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Progress Report on 2002 Field Season and Hatching Success of the Bog Turtle in the [redacted] and [redacted] Drainage Basins, Monroe County, Pennsylvania

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to

The Nature Conservancy
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by

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

Herpetological Associates, Inc (HA) was commissioned by The Nature Conservancy (TNC) to perform a two year bog turtle (*Clemmys muhlenbergii)* presence or absence, and mark and recapture study in the [redacted] drainage basins in Monroe County, Pennsylvania. HA has previously conducted intensive bog turtle studies in the [redacted] drainage basin from 1999 through 2001. This marks the first year HA has conducted a bog turtle study in the [redacted] Creek drainage basin. This project includes research of various bog turtle colonies in the two drainage basins to determine the viability of these populations, and also, surveying potential habitats in new areas in an attempt to document previously unrecorded bog turtle. GPS coordinates of wetland boundaries and nest site locations have been recorded on all confirmed bog turtle sites (**Appendix 1**). Recommendations for habitat management, restoration, predator control, population health, and long term viability will be included in the final report. TNC biologists assisted in locating potential habitat, and securing permission from landowners to enter upon private property. This project was encouraged by the United States Fish and Wildlife Service (USFWS) and the Pennsylvania Fish and Boat Commission (PFBC). These agencies also provided HA with the endangered species scientific collecting permits necessary to conduct this study.

HA's contract was amended on July 31, 2002 to include the installation of 10 predator exclusion devices on bog turtle nests (up to nine in [redacted] and one in [redacted]). This progress report is a combination of the field results of 2002, and hatching success inventories of a two year bog turtle research study, contracted by TNC in the [redacted] drainage basins.

STUDY SITES

HA visited twenty seven sites (23 within [redacted] basin and 4 within [redacted] basin) that were identified by TNC as potential bog turtle habitat. TNC secured permission from landowners for HA staff to enter all properties. The properties that HA surveyed in [redacted] in 2002 were: [redacted]. The properties in the [redacted] Creek that HA surveyed in 2002 were [redacted]. All of the sites surveyed are in Monroe County, Pennsylvania. HA's visits to previously studied areas include a continuation of the ongoing mark-recapture studies as well as intensive searches for bog turtle nests.

DATA COLLECTED ON BOG TURTLES

Upon initial capture, turtles were assigned field numbers and were marked by filing code notches in their marginal scutes (Ernst et al 1974). Data collected on newly captured, and recaptured turtles included cloacal temperature, sexing, weighing, palpating adult females to determine the presence of eggs, appropriate measurements of carapace, and plastron length, and width, along with shell height, aging (number of growth annuli on the shell or abdominal scutes), activity, and noting any visual injuries or abnormalities. Notes were also taken on the macrohabitat and microhabitat characteristics of the capture site, including relative humidity and temperatures at the time of capture (**Appendix 2**).

POPULATION SIZE ESTIMATION

In order to gain applicable information about population trends, and relative abundance of individual populations of bog turtles, an estimation of population size is calculated by using the number of individual turtles captured along with the number of recaptures, excluding current years hatchlings. The methods and formula 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.

The formula used is as follows:

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

Where:

$\hat{N}$ = 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 tth sample is taken
S = Total number of samples

NESTING STUDY METHODS

Bog turtles characteristically nest in the base of *Carex* sedge tussocks or other small vegetated hummocks. The female turtles camouflages the eggs by covering them with vegetative material and humus (Zappalorti 1976; Zappalorti et. al. 1995). 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. Great care was taken to avoid damaging potential bog turtle nesting sites that may contain a clutch of eggs. Each nest that was discovered was flagged with surveyor's tape for monitoring purposes, and to alert researches of the nest locations thus avoiding it. The information recorded on the nests included clutch size, condition of eggs, the nest's location, dimensions, surrounding vegetation, the nest chamber's height above water, and the distance of the nest chamber's bottom above water.

RESULTS OF INVESTIGATION

HA staff spent a total of 126 person-days surveying sites in the [redacted] drainage basins, from April through August (**Table 1**) in 2002. It should be noted that these were 6 to 12 hour days with 2 to 6 consultants (where 3 or more consultants were used, duties among consultants were divided at different sections of the wetlands in ensure we met the USFWS guideline of not exceeding three persons at any one area of a wetland) (**Appendix 3**). The initial habitat evaluations at new sites were conducted in late April and early May.

Table 1. Total Person-Days Spent in [redacted] 2002

Month	Actual Person-Days	Contracted Person-Days	Variance
April	16	9	+7
May	49	36	+13
June	32	36	-4
July	21	8	+13
August	10	8	+2
September*	2	8	-6
Total	**130**	**105**	**+25**

**Tasks scheduled for September were completed in July and August.*

HA staff confirmed the presence of bog turtles at eight of the nineteen new sites surveyed in 2002 (**Table 2**). A total of 142 bog turtles captures have been made during surveys in 2002 at the [redacted] drainage basins. Of the 142 bog turtle captures, 82 were initial captures and 60 were recaptures.

A total of 256 bog turtles have been captured from 1999 through 2002 (**Table 3**) in [redacted] drainage basins, with 171 being initial captures and 88 being recaptures (**Appendix 4**). The population structure (**Table 4**) of the 171 initial turtles consists of 71 males, 82 females, 15 juveniles (undetermined sex) and 3 yearlings (last years hatchlings). A large number of marked bog turtles, 113 in total, were captured at the [redacted] sites, with many turtle being either sub-adults, juveniles or yearling turtles, indicating recruitment at these two sites. The [redacted] sites also had a number of juveniles and yearling bog turtles exhibiting signs of recruitment.

POPULATION SIZE ESTIMATION

Due to a small recapture rate of marked turtles, HA was not able to calculate an overall population size estimate at all confirmed sites in [redacted] However, HA was able to calculate the population size estimate for [redacted] Marsh and [redacted] Fen due to the large number of captures and recaptures from 1999

to 2002, especially during the 2001 and 2002 field season (**Table 5**). Calculations for population size estimates can only be done in those areas surveyed intensively enough to find an abundant amount of recaptured turtles. In order to recapture a large number of bog turtles, HA conducted intensive follow-up surveys at the [redacted] and [redacted] wetlands in the [redacted] drainage basin in the 2001 and 2002 field season.

Table 5. Population Estimate and Confidence Interval*

Property/Site Name	Year(s)	Number of Turtles marked	Population Estimate	95% Confidence Interval
[redacted]	2001	26	50	47-185
[redacted]	1999-2001	39	70	42-215
[redacted]	2002	11	39	25-86
[redacted]	1999-2002	50	66	55-82
[redacted]	2001	12	54	35-117
[redacted]	2000-2001	39	73	49-142
[redacted]	20002	23	97	58-281
[redacted]	2000-2002	62	110	83-162

**Note: 2002 Bog Turtle hatchlings are not reflected in these numbers.*

Frequency of Bog Turtle Captures

Data collected on the 142 bog turtles captured was recorded systematically at hourly intervals through the field months (**Table 6**). A large percentage (88%) of the turtles captured were caught during the month of May (52%), and June (36%). Throughout the field study 77% of the turtles observed were found to be more active between the hours of 1000h and 1600h, with no tendency to shift time of activity to evade the increase in summer temperatures.

Nesting Survey

HA concentrated on bog turtle nest searches during the months of June and July at all sites with confirmed bog turtle populations, with emphasis placed on [redacted] Marsh and [redacted] Fen, where the population of bog turtles is more abundant. This was done in an effort to maximize the amount of potential nests that could be located and monitored. There were twelve bog turtle nests located. Four of the nests were predated prior to placing predator excluder devices around them. An additional nest was lost due to the heat which caused the eggs to dehydrate. The seven remaining nests, were enclosed with the predator excluder devices to protect them from mammal predation. A total of 22 eggs successfully hatched. One of the nests containing 5 eggs turned out to be spotted turtles. Refer to (**Table 7**) for individual nest and hatchling

information.

Table 6. Frequency of capture by month and hour for *Clemmys muhlenbergii* in 2002					
Time	**Month**				
	April	**May**	**June**	**July**	**Total (%)**
700	0	0	1	0	1 (1%)
800	0	0	4	0	4 (3%)
900	0	1	5	1	7 (5%)
1000	0	6	7	1	14 (10%)
1100	1	13	3	1	18 (13%)
1200	0	17	7	1	25 (18%)
1300	3	14	4	2	23 (16%)
1400	2	9	4	0	15 (10%)
1500	3	7	5	0	15 (10%)
1600	2	6	5	0	13 (9%)
1700	0	1	1	0	2 (1%)
1800	0	0	4	0	4 (3%)
1900	0	0	1	0	1 (1%)
Total (%)	**11 (8%)**	**74 (52%)**	**51 (36%)**	**6 (4%)**	**142**

ABUNDANCE OF *CLEMMYS* SPECIES

While conducting the bog turtle surveys in the [redacted] drainage basins, the number of spotted turtles (*Clemmys guttata*) and wood turtles (*Clemmys insculpta*),that were found were recorded. A total of 142 bog turtles, 51 spotted turtles and 94 wood turtles were found in the 2002 field season (**Table 8**). The number of spotted and wood turtles recorded is not an accurate representation of their population size because these turtles were randomly found.

Table 7. Individual Nest Data by Site						
Property/Site Name	**Nest#**	**Clutch Size**	**Height from Surface to Top of Nest (cm)**	**Height from Surface to Bottom (cm)**	**Number of Eggs Hatched**	**Description of Unhatched Eggs**
[redacted]	1	3	6.8	2.0	3	All Hatched
[redacted]	1	4	1.8	1	4	All Hatched
[redacted]	1	3	10.8	6.2	1	2-Died while hatching
[redacted]	2	4	1.4	1.0	0	4-Dehydrated due to day heat
[redacted]	1	5	12.5	5.3	3	1-Not Viable 1-Embryo died
[redacted]	1	5	7.0	2.0	5	Spotted Turtles
[redacted]	2	3	6.6	6.0	0	3-Predated*
[redacted]	3	4	7.3	2.0	0	4-Predated*
[redacted]	4	4	11.5	3.0	0	4-Predated*
[redacted]	5	5	2.0	0.6	3	2-Not Viable
[redacted]	6	4	1.3	0.7	2	2-Not Viable
[redacted]	1	4	6.2	1.2	0	4-Predated*
Total	**12**	**48**	**Avg. 6.3**	**Avg. 2.6**	**21**	**27**

**Eggs were predated before the implementation of the predator excluder devices.*

VEGETATIVE ANALYSIS

In an effort to classify the wetland habitats of the confirmed bog turtle sites in the [redacted] watersheds, HA is compiling an inventory of the vegetation present at each site. This preliminary investigation provides a general representation of the plant community and stage of succession present at each bog turtle study site (**Appendix 5**). Preliminary findings suggest that some management is required to control the encroachment of woody and invasive species at some of the study sites.

Each bog turtle study site was visited once on August 7 or August 8, 2002. The extent of the known areas of habitat being utilized by bog turtles was visually examined to identify and determine the abundance of vegetation present at each study site. Vegetation within each site was identified to genera and species using several field guides (Cobb 1984; Harlow 1946; Graves 1992; Knobel 1980; Magee 1981; Newcomb 1971).

Plants are identified to genus, where more than one species of the same genera occur or if a particular plant species is undetermined. Focus was placed on the herbaceous and dominant vegetation present at each study site. The woody vegetation in this preliminary list include dominant and common woody plant species within each site. The top five dominant plant species were distinguished from the other vegetation present. The transitional zone between wetland and upland was disregarded at this time, but will be included in the final analysis. Additional site visits will be made at varying times within the growing season in 2003 to cumulate a more complete and accurate list. These preliminary observations are subject to change with the successive site visits.

SUMMARY

Herpetological Associates, Inc. conducted habitat evaluations, presence or absence surveys, mark-recaptures studies, and searching and monitoring of nests during 1999 through 2002, at 27 sites (23 in [redacted] and 4 in the [redacted] drainage basins). HA confirmed the presence of bog turtles at 16 of these sites (14 in [redacted] and 2 in [redacted] drainage basins).

A total of 256 bog turtles (242 in [redacted] and 14 in [redacted] drainage basins) have been found from 1999 to the present, excluding this years hatchlings. Of the 256 bog turtles found, 170 were new turtles, and 86 were recaptures.

The [redacted] drainage basin contains highly suitable bog turtle habitat, with a total of 14 confirmed sites located along an eight mile section of the drainage basin. Twelve of these sites are located within five miles of each other, with the remaining two sites located northeast along the basin. In [redacted], 161 turtles have been marked, forming a population structure of 69 adult females, 5 sub-adult females, 66 adult males, 5 sub-adult males, 12 juveniles, and 4 yearlings. This recruitment suggests that there is a healthy and viable population of bog turtles along the [redacted] drainage basin.

It appears that gene flow exists between the metapopulation in the [redacted] drainage basin. The existing habitat condition helps to maintain the genetic variability between and within the bog turtle sites. This metapopulation is a stronghold for the bog turtle in Pennsylvania, and represents the possible long-term survival of the bog turtle in the Northeast.

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LITERATURE CITED AND OTHER REFERENCES

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.

Cobb, Boughton. 1984. A Field Guide to Ferns and their Related Families. The Peterson Field Guide Series. Houghton Mifflin Company, Boston and New York.

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