HA File No.2001.25

Bog Turtle Survey and Radiotelemetry Study at the [redacted] Fen Complex, Northampton County, Pennsylvania

Notice: Certain portions of this document have been redacted in order to protect, and not divulge the exact locations of critical Bog Turtle habitat.

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to

The Nature Conservancy
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by

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DATA COLLECTED ON BOG TURTLES

Upon initial capture, turtles were assigned field numbers and marked by filing code notches in the marginal scutes (Ernst et al., 1974) in a manner consistent with the previous work performed in [redacted]. In this study, as in previous HA studies, data collection on initially captured or recaptured turtles included date, time, location and cloacal temperature. In addition, sex, weight, reproductive status, length and width of the carapace and plastron, shell height, age (by counting the growth annuli on the shell or abdominal scutes) and overall health were all recorded. Notes were also taken on the macro and microhabitat characteristics of the capture site, including relative humidity and surface and ambient temperatures at the time of capture (**Figure 1**).

Figure 1. Robert Zappalorti and Raymond Farrell processing a bog turtle in [redacted]. Photo: Herpetological Associates, Inc. 2001.

Tissue samples were collected from many of the bog turtles captured. This is a cooperative effort with Dr. James Howard (Frostburg University), Scott Smith (Eastern Regional Manager of Heritage & Biodiversity Conservation Programs, Maryland Department of Natural Resources), Dr. Tim King (Leetown Science Center, Aquatic Ecology Laboratory, Kearneysville, West Virginia), Dr. Jeffrey Lovich (U.S. Department of the Interior, Biological Resources Division), and Dr. Fred Janzen (University of Iowa). This project seeks to (1) reconstruct historic phylogeographic relationships among populations of bog turtles using mtDNA analysis and (2) assess levels of genetic variation within a subset of key populations using microsatellite DNA analysis. Spotted turtle (*Clemmys guttata*) and wood turtle (*Clemmys insculpta*) tissue were also collected for use as outgroups.

The tissue sample collected consists of a small clipping (approximately 2mm) from the tip of the tail. Extreme measures were taken to ensure the health and welfare of the turtle during the tissue collection. The tail was swabbed with alcohol before the sample was collected to ensure sterility. After the sample was collected, alcohol was reapplied, along with Nu-skin to seal the wound. HA did not attempt to collect a tissue sample from turtles that appeared sick, injured, or had a stubbed tail.

The results of the DNA analysis will eventually be published in a scientific journal. Such information is important as it will allow both state and federal governments to make sound decisions on the management of this endangered species and will strengthen our ability to develop appropriate and much needed conservation strategies. Permission to collect tissue from bog turtles has been granted by PFBC (Andy Shiels, personal communication). After all data was recorded, the turtles were released at their exact capture location within the marsh.

RADIOTELEMETRY STUDY

Turtles were radiotracked once a week to determine their movements and home range. However, no attempt was made to handle the turtles to avoid influencing their behavior. The data collected on these turtles was limited to date, time, location, micro and macrohabitat, activity and GPS data. Following the movements of radiotracked turtles aids in determining their use of various habitats within the wetland. Foraging habitat, hibernacula, nest sites, and Minimum Convex Polygon (MCP) home range were determined through this study.

Minimum Convex Polygon Home Range

Home Range was calculated by the 100% Minimum Convex Polygon method. This method uses the smallest convex polygon produced by including all of the location points of an animal to calculate home range. The area contained by the polygon is then calculated to arrive at the MCP home range. These calculations were made using ArcView GIS and Spatial Analyst with the Animal Movement Extension.

Population Size Estimation

In order to gain meaningful information about population trends and relative abundance within individual populations of bog turtles, the number of individual turtles captured along with the number of recaptures (excluding the turtles recaptured in telemetry survey), were used to estimate the size of a population. The methods and formula HA used to arrive at a population size estimate for each site are provided below.

Individual Turtles. The number of initial captures at each site is considered a raw measure of population size.

Schumacher Eschemeyer Estimate. Bog turtle population estimates with 95% confidence intervals are based on mark-recapture sampling and were calculated by the Schumacher Eschemeyer method (Krebs, 1989). These estimates include mark-recapture sampling of adult, sub-adult, and juvenile turtles. Hatchlings (first season) were excluded from the analysis.

The formula used is as follows:

Where:

$$\hat{N} = \frac{\sum_{t=1}^{S} \left(C_t M_t^2 \right)}{\sum_{t=1}^{S} \left(R_t M_t \right)}$$

$\hat{N}$ = Population Estimate
C_t = Total number of individuals caught in sample t
R_t = Number of individuals already marked when caught in sample t
M_t = Number of marked individuals in the population just before the t^{th} sample is taken
S = Total number of samples

Nesting Study Methods

The bog turtle characteristically nests in the base of an individual *Carex* sedge tussock or other small vegetated hummocks. The female turtles camouflage the eggs by covering them with vegetative material and humus (Zappalorti, 1976; Zappalorti. et al, 1995a). During and after the June-July nesting season, canopy-free *Carex* spp., *Sphagnum,* and grass hummock areas in each study site were searched intensively for concealed eggs. While searching, great care was taken not to disturb or crush any unseen eggs in hidden bog turtle nests. Each nest found was flagged with surveyor's tape. The information recorded included the nest's location, dimensions, surrounding vegetation, the nest chamber's height above water, and the number and condition of the eggs or shells.

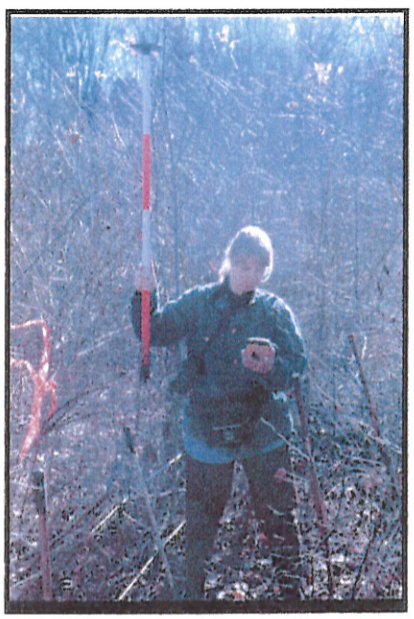


Figure 2. Catherine Eser taking a GPS point at [redacted] Fen. Photo: Raymond Farrell, Herpetological Associates, Inc. 2001.

RESULTS OF INVESTIGATION

HABITAT DESCRIPTIONS OF CONFIRMED BOG TURTLE SITES

[redacted] Fen

[redacted] Fen is a large complex of integrated wetland types. The area consists of a large fen fed by two large seepages. There are small pools of water and rivulets flowing throughout the area which is interspersed with shrub "islands" of red maple, red cedar (*Juniperus virginiana*), alder, and poison sumac (*Rhus vernix*). The fen is bordered to the south by [redacted] Creek and the old railroad bed to the north. The fen is partially affected by seasonal flooding due to the presence of beaver (*Castor canadensis*) which have created numerous pools of water and flooded the area under the powerline between the [redacted] and the [redacted] properties. The open fen intergrades with stream-side wetlands and contains vegetation typical of wetland habitats (i.e., alder, cattail, button bush (*Cephalanthus occidentalis*), poison sumac and various sedges (*Carex* spp). There are small areas of exposed rock along the powerline, in the seepage areas, and along the creek. Cattail, *Phragmites* and purple loosestrife (*Lythrum salicaria*) are present in the powerline right-of-way. *Phragmites* and purple loosestrife have invaded both [redacted] fens and is spreading despite the efforts of TNC to control it (**Figure 3**). These invasive plants have completely taken over some areas of the [redacted] wetland choking out most of the native plants. In addition, wetland shrubs and hardwoods are also encroaching on the fen. **This site is ranked a 5 on HA's Z-scale (Table 1).**

Figure 3. Photo taken at [redacted] showing a portion of the large area containing purple loosestrife and *Phragmites*. Photo: Raymond Farrell, Herpetological Associates, Inc. 2001.

[redacted] Fen

The [redacted] Fen is the only true fen of the three study sites with an open area more than two acres in size characterized by low herbaceous vegetation. Poison sumac, alder, silky dogwood (*Cornus amomum*), and red cedar are the dominant woody shrubs interspersed throughout the fen, which become more dense around the wetland. At the northwest edge of the fen there is a wet area, with constant flow, that is vegetated by purple loosestrife, button bush, *Scirpus*, cattail and various sedges. Small seeps forming narrow rivulets trickle down a gentle slope toward the railroad bed, occasionally flowing through underground tunnels, which serve as subterranean movement corridors for the bog turtles. These rivulets spread into wide, shallow wet areas in the center of the fen, converging into a single mucky rivulet toward the railroad bed. The southeast edge of the fen consists mainly of woody shrubs (poison sumac, alder, silky dogwood and other hardwoods). This portion of the fen is also fed by small seeps, forming several rivulets that flow in a southward direction into a hardwood stand and continue into a wetland near the railroad bed. **This site is ranked a 4 on HA's Z-scale (Table 1).**

[redacted] Fen

[redacted] is part of a series of wetlands located along the [redacted] Railroad in [redacted] is the first fen encountered when heading northeast along the railroad and is bordered by the railroad to the northwest and [redacted] the southwest. The habitat consists of shrubs, deciduous trees, cattail, grass/sedge tussocks and *Phragmites* (**Figure 4**). In 1996, HA estimated that this site contained approximately 1.5 hectares of suitable habitat for bog turtles. Since 1996, *Phragmites* has continued to expand into the fen and has taken over approximately 60% of the open area. It has shaded out most of the native plants and dramatically reduced the available habitat for bog turtles. Secondary succession is also having a negative impact on the fen. **This site is ranked a 3 on HA's Z-scale (Table 1).**

Figure 4. Photo showing the habitat at Taylor II Fen. Photo: Raymond Farrell, Herpetological Associates, Inc. 2001.

HABITAT DESCRIPTIONS OF UNCONFIRMED SITES WITHIN THE [redacted] COMPLEX

A cursory evaluation of four sites within the [redacted] Complex was performed in June. Detailed information was not gathered on these sites but a general description of each site is presented below.

[redacted] Fen

[redacted] Fen is a small fen approximately one hectare in size that has been invaded by *Phragmites*. There are two rivulets that trickle down a gentle slope toward the railroad bed and small ephemeral wet areas. The fen is surrounded by hardwoods and contains some shrubs in the southeast portion. TNC has been cutting and removing the *Phragmites* to control it from spreading to other areas. Although this marsh contains typical bog turtle habitat the canopy is very dense and does not allow sunlight to penetrate the wetland floor. However, two dead bog turtles were found in this fen, one on top of some cut *Phragmites* and another along the trail leading to this site indicating that the turtles are utilizing this habitat. It is our opinion that these turtles migrated from the [redacted] Marsh, which is nearby. **This habitat is ranked as a 3 on HA's Z-scale (Table 1).**

[redacted] Fen

This is a small seep under the powerline right-of-way. It does contain a small amount of water and has some open areas, but it lacks two of the main features associated with bog turtle habitat (vegetation and mucky soils). This area is not bog turtle habitat. However, it may be used by bog turtles as a corridor between wetlands. **This site is ranked a 1 on HA's Z-scale (Table 1).**

[redacted] Fen

This fen is located under and around the powerline right-of-way. There are seeps forming rivulets that flow down a slope into a partly open area interspersed with woody shrubs and herbaceous vegetation. Poison sumac, alder, and red cedar are some of the dominant woody shrubs in and around the wetland. The fen contains mucky soils, vegetation and hydrology characteristic of the bog turtle habitat found in this complex. **This site is ranked a 4 on HA's Z-scale (Table 1).**

[redacted] Marsh

This marsh contains various sedges and other herbaceous vegetation. The marsh contains numerous rivulets and small pools of water. The soils are mucky in some of the areas within the marsh. Natural succession of hardwood trees has almost totally shaded the site. No bog turtles were found in 2001, however bog turtles were known from this site in the past and may still be in the wetland. **This site was ranked a 3 on HA's Z-scale (Table 1).**

SURVEY FINDINGS

HA staff was on-site for a total of 37 days in 2001: April 18, 22, 26, 27; May 4, 7, 10, 11, 12, 14, 25, 29, 31; June 5, 7, 11, 12, 19, 20, 21, 26, 28; July 5, 13, 17, 28; August 1, 17, 23, 31; September 7, 14, 21, 27; October 5, 12; and November 19. It should be noted that these were 9 to 13 hour days in May and June with a staff of 2 to 6 biologists.

HA and TNC staff confirmed bog turtles at all three sites visited (**Table 2**). A total of 134 bog turtle captures have been made during surveys in 1995, 1996, and 2001 at the [redacted] fens. Of these 134 captures, 75 were initial captures and 59 were recaptures. The population structure (**Table 3**) of the 75 turtles consists of 29 males, 34 females, 7 juveniles (undetermined sex), 3 yearlings (last years hatchling) and 2 hatchling (first season). The vast majority of these marked turtles (53) were captured at the [redacted] fen.

A list of confirmed bog turtles sites including the number of captures and recaptures is included in **Table 2**. The population structure by site is shown in **Table 3**, and injuries and abnormalities is recorded in **Table 4**.

Notice: Certain portions of this document have been redacted in order to protect, and not divulge the exact locations of critical Bog Turtle habitat.

Table 2. Bog Turtle Captures by Site 1995-2001.

Property/Site Name	Turtles Marked in Prior Years	Turtles Recaptured In Prior Years	Turtles Recaptured in 2001 that were Marked in Prior Years	New Turtles Marked in 2001	Recaptures in 2001 that were marked in 2001	Total Turtles Marked
[redacted]	32	11	12	21	16	53
[redacted]	5	3	3	2	0	7
[redacted]	13	5	9	2	0	15
Total:	50	19	24	25	16	75

Other Animals Observed at the Three [redacted] Sites (Tables 5-7)

HA staff observed a number of animals in or near the three study sites during the searches for bog turtles. These animal species included 10 amphibians, 12 mammals, 5 snakes, and 6 turtles (including the bog turtle). These animals are an indication of the diversity of species found in the [redacted] Fens.

Table 3. Bog Turtle Population by Site, Age and Sex Category.

Category	[redacted]		[redacted]		[redacted]		Total	
	Prior Years	2001	Prior Years	2001	Prior Years	2001	Prior Years	2001
Adult Males	13	5	2	1	5	1	20	7
Subadult Males	1	2	0	0	0	0	1	2
Total Males	14	7	2	1	5	1	21	9
Adult Females	9	10	3	1	7	0	19	11
Subadult Females	1	2	0	0	0	1	1	3
Total Females	10	12	3	1	7	1	20	14
Juveniles[1]	5	2	0	0	0	0	5	2
Yearlings[2]	2	0	0	0	0	0	2	0
Hatchlings[3]	1	0	0	0	1	0	2	0
Total	32	21	5	2	13	2	50	25

[1] Juveniles are defines as individuals 1-7 years (approximate) of age, and plastron length < 49.9 mm.
[2] Yearlings are defined as individuals captured the season following hatching (up to 1 year old).
[3] Hatchlings are defined as individuals captured during their first season (immediately following hatching and prior to their first winter).

Table 4. Injuries and Abnormalities in New Bog Turtles Captured at the [redacted] Fens in 2001.

Field No.	Sex	Age (year)	Injuries or Abnormalities
[redacted]	**6 of 21 new bog turtles have evidence injuries:**		
2001.04	F	12	Tooth marks on posterior carapace (pleural and vertebral scutes) and plastron (intergular and gular scutes).
2001.06	M	8	Small area of plastron missing between intergular scutes.
2001.13	M	10	Pitting on carapace (pleural and vertebral scutes).
2001.15	F	20+	Pitting on plastron bridge (pectoral and abdominal scutes).
2001.18	F	15	Stump tail.
2001.21	F	12	Pitting on carapace between marginal and pleural scutes.
Savadge: 1 of 2 new bog turtles have evidence of injuries:			
2001.02	F	11	Several scutes on plastron show regeneration (gular, hemeral, pectoral, femoral and anal scutes).
Taylor II: No injuries or abnormalities found on either of the two new turtles.			

Table 5. Amphibians Observed during Bog Turtle Studies at the [redacted] Fens.

		Number Observed			
Common Name	**Scientific Name**	[redacted]	[redacted]	[redacted]	**Total**
Frogs and Toads: Anura					
American Toad	*Bufo americanus*	14 + 13 egg masses	2 + 0 egg masses	11 + 4 egg masses	27 + 17 egg masses
N. Gray Treefrog	*Hyla versicolor*	7	1	3	11
Spring Peeper	*Hyla crucifer*	3	2	3	8
Bullfrog	*Rana catesbeiana*	3	0	0	3
Green Frog	*Rana clamitans*	27	31	37	95
Pickerel Frog	*Rana palustris*	31	5	66	102
Wood Frog	*Rana sylvatica*	4	0	5	9
Total Frogs and Toads	**7 Species**	**89 + 13 egg masses**	**41 + 0 egg masses**	**125 + 4 egg masses**	**255 + 17 egg masses**
Salamanders: Caudata					
Spotted Salamander	*Ambystoma maculatum*	0 + 31 egg masses	0 + 0 egg masses	2 + 4 egg masses	2 + 35 egg masses
N. Dusky Salamander	*Desmognathus f. fuscus*	0	0	2	2
Redback Salamander	*Plethodon cinereus*	3	0	2	5
N. Red Salamander	*Pseudotriton ruber*	0	2	0	2
Total Salamanders	**3 Species**	**3 + 31 egg masses**	**2 + 0 egg masses**	**6 + 4 egg masses**	**11 + 35 egg masses**
Total	**10 Species**	**92 + 44 egg masses**	**43 + 0 egg masses**	**131 + 8 egg masses**	**266 + 52 egg masses**

Table 6. Mammals Observed during Bog Turtle Studies at the [redacted] Fens.

		Number Observed			
Common Name	**Scientific Name**	[redacted]	[redacted]	[redacted]	**Total**
Shorttail Shrew	*Blarina brevicauda*	6	3	4	13
Meadow Vole	*Microtus pennsylvanicus*	11	2	6	19
White-footed Mouse	*Peromyscus leucopus*	3	0	2	5
Eastern Chipmunk	*Tamias striatus*	21	3	8	32
Eastern Cottontail	*Sylvilagus floridanus*	10	2	7	19
Gray Squirrel	*Sciurus carolinesis*	6	3	6	15
Striped Skunk	*Mephitis mephitis*	2	0	1	3
Woodchuck	*Marmota monax*	8	1	2	11
Beaver	*Castor canadensis*	5	0	0	5
Raccoon	*Procyon lotor*	4	2	5	11
White-tailed Deer	*Odocoileus virginianus*	3	2	4	9
Black Bear	*Ursus americanus*	1	1	0	2
Total	**12 Species**	**80**	**19**	**45**	**144**

Table 7. Reptiles Observed during Bog Turtle Studies at the [redacted] Fens.

		Number Observed			
Common Name	**Scientific Name**	[redacted]	[redacted]	[redacted]	**Total**
Turtles: Testudines					
Common Snapping Turtle	*Chelydra serpentina*	5	0	4	9
E. Box Turtle	*Terrapene carolina*	7	2	5	14
E. Painted Turtle	*Chrysemys picta*	24	0	3	27
Spotted Turtle	*Clemmys guttata*	19	0	7	26
Wood Turtle	*Clemmys insculpta*	7	0	0	7
Bog Turtle	*Clemmys muhlenbergii*	53	7	15	75
Total Turtles	**6 Species**	**115**	**9**	**34**	**158**
Snakes: Serpentes					
E. Garter Snake	*Thamnophis sirtalis*	2	3	2	7
E. Ribbon Snake	*Thamnophis sauritus*	0	0	2	2
E. Hognose Snake	*Heterodon platyrhinos*	0	0	1	1
E. Milk Snake	*Lampropeltis triangulum*	3	0	3	6
N. Black Racer	*Coluber constrictor*	0	0	2	2
N. Water Snake	*Nerodia s. sipedon*	1	2	0	3
Total Snakes	**5 Species**	**5**	**3**	**10**	**21**
Total	**11 Species**	**120**	**12**	**44**	**179**

IMPACTS OF AMERICAN BEAVER ON BOG TURTLES IN [redacted] FENS

American Beaver Ecology

The American beaver inhabit areas that provide an adequate water source, and abundant food supplies of rich quality. Beaver ponds are constructed by building dams out of sticks and mud along streams, flooding an area. The beavers cut down many trees along the banks of their pond, and use these fallen trees for food, and to aid in the construction of their dens. Beavers often forage about 100m from their pond, and frequently build canals from the pasture to the pond, to exploit rich food sources (Tesky, 1993). The canals facilitate transporting these foods to the beaver's den, while providing the beaver with cover (Sevilleta Long-Term Ecological Research Project, Jul. 16 2002, electronic communication). The beavers primarily feed on herbaceous material when present, if not the beavers will feed on woody vegetation. Woody plant species that beavers prefer are poplar (*Populus* spp.), red maple (*Acer rubrum*), cottonwood (*Populus* spp.), willow (*Salis* spp.), alder (*Alnus* spp.), sassafras (*Sassafras albidum*), sweetgum (*Liquidambar styraciflua*), blackgum (*Nyssa sylvatica*), dogwood (*Cornus* spp.), holly (*Ilex* spp.), oaks (*Quercus* spp.), and pine (*Pinus* spp.) when food is scarce (Moore, 1995). The beavers will cache much of the food they forage for winter stores, unless there are aquatic plants, such as duckweed (*Lemma* spp.), and water lilies (*Nymphaea* spp. and *Nuphar* spp.), which the beaver will exploit throughout the year (Tesky, 1993). When beavers relocate to a new habitat, they indirectly modify their environment considerably to the benefit of other wildlife, and plant species. The beavers flood fields, killing trees, which provide shelter, and perches for birds, which normally would not inhabit such a place (Sevilleta Long-Term Ecological Research Project, Jul. 16 2002, electronic communication). Invertebrates will be found extensively throughout the wetland providing food for birds, mammals, and waterfowl, which would also breed on the tranquil ponds water. The beaver's pond causes the water table to rise, which causes the growth of water-loving plants, providing more shelter, and food for other wildlife. The pond also improves the overall hydrology of the habitat by, preventing floods, preserving soil, maintaining the water table level, and conserving water from spring runoff, assuring the stream to run smoothly year-round (Tesky, 1993). The stream, then insures the survival of trout, and allows for agricultural practices by humans. If and when the pond fills up with silt, the beavers will move further downstream or upstream. The abandoned pond then fills with grasses, and other vegetation (Sevilleta Long-Term Ecological Research Project, Jul. 16 2002, electronic communication).

American Beaver Impact on Bog Turtles in the [redacted] Fens

In Pennsylvania, the beaver was almost extirpated before the first permanent white settlements, and due to reintroduction of beavers into Pennsylvania in 1917, and subsequent trapping and relocation programs, beaver populations in Pennsylvania have increased dramatically (Doutt, Heppenstall, and Guilday, 1977 as quoted in Moore, 1995). The [redacted] Fen is an ideal habitat for the beaver. There are many trees surrounding the wetland that provide the beaver with food, and logs and twigs for their den. Duckweed, and water lilies are also present providing the beaver with food year-round. Beavers are mainly nocturnal creatures, and are seldom observed. Therefore, the work of the beavers at [redacted] has not been witnessed but has been highly evident, since initial bog turtle surveys that began in 1995. Throughout [redacted] there are fallen trees that clearly exhibit that the beavers have been foraging around the wetland, and continue to forage around the wetland. Many fallen trees can be found upward from the existing beaver's pond providing evidence that the beavers are continually moving around the wetland. Also, there are remnants of previous dikes upstream that show that the beaver may have had a pond there, and have since moved slightly downstream. Evidence of these dikes, show that the beavers have the ability to fluctuate water levels drastically from year to year, improving the hydrology of the surrounding environment. There are many dams on the outer edges of the pond, few also downstream, to aid in retaining water in the pond. Located near the edge of the stream there is a large den, constructed of twigs and branches believed to be the beaver's present lodge, and den.

Upon first observation, the impact that the beavers have had on [redacted] did not seem like ideal bog turtle habitat. However, the bog turtles have adapted to this situation, as we continue to capture new and marked turtles in these areas, and also continually find radio-tracked turtles utilizing these areas. Many areas where the bog turtles have

Table 10. Information on Radiotracked Bog Turtles at [redacted] Fens during 2001.

Turtle No.	Field No.	Marginal No.	Sex	Mass (grams)	Plastron Length (mm)	Transmitter Attached	No. of Relocations (GPS)	Range Length (meters)	Minimum Convex Polygon Home Range (hectares)
BS1.11	95.07	L1-R11	M	105	73.7	4/22	20	185	0.36
BS2.9	98.02	L2-R9	F	129	80.3	5/10	16	115	0.36
BS3.1	2001.02	L3-R1	F	107	73.3	4/26	17	175	0.24
BS3.8	2001.03	L3-R8	M	101	77.5	5/4	3	15	N/A
BS3.12	2001.07	L3-R12	M	121	77.0	5/4	12	120	0.17
BS8.3	2001.17	L8-R3	F	104	69.2	5/4	17	160	0.32
BS10.11	96.17	L10-R11	F	112	73.7	5/10	17	65	0.06
BS11.10	96.24	L11-R10	M	111	73.9	5/4	8	145	0.04
S1.1	95.01	L1-R1	F	111	78.1	5/12	19	165	0.29
S1.3	95.03	L1-R3	M	105	69.6	5/10	9	120	0.08
S1.8	2001.02	L1-R8	F	93	70.4	7/19	7	25	0.01
S8.2	2001.01	L8-R2	M	104	86.9	5/3	4	50	N/A
S8.12	95.13	L8-R12	M	98	72.3	5/10	19	95	0.30
T9.10	96.08	L9-R10	F	104	71.5	5/7	17	65	0.08
T12.3	96.29	L12-R3	M	100	69.9	5/3	2	NA	N/A

Note: Some of the GPS points that were taken for each turtle are not visible on the individual turtle maps due to the selected resolution of the maps. Some of the points are within a meter or less of each other which causes them to be displayed on top of one another in the map layouts. At the selected resolution, the software clusters these points and may not show each dot on the map.

The following is a summary of the movements of the radiotracked bog turtles:

[redacted] *Fen*

There were 8 bog turtles radiotracked at this site. **Map 1** represents all of the bog turtle locations with the minimum convex polygon home range. The nest site and hibernacula are shown on the transparency overlay.

Turtle BS1.11: This male was fitted with a transmitter on April 22 and monitored on 25 occasions until November 9. GPS points were recorded on 20 of the 25 occasions. This turtle was originally captured under the powerline between the [redacted] on April 22. He was observed on 16 occasions swimming, walking, hidden in mud and under vegetation through August 23. His maximum distance moved was 80 meters. On August 31, BS1.11 was located at the base of a poison sumac bush, opposite the entrance to the fen, 90 meters from his original capture location. The poison sumac bush had various grasses at its base along with three tunnels under its roots. He spent most of his time in and out of the tunnels at this site before going into hibernation. This location was named Hibernaculum No. 4. **Map 2** shows the movements and minimum convex polygon home range for this turtle.

Turtle BS2.9: This female was fitted with a transmitter on May 10 and monitored on 18 occasions until September 27. GPS points were recorded on 16 of the 18 occasions. She was originally captured in the center of the cattail area near the entrance to the fen on May 10. Two weeks later she was located in a sedge tussock wetland, south-east of her last location, under vegetation approximately 110 meters away. In order to reach this location she had crossed [redacted] Creek (which is approximately 6 meters wide and 1 meter deep at its deepest point), and scaled a steep embankment, and continued southeast 80 meters to the sedge tussock wetland. On June 7 she was located 7 meters from Hibernaculum No. 1, a distance of approximately 100 meters from her previous location. On June19, she was located back in the sedge tussock area across [redacted] Creek. She was observed in this area until August 31. On September 7, she was found 75 meters south of the beaver pond under the powerline right-of-way. Her last recorded signal was on September 27. **Map 3** shows the movements and minimum convex polygon home range for this turtle.

Turtle BS3.1: This female was fitted with a transmitter on April 26 and monitored on 20 occasions until November 9. GPS points were recorded on 17 of the 20 occasions. This turtle was captured under the powerline approximately 7 meters east of the beaver dam under 6 inches of water. She stayed within 70 meters of this location until August 1. During this time she was observed walking between sedge tussocks, hidden in water, under vegetation and in tunnels. On August 23, she moved to the base of a silky dogwood bush (Hibernaculum No. 2) approximately 80 meters south of her original capture. There are a number of tunnels in the roots of this silky dogwood bush that she used. She was observed basking near the entrances to these tunnels and in the tunnels several times. On September 14, she was found mating with male BS11.10 at the entrance to one of the tunnels. She is currently hibernating at this site with male BS11.10. **Map 4** shows the movements and minimum convex polygon home range for this turtle.

Turtle BS3.8: This male was fitted with a transmitter on May 4 and monitored on 7 occasions until July 5. GPS points were recorded on 3 of the 7 occasions. This turtle was captured in a pool approximately 25 meters south of the road. After May 12, HA was no longer able to pick up a signal from its transmitter. On June 5, this turtle was captured in the same pool without its transmitter. A new transmitter was fitted on the turtle and was monitored until July 5. This turtle stayed in and around the pool near Hibernaculum No. 1 during the next seven weeks. After July 5, no signal was received. **Map 5** shows the movements of this turtle. No minimum convex polygon home range was created due to lack of GPS relocations.

Turtle BS 3.12: This male was fitted with a transmitter on May 4 and monitored on 18 occasions until November 8. GPS points were recorded on 12 of the 18 occasions. He was initially captured in the same pool as female BS8.3 and male BS3.8. This male remained in this area until May12. On May 31 he was located across the gravel road in the dense *Phragmites* stand, approximately 120 meters from his original capture location. This is a wet area which floods from run-off from the land mining area adjacent to the wetland. The *Phragmites* in this wetland exceed 16 feet in height and was almost impossible to penetrate. This turtle remained in this wetland until August 23 when it was found back across the road in the same area as its original capture on May 4. This male has remained in this area and is currently in Hibernaculum No. 1. **Map 6** shows the movements and minimum convex polygon home range for this turtle.

Turtle BS8.3: This female was fitted with a transmitter on May 4 and monitored on 21 occasions until November 9. GPS points were recorded on 17 of the 21 occasions. This turtle was initially captured in the same pool as male BS3.8. She moved out of this area after June 7 and was located approximately 110 meters southwest under the powerline on June 21. She continued to follow the open area under the powerline right-of-way for the next three weeks, traveling approximately 100 meters south until she settled in a wooded area within 3 meters of the [redacted]. This turtle stayed in this dry wooded area, moving as close as one

Figure 7. [redacted] Hibernaculum No. 3.

meter to the road, but apparently never crossed the road. She returned to her initial capture location sometime after September 14. On September 2, she was found approximately 50 meters from Hibernaculum No. 1. On September 28 she was located in Hibernaculum No. 1 and was still there on November 9 when she was last checked. **Map 7** shows the movements and minimum convex polygon home range for this turtle.

Turtle BS10.11: This female was fitted with a transmitter on May 10 and monitored on 17 occasions until November 9. GPS points were recorded on 16 of the 17 occasions. This turtle was originally captured in the Indian paint brush (*Castilleja coccinea*) area approximately 20 meters west of Hibernaculum No. 1. She stayed in this area from May 10 to August 1 except for a temporary move of 45 meters to the powerline right-of-way in July. She returned to her initial capture location and moved 15 meters east from the Indian paint brush area to a pool near Hibernaculum No. 3 (**Figure 7**). She has remained at this location since September 27 and is currently hibernating under the bank. **Map 8** shows the movements and minimum convex polygon home range for this turtle.

Turtle BS 11.10: This male was originally captured walking on mud near the beaver pond on May 4. He was fitted with a transmitter on May 4 and was lost before May 10. He was found on August 31 without the transmitter. A new transmitter was attached to the turtle, and he was monitored on 8 occasions until November 9. GPS points were recorded on 8 occasions. On August 31 he was located 75 meters northeast of his original capture. It was found basking on the roots of a silky dogwood bush at Hibernaculum No. 2. On September 14 this male was found mating with female BS3.1 at the entrance to one of the tunnels at the base of the silky dogwood bush. This turtle was located on September 21 approximately 140 meters east of Hibernaculum No. 2. This site was identified in April as a potential hibernaculum. Originally, the site contained openings and tunnels full of water and mud (**Figure 8**). In August and September the site was dry. The male was located on September 27 at Hibernaculum No. 2 and is currently hibernating at this site. **Map 9** shows the movements of this turtle. No minimum convex polygon home range was created due to lack of GPS relocations.

[redacted] *Fen*

There were 5 turtles fitted with transmitters and radiotracked at this site. **Map 10** represents all of the bog turtle locations with the minimum convex polygon home range. The nest site and hibernacula are shown on the transparency overlay.

Turtle S1.1: This female was fitted with a transmitter on May 12 and monitored on 19 occasions until October 12. GPS points were recorded on 19 occasions. This turtle was found basking by a rivulet in the southwest end of the fen. She remained in this area until June 11 after which she was located over 140 meters northwest in a seep next to the railroad. She remained in this area through July 17, then moved to the southwest end of the fen on July 28. She subsequently traveled approximately 30 meters south into the woodland and remained there in a tunnel for two weeks. After this Period, she returned to the edge of the open fen, and on September 7 was found in a tunnel at the base of a silky dogwood. She remained there through October 12. She is hibernating with male S8.12 and female S1.8 at this location (**Figure 2**). This site was named Hibernaculum No. 1. **Map 11** shows the movements and minimum convex polygon home range for this turtle.

Figure 8. Bog turtle coming out of a mud hole at Bartlett-Stabler Fen. Photo: Raymond Farrell, Herpetological Associates, Inc. 2001.

Turtle S1.3: This male was fitted with a transmitter on May 10 and monitored on 9 occasions until August 1. GPS points were recorded on 6 of the 9 occasions. This turtle was captured in a rivulet in the southwest end of the fen attempting to mate with male S8.12. This turtle was located on July 5 not far from the powerline right-of-way, a distance of 120 meters from its last location. This turtle remained in the southwest end of the fen until August 1 when its signal was lost. **Map 12** shows the movements of this turtle.

Turtle S1.8: This female was fitted with a transmitter on July 17 and monitored on 8 occasions until October12. GPS points were recorded on 7 of the 8 occasions. This turtle was captured walking out of a rivulet at the southwest end of the fen. She remained in the southwest end of the fen for the duration of the season. On September 21 she was located in a tunnel at the base of a silky dogwood. She hibernated with male S8.12 and female S1.1 (Hibernaculum No. 1). **Map 13** shows the movements of this turtle. No minimum convex polygon home range was created due to lack of GPS relocations.

Turtle S8.2: This male was fitted with a transmitter on May 3 and monitored on 4 occasions until May 8. GPS points were recorded on 4 occasions. This turtle was originally captured in the center of the fen sitting on a deer trail. One week before he disappeared he moved to the lower portion of the fen approximately 50 meters north, and then three days later was located near his original capture location. The next day he moved southeast to the center of the fen. On May 29 a signal was picked up from this turtle and HA tracked it up the steep slope to Route 611, and north along Route 611, for approximately ½ mile. The signal was never picked up again. It is HA's belief that someone or possibly a dog picked it up. **Map 14** shows the movements of this turtle. No minimum convex polygon home range was created due to lack of GPS relocations.

Turtle S8.12: This male was fitted with a transmitter on May 10 and monitored on 21 occasions until November 9. GPS points were recorded on 19 of the 21 occasions. This turtle was initially captured in a rivulet in the southwest end of the fen. Male S1.3 was on top of him attempting to mate. This turtle traveled throughout the open area of the fen during the field season. He moved almost to the powerline, 90 meters northeast of his original capture and then returned back to the southwestern part of the fen in August. The turtle is currently hibernating in a tunnel at the base of a silky dogwood with females S1.1 and S1.8 (Hibernaculum No. 1). **Map 15** shows the movements and minimum convex polygon home range for this turtle.

[redacted] *Fen*

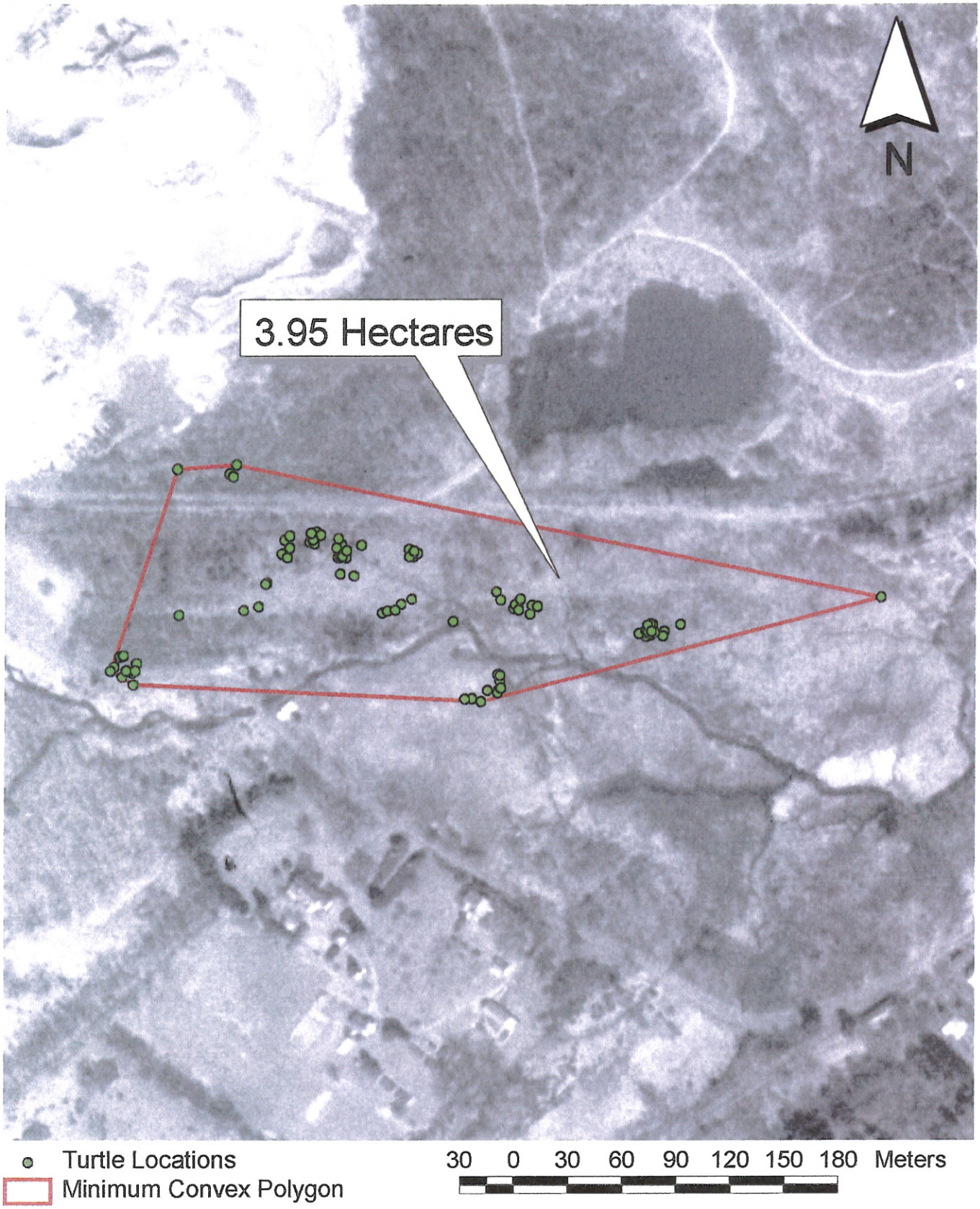
There were two bog turtles fitted with transmitters and radiotracked at this site. **Map 16** represents all of the bog turtle locations with the minimum convex polygon home range. The nest site and hibernacula are shown on the transparency overlay.

Turtle T9.10: This female was fitted with a transmitter on May 7 and monitored on 23 occasions until November 9. GPS points were recorded on 17 of the 23 occasions. This turtle was originally captured basking on a sedge tussock 25 meters southeast of the railroad bed. She moved 45 meters southwest of the railroad bed and remained there until July 5 when she was located, under vegetation, 1m from Sand Pit Road. She remained in this area along the road for seven weeks and appears to have never crossed the road. She returned to the fen sometime before August 31. She moved short distances within the fen until the end of September. On September 27 she was located in a tunnel under the roots of a dead tree. She is currently hibernating at this site (Hibernaculum No. 1). **Map 17** shows the movements and minimum convex polygon home range for this turtle.

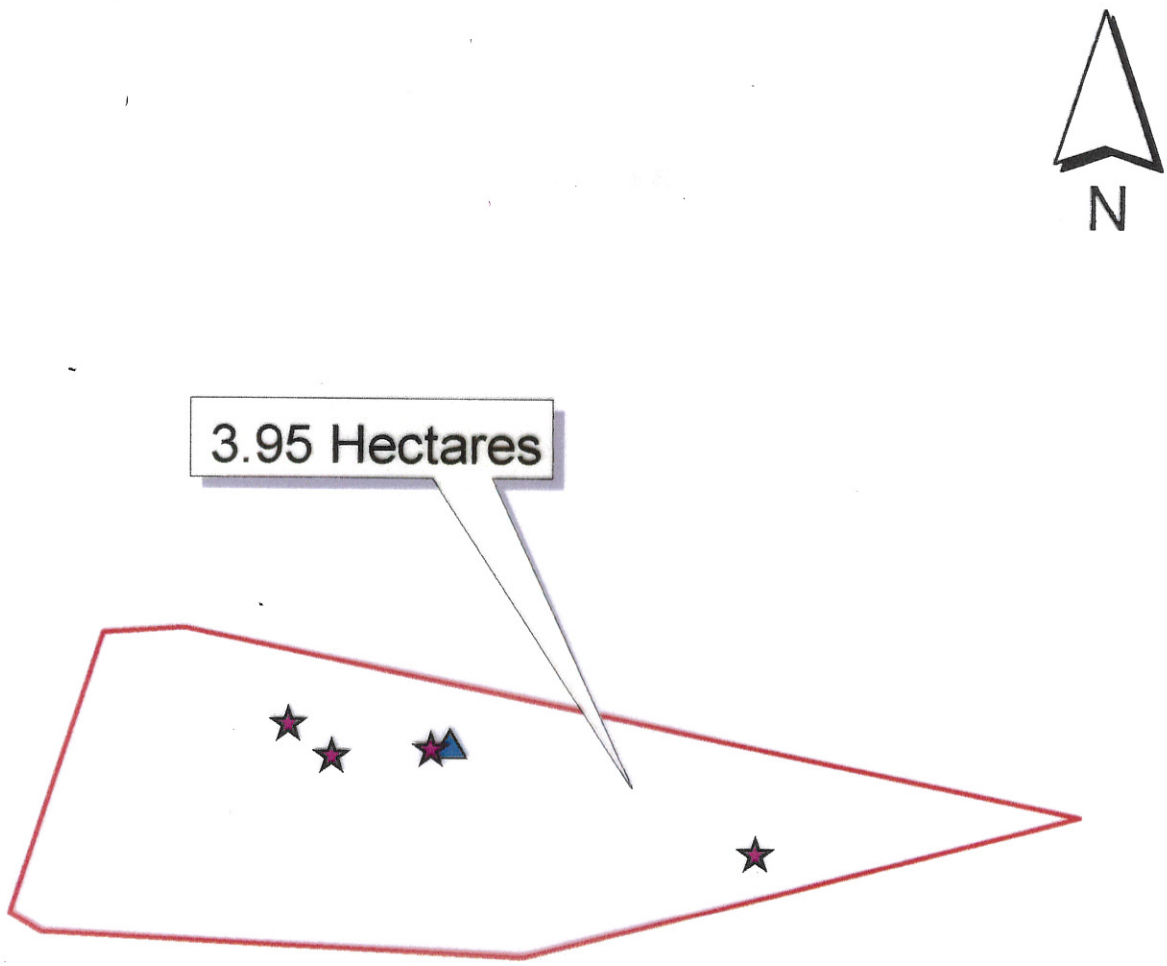
Turtle T12.3: This male was fitted with a transmitter on May 5 and monitored on 5 occasions until June 11. GPS points were recorded at 2 locations. This turtle was captured basking on dead vegetation, 12 meters southeast of the railroad bed. This turtle moved only a short distance during the five week period that she was tracked. The transmitter failed and was removed on June 11. No transmitters were available at this time to refit on the turtle. **Map 18** shows the movements of this turtle. No minimum convex polygon home range was created due to lack of GPS relocations.

Map 1

[redacted] Movements and Minimum Convex Polygon Home Range of Radiotracked Turtles



[redacted] Movements and Minimum Convex Polygon Home Range of Radiotracked Turtles



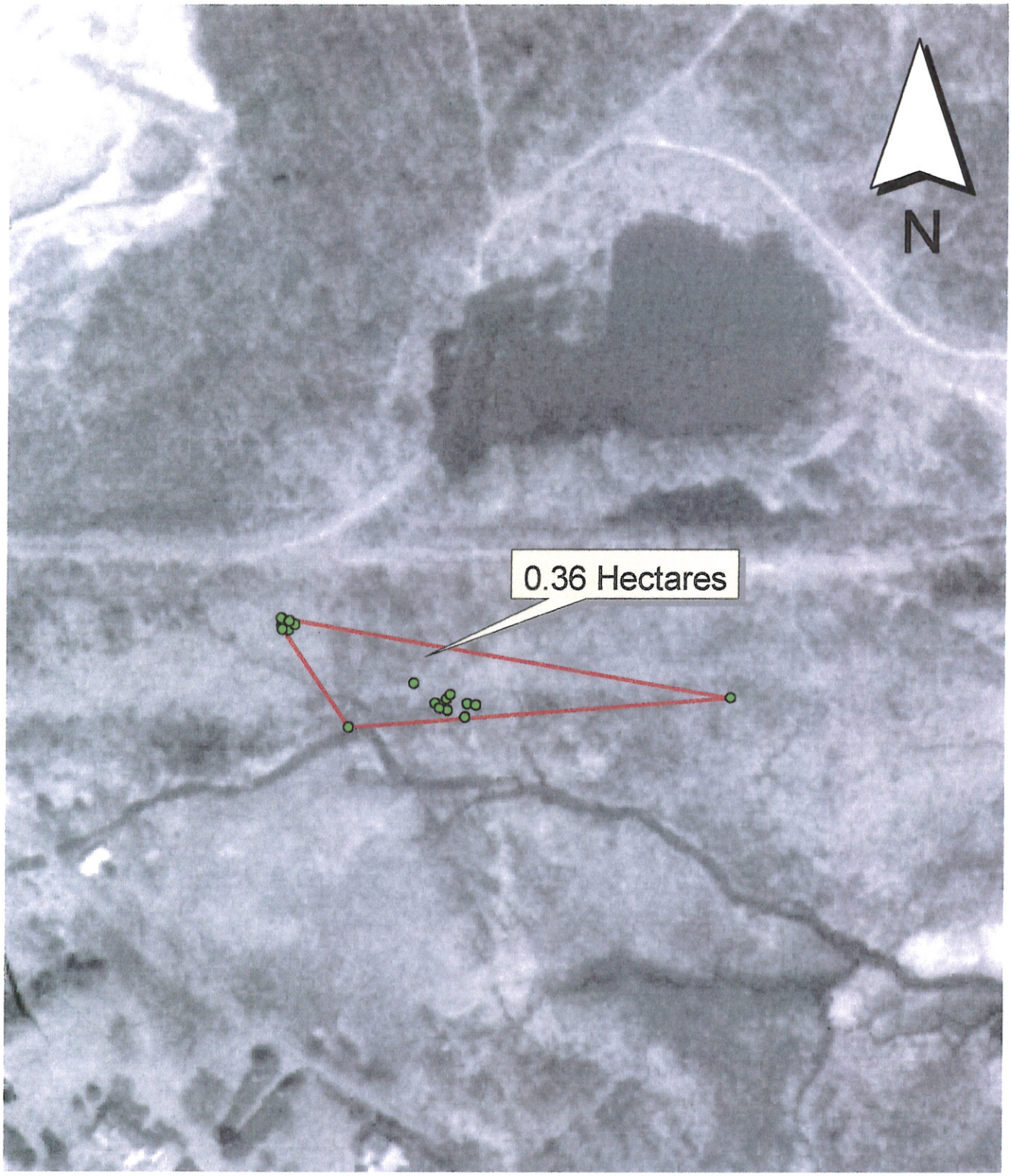
30 0 30 60 90 120 150 180 Meters

★ Hibernacula Locations
▲ Nesting Area
Minimum Convex Polygon

Herpetological Associates, Inc. 2002

Map 2

Turtle No. BS1.11: Movements and Minimum Convex Polygon Home Range

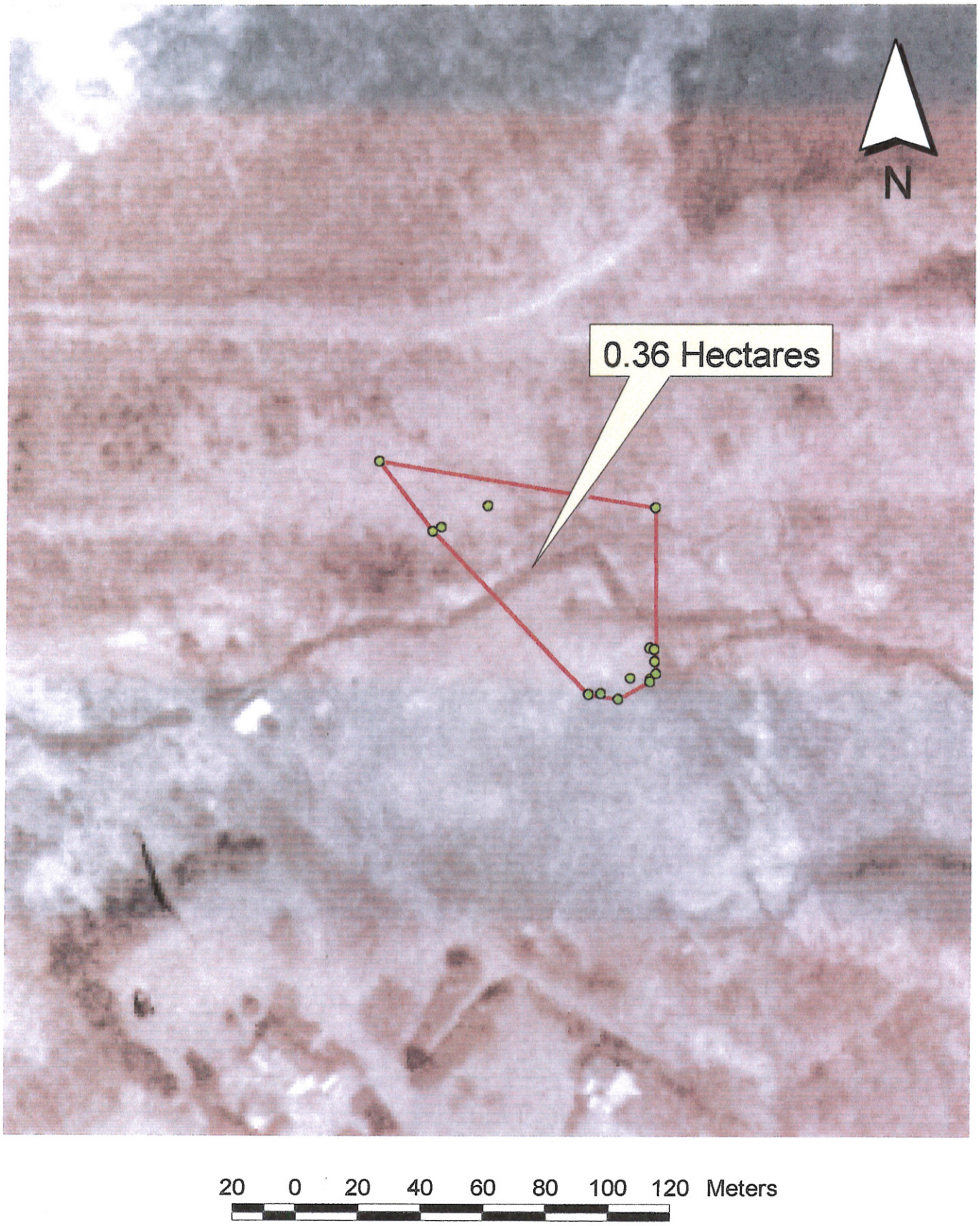


Turtle No. BS1.11

Minimum Convex Polygon

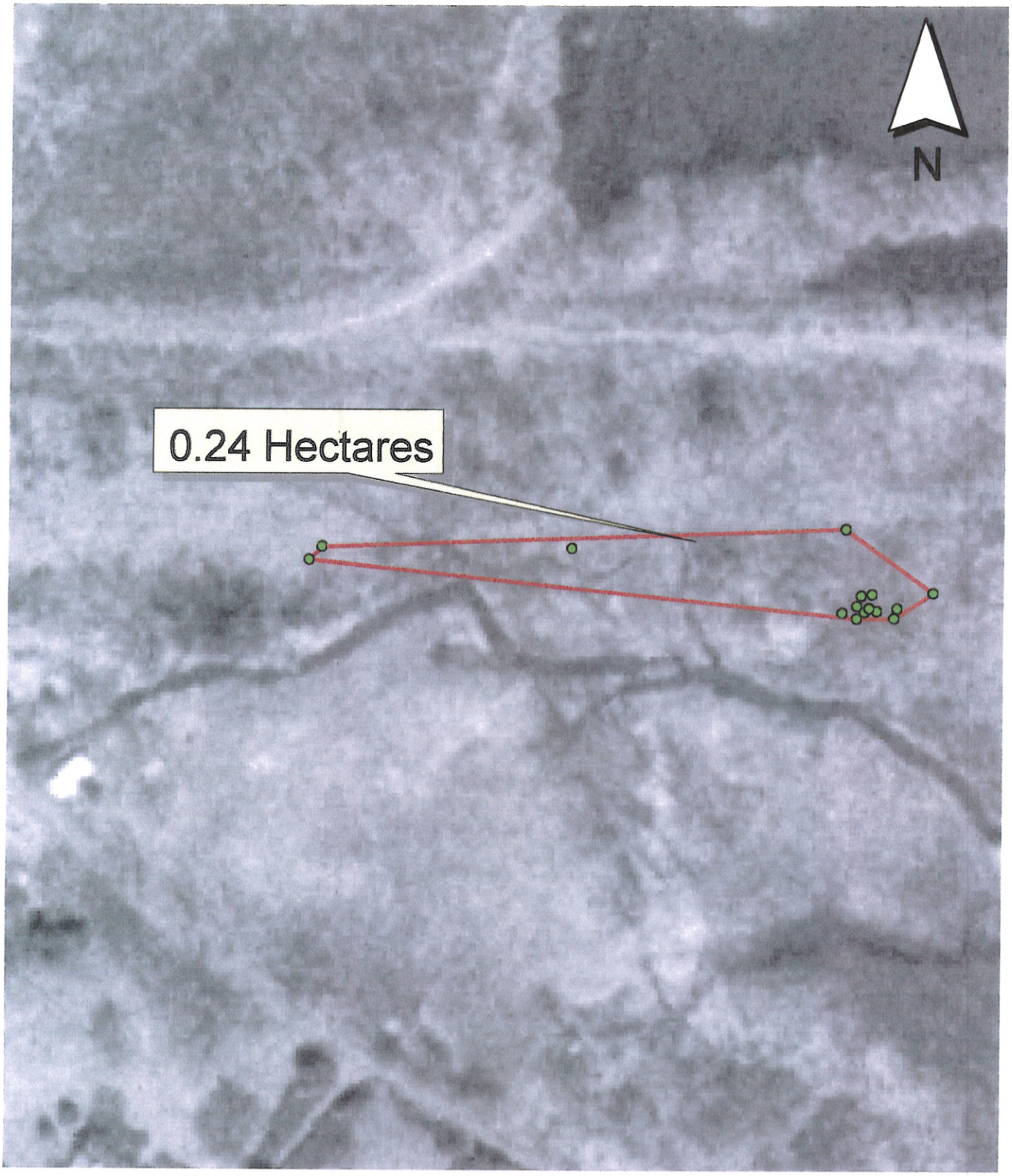
Map 3

Turtle No. BS 2.9: Movements and Minimum Convex Polygon Home Range



Map 4

Turtle No. BS3.1: Movements and Minimum Convex Polygon Home Range

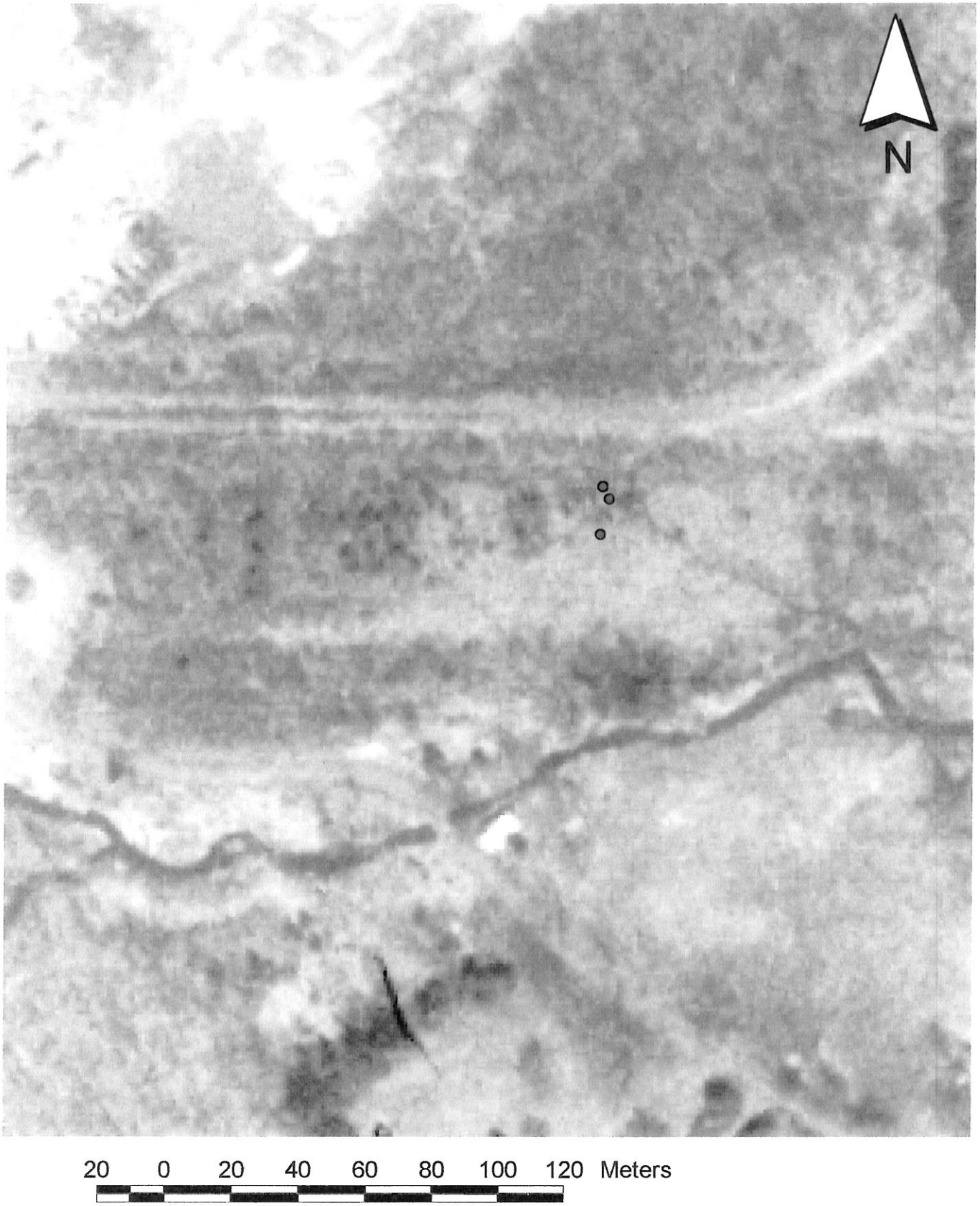


Turtle No. BS3.1

Minimum Convex Polygon

Map 5

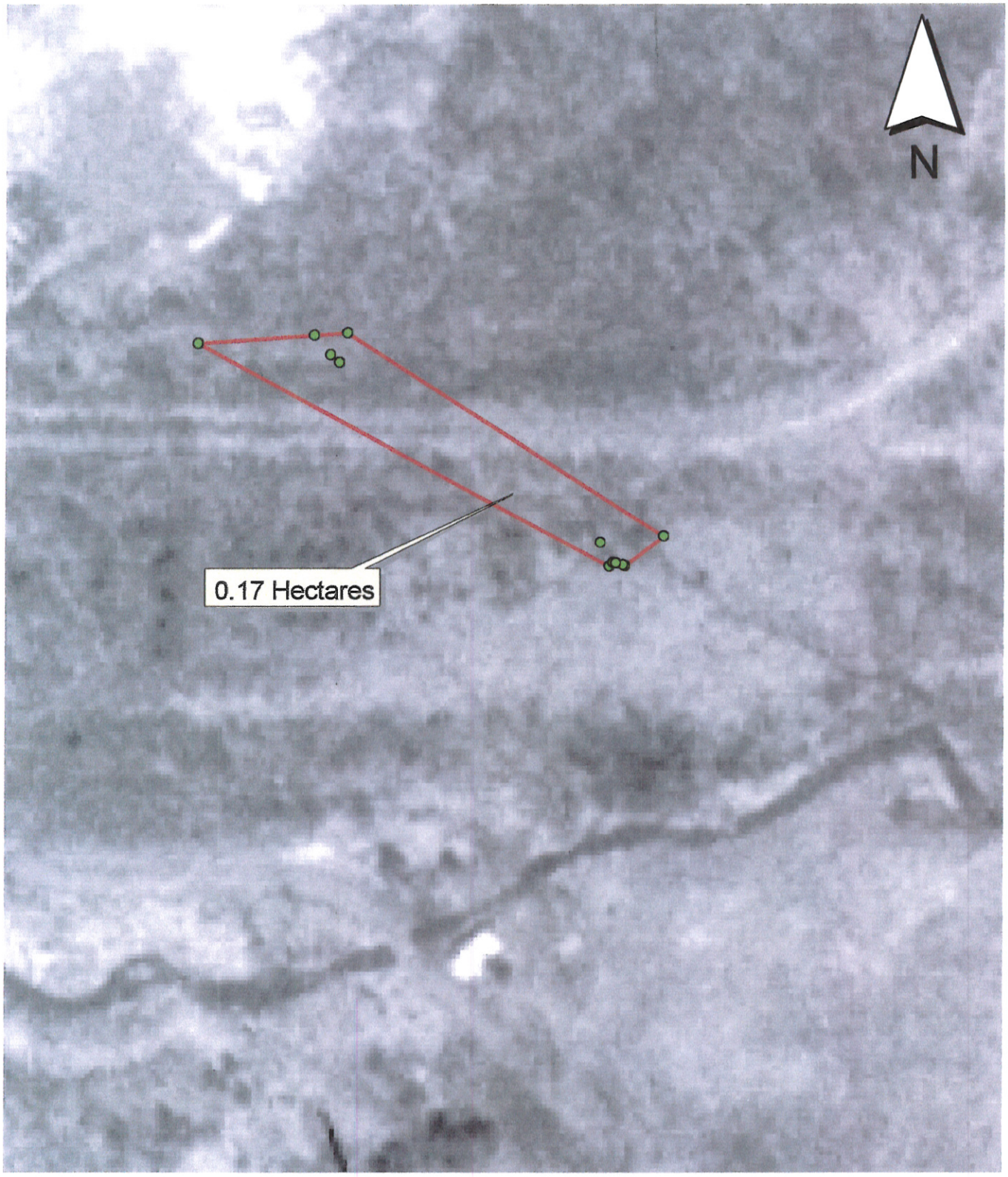
Turtle No. BS3.8: Capture Locations



● Turtle No. BS3.8

Map 6

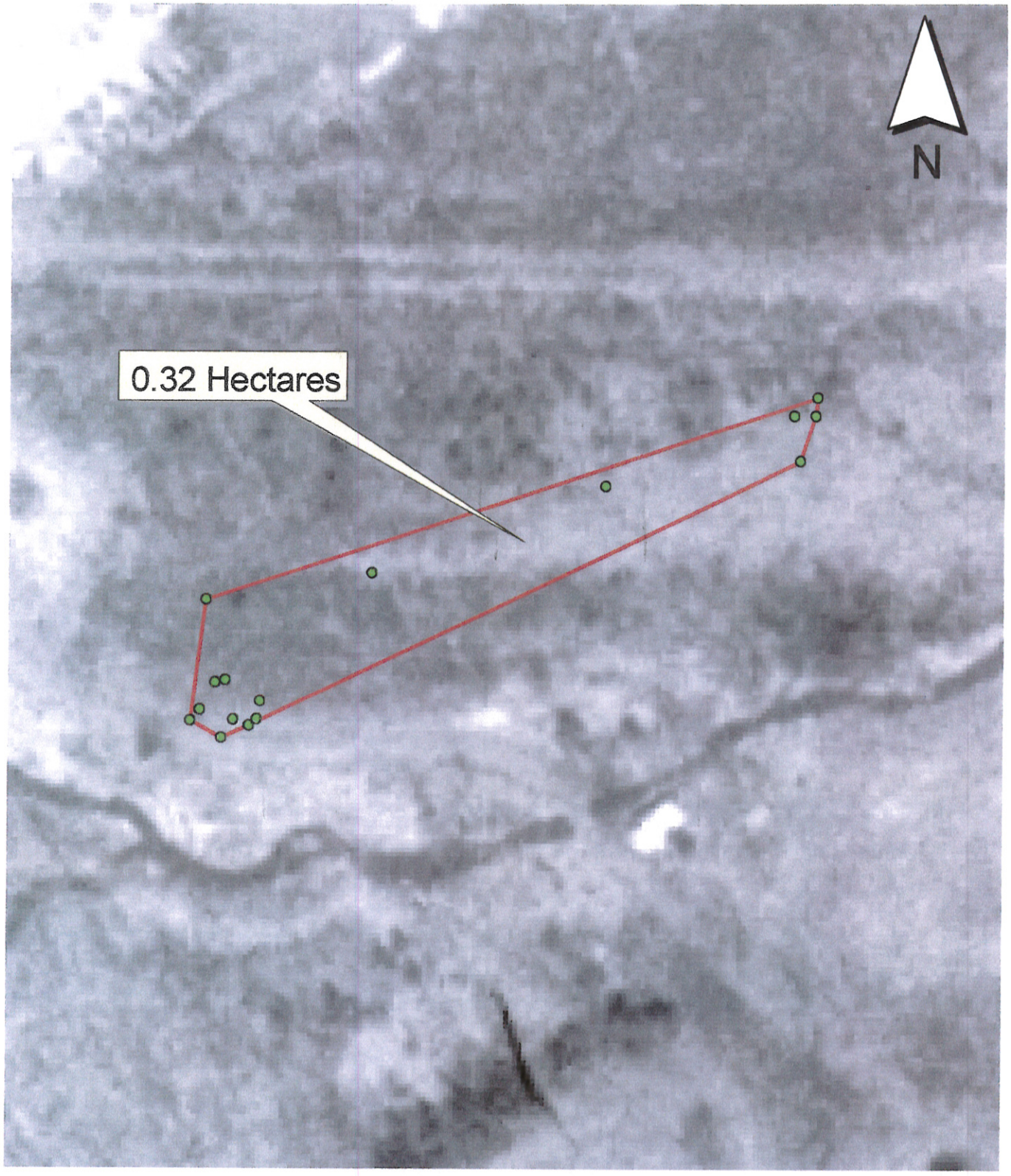
Turtle No. BS3.12: Movements and Minimum Convex Polygon Home Range



Turtle No. BS3.12
Minimum Convex Polygon

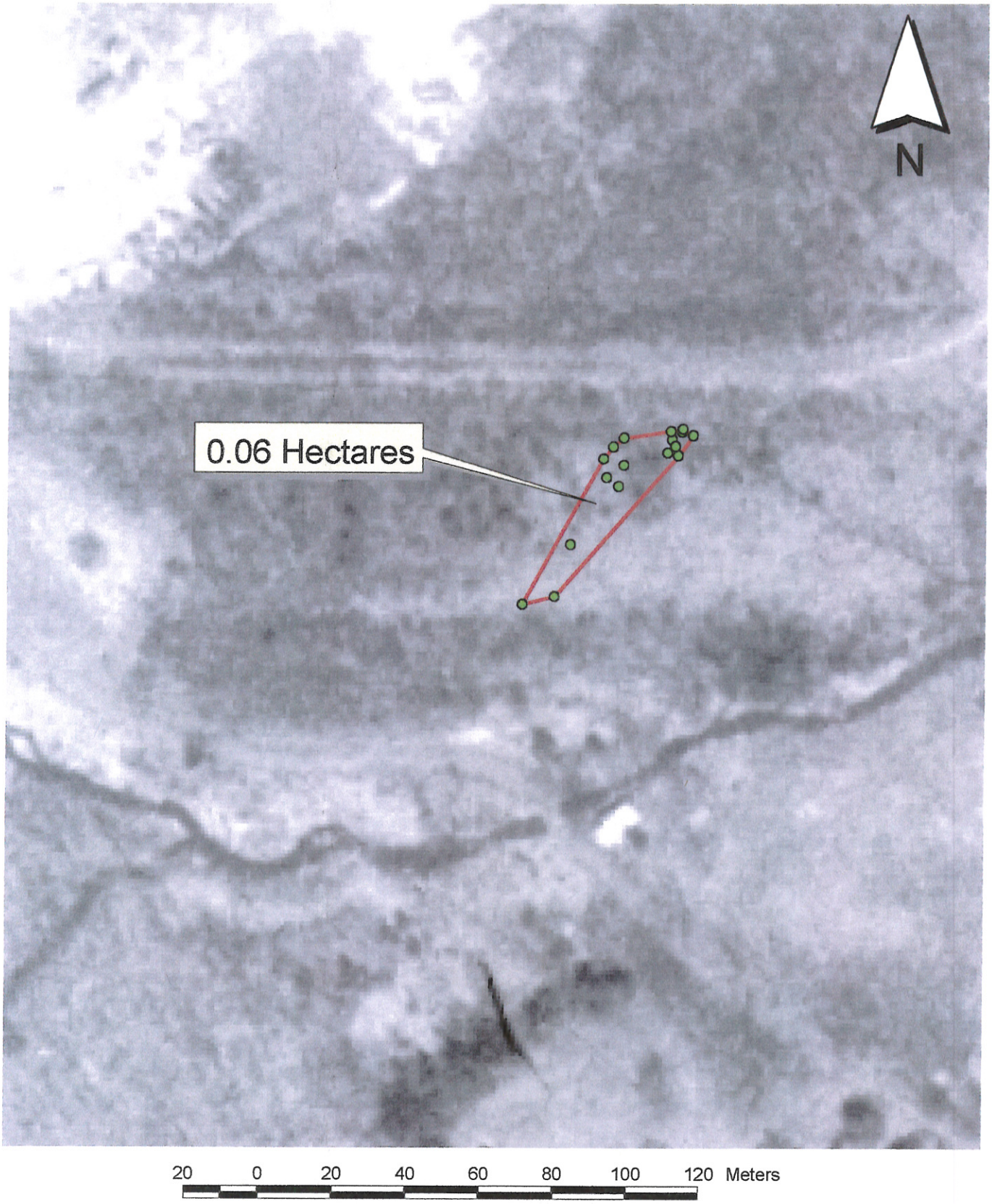
Map 7

Turtle No. BS8.3: Movements and Minimum Convex Polygon Home Range



Map 8

Turtle No. BS10.11: Movements and Minimum Convex Polygon Home Range

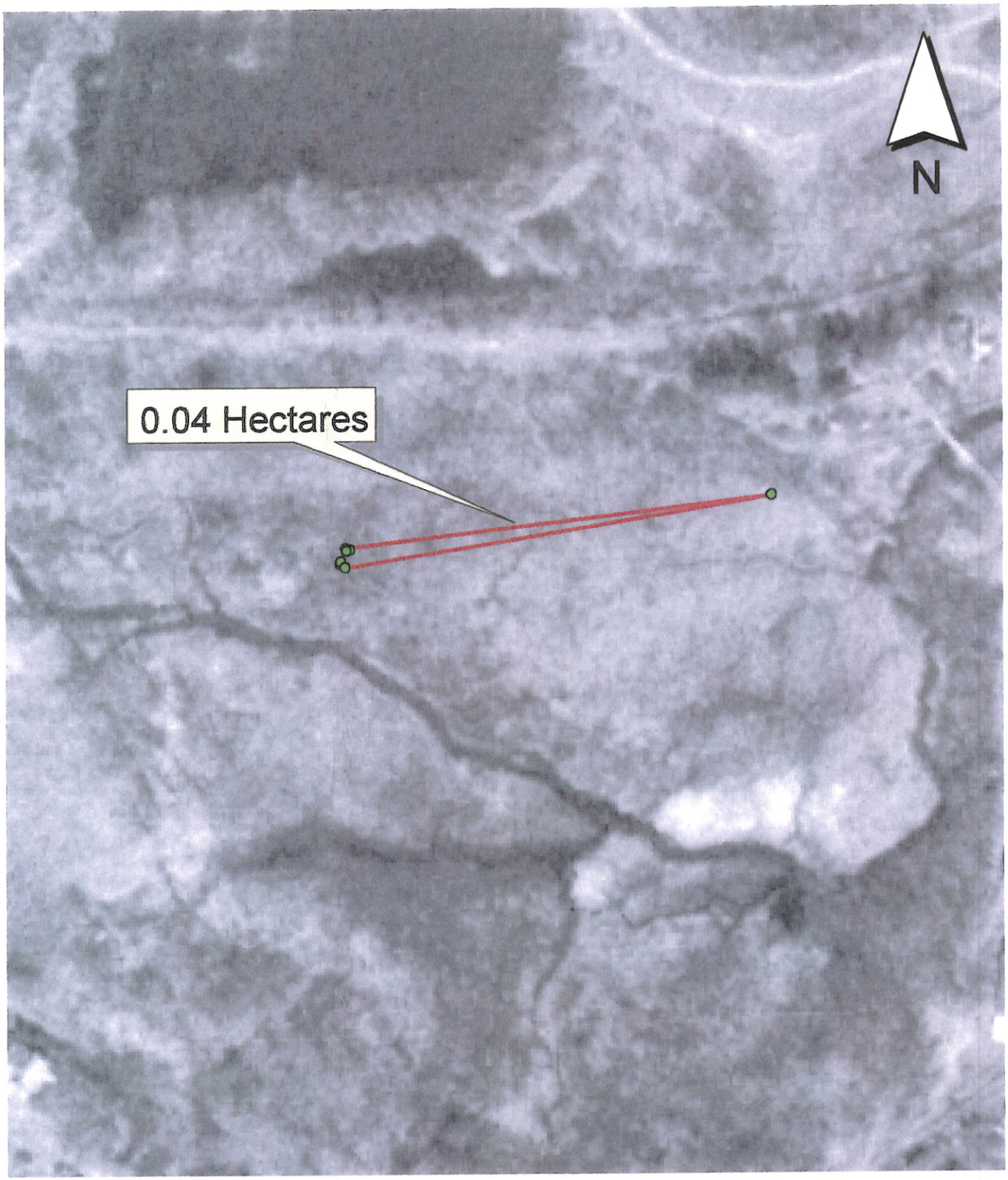


Turtle No. BS10.11

Minimum Convex Polygon

Map 9

Turtle No. BS11.10: Movements and Minimum Convex Polygon Home Range

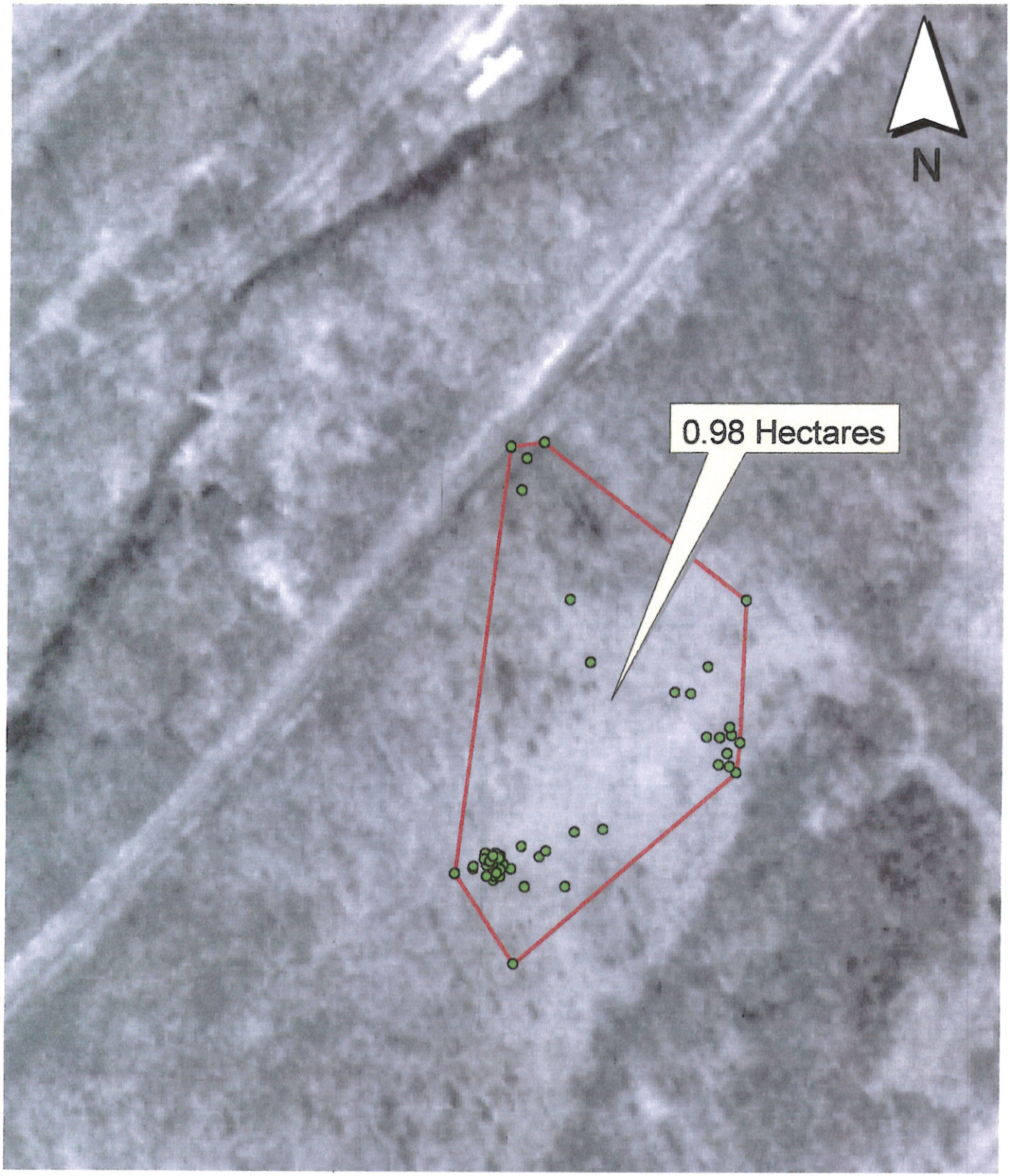


Turtle No. BS11.10

Minimum Convex Polygon

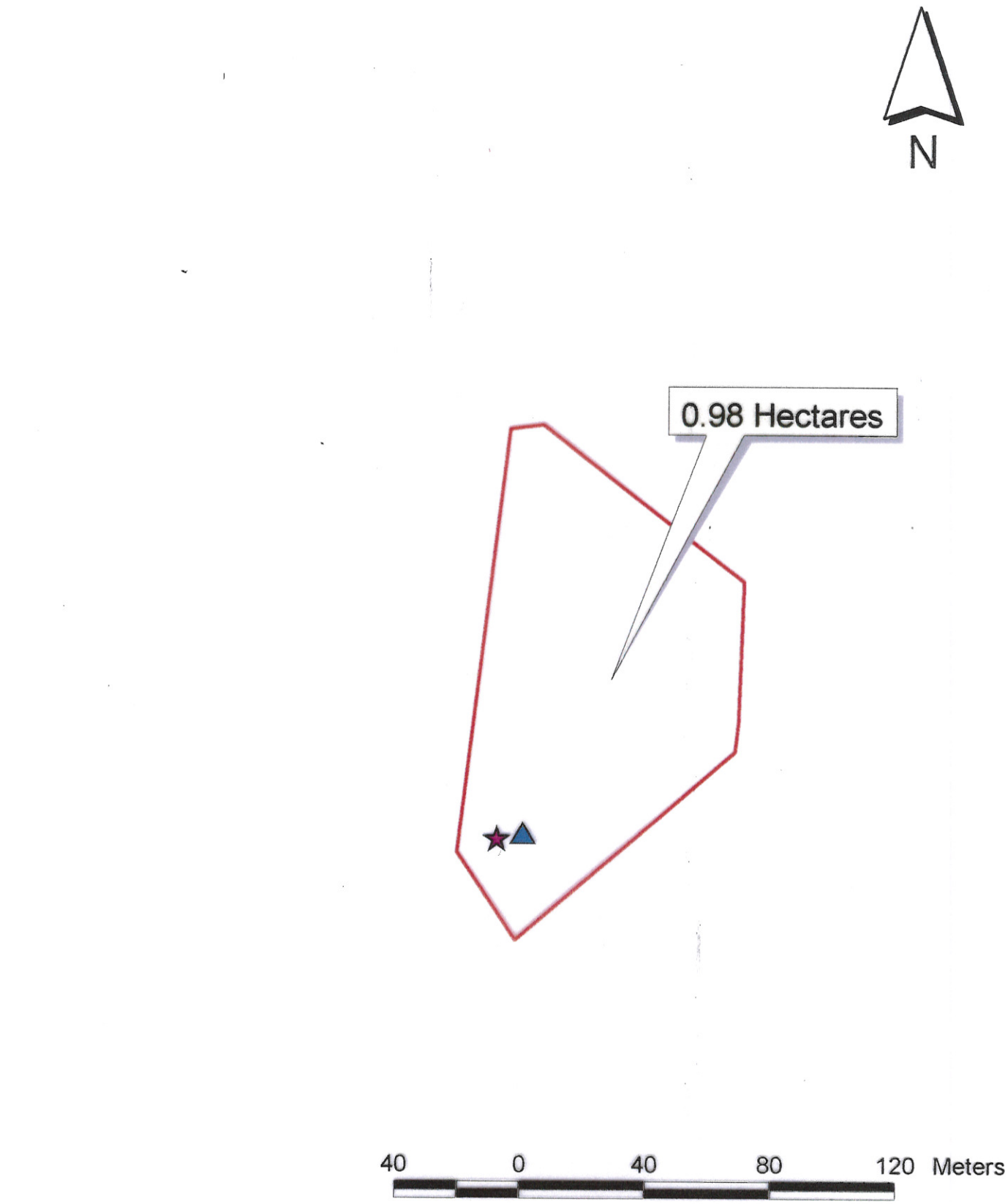
Map 10

[redacted] Movements and Minimum Convex Polygon Home Range



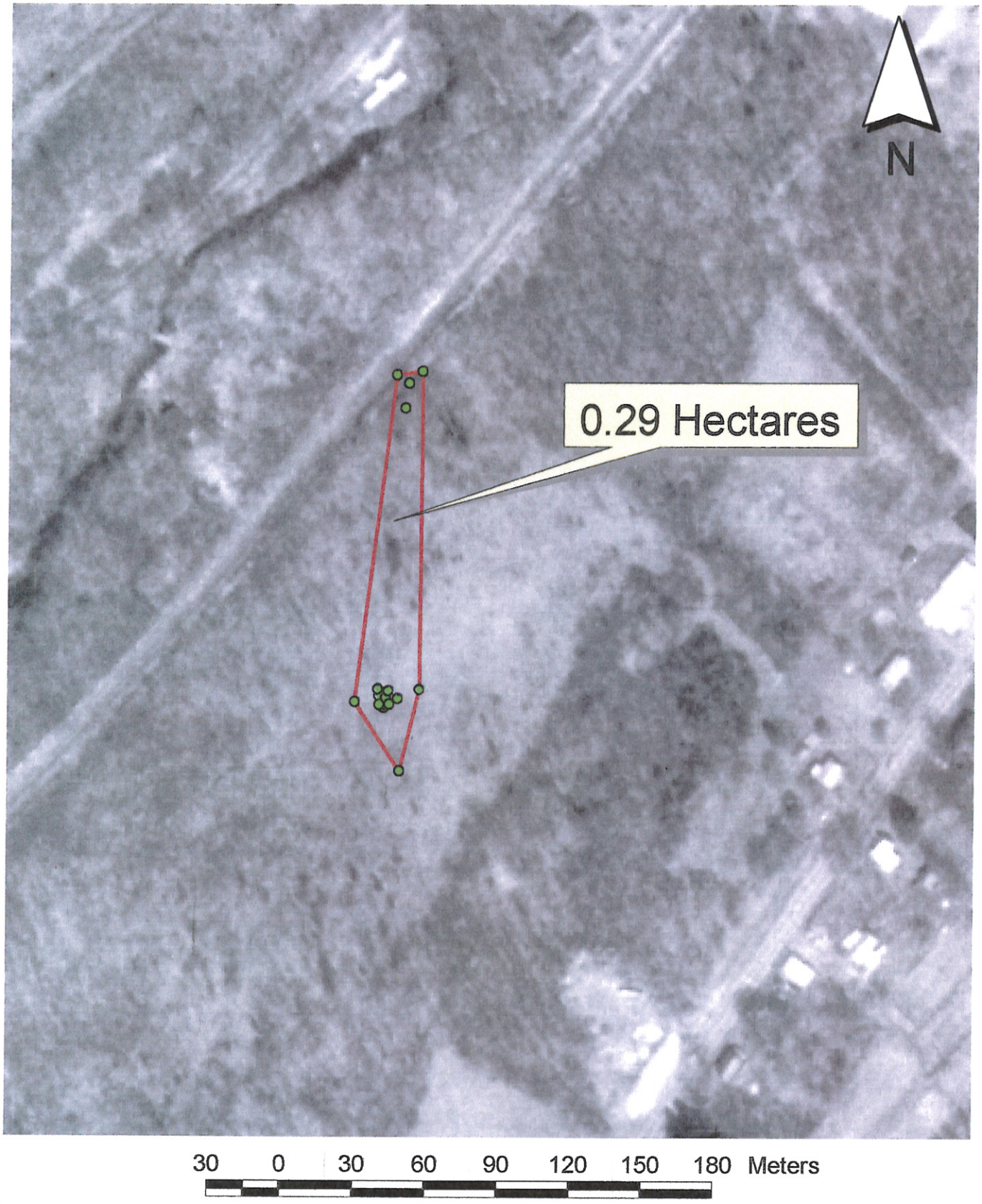
Map 10

[redacted] Movements and Minimum Convex Polygon Home Range



Map 11

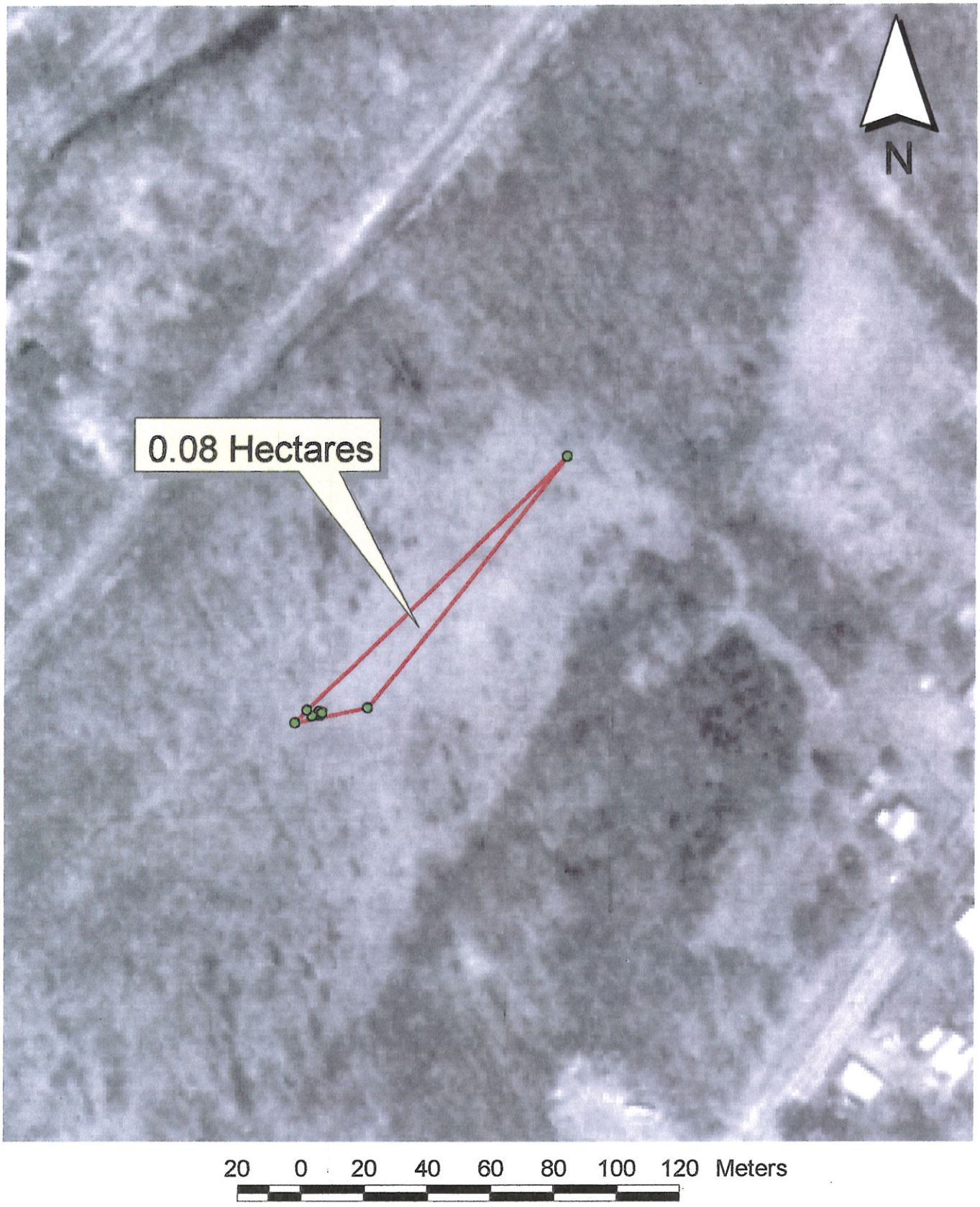
Turtle No. S1.1: Movements and Minimum Convex Polygon Home Range



Turtle No. S1.1
Minimum Convex Polygon

Map 12

Turtle No. S1.3: Movements and Minimum Convex Polygon Home Range

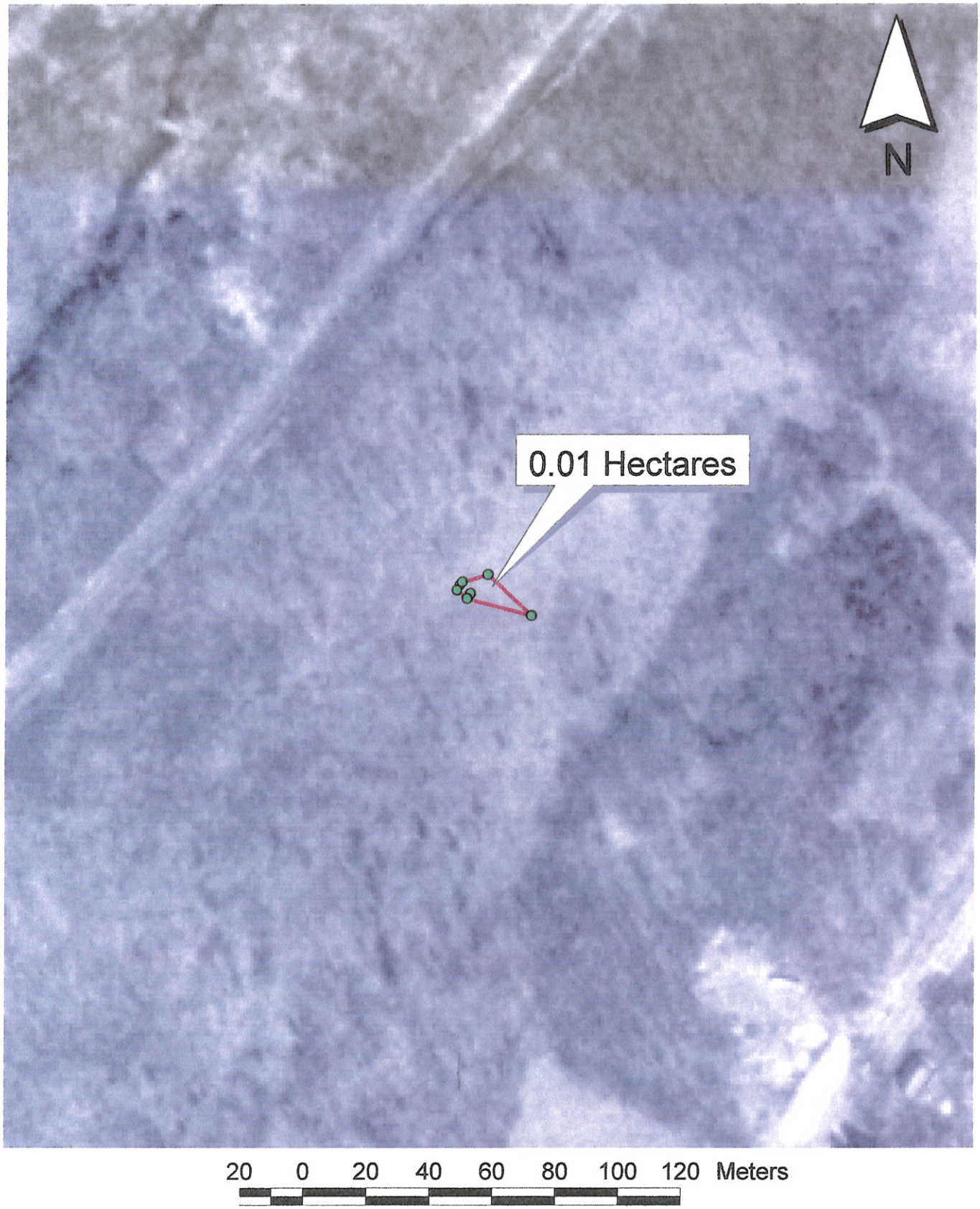


Turtle No. S1.3

Minimum Convex Polygon

Map 13

Turtle No. S1.8: Movements and Minimum Convex Polygon Home Range



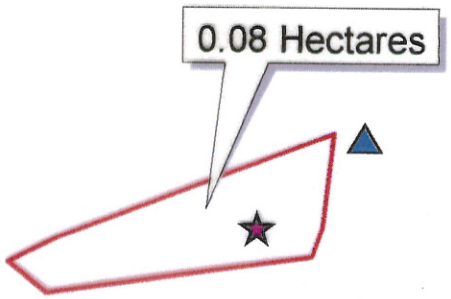
Turtle No. S1.8
Minimum Convex Polygon

Map 16

[redacted] Movements and Minimum Convex Polygon Home Range of Radiotracked Turtles

Map 16

[redacted] Movements and Minimum Convex Polygon Home Range of Radiotracked Turtles



10 0 10 20 30 40 50 60 Meters

Nesting Area

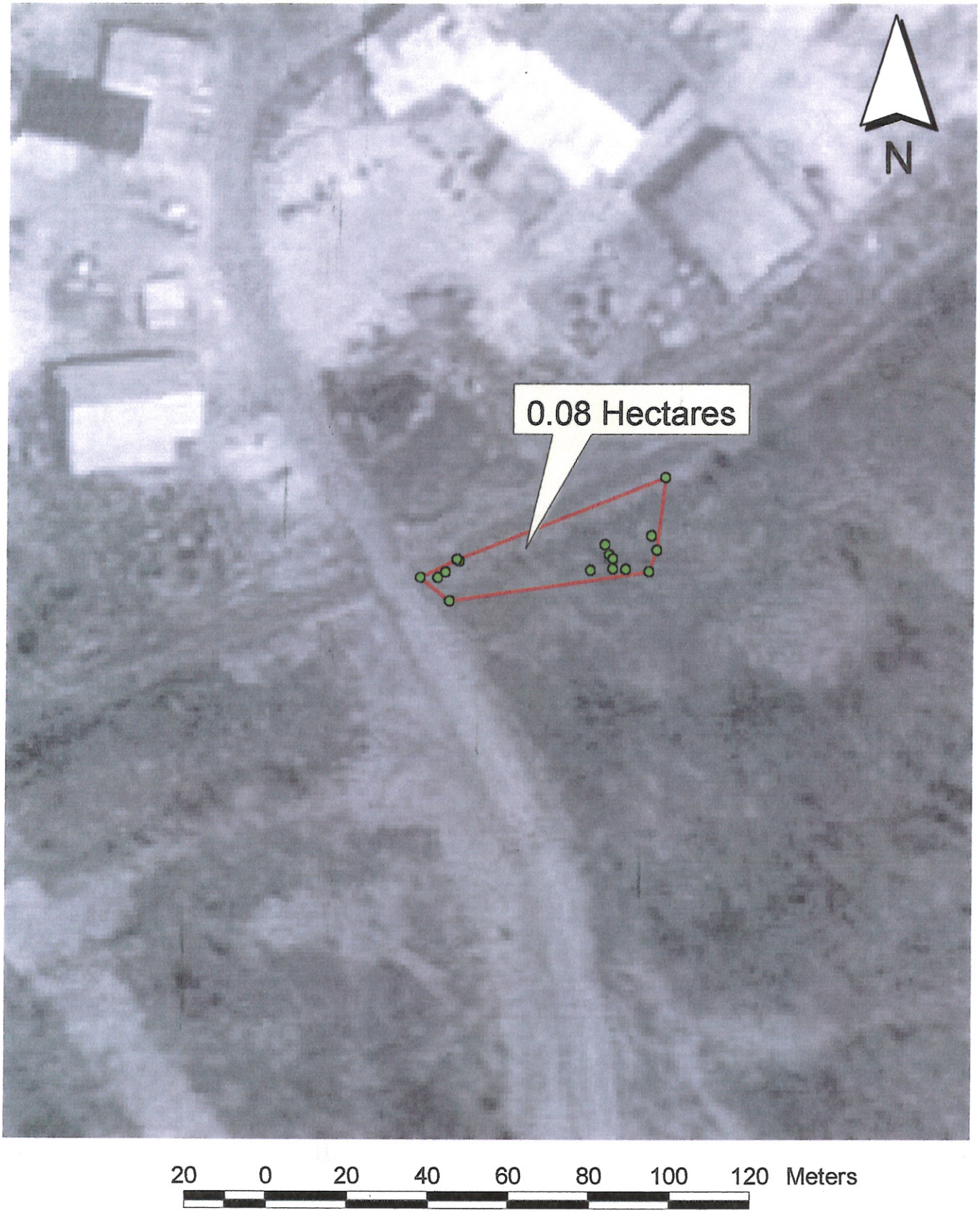
Hibernaculum Location

Minimum Convex Polygon

Herpetological Associates, Inc. 2002

Map 17

Turtle No. T9.10: Movements and Minimum Convex Polygon Home Range



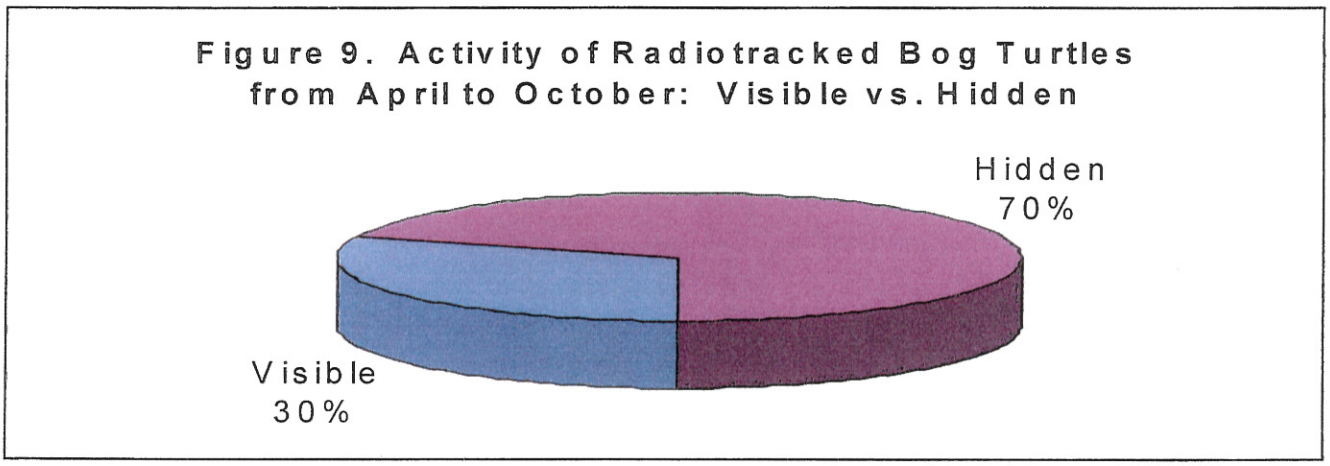
Turtle No. T9.10
Minimum Convex Polygon

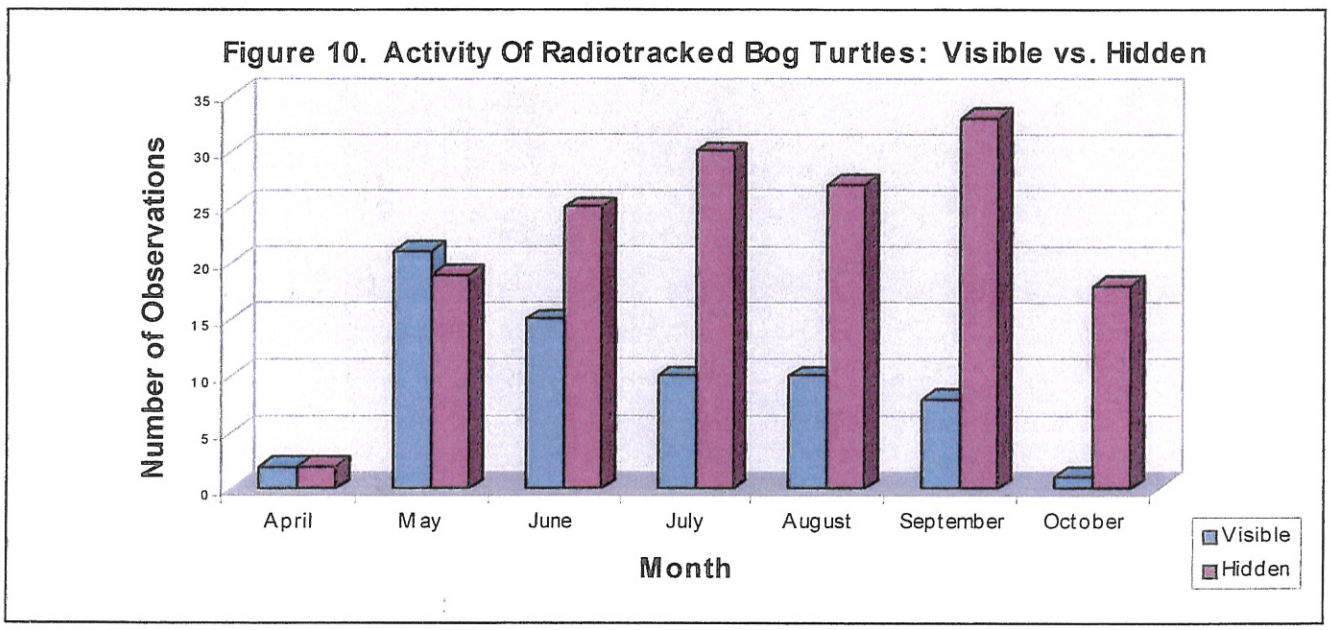
BOG TURTLE BEHAVIOR

The data collected, via radiotelemetry, shows a marked shift in the visibility (exposed on the surface) of bog turtles over the course of the season (**Figure 9**). In April, there were 4 relocations of bog turtles via radiotracking; the turtle was visible at 2 out of the 4. May was the only month where turtles were visible more often than hidden (visible = 21, hidden = 19). This may be due to milder temperatures and possibly a higher frequency of basking. June (visible = 15), July, August, September, and October showed a decrease in the visibility of turtles and an increase in the number of observations where turtles were hidden (**Figure 10**). The various situations that bog turtles were hidden in during this period include: walking under vegetation, under vegetation, in mud, under water, in tunnel, under bank, and in hibernaculum. These behaviors are well documented for bog turtles from random searching methods, however, radiotelemetry removes a significant amount of bias associated with bog turtle observation. This allows researchers to locate turtles with almost predictable regularity.

HIBERNATION

Fall ingress, at the [redacted] Fen Complex, was found to begin approximately September 27 with some turtles entering hibernation as late as October 12.





MANAGEMENT RECOMMENDATIONS

[redacted] FEN

The [redacted] Fen is ranked a 5, and the [redacted], which abuts the [redacted] Fen, is ranked a 3 on HA's standardized habitat ranking system. The main reason for the different ratings is that a considerable portion of the [redacted] bog turtle habitat has been negatively impacted by the encroachment of *Phragmites* and purple loosestrife (**Figure 11**). In addition, woody shrubs and trees are spreading, further reducing available habitat. Given that this is the largest known population of bog turtles in [redacted], a comprehensive habitat management plan needs to be developed and implemented to improve the existing habitat by controlling the encroachment of invasive plants and natural succession of shrubs and hardwoods.

Figure 11. Photo taken in the eastern portion of [redacted] Fen showing the invasion of purple loosestrife. Photo: Raymond Farrell, Herpetological Associates, Inc. 2001.

In the past TNC has cut and removed *Phragmites* from the fen during the winter months. This method has proved to be somewhat successful in controlling the growth of this persistent invasive species. HA strongly recommends that this continues. The effort should be expanded to include the removal of purple loosestrife throughout the fen and into the [redacted] wetland. In order for this approach to accomplish its objective, it will be necessary to cut and remove these species again during May when new growth begins (before June when the bog turtles nest). Although this approach is labor intensive, if done every year, it will retard the expansion of these invasive plants.

Another approach is to have controlled burns during the winter followed by the removal of the invasive plants during May. However, the ideal approach is the use of hoofed animals, such as goats, during the spring and summer months coupled with the winter removal of invasive plants and shrubs. Goats will eat all of the vegetative species that have become a concern, as well as the young shrubs that are also expanding into the fen and the surrounding wetland. In addition, the girdling of many of the trees that are encroaching on the fen would be beneficial.

All of these recommendations will require both financial and labor resources. The use of hoofed animals along with winter removal of invasive plants and the girdling of trees, where necessary, would be the most cost effective approach over time. Within three to five years, the use of hoofed animals would all but eliminate the need for winter removal of plants and shrubs.

[redacted] FEN

The conditions in the fen during 2001 were much wetter than in 1995 and 1996, and the site was more representative of typical bog turtle habitat. In 1995 and 1996 HA had given this site a rating of 3 (Marginal) primarily because of the dry conditions in the fen. Since that time TNC has been managing this area by removing invasive plants and monitoring the hydrology in the fen. The only suggestion that we feel might improve the fen for bog turtles would be to cut and remove some of the woody shrubs shading out the habitat in the upper area of the southeast end of the fen on a biennial basis. Four of the five bog turtles that HA radiotracked in 2001spent several weeks in the rivulets and tunnels under the woody shrubs adjacent to the open fen. Three of the turtles are also hibernating in the tunnels under the shrubs in this area. This area does not require any habitat management.

[redacted] FEN

This fen is being lost to the expansion of *Phragmites* and to the natural succession of shrubs and hardwoods in the wetland. This site is in need of long term habitat management. An aggressive program needs to be put in place to eradicate *Phragmites* and address the shrub and hardwood succession. There are a number of ways to approach this issue. The first approach, not the most ideal, is to manually cut and remove *Phragmites* during the growing season. This approach would have to be continued for up to five years to have any chance of reaching the desired effect. This approach is labor intensive and expensive. The second approach involves the use of chemicals to rid the habitat of *Phragmites*. This is also labor intensive and expensive and would have to be continued for up to five years to reach the desired effect. There is also some concern as to the long term, and often times cumulative, effects that the use of chemicals can have on the food chain. There is not much known about how these chemicals may affect bog turtles. The third approach is the use of hoofed animals such as cows, goats and sheep. Hoofed animals are currently being used as a management tool to control natural succession and invasive plants in New Jersey, Maryland, North Carolina, Pennsylvania, and Virginia.

The feedback to date, regarding the use of hoofed animals for habitat management, has been positive. HA strongly recommends that a program be implemented in [redacted] would be an excellent pilot site since we have baseline data from 1995 -2001. The cost would have to be determined to install the proper fencing and to purchase or rent the animals (goats are recommended). If this pilot project is started, HA would be happy to assist with the design and implementation of such a program.

[redacted] FEN

HA recommends that TNC continue to cut and remove the *Phragmites* in the spring, in July, and if necessary again in August to reduce the nutrients going into the root system. In addition some of the shrubs should be cut to keep the fen open. An alternative approach would be to utilize hoofed animals to control the growth of *Phragmites*, shrubs, and hardwoods.

[redacted] FEN

Although this site is atypical bog turtle habitat, bog turtles may use it as a corridor between the various wetlands within the [redacted] complex. Therefore, it would be beneficial to cut and remove any invasive plants and shrubs that shade the area. In addition any hardwoods that are starting to shade the area should be girdled.

[redacted] FEN

This site could use some management in the form of cutting the shrubs and girdling some of the hardwoods that are starting to shade the fen.

[redacted] MARSH

As was previously stated bog turtles were found at this site in the past, before the natural succession of hardwoods shaded the marsh. HA recommends the cutting and removal of nearly all of the shrubs and the girdling of several of the trees in this marsh. This would improve the habitat by providing additional basking opportunities which are essential to many aspects of bog turtle life history (thermoregulating, nesting, egg incubation, etc.).

It is HA's suggestion that a comprehensive plan be developed which would address all of the [redacted] wetlands including those that have not been covered in this report. This plan should address the need for an open migration corridor for the bog turtles between the wetlands, eradication of invasive plants, control of natural succession of shrubs and hardwoods and the protection of the overall habitat.

DISCUSSION

The [redacted] Fen Complex consists of several wetlands that contain bog turtle habitat. These fens are within one mile of each other and contain three known populations of bog turtles. There is a good chance that these populations interacted with each other before the [redacted] Railroad was built. Since that time, there appears to have been little opportunity for individual bog turtles to cross over the railroad tracks. This barrier has most likely prevented the [redacted] and the [redacted] Fen populations from interacting with each other. Although the railroad is the main barrier stopping this potential migration, the turtles must first cross [redacted] and the Jacoby Creek. The [redacted] Fen and [redacted] Fen populations may interact with each other over time, but turtles still have to cross a road that separates the wetland corridor. There is a 1700m straight line distance between the Taylor II Fen and the [redacted] Fen. This may seem like a long distance for a bog turtle to travel, but in southwestern Virginia, a marked male bog turtle traveled a straight line distance of 2700m from its previous capture location in one year (Carter et al., 2000). Therefore, it is conceivable that bog turtles could migrate between the two fens.

A total of 15 adult bog turtles (8 males and 7 females) were radiotracked at the three study sites for up to 25 weeks. The purpose of this study was to determine the movements of bog turtles within, and possibly between, wetland habitats. None of the radiotracked turtles moved out of their native wetland complexes. In general, the movements of the turtles were clustered in one or more areas of concentrated activity ranging from 5m to 25m in diameter. Several of the turtles had outlying locations (>25m and up to 140m from center of clustered locations) over the course of the season. Five of the turtles (33%) moved to other adjacent areas in or near the fens for up to several weeks. Three of the five turtles (one male and two females) moved to other areas within the wetland complex. Two of which were found outside the fen, 112-140 meters from their initial capture locations. The remaining two turtles (both females) migrated to wooded habitats at the edge of the wetlands 45-170 meters away from their initial capture location. All five turtles returned to their original wetland areas by early September.

It is interesting to note that four of the five turtles that moved to other wetland areas were adult females. Two of the them moved the furthest distance of any turtles. This observation differs from the results of other studies that reported male bog turtles as more active than females (Ernst, 1977; Chase et al., 1989; Lovich et al., 1992). Longer and more frequent movements by male turtles have been observed in freshwater species (Morreale et al., 1984; Gibbons et al., 1983; Tubervilie et al., 1996) and terrestrial species (Rose and Judd., 1975). HA observed female turtles moving longer distances than males at [redacted] and [redacted] Fens. The maximum distance moved over the study period, for the 10 turtles that remained within their wetland, averaged 70 meters and ranged from 20-140 meters.

There are several aspects of bog turtle behavior that become apparent to the observer through radiotracking. Many of these aspects would remain unknown to researchers without the ability to locate turtles predictably, regardless of their behavior. One of these aspects is the seasonal shift in fossorial/secretive behavior. In the spring (April and May), bog turtles are often found basking or moving above ground and exposed. However, bog turtles are extremely difficult to find as the season progresses for several reasons. The growth of vegetation, throughout spring and the rest of the season, undoubtedly makes turtles harder to find. A second factor affecting the ability of finding bog turtles is the oppressive heat which drives many reptiles and amphibians to seek shelter underground in July and August. Radiotracking has been instrumental in answering questions about how bog turtle behavior changes over the course of the season.

Some of the monitored turtles moved into areas that would be considered upland or transitional habitat compared to the typical bog/fen habitat that has been reported in the literature. Some of these areas were characterized by dry substrate and transitional vegetative species. These turtles were often found completely concealed. These movements illustrate the importance of looking at surrounding areas when evaluating bog turtle habitat. The use of upland habitats by bog turtles is of interest because it demonstrates the need for the protection of varying habitat types outside the typical bog/fen. Bog turtles, often considered an aquatic or semi-aquatic species, use a considerable amount of the available habitat found within their home range, including transitional and upland habitat types. The use of these areas

could be as temporary as a migratory corridor or as long term as a foraging area that is used for several weeks or more.

Turtle BS3.12 crossed over an old railroad bed while turtle BS8.3 crossed [redacted] to reach other wetland areas. Turtle BS3.12 (male) crossed over the old railroad right-of-way, located at the northern edge of the fen at [redacted], that is used as an access road by the mining operation. He then moved into an area thick with *Phragmites* and stayed there from May 31 to August 23 (Map X). This area was not used as a movement corridor, but possibly as a foraging area. This turtle may have stayed in this area for several reasons. This area may have been part of this turtles historic home range and may have been more suitable for bog turtles in the past. This area may have been used by turtles before the railroad was built and may still be used by a few turtles since it is within their home range. During mid-summer, there may be little or no need for basking due to warm ambient temperatures. Turtle BS3.12 may have stayed in this shaded, *Phragmites* choked area due to foraging success coupled with shelter from the hot sun. Turtle BS8.3 (female) crossed over [redacted] to reach an area of suitable habitat on the other side (Map X). This was an interesting observation because it shows that fast flowing streams do not act as barriers to the bog turtles. There have been other reports of streams being crossed by bog turtles (Dennis Herman Pers. Comm.). Bog turtles may be able to cross streams like this by walking along the substrate on the streambed. BS8.3 was found to have crossed to the other side of [redacted] 3 times during the season (a total of 6 one-way crossings). Another turtle (T9.10) used a dry area (approx. 1m from [redacted]) for an extended period of time (Map X). This data may indicate that bog turtles use upland habitat more often than was previously thought.

HA observed bog turtles mating in the fall of 2001. This is noteworthy because bog turtles typically mate in the spring. Although others have reported bog turtle mating in the fall, HA has never observed this in Pennsylvania. HA has also observed atypical nest site selection in Pennsylvania in 2001. Many of the nest that were found were located extremely close to the wet surface of the bog/fen.

The short, one season duration of this project may limit HA's ability to draw general conclusions about this data. HA's findings are preliminary and further radiotracking is necessary in order to determine all of the habitat that bog turtles are using in [redacted] Radiotracking efforts should be expanded to include any new bog turtle locations in the [redacted] Fen complex along with the already known and studied sites. HA strongly recommends that radiotracking continue for the next two years in order to have body of data that can provide some real insights into bog turtle habitat selection and home range in the [redacted] Fen Complex.

SUMMARY

Herpetogical Associates, Inc. conducted habitat evaluations, mark-recapture studies, and nesting searches during 1995, 1996 and 2001 at 3 fens in the [redacted] Fen Complex. The scope of the project was expanded in 2001 to include a baseline telemetry study. HA started field work in April and the first bog turtle was fitted with a transmitter on April 22. Eight turtles were fitted with transmitters from [redacted] (4 females and 4 males), five from [redacted] (2 females and 3 males), and two from [redacted] (1 female and 1 male). Turtle movements were monitored from the date the transmitters were attached through the middle of November when all activity had ceased and the turtles went into hibernation.

A total of 66 bog turtles were captured at the [redacted] Fens in 2001 (26 new turtles and 40 recaptures). [redacted] Fen accounted for 50 of these captures. The Schumacher-Eschmeyer population estimate was used to calculate population size based on these captures and recaptures. The population estimate is 50 turtles (excluding hatchlings), with a 95% confidence interval of 32-113 turtles. This was an increase of 100% over the 1995-1996 estimate of 25 turtles (95% confidence interval of 30-69). Five bog turtle were captured at [redacted] while 11 turtles were found at [redacted]. Population estimates were not determined at [redacted] Fen or [redacted] Fen because of the inadequate number of turtle captures and recaptures at these sites. The low number of captured turtles at [redacted] is due in part to the spread of invasive plants which have taken over 60% of the bog turtle habitat. It is HA's opinion that the bog turtles formally found at this site have dispersed outward into the [redacted] wetland complex in search of other areas of

suitable habitat. Although 5 bog turtles were captured at the [redacted] Fen, it is quite possible that there are more turtles in the southeast end of the fen within the shrub wetland. Four of the radiotracked bog turtles spent several weeks in the shrub wetland and three are hibernating there.

Three bog turtle nests were located within the study areas. One nest in each of the three fens. The three nests contained a total of 8 eggs. The nest at [redacted], containing four eggs, was predated in July. The nest at [redacted] containing three eggs, was predated after two of the eggs were lost due to an excessive amount of moisture in the nest. The third nest, containing one egg, did not hatch because it was infertile or the embryo died in the egg prior to development.

The habitat ranking for each of the three fens containing bog turtles are: [redacted] (5: Ideal), [redacted] (4: Typical) and [redacted] (3: Marginal). The [redacted] Fen Complex contains highly suitable habitat for bog turtles. However, many of the fens are being degraded by invasive plants and natural succession of shrubs and hardwood trees. In order to ensure that the habitat continues to support bog turtles, it is recommended that a long-term management and monitoring program be developed and implemented to help better manage these sites. The information that has been gained from this study will aid in the creation of an effective management plan for the bog turtle in the [redacted] Fen Complex. Long-term monitoring, including radiotracking, should be continued and expanded at these sites in order to gain as much information as possible about the bog turtles of the [redacted] Fen Complex.

Respectfully Submitted,
HERPETOLOGICAL ASSOCIATES, INC.

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In addition to the literature cited, this list includes other publications concerned specifically with the bog turtle (Clemmys muhlenbergii) or with amphibians and reptiles in general. Those who wish to learn more about bog turtles in Pennsylvania, New Jersey, or throughout the eastern United States may find these publications or papers of interest.

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Appendices

Appendix 1

CONVERSION LEGEND
FOR NUMBERS ON DATA SHEET

Spec
1 = Bog
2 = Spotted
3 = Wood

DNA
1 = Yes
2 = No

Sex
1 = Male
2 = Female
3 = Undetermined

Gravid
1 = Yes
2 = No
3 = N/A

Age Category
1 = Adult [12yrs+] >70mm PL
2 = SubAdult[8-11yrs] >50-69.9mm PL
3 = Juvenile[2-7yrs] <49.9mm PL
4 = Yearling[Second season]
5 = Hatchling[First season]

Weather
1 = Sunny [cloud cover 0-20%]
2 = Partly Cloud [21-50%]
3 = Mostly Cloudy [51-95%]
4 = Overcast [96-100%]
5 = Fog
6 = Mist
7 = Drizzle
8 = Rain
9 = Other

Activity
1 = Basking/Sitting
2 = Feeding
3 = Fighting
4 = Hibernating
5 = Inactive
6 = Mating
7 = Nesting
8 = Swimming
9 = Walking
10 = Hidden in Tunnel
11 = Hidden under Mud
12 = Hidden under Veg
13 = Hidden under Water
14 = Other

Substrate
1 = Soil
2 = Vegatation
3 = Water

Exposure
1 = Exposed
2 = Partially Concealed
3 = Totally Concealed

Capture Techniques
1 = Visual
2 = Muddling
3 = Probing
4 = Audible
5 = Radio Telemetry

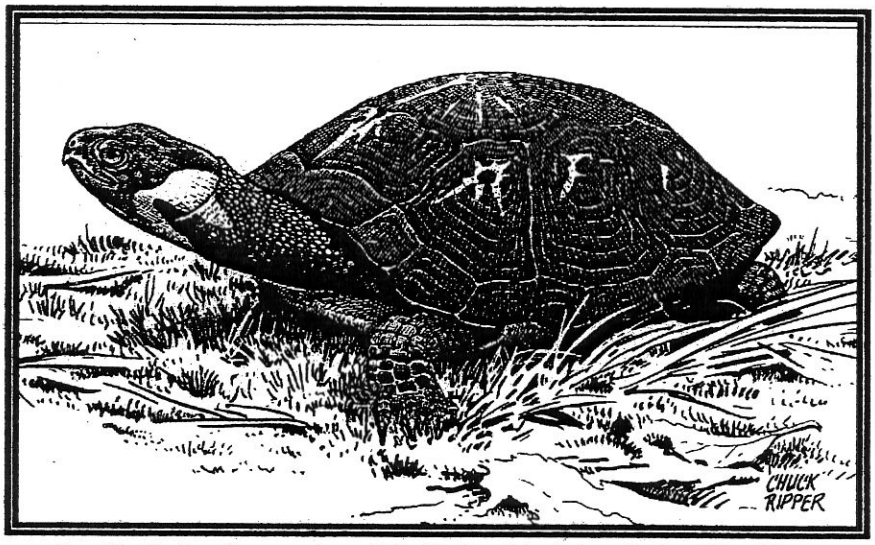
Soil
1 = Dry Mud
2 = Gravel
3 = Mud
4 = Rock
5 = Upland
6 = Other

Vegetation
1 = Cattail
2 = Small Grass Hummocks
3 = Hummocky
(1,2,4,5,6,9,10,11)
4 = Moss
5 = Phragmites
6 = Purple Lossestrife
7 = Reed/Canary Grass
8 = Rush
9 = Grass/Sedge Tussock
10 = Skunk Cabbage
11 = Woody Shrub
12 = Hardwood
13 = Other

Water
1 = Creek
2 = Footprint/Puddle
3 = Pond
4 = Pool
5 = Rivulet
6 = Seep
7 = Stream
8 = Wet
9 = Flooded
10 = None
11 = Other

Macro-Habitat
1 = Cattail [wet]
2 = Cattail [flooded]
3 = Herbaceous Emergents
4 = Phragmites [wet]
5 = Phragmites [flooded]
6 = Purple Loosestrife [wet]
7 = Purple Loosestrife [flodded]
8 = Reed [wet]
9 = Reed [flooded]
10 = Grass/Sedge Tussock [wet]
11 = Grass/Sedge Tussock [flooded]
12 = Sweetflag
13 = Shrub Wetland
14 = Shrub/Wooded Upland
15 = Shrub/Wooded Wetland
16 = Fen
17 = Various Wetland Plants
18 = Swamp Forrest [heavy canopy]
19 = Other

Bog Turtle Habitat Studies



Bog Turtle drawing courtesy of the National Audubon Society, New York.

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