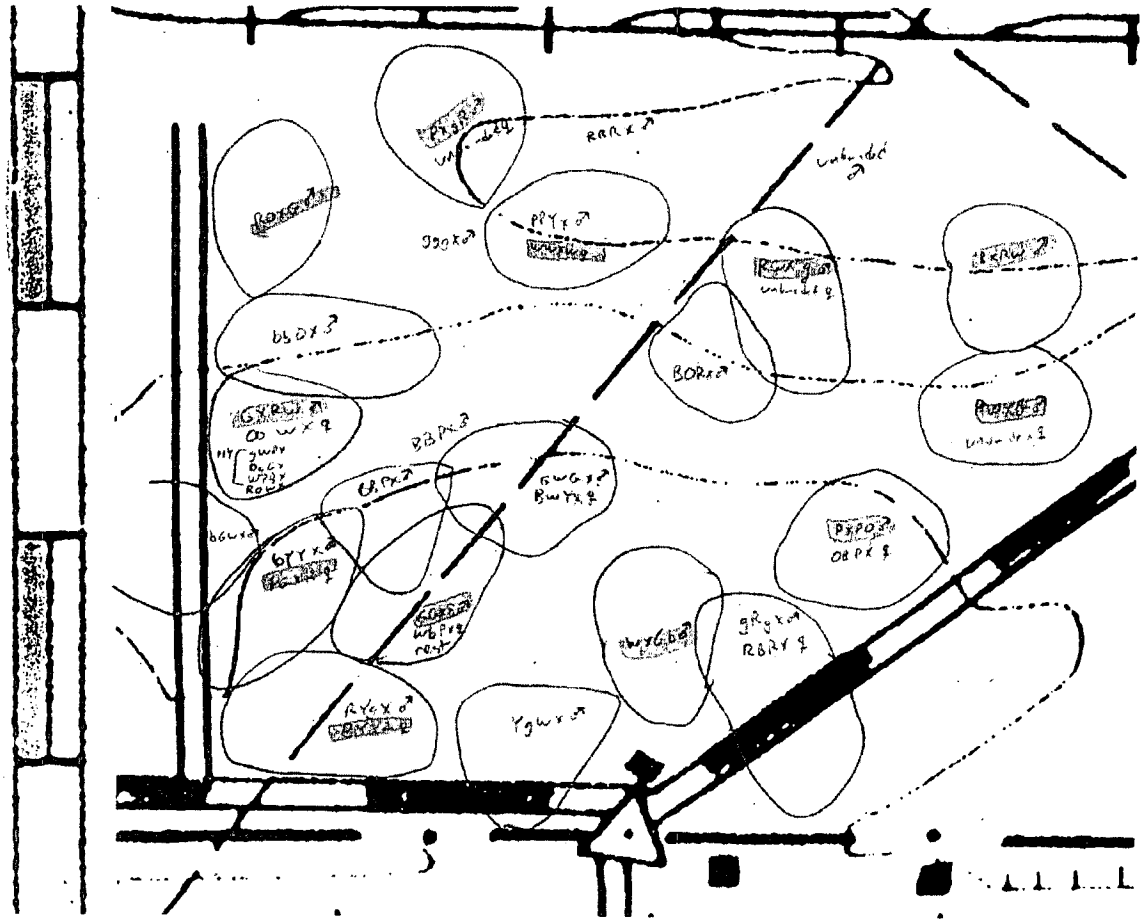
Appendix 1g. Grasshopper sparrow territories at Thomson Natural Area of the Upper Mississippi River National Fish and Wildlife Refuge in 2002. Scales are in 100m segments. Highlighted birds were originally banded in 2000 (pink) or 2001 (blue).



Appendix 1h. Grasshopper sparrow territories at Whitton Gate area of the proposed Lost Mound National Wildlife Refuge in 2000. Scales are in 100m segments.



Appendix 1i. Grasshopper sparrow territories at Whitton Gate area of the proposed Lost Mound National Wildlife Refuge in 2001. Scales are in 100m segments. Birds highlighted in blue were banded in 2000.



Appendix 1i. Grasshopper sparrow territories at Whitton Gate area of the proposed Lost Mound National Wildlife Refuge in 2002. Scales are in 100m segments. Highlighted birds were originally banded in 2000 (blue) or 2001 (pink).