Colorado Springs Deer Movement Management Study
Study Report - DRAFT

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INTRODUCTION

On 18 April 2004 a mule deer (*Odocoileus hemionus*) was collected in the eastern portion of the Broadmoor neighborhood in Colorado Spring that tested positive for Chronic Wasting Disease (CWD). The finding of CWD in Colorado Springs was the first in the Southeast region of the Colorado Division of Wildlife (CDOW) and the farthest south CWD had been discovered at the time.

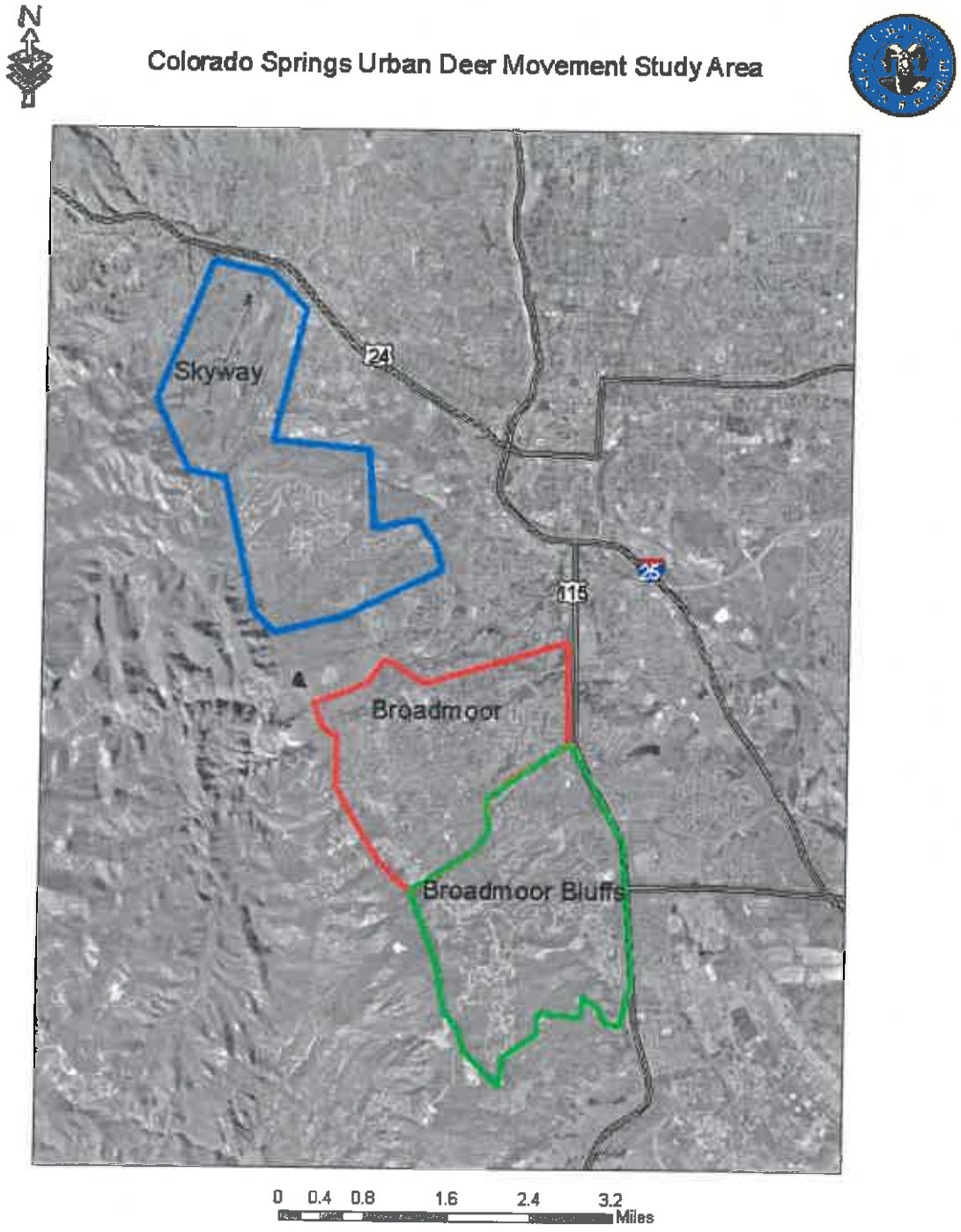
Very little is known about the movements and demographics of mule deer in the Colorado Springs area. Since 1999, approximately 11 deer have been marked with ear tags in the Colorado Springs area after being handled by CDOW personnel. Public sightings of these animals are not numerous and have been in the same general area of capture.

In an effort to better understand deer movements in the Colorado Springs area and the possible spread of the disease, it was decided that radio collars be placed on mule deer and monitored for management purposes.

STUDY AREA

Three neighborhoods were chosen that included and surrounded the neighborhood where the positive animal was found. These neighborhoods include the Broadmoor, Broadmoor Bluffs and Skyway (Figure 1). The overall size of the study area is approximately 31.26 km^2. The area is characterized by moderate housing density with housing subdivisions separated by open space. The open space is composed of vegetation associated with a mountain shrub community, which includes, but is not limited to, ponderosa pine (*Pinus ponderosa*), mountain mahogany (*Cercocarpus montanus*), and gambel oak (*Quercus gambelii).* Vegetation within the housing areas is varied, but includes landscape plantings that provide desirable forage for mule deer.

Figure 1. Map depicting the study area in Colorado Springs, which includes the Skyway, Broadmoor and Broadmoor Bluffs neighborhoods.



METHODS

Capture

Because mule deer in Colorado Springs are habituated to both people and vehicles, deer were captured using anesthetizing drug administered from a dart fired from a Dan-inject (Dan-inject International, Fort Collins, Colorado) dart gun. After each animal was immobilized, blood, and tonsil samples for subsequent CWD testing was collected. Each animal was ear tagged and outfitted with a mortality sensing radio collar that had visible, colored, number placards for easy identification.

Deer Movement and Home Range

To examine movements animals were radio located on an approximate weekly basis. After the animal was radio located, the mule deer's UTM location was estimated by either visual observation or triangulation with locations estimated using LOCATE II (Nams 2000). In addition, credible public sightings and the CDOW airplane were used to collect a number of locations.

Movement information was analyzed using ArcView 3.3 (Environmental Systems Research Institute, Redlands, California) and resource use areas identified by calculating minimum convex polygons (MCP) using the animal movement extension (Hooge and Eichenlaub 1997).

Survival

In addition to estimating movements, the radio collared deer provided a means to estimate survival rates for mule deer in Colorado Springs. Suvival rates were estimated using known fate models in program MARK (White and Burnham 1999).

Population Estimation and Demographics

To estimate population abundance and demographics an intensive search was performed in the Broadmoor, Skyway and Broadmoor Bluffs neighborhoods between 17-19 November 2004. Three groups of volunteers were identified and trained for the searches. Training included a field trip prior to 17 November where participants were instructed to individually classify groups of deer as, buck, doe and fawn. After individuals classified animals, the group of participants then discussed their individual results. This exercise was duplicated until results were consistently the same for all group members. For the actual search, three groups were created and each group had at least two individuals. Data forms were developed and driving routes were created to cover the study area. Groups were instructed to begin driving at approximately ½ hour before sunrise and end the route at approximately 9 am. They were then instructed to begin the afternoon search at approximately 2 pm and search till dark. Each group was to look for deer and record the number of bucks, does and fawns within each group. In addition, they were instructed to document any of the radio marked deer that were seen. Each group was assigned a different neighborhood for a total of three days. This made a total of six sighting occasions for each neighborhood.

To estimate population size we used the Bowden's estimator in program NOREMARK (White 1996). To determine if the radio marked animals were on the search area we radio located each animal immediately after the ground searches.

RESULTS

On 12 and 13 May 2004, 21 mule deer (13 bucks and 8 does) were captured in three Colorado Springs neighborhoods (Table 1). One buck was believed to be an adult at the time of capture, but further inspection showed that this animal was a juvenile and the deer was ear tagged and released without a radio collar. In addition to the initial 20 radio collared mule deer, three additional bucks were captured on 7 October 2004 and outfitted with radio collars collected from mortalities that occurred in the first 20 animals.

Results from all viable tonsil samples came back negative for the presence of CWD.

We collected 727 individual locations from the 23 radio collared deer from May 2004 to May 2005 (Table 2). The number observation per animal ranged from a high of 50 observations and a low of five observations (low number because the animal was a mortality; Table 2).

Home range size for the radio collared animals varied (Table 2; Appendix A). In general, the radio collared animals did not leave the three neighborhood area of their capture. Two animals, 151.400 (male) and 149.991 (female) made seasonal movements to the west of Colorado Springs near Gold Camp Road and Rosemont Reservoir (Appendix A). Of the nine female mule deer captured, five were tracked from from May 2004 to May 2005, and seven of the fourteen males for the same period. All other mule deer did not survive for the entire year. The average MCP home range size for the five females was 0.9 km^2 (SE=0.45) and the average MCP home range size for males was 6.07 km^2 (SE=5.69).

Table 1. Deer radio frequency, sex, age and neighborhood of capture for 23 mule deer radio collared in the Colorado Springs area.

Deer Radio Frequency	Sex	Age	Neighborhood Of Capture
151.250	M	Adult	Sky Way
151.988	M	Adult	Sky Way
151.420	F	Adult	Sky Way
151.340	F	Adult	Sky Way
151.000	M	Adult	Sky Way
149.991	F	Adult	Broadmoor
148.200	F	Adult	Broadmoor
151.230	F	Adult	Broadmoor
151.350	F	Adult	Broadmoor Bluffs
151.270	M	Adult	Broadmoor Bluffs
151.309	M	Adult	Broadmoor Bluffs
151.290	F	Adult	Broadmoor Bluffs
151.090	M	Adult	Broadmoor
151.729	M	Adult	Broadmoor
151.400	M	Adult	Broadmoor
151.009	M	Adult	Broadmoor Bluffs
151.120	F	Adult	Broadmoor Bluffs
151.670	F	Adult	Sky Way
151.279	M	Adult	Broadmoor
150.871	M	Adult	Broadmoor
151.250A	M	Adult	Skyway
151.270A	M	Adult	Broadmoor

Table 2. Radio frequency, sex, mortality status, MCP home range size, and the number of locations used in the MCP calculations.

Radio Frequency	Sex	Mortality	MCP Home Range Size km^2	MCP Home Range Size mi^2	No. Locations
148.2	F	No	1.52	0.59	45
151.35	F	No	0.71	0.27	38
151.42	F	No	1.18	0.46	48
151.67	F	No	0.35	0.13	45
151.23	F	Radio Failure	0.75	0.29	39
149.991	F	Yes	22.96	8.86	16
151.12	F	Yes	0.42	0.16	40
151.29	F	Yes	0.67	0.26	26
151.34	F	Yes	0.55	0.21	26
151.000	M	No	3.97	1.53	46
151.090	M	No	2.37	0.92	45
151.250A	M	No	1.00	0.39	29
151.279	M	No	5.05	1.95	48
151.309	M	No	9.58	3.70	50
151.400	M	No	17.41	6.72	40
151.729	M	No	3.09	1.19	45
150.871	M	Yes	2.06	0.80	13
150.988	M	Yes	1.70	0.65	27
151.009	M	Yes	2.36	0.91	14
151.140	M	Yes	1.36	0.53	24
151.250	M	Yes	2.49	0.96	5
151.270	M	Yes	0.86	0.33	6
151.270A	M	Yes	0.54	0.21	12

From May 2004 to May 2005, 11 of the 23 radio collared deer were mortalities. These included four of the nine females were mortalities and seven of the fourteen males. This equated to an annual survival of 44.93% (95% C.I. 0.2176 – 0.7053) for females and 58.27% (95% C.I. 0.2821 – 0.8323) for males. Causes of mortality include auto collisions (6 deer), mountain lion predation (2 deer) and unknown (3 deer). In addition, we documented two cases where radio collared deer were struck by vehicles during the study, but not killed. Nearly half of our sample of 23 deer was hit by a vehicle during a one year period.

In total, 1,228 deer were classified during the three day search in the Skyway, Broadmoor and Broadmoor Bluffs neighborhoods (Table 3). Invariably, many of these sightings

were duplicates of the same animals. However, the largest number of deer seen across all occasions was the afternoon of 17 November when 240 different deer were classified. During this session no marked deer were recorded.

This search resulted in a buck/ doe ratio of 37.3 bucks (95% C.I. 31.7 – 43.4) per 100 does and a doe/ fawn ratio of 65.7 fawns (95% C.I. 59.8 – 72.0) per 100 does.

Overall, there were 15 radio marked deer on the search area during our ground searches. Of the 15, nine animals were sighted at least once across the six ground search occasions. One animal was sighted on five occasions and seven of the animals were only seen on one of the six occasions. Program NOREMARK produced an estimate of 931 deer (95% C.I. 505-1,718) in the Skyway, Broadmoor and Broadmoor Bluffs neighborhoods.

Table 3. Neighborhood, dates searched, occasion searched, number of bucks, number of does, number of fawns, number of marked animals, and the total number of animals classified during the 2004 ground classification.

Neighborhood	Date	Occasion	Bucks	Does	Fawns	Marked Animals	Total Animals
Skyway	11/17/2004	Morning	10	39	35	0	84
Skyway	11/17/2004	Afternoon	17	61	36	0	114
Skyway	11/18/2004	Morning	32	88	54	2	173
Skyway	11/18/2004	Afternoon	31	72	37	2	140
Skyway	11/19/2004	Morning	24	57	36	1	117
Skyway	11/19/2004	Afternoon	26	72	45	1	143
Broadmoor	11/17/2004	Morning	11	17	15	0	43
Broadmoor	11/17/2004	Afternoon	13	29	24	2	66
Broadmoor	11/18/2004	Morning	10	9	7	1	26
Broadmoor	11/18/2004	Afternoon	2	9	1	1	12
Broadmoor	11/19/2004	Morning	2	7	5	0	14
Broadmoor	11/19/2004	Afternoon	7	28	22	2	57
Broadmoor Bluffs	11/17/2004	Morning	3	15	5	1	23
Broadmoor Bluffs	11/17/2004	Afternoon	10	27	23	2	60
Broadmoor Bluffs	11/18/2004	Morning	4	14	9	0	27
Broadmoor Bluffs	11/18/2004	Afternoon	5	30	18	1	53
Broadmoor Bluffs	11/19/2004	Morning	8	22	16	0	46
Broadmoor Bluffs	11/19/2004	Afternoon	6	13	11	1	30
TOTALS			**221**	**609**	**399**	**17**	**1228**

DISCUSSION

Deer Movements and Home Range

The annual home range size of mule deer in Colorado Springs is smaller than the home range size of mule deer in non-urban areas in Colorado. Stephenson et al. (1996) found that the annual home range size of male and female mule deer on Pińon Canyon Maneuver Site was 41.67 km^2 (SE=18.72) and 12.21 km^2 (SE=1.66), respectively. Kuefeld et al. (1989) found the largest winter home range size of female mule deer west of Fort Collins, Colorado in three years of study to be 1.67 km^2 (SE=1.9). This was larger than the female home range found in this study (0.9 km^2 - SE=0.45).

In many instances, deer made movements across busy roadways on a daily or weekly basis. For example, three bucks were captured in close proximity to Highway 115. All three made routine movements across Highway 115 and this resulted in all three being struck by vehicles. Two of the deer were killed and the third was struck, but not killed. Routine movement behaviors across busy roadways seem to ultimately result in mortality by vehicle collisions.

Survival

Annual survival rates as observed in this study are low, but sample sizes are small. The CDOW has four research mule deer herds in the state which include the Arkansas River, Uncompahgre Plateau, Middle Park and the White River. Survival rates for adult doe mule deer in from 2004 to 2005 were: 79.7% for the Arkansas River deer herd, 79.4% for the Uncompahgre deer herd, 91% for the White River deer herd, and 76% for the Middle Park deer herd. These rates higher than the 44.93% doe annual survival rate that we obtained for adult does in Colorado Springs over the same period. In year 2000, buck mule deer were radio collared on the Uncompahgre Plateau and the estimated annual survival was 75% (SE = 0.071). This measured value was higher than the value of 58.27% buck annual survival that we found in Colorado Springs. In all cases survival of deer in Colorado Springs is lower than the survival rates of non-urban deer around Colorado. This is undoubtedly because of increased mortality attributed to deer/vehicle collisions that occur in Colorado Springs. In general, this source of mortality appears to be limiting the deer population within the city.

Population Estimate

The precision of a mark-resight population estimate is determined by the number of animals marked in the population and the number of re-sighting occasions. Given the large number of deer within the Skyway, Broadmoor, and Broadmoor Bluffs neighborhoods, the number of marked deer (15) within the study area during our re-sighting occasions translated into a fairly large confidence interval (95% C.I. 505-1,718). However, during the searches the average number of different deer sighted in these neighborhoods was 204. In one case we observed 240 deer and not one of our 15 marked deer was seen. Therefore, it is not implausible that the number of deer within this study area is over 900 deer.

The estimated density of deer in the Skyway, Broadmoor, and Broadmoor Bluffs neighborhoods was 29.78 deer (95% C.I. 16.15 – 54.96) per km^2. In the late 1980's the United States Air Force Academy (USAFA) was having problems with an over-abundant deer population, which translated into habitat degradation and numerous deer/vehicle collisions. In 1988 a hunting season was started as a means to control the deer population. In addition, a quadrat survey was designed to estimate the number of deer on the base. In 1988 the population size was estimated at 1,489 deer, which equates to a density of 20.88 deer per km^2. Therefore, the measured density from the Broadmoor, Broadmoor Bluffs, and Skyway neighborhoods is approximately 9 more deer per km^2 than what was estimated on the USAFA in 1988. Since 1988 the deer population on the USAFA has been drastically reduced because of a controlled harvest. Based on he low survival rates caused by deer/vehicle collisions in our Colorado Springs study, it would appear that vehicles are controlling this population, much like harvest has done on the USAFA.

ACKNOWLEDGEMENTS

Thanks to all the area 14 and wildlife health staff that assisted with the deer capture. A number of dedicated volunteers assisted with the radio tracking of deer, they include: L. Ackley, D. Ackley, L. Conner, J. Conner, M. Emmons, J. Emmons, W. Gammill, T. Martin, and R. Stetson. Special thanks to C. Cooley, who assisted with the creation of maps for this report.

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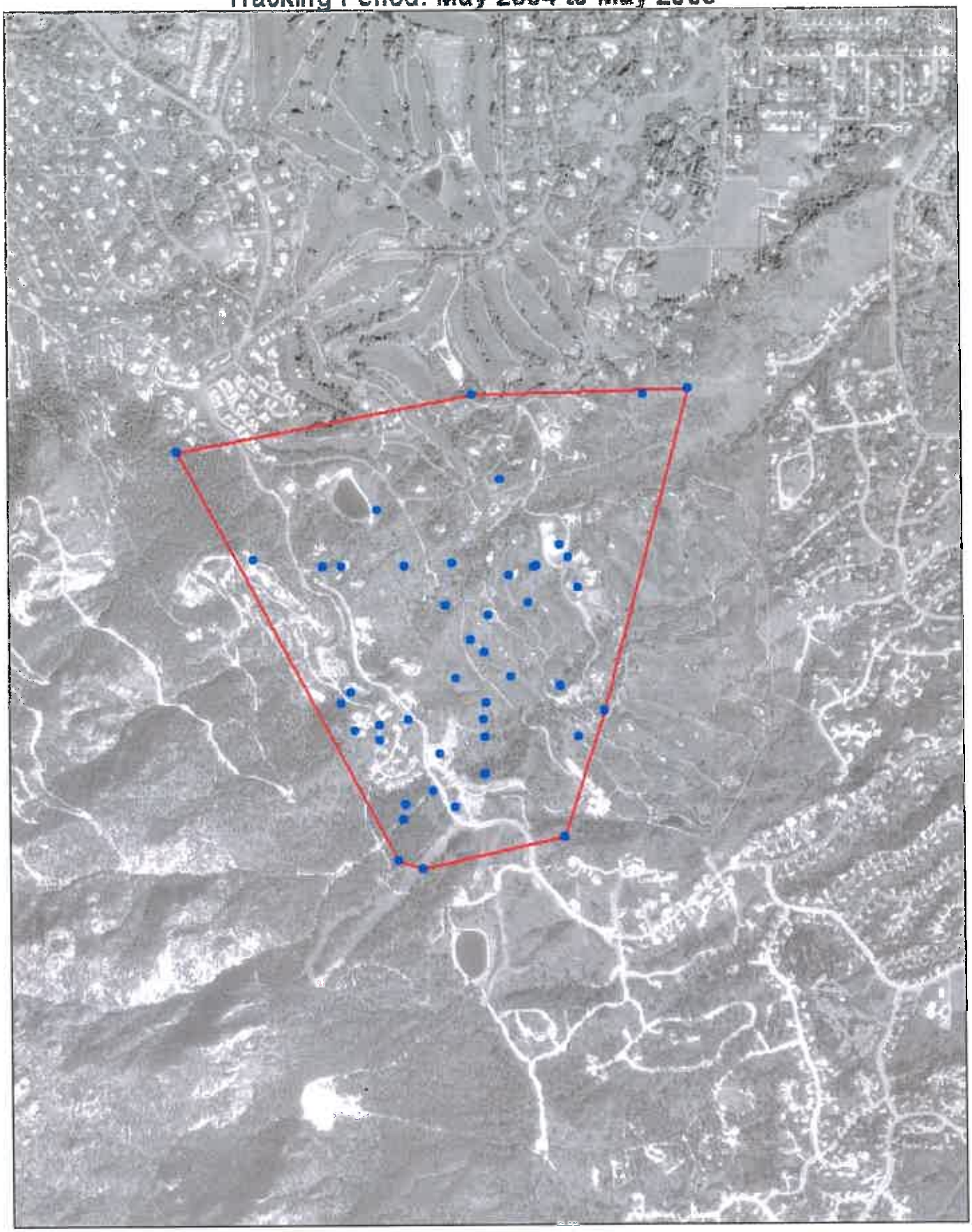
Appendix A – Home Range Maps

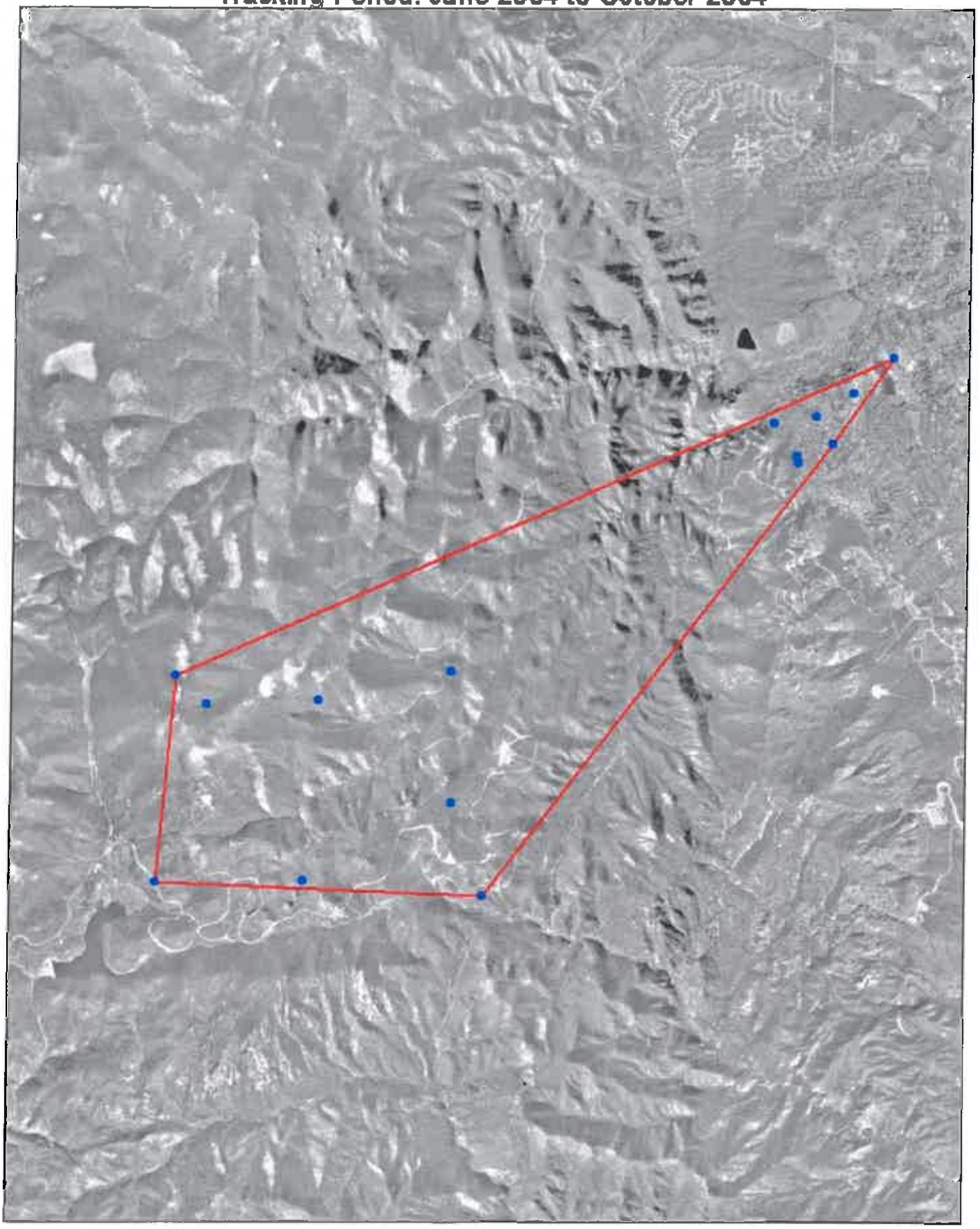
Colorado Springs Urban Deer Movement Data

Deer: 148.200

Tracking Period: May 2004 to May 2005



Colorado Springs Urban Deer Movement Data
Deer: 149.991
Tracking Period: June 2004 to October 2004



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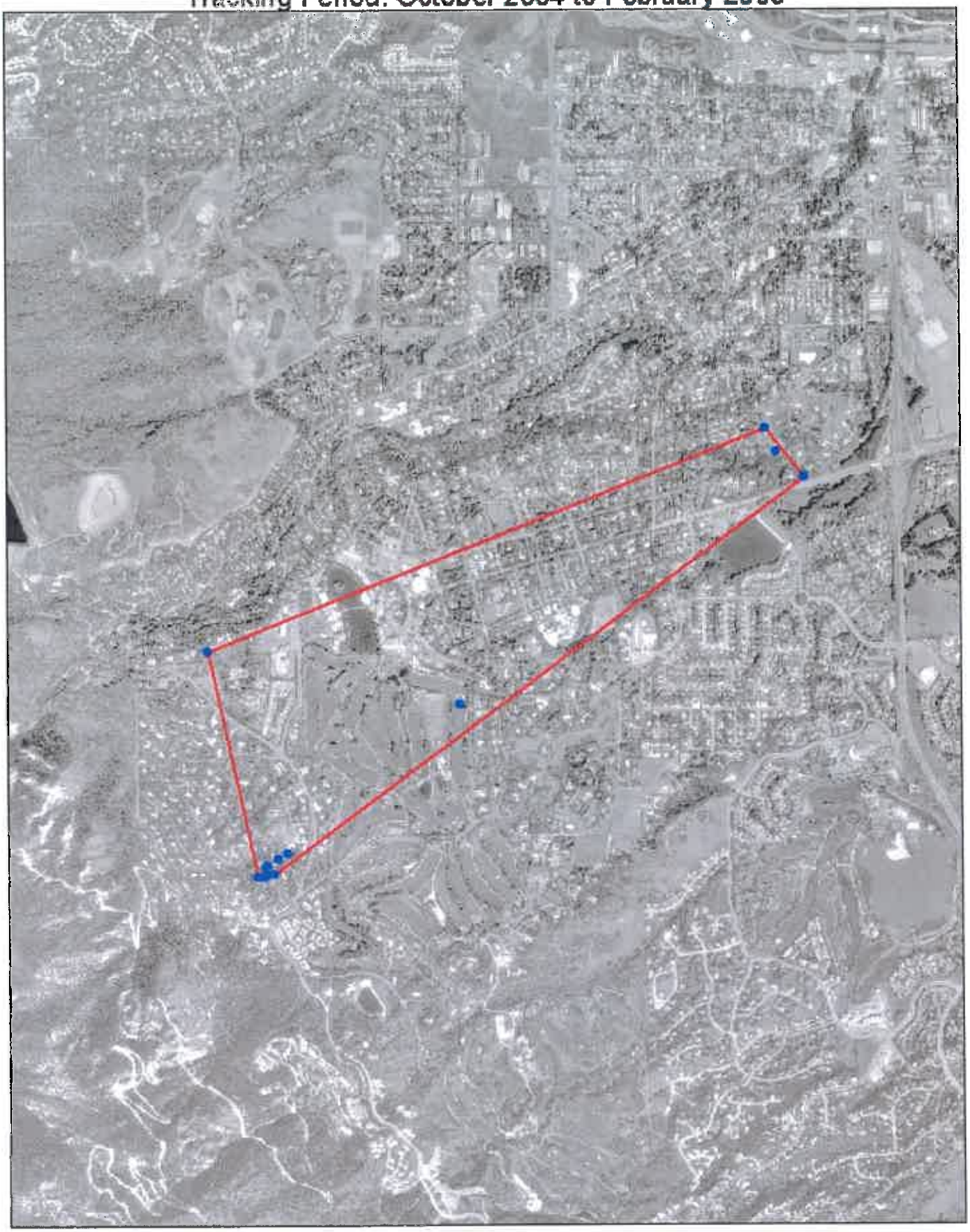

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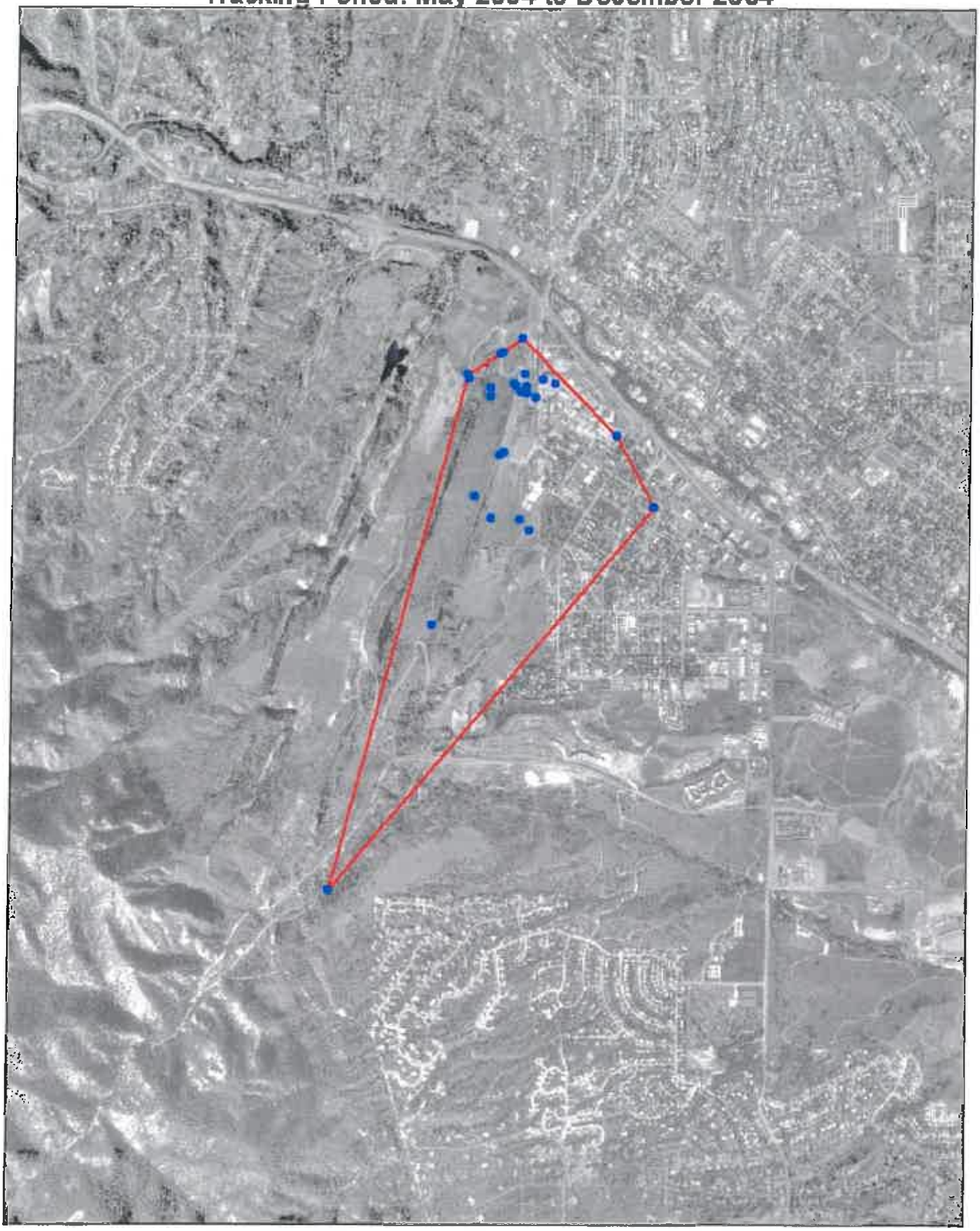

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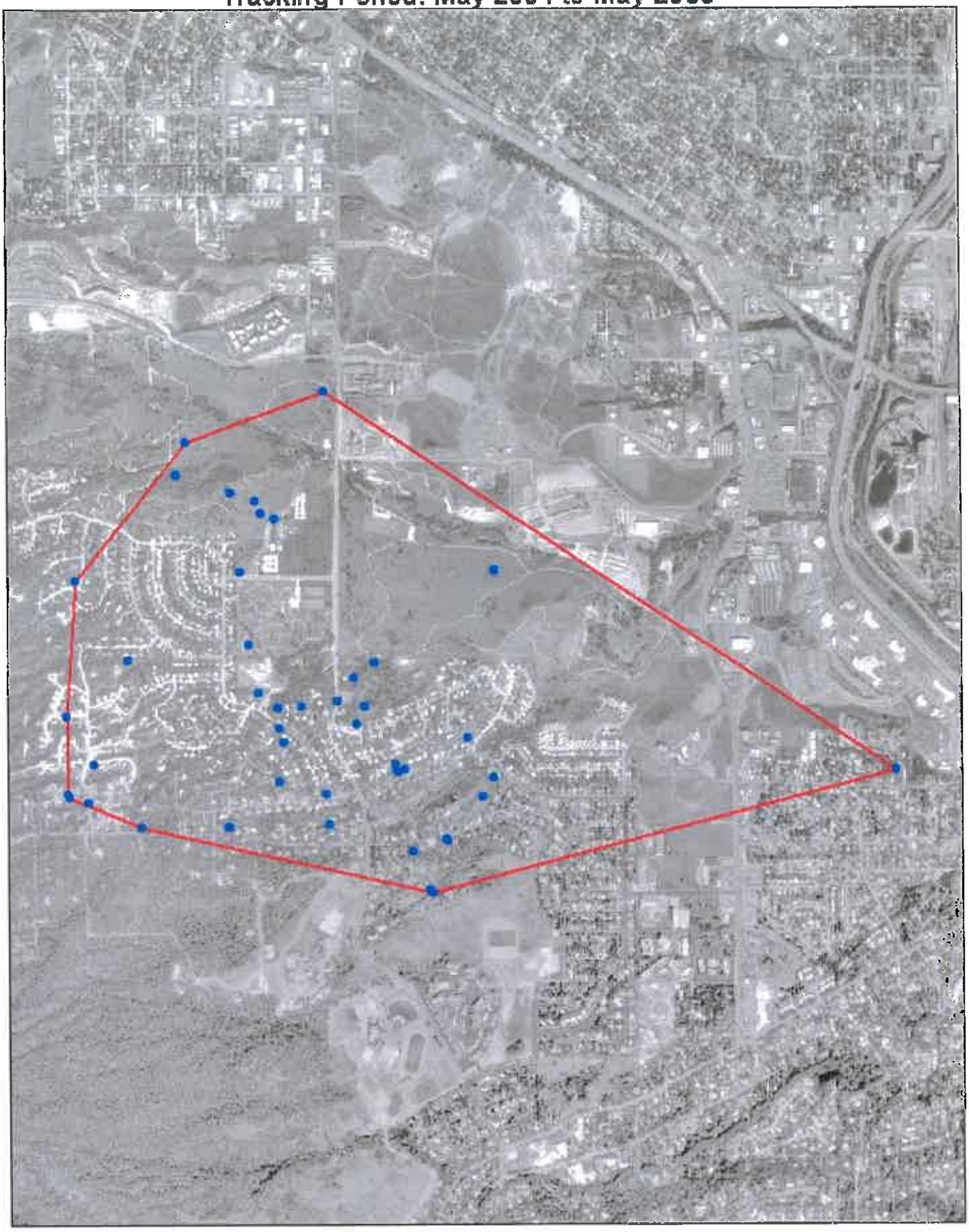

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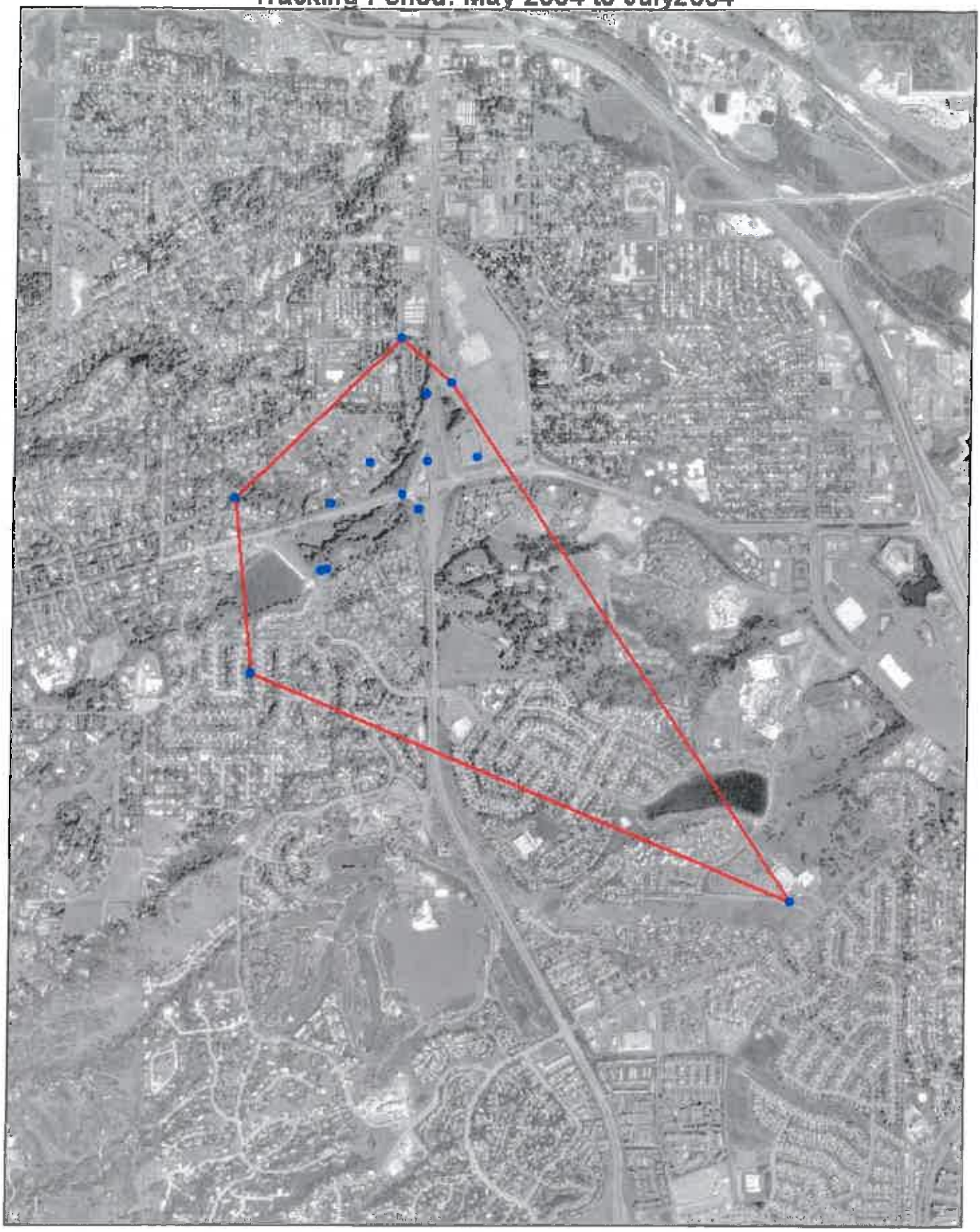

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Deer: 151.090

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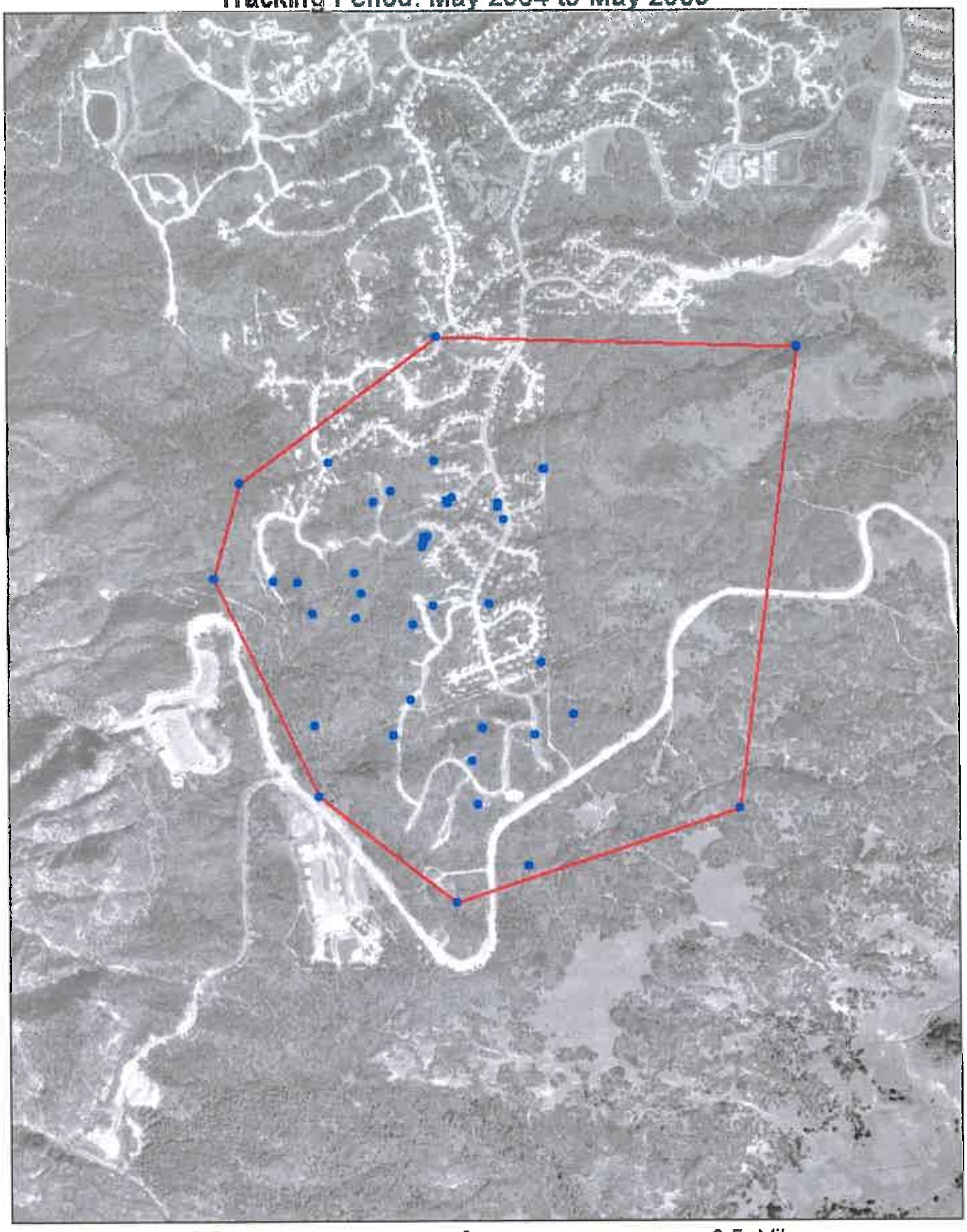

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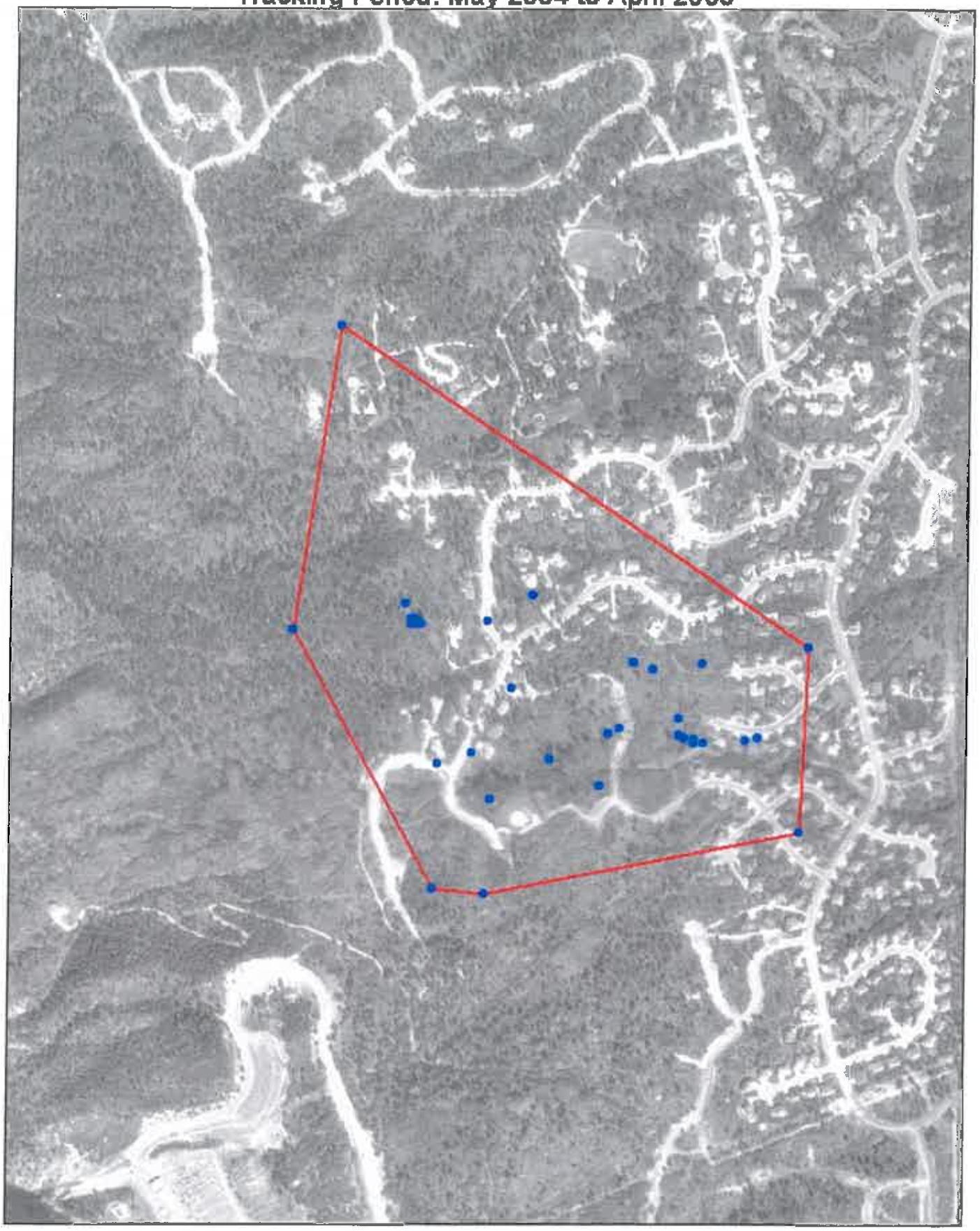
Deer: 151.120
Tracking Period: May 2004 to April 2005



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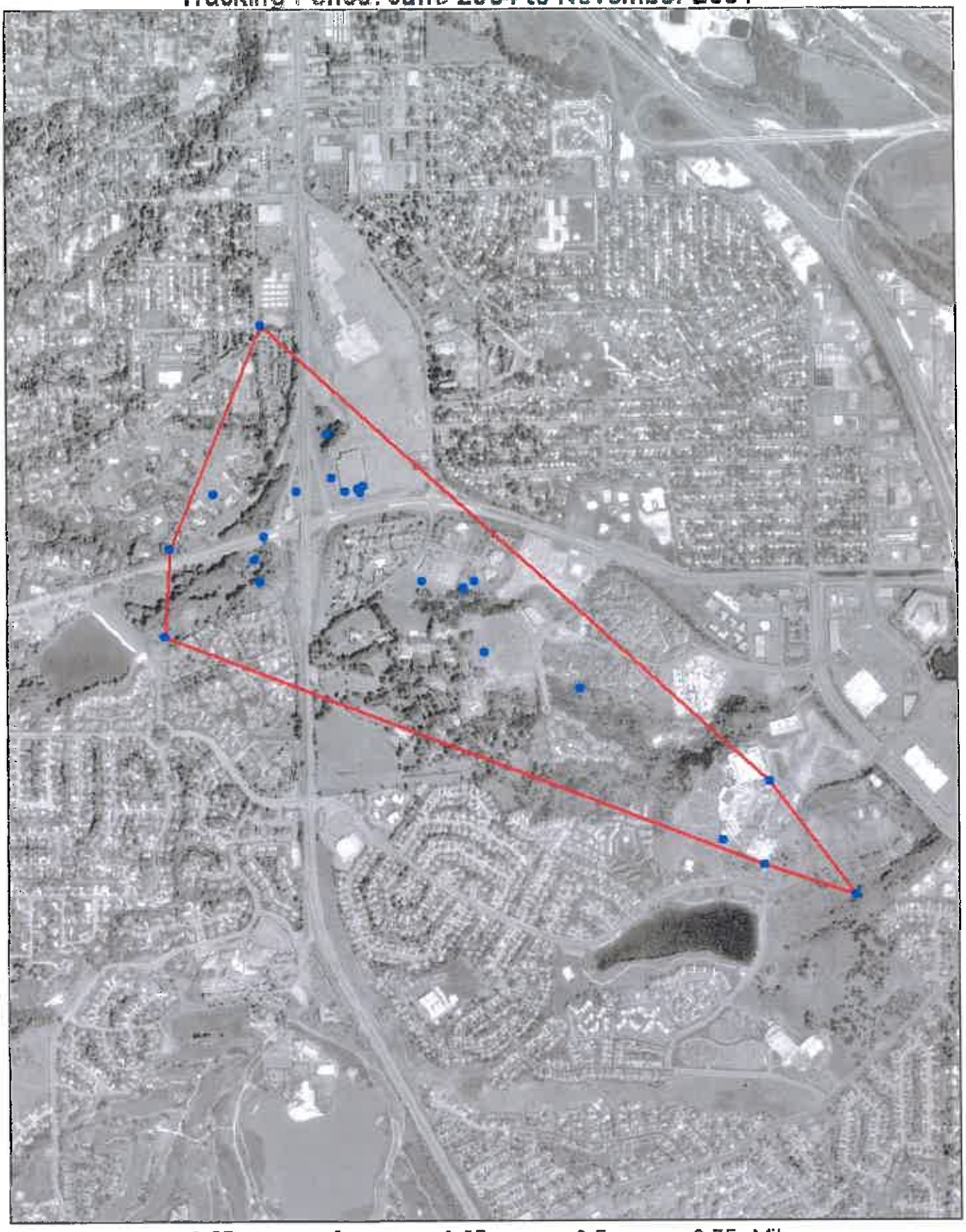

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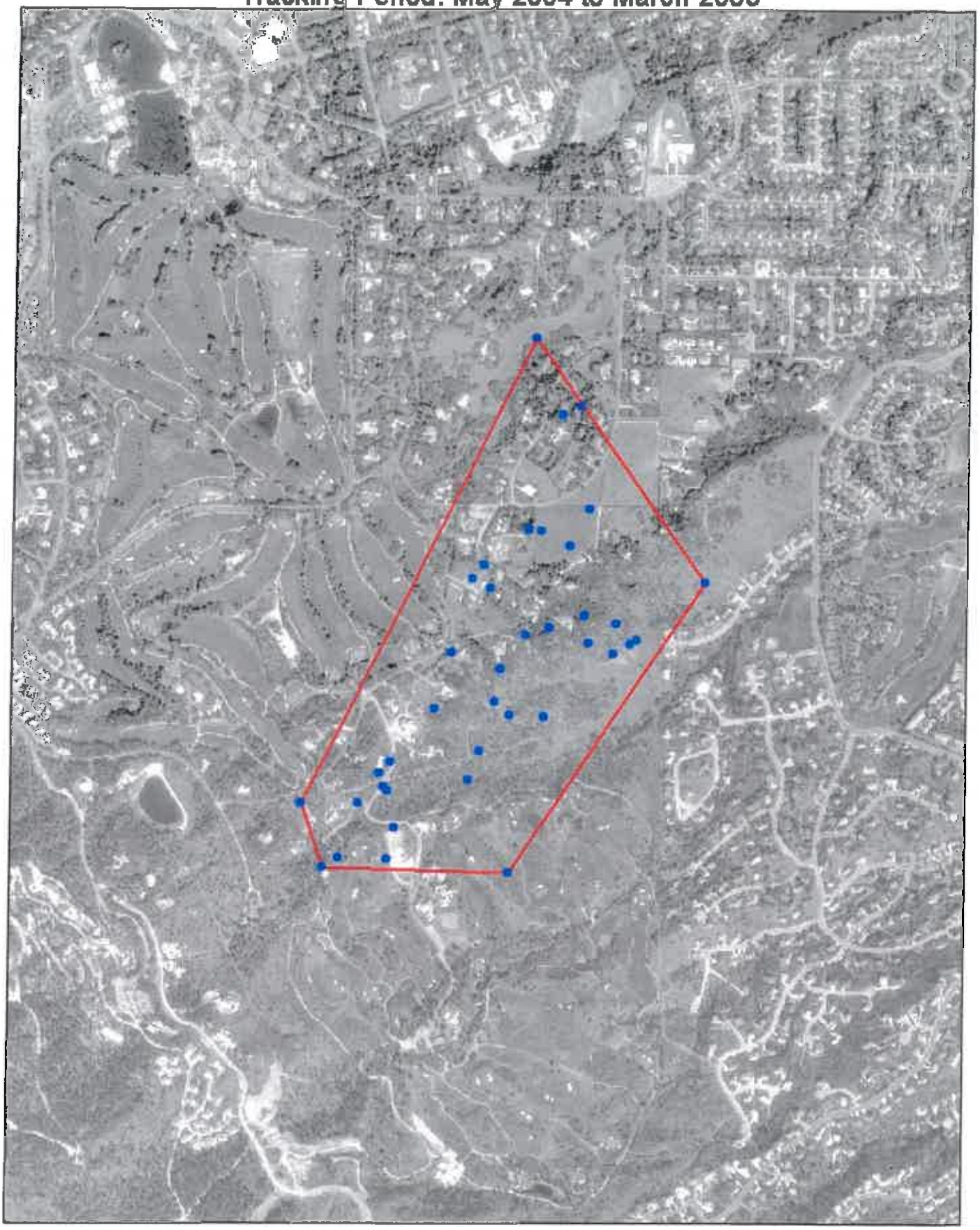
Tracking Period: May 2004 to March 2005



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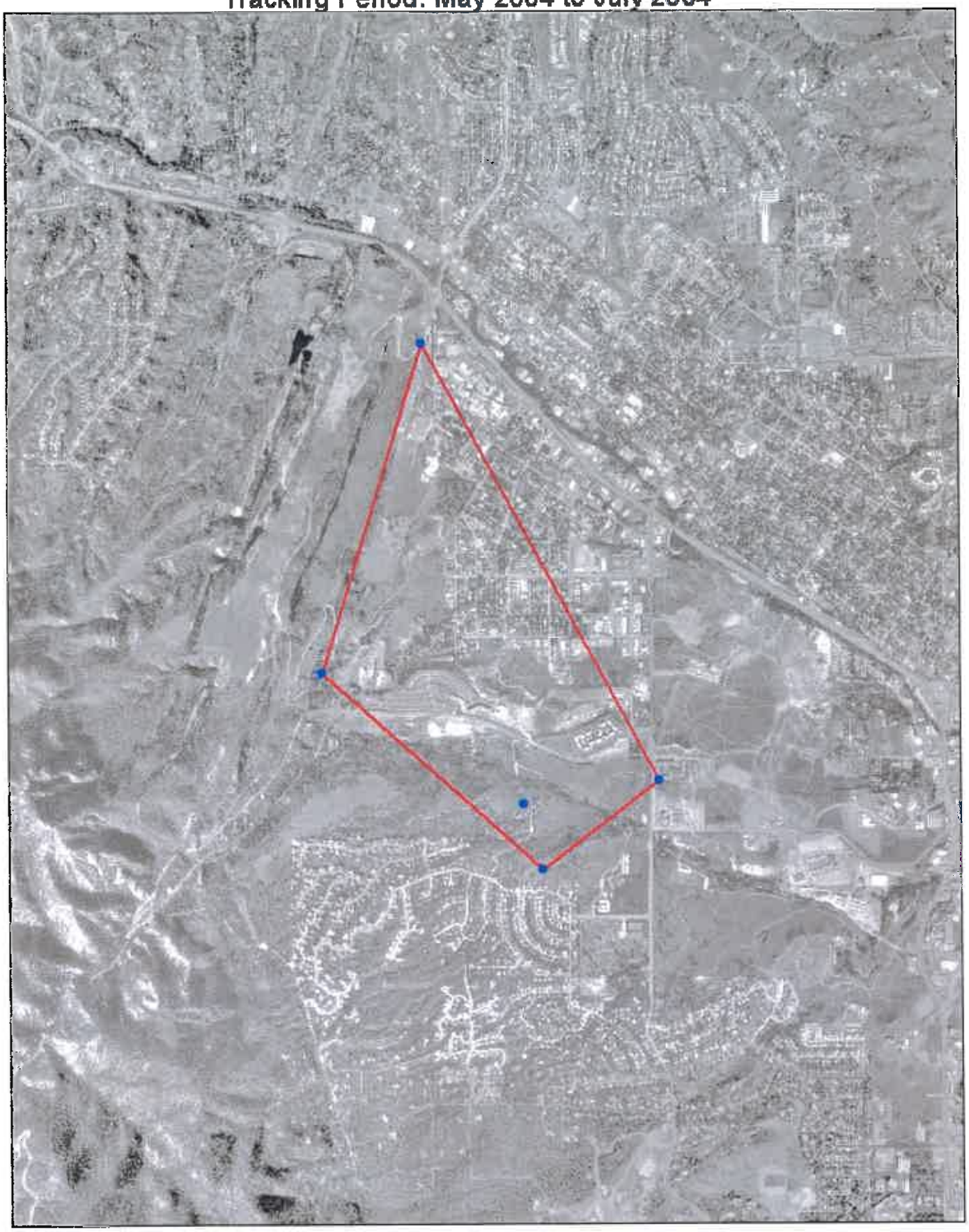

Colorado Springs Urban Deer Movement Data
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Tracking Period: October 2004 to May 2005

Colorado Springs Urban Deer Movement Data
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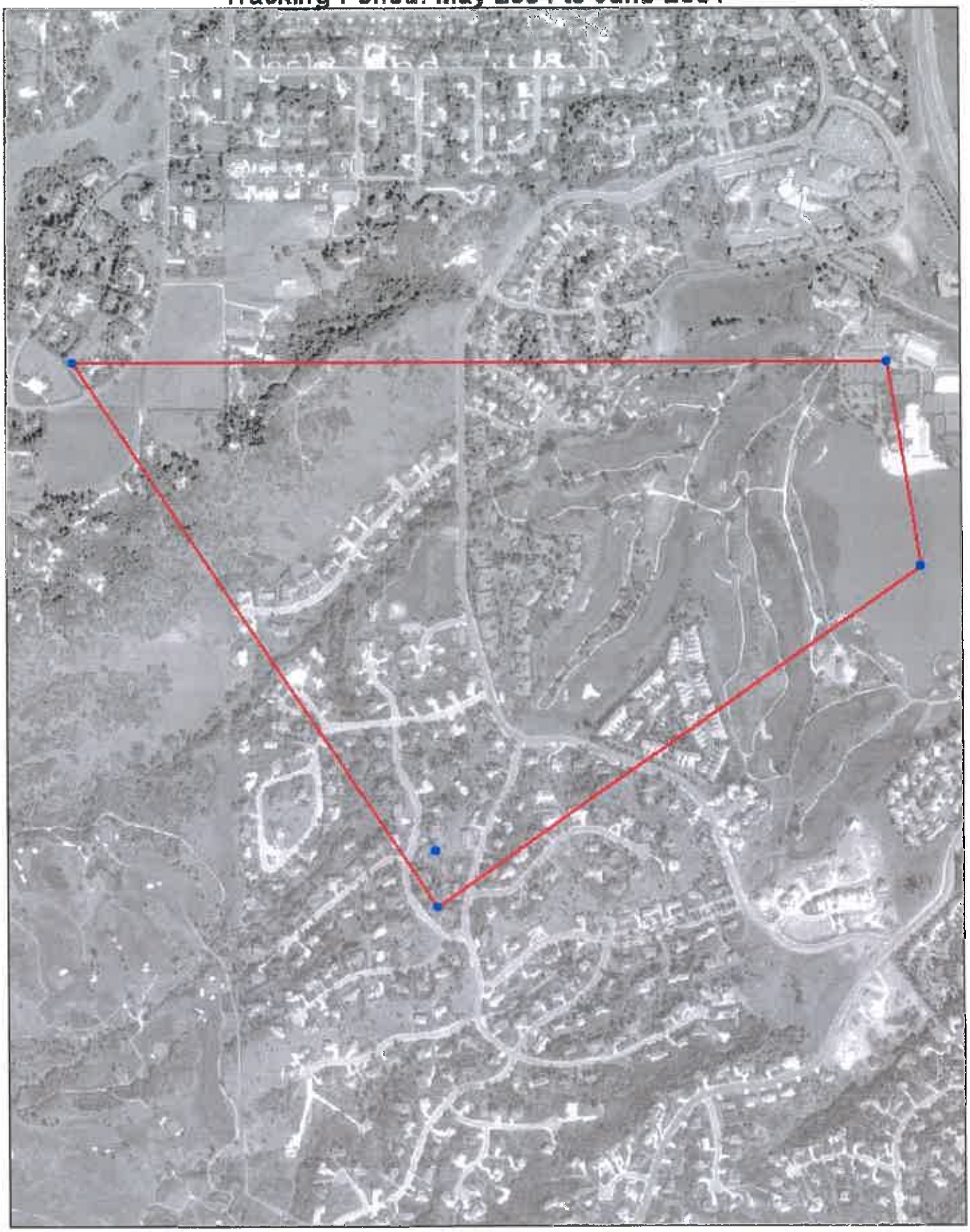

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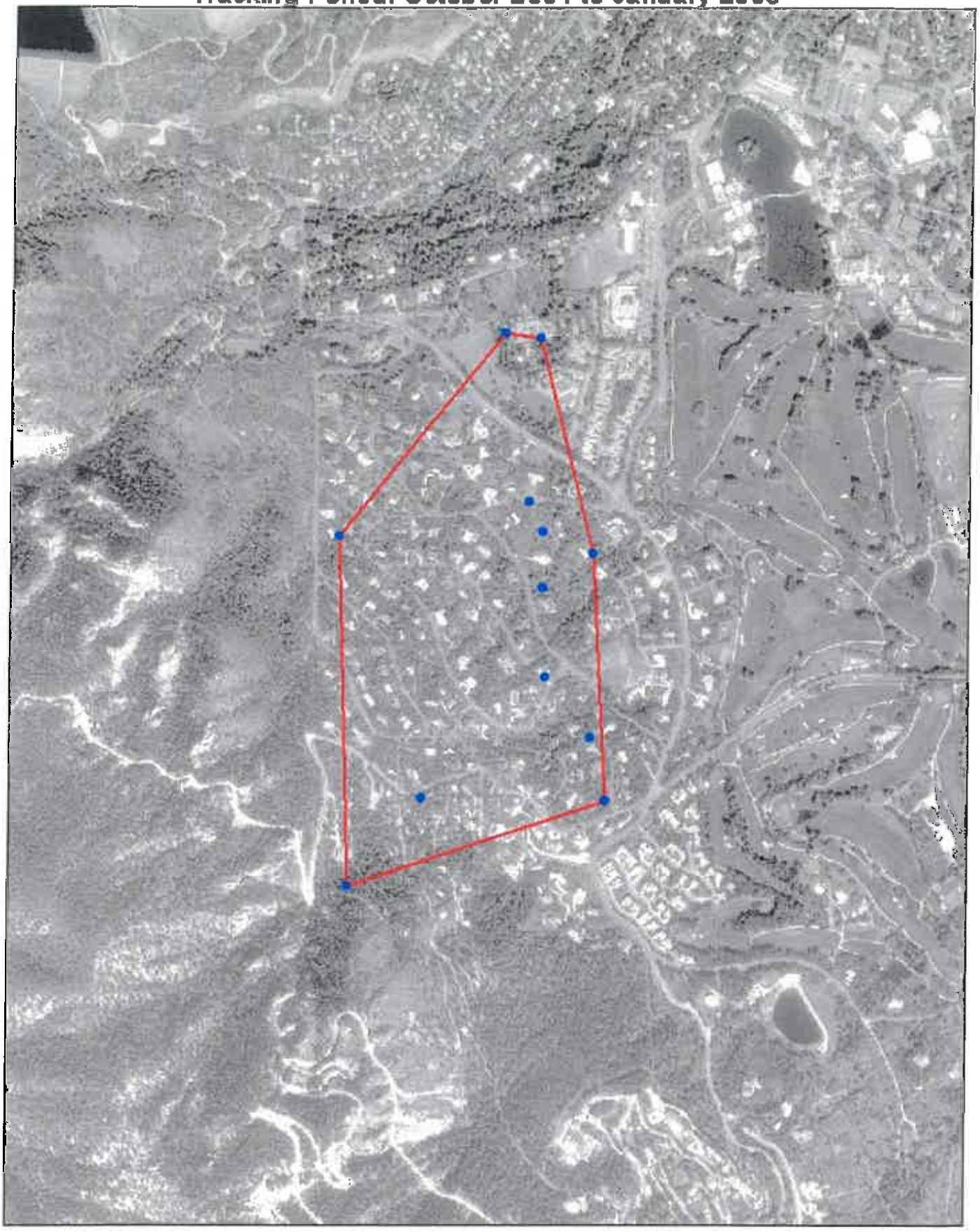

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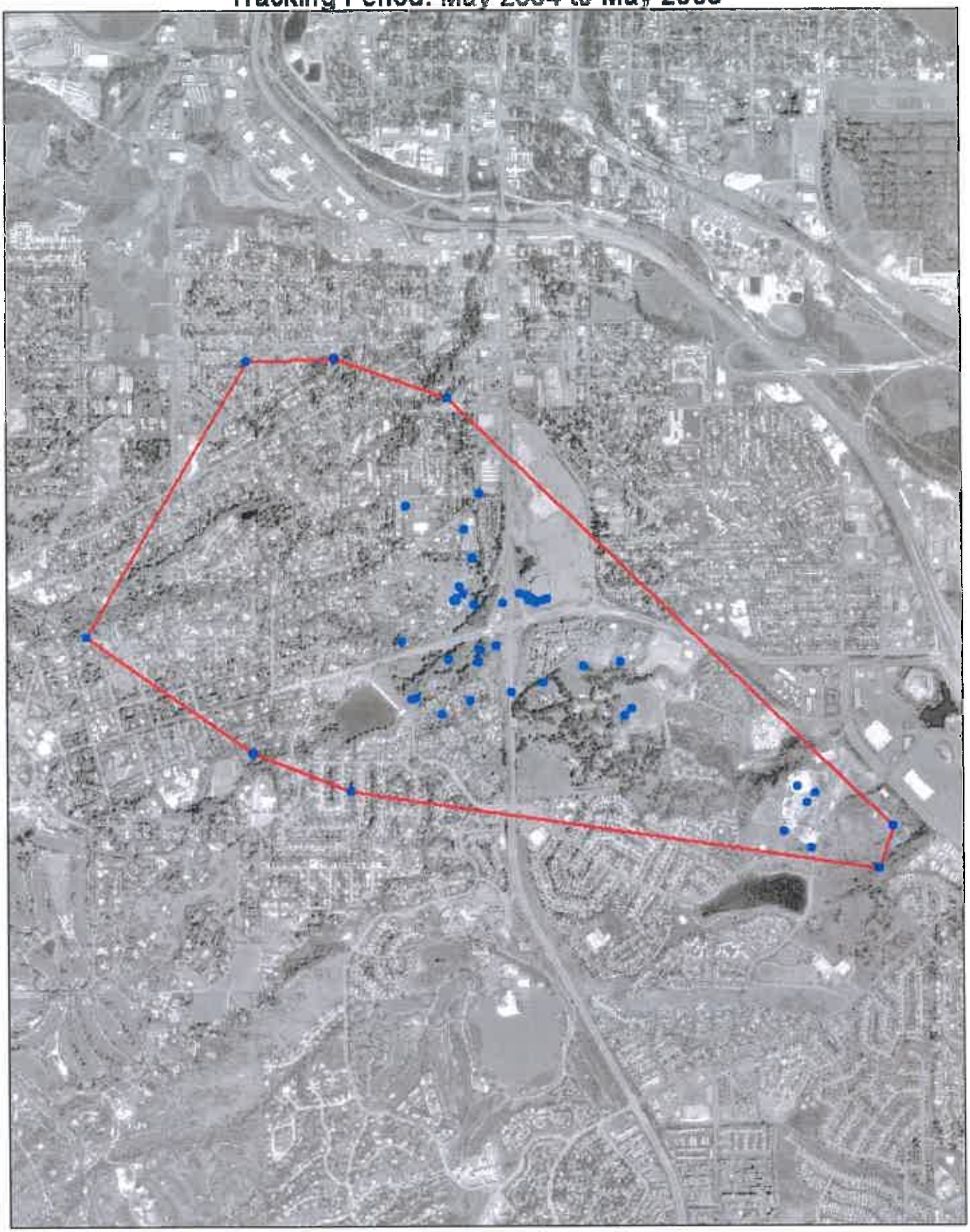

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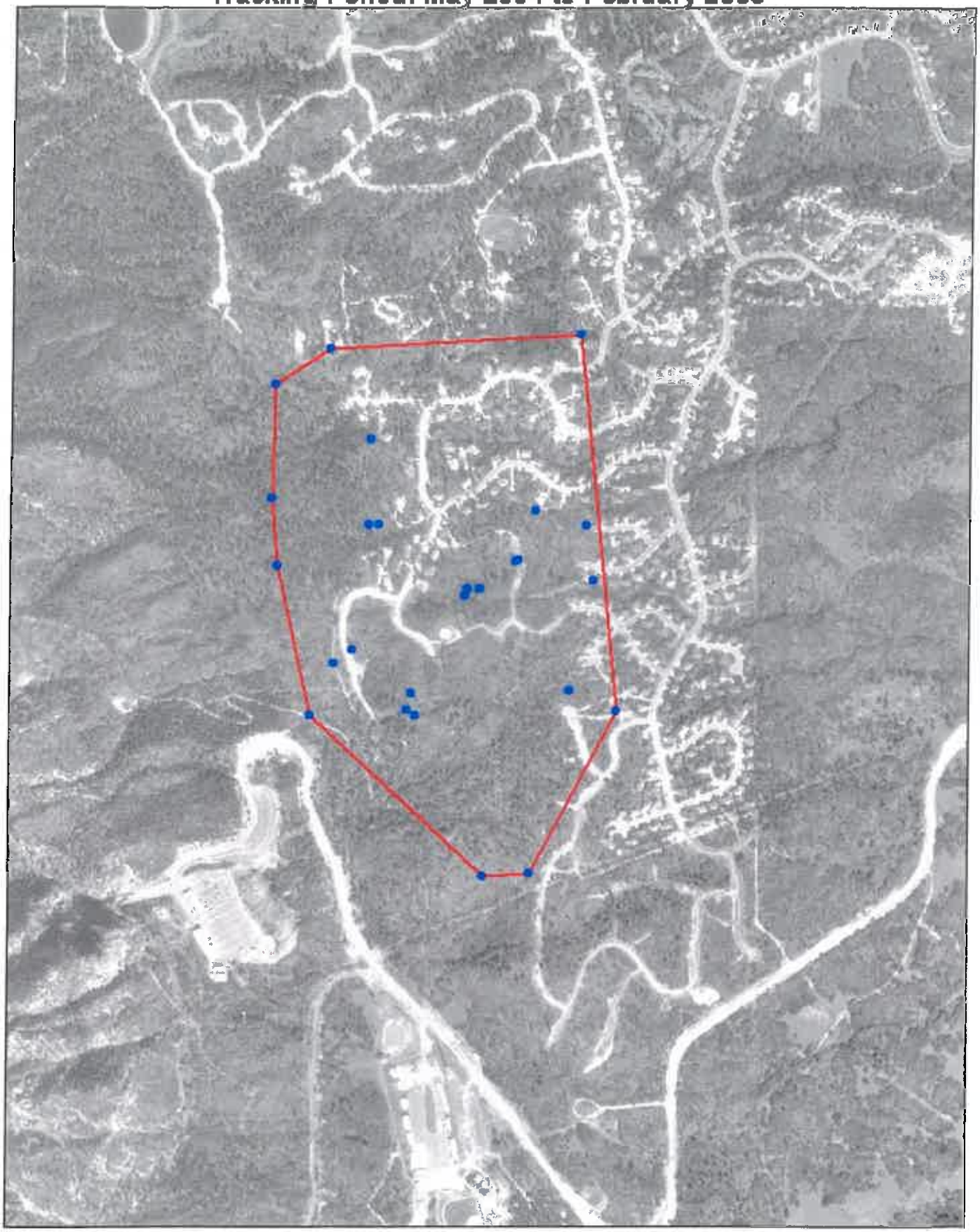

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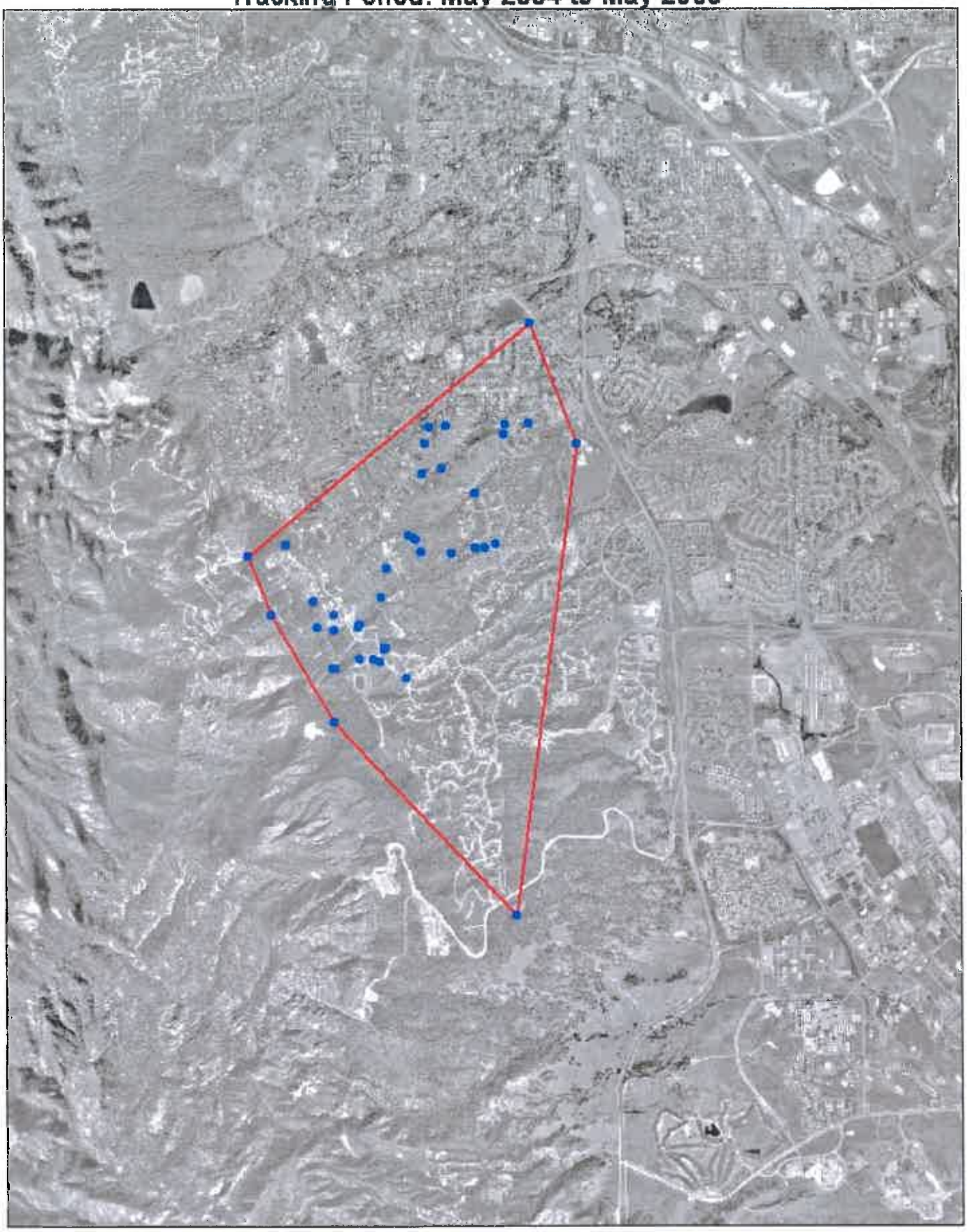

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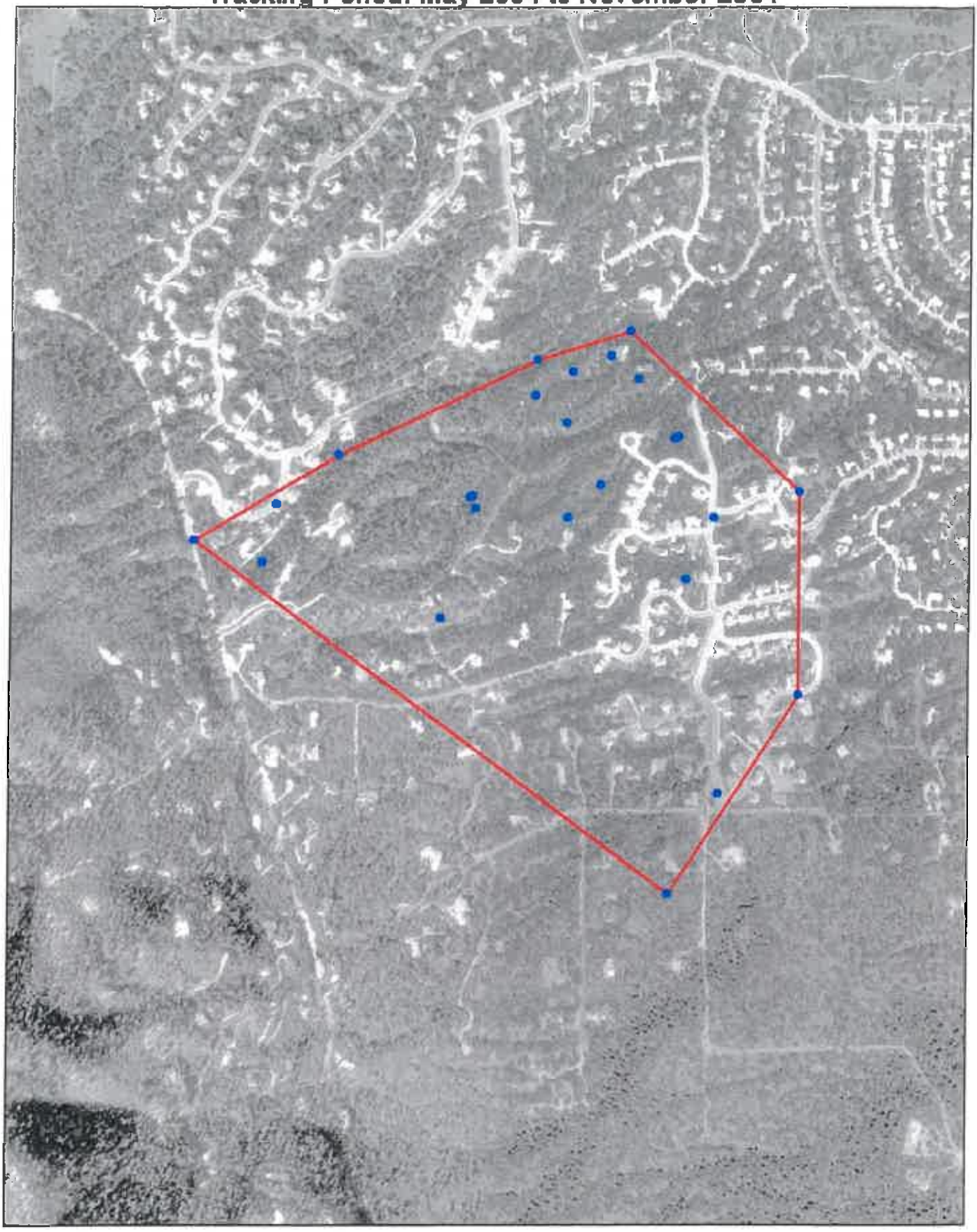

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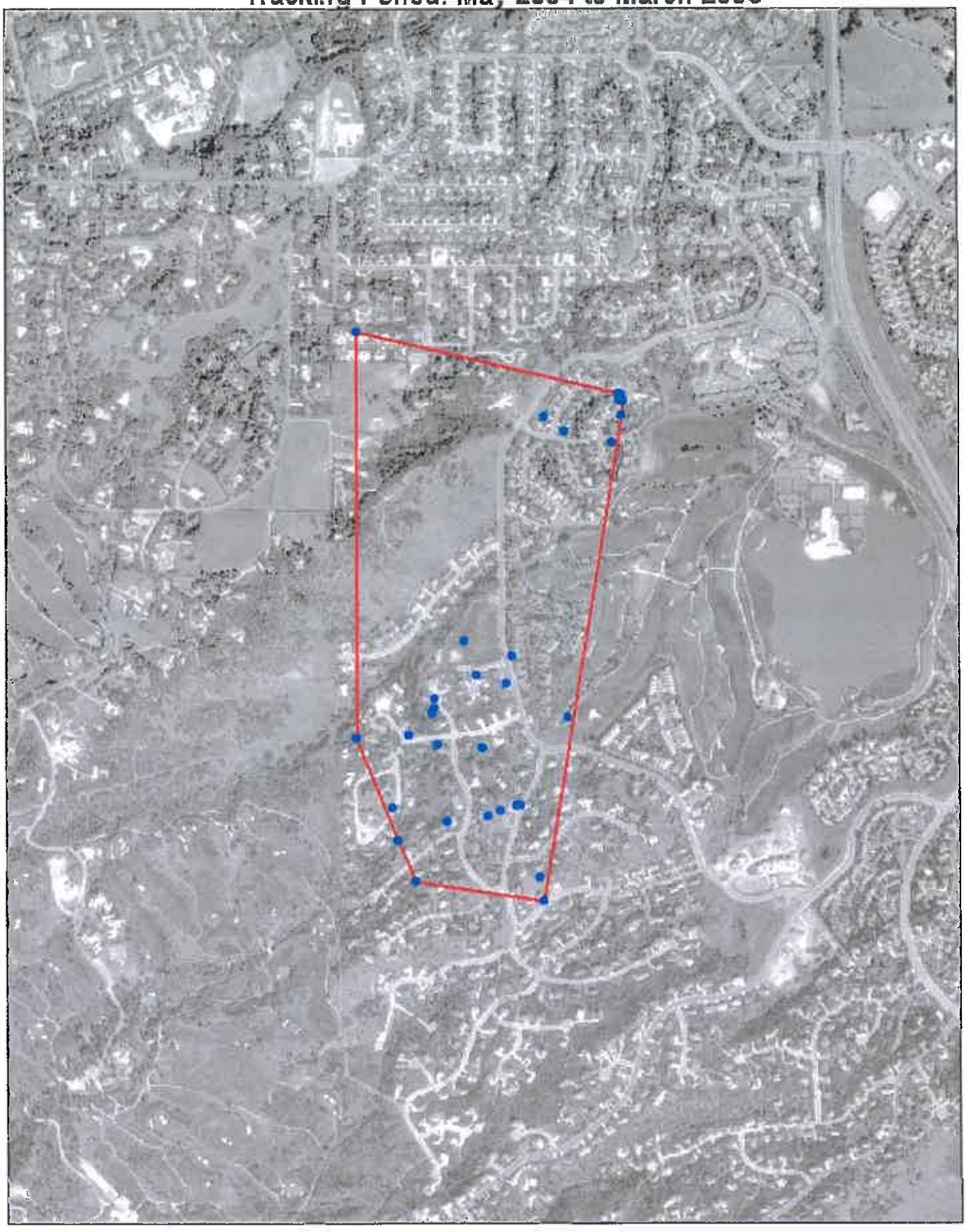

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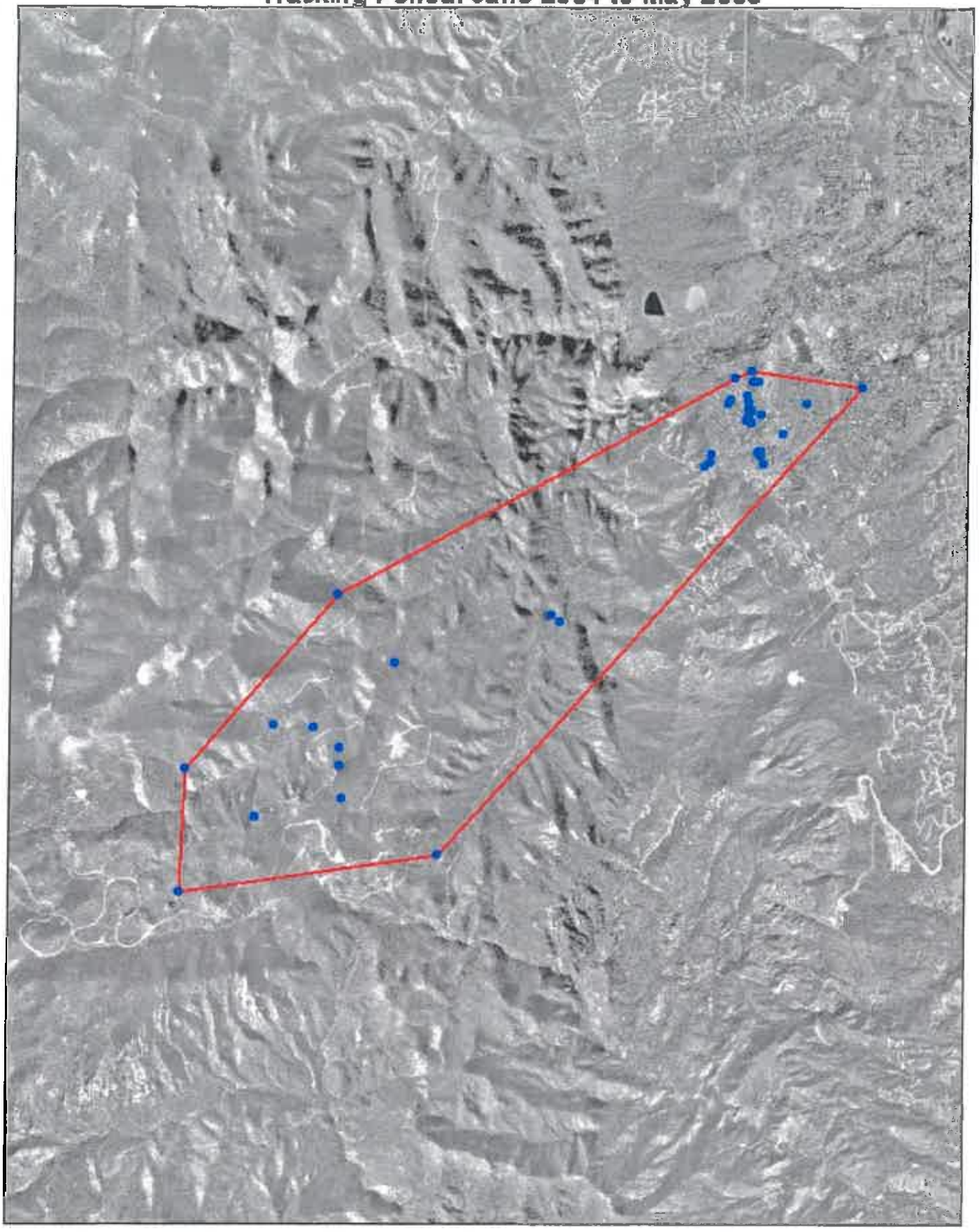

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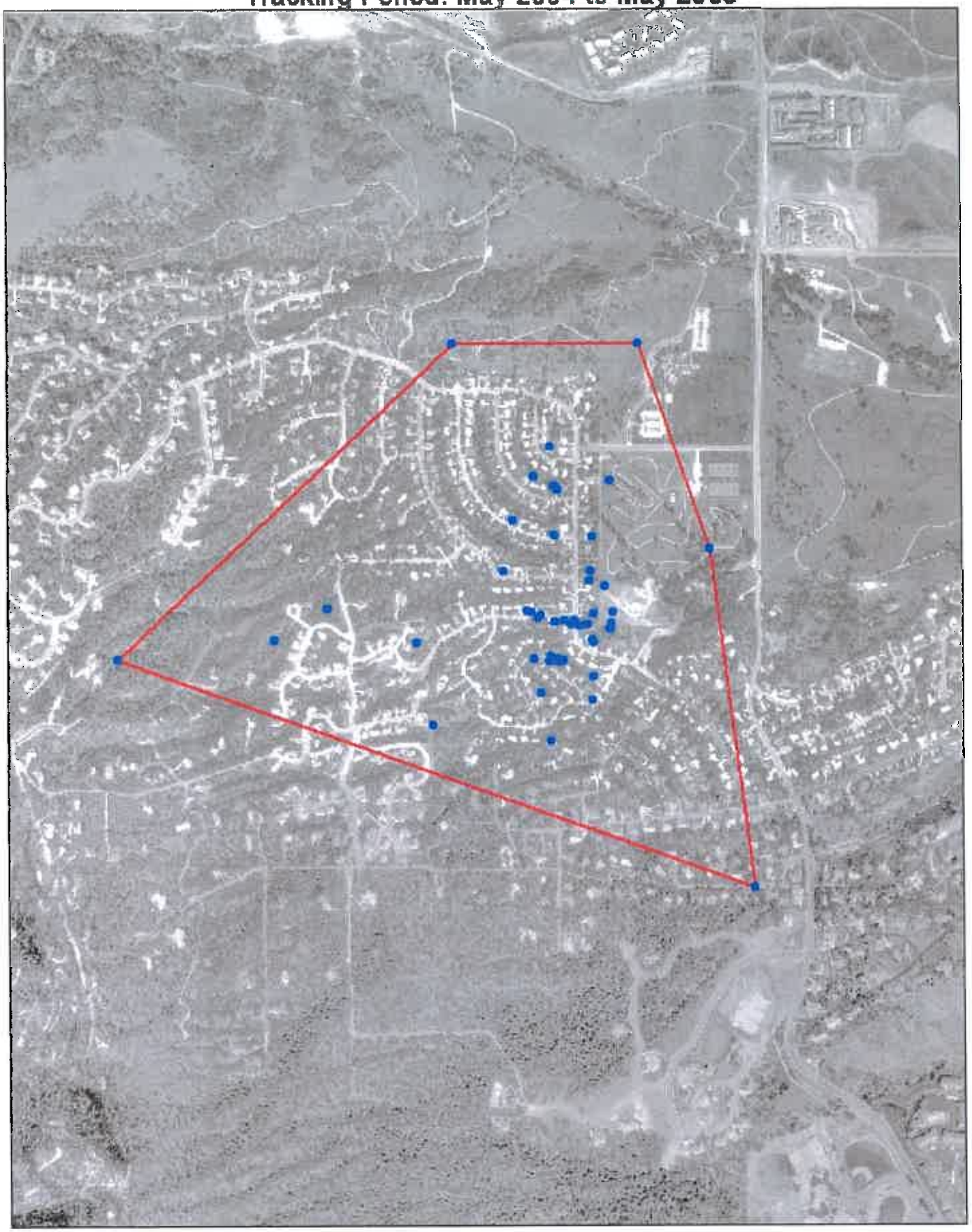

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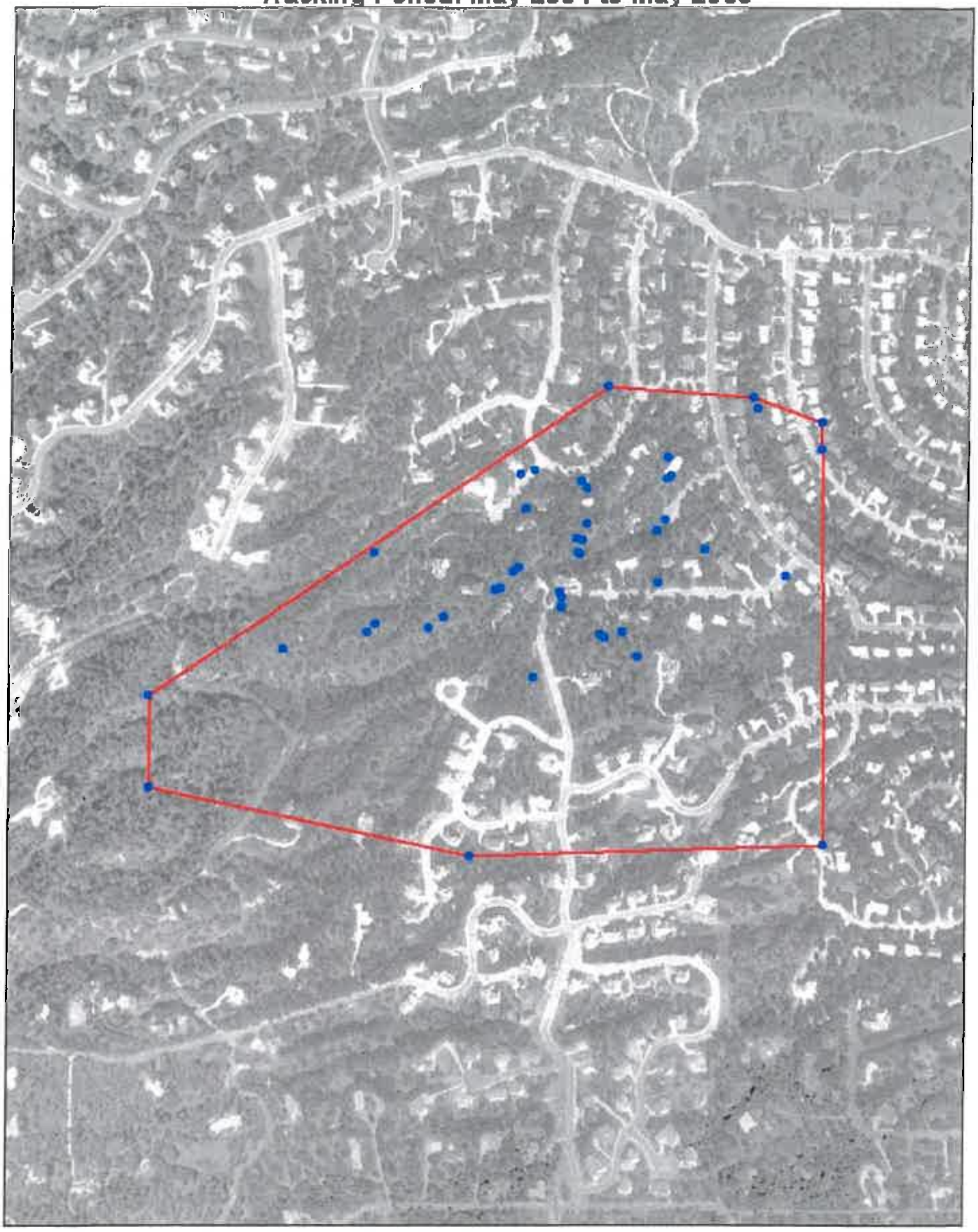

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