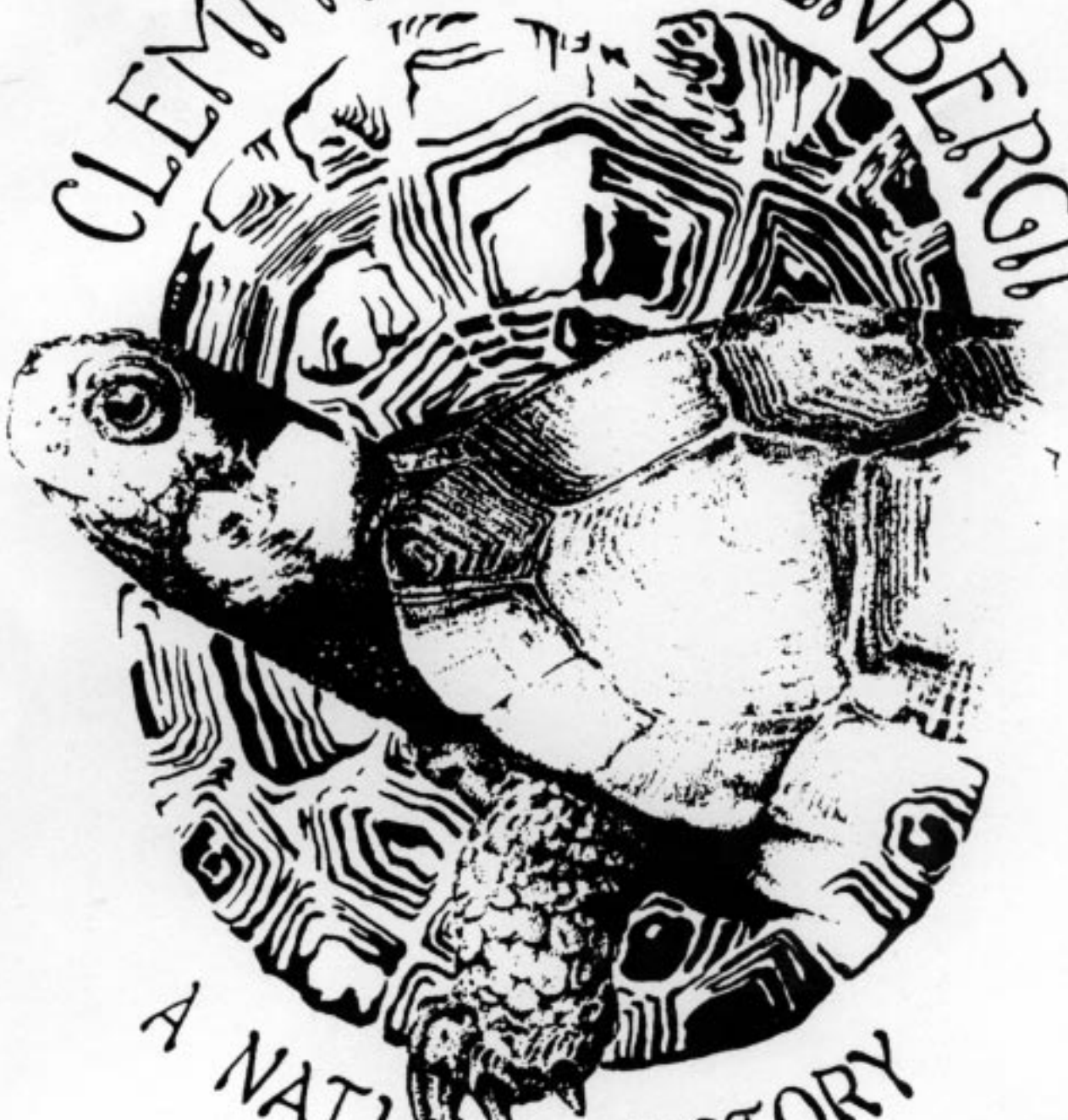
CLEMMYS MUHLENBERGII



A NATURAL HISTORY

by Tom J Bloomer

Fourth Revised Edition
2004

Booklet Project Managed by Diane Emily Krown
Front Cover Illustration by Michael J Holub
Art Direction, Layout, Editing and Manuscript Preparation by
James Williams, Debra A Schmidt and the Natural History Booklets Project Volunteers
Gainesville and Switzerland, Florida USA
For Additional Copies Of This Or Other Booklets In The Natural History Series: (888) 510 - 6226

Printed and Distributed
by
LongWing Press and
Turtlenest In The Park
c/o Gainesville, Florida 32614-0935
United States of America

Fourth Revised Edition - 2,500 copies - Printed August 9, 2004

Introduction

The original version of this revised natural history of the Bog Turtle (Glyptemys muhlenbergii), that you are about to read, was published by the New York Herpetological Society in 1977. At that time, it was considered by many to be one of the more important papers to be written about the species.

Much has changed for Glyptemys muhlenbergii, since that original natural history first appeared in print. Many former populations of this very rare turtle have become isolated, have seriously declined or have been eradicated. Land development, environmental deterioration, needless intentional and unintentional encounter killing and illegal collecting for the pet trade and for private collections have reduced Bog Turtle numbers by more than eighty percent since the late 1970s. The result is that Glyptemys muhlenbergii is now endangered and legally protected wherever Bog Turtles still occur. Today, the odds of being able to repeat this kind of study of wild and captive colony populations are extremely low, if not impossible, thus making this information more important than ever.

With that in mind, I was recently asked to review, condense and revise the original 1977 paper, and once again make it available to wildlife conservationists and other people involved with or concerned about the Bog Turtle. While many believe that Glyptemys muhlenbergii may become extinct in the wild during the next 25 years or so, perhaps having this information available will somehow, in some way help to prevent such a loss. One can only hope.

Tom J Bloomer
New York City
2 August 2004

This paper is dedicated to my parents, Arthur Jackson Bloomer and Lillie Wilson Bloomer, who taught and encouraged an appreciation for nature and respect for all life.

The Bog Turtle, Glyptemys muhlenbergii ... A Natural History

by Tom J Bloomer

Data resulting from studies conducted by
Tom J Bloomer from 1969 through January, 2002

Bog Turtle, Glyptemys muhlenbergii photographed during 1979 in Wantage Township (Sussex County) New Jersey.

RUTGERS · THE STATE UNIVERSITY

NEWARK, NEW JERSEY 07102

October 11, 1977

Mr. Tom J. Bloomer
Cross Creek Farms
Fenwick Road
Augusta, New Jersey 07822

Dear Tom :

We have received your manuscript titled " The Bog Turtle ... Natural History " and it will be published in the next issue of HERP which should come out in the end of November.

The correction concerning average clutch size has been made and the manuscript is currently being typed for offset reproduction.

I really enjoyed reading your report ; it is beautifully written and a fitting tribute to Rich Holub. It is nice to see that some of the things that I have observed with my radio transmitter animals are confirmed in your paper. I am also happy to see that you have made similar observations concerning hibernation sites of hatchlings.

I have some prints of Bog turtle nests and copulation in the field if you would like to include them in your article.

We will send you xerox copies of the galley proofs to read before publication. This way you can personally check for any typographical errors that we may miss.

Sorry that I missed the E.S.H.L. meeting. I heard that it was a great success !

Sincerely,

Keith Hawthorne

Keith A. Hawthorne
Co-editor , HERP
Bull. of N.Y.H.S. Inc.

cc: D. Hulmes

The Study

Introduction to the Bog Turtle as a species, first occurred during boyhood wanderings in Bergen County, New Jersey during the 1950s. Formal study of Glyptemys muhlenbergii, however, began in 1969 within Newark, New Jersey's northern Passaic County reservoir lands.

Field observations of wild Bog Turtle colonies continued until January, 2002 within portions of Connecticut, New York, New Jersey, Pennsylvania, Ohio, Delaware, Maryland, Virginia, North Carolina and Georgia.

Published literature, correspondence and discussions with other Bog Turtle enthusiasts and researchers, combined with observations of wild populations, were the main ingredients involved with the work completed on range, habitat and decline in populations.

General behavior, breeding, nesting data and growth rates resulted from work with wild populations and with captive breeding colonies maintained within outdoor natural habitat enclosures during the 1970s. At that time, marking turtles with codes in order to distinguish individuals and follow movement, monitor growth rates and the like, was the simple method used to avoid confusion when working with scores of specimens at any given time.

General background information about Glyptemys muhlenbergii, such as the discovery of the species, has been omitted in this paper in order to avoid redundancy, since so much has been written about the Bog Turtle in recent years.

Name/Common Names

Within scientific circles, the Bog Turtle is known as Glyptemys muhlenbergii, and belongs to a genus of turtles that includes Glyptemys insculpta, the Wood Turtle.

During the course of this study, the author recorded the following common names used for Glyptemys muhlenbergii: Bog turtle, Muhlenberg's turtle, Muhley, Mud turtle, Marsh turtle, Meadow turtle, Redhead, Yellowhead, Swamp turtle and Snapper.

Few people living within areas inhabited by the Bog Turtle knew anything about the species or about it's protected status.

Identification

This small, rare turtle is usually recognized in the field by it's conspicuous yellow, orange or red blotches, located on the temples of it's otherwise dark brown head. The carapace is normally dull brown to black, and either slightly sculptured in juveniles and young adults (somewhat resembling Glyptemys insculpta in miniature), or worn smooth in older adults, from years of burrowing.

Some specimens have distinct yellow, orange or rust colored markings radiating from the center of the carapace shields, while other specimens lack

these markings altogether.

The plastron is normally dark brown or black, with or without irregularly marked areas of yellow within the central area of the shell.

Yellow, orange or rust colored markings may be noticeable on the throat, legs and tail.

Abnormal Coloration/ Melanism

As is the case with Clemmys guttata, melanistic and abnormally colored specimens of Glyptemys muhlenbergii do rarely occur. Some of these turtles may be coal black with only the temple blotches being yellow, orange or red, or they may be coal black and even lack the familiar head blotches.

On occasion, a specimen is found with normal coloration, but without the temple blotches, the head and neck being either plain brown or brown with small rust colored lines and/or spots.

These oddities may occur from time to time within any colony of Bog Turtles, and may occur without regard for sex, age or colony location.

The author has no knowledge of any albino specimens of Glyptemys muhlenbergii having ever been found.

Size

Glyptemys muhlenbergii is small. The average adult length (straight line carapace measurement) recorded during this study was 94 mm for males and 89 mm for females. The average straight line carapace measurement recorded for hatchling Bog Turtles was 27.5 mm.

The largest male Glyptemys muhlenbergii recorded during this study, was measured during 1974 by the late Richard J Holub in Branchville, New Jersey. That male was 101 mm in length, straight line carapace measurement. The largest female was recorded by the author and had a straight line carapace measurement of 95 mm.

Growth

The rate of growth for Glyptemys muhlenbergii is relatively rapid. One example of that growth was a hatchling that measured 32 mm during August, 1975, and when measured the following April after hibernation, had a 40 mm straight line carapace measurement.

Another juvenile Bog Turtle, a captive male kept indoors during winters, grew from 45 mm to 85 mm (straight line carapace measurements) within a four year period.

Wild specimens normally reach a straight line carapace measurement of 70 mm to 75 mm by their fifth or sixth summer.

Age

Although the exact maximum age that Glyptemys muhlenbergii may live is unknown to the author, he speculates that it is probably around 40 years. The oldest specimen known to the author was a male Bog Turtle that lived 23 years, 7 months in captivity, having been captured as an adult.

Sex

The plastron of the male Bog Turtle is conspicuously concave, while that of the female is flat. Female Bog Turtle shells are noticeably wider and higher than those of the males. The tail of the mail is longer and thicker than that of the female, with the anal opening being beyond the edge of the carapace. The head of the male is larger and more squared in shape, than that of a female of equal size. However, there is very little or no sexual differences in hatchlings and very young juveniles.

In the wild, or in outdoor natural habitat enclosures within northern New Jersey, sexual maturity is reached by most males during their fourth or fifth year, and reached by most females during their fifth or sixth year. Sexually active males are almost never smaller than 65 mm, and sexually active females are almost always larger than 70 mm (straight line carapace measurements).

Records for this study, show a sex ratio in the wild that almost always has adult females outnumber adult males to one degree or another.

General Range

The known range of Glyptemys muhlenbergii is within an area bordered by southwestern Vermont, northern New York and northeastern Ohio in the north; western Massachusetts, the Connecticut River drainage system, Staten Island, New Jersey, Delaware, Maryland, Virginia, western North Carolina and northwestern South Carolina in the east; northern Georgia in the south; and eastern Tennessee, eastern Kentucky, southwestern Pennsylvania and northeastern Ohio in the west.

Within this range, Bog Turtle colonies may exist within mildly polluted or unpolluted wetland habitat bordering or flowing into the brooks and streams of the headwaters and tributaries of major waterways. Examples of this include, but are not limited to, the Connecticut, Hudson, Delaware, Hackensack and Raritan River drainage systems.

During 1977, when the original version of this revised natural history was first published, the author had included speculation that future field work would probably result in Glyptemys muhlenbergii populations being found in eastern Kentucky, northeastern Georgia and northwestern South Carolina. Later field research proved that prediction correct.

New Jersey Distribution

In the past, Glyptemys muhlenbergii has been recorded from almost every county within the State of New Jersey. However, due to land development, environmental pollution and deterioration, and the illegal collecting of specimens for the pet trade and for private collections, most former Bog Turtle colonies have been annihilated.

Small colonies (populations) are still found within the northwestern portion of the state, and within some of New Jersey's rural southern areas. Habitat destruction and illegal collecting continue, however, and may result in the statewide extirpation of the species.

Habitat

The Bog Turtle is normally associated with moist to wet meadows and bog lands having a number of slow moving, spring fed rivulets flowing through the area. Soft, black silt and mud is the ideal burrowing material with the conspicuous plant life being sphagnum moss, sedge grass, skunk cabbage and cattails.

Almost always the preferred habitat is open lands, sloping gently towards or within the drainage system of streams or rivers.

Very rarely, the Bog Turtle is found in areas that lack the usual plant life or burrowing material association, such as within the more rocky terrain parts of Bucks County, Pennsylvania or Passaic County, New Jersey. However, these populations are almost always remnant populations in a state of decline, either due to natural or man made alteration of their original habitat.

Habits

Much has been written over the years about the habits of Glyptemys muhlenbergii, which sometimes closely resemble those of Clemmys guttata and Glyptemys insculpta. In fact, these two species are often found inhabiting the same locales as the Bog Turtle.

Glyptemys muhlenbergii seems to exist, with regard to it's daily behavior, somewhere between the more aquatic Spotted Turtle and the more land roving Wood Turtle.

Both sexes are found during all daylight hours, when the air temperature is 60 degrees F or higher, with activity observed in sunshine, on cloudy days or during light rains. In fact, the only time that daylight activity may slow or stop altogether is on very hot days.

Early morning is normally the time when Bog Turtles emerge from their burrows or retreats for a period of basking that depends upon the season. Spring and fall basking periods usually last longer than midsummer basking periods.

Sufficiently warmed, Bog Turtles prowl for food among the bog land waterways until mid morning. During the hottest part of the day, the turtles become inactive and often retreat from the sun into their burrows, or by digging in around sedge grass clumps. Prowling usually resumes during late afternoon hours, and may continue into the early evening and sometimes even into darkness.

Many times during the 1970s, the late Richard J Holub observed Glyptemys muhlenbergii in the outdoor natural habitat enclosure in which he kept Bog Turtles, find and devour earthworms and strips of beef in the dark. Work with wild populations also revealed Bog Turtle activity as late as 11:00 PM, during mid summer.

During the months of activity in northern New Jersey (March through October), Glyptemys muhlenbergii keep to themselves, avoiding contact with others of their own species, except during breeding and sometimes during nesting.

During their usual, every day activities, both sexes wander the bog land waterways and rivulets. But while females tend to remain in the vicinities of their mouse like burrows and tunnels through and under sphagnum moss and other plant life, males are often prone to more distant wanderings.

Bog Turtle burrows and tunnels are used by both adult and juvenile turtles, but it is the adult females and juveniles that normally retreat to a particular favored burrow at the end of the day. It is not uncommon to find an adult female using the same burrow or network of tunnels for long periods of time, and sometimes from one year to another. Due to their sometimes long distance wanderings, however, male Bog Turtles often dig in at day's end wherever they find themselves in the bog. And, they are often found in many different areas of the bog, over the course of a season.

Female Glyptemys muhlenbergii removed from their tunnel system area will return to that area if released within the bog land, and released within a fifth of a mile from the point of capture. Males will return to their general area of capture if released within a quarter mile of there. This study showed that such return trips can be made by some individuals within a thirty hour time period. However, the author found (during 1976) that when specimens were released beyond the distances stated, or released beyond the boundary of the bog land habitat, those individuals became disoriented and rarely returned to their former haunts.

Glyptemys muhlenbergii is an aggressive species of turtle, when it comes to it's own kind. Large adults have been observed threatening and pushing aside smaller specimens, in order to take command of food or to control a burrow, network of tunnels or other small area of bog land. Adult females and juveniles give ground to larger females and males, and smaller specimens have been observed to react in fear and almost panic when approached by an aggressive or threatening individual.

Some adult males are quite aggressive, and will almost always threaten or even attack smaller males, when these are encountered. With neck extended and mouth opened or closed, these aggressive males crawl rapidly towards a discovered smaller male. When almost touching, the advancing male will partially

withdraw his head while lifting the back of his shell high by lifting his hind legs and lowering his front legs. If the smaller male retreats, the aggressive, larger male will continue to advance in a threatening manner, but will soon calm down and return to minding it's own business. On the other hand, if a threatened male refuses to retreat or also responds in an aggressive manner, both turtles will attack one another by pushing and biting. Such encounters rarely last longer than seconds or more than a few minutes before one of the turtles completely withdraws into it's shell or turns and flees. Winning males may pursue the fleeing male for a few feet, or momentarily bite at a withdrawn male, but then the contest is over. With very few exceptions, the attacking male usually is the winning male.

These male type aggressive encounters do not appear to be duplicated by adult female Bog Turtles. Adult female Glyptemys muhlenbergii do not resist nor aggressively respond to threatening adult male Bog Turtles, and aggressive encounters between adult females are usually restricted to a slight push, nip or single quick bite.

Adult male Bog Turtles encountering hatchling or juvenile Bog Turtles usually do not display threatening behavior, but may be aggressive nonetheless. Adult males have been observed investigating hatchlings and juveniles by crawling around and over the youngsters, nosing leg, tail and head areas. Sometimes these males will begin to savagely bite at these juveniles before rapidly losing interest in such activity. Rarely the attacks persist, but when they do, a juvenile or hatchling may be severely injured or killed.

Aggressive Bog Turtle behavior may increase with captive specimens that are closely confined with other Bog Turtles. When a juvenile or small adult Bog Turtle cannot retreat or flee from an aggressive attack, due to an enclosure, the killing of one specimen by another may take place.

In the wild, the burrow and/or the vicinity of the tunnel network may be defended against female Bog Turtles by an adult female Bog Turtle that has used the area for some time. These same females ignore juvenile Glyptemys muhlenbergii that may wander through their areas, and will avoid (except when interested in breeding) adult male Bog Turtles that happen by.

Adult males also defend a kind of territory, that territory being wherever the wandering male happens to be. As described previously, adult male Bog Turtles are often aggressive, and will threaten and/or attack other Bog Turtles on sight.

In the wild, both adult male and female Glyptemys muhlenbergii often react in fear at the approach of large specimens of other turtle species, such as Chelydra serpentina or Glyptemys insculpta. Adult Bog Turtles appear to recognize these two species as dangerous, and will retreat or crawl rapidly away if given the opportunity.

The approach of Wood Turtles and Snapping Turtles does not create the same fear reaction in hatchling and young juvenile Bog Turtles, but is a reaction that appears to become more acute with age.

In the wild, the approach of Clemmys guttata and Chrysemys picta does not cause a fear reaction in adult Bog Turtles, only an avoidance reaction if the approaching turtle is much bigger than the Bog Turtle. The approach of these

two species towards hatchling or juvenile Bog Turtles, causes the same reaction as when those juveniles are approached by other larger turtles.

Further investigation of Bog Turtle recognition of other turtles was made by the author during 1975. At that time, the author and the late Richard J Holub experimented by using an outdoor natural habitat enclosure housing one juvenile Bog Turtle, seven adult female Bog Turtles and two adult male Bog Turtles. An artificial pool, laden with black silt, due to turtles crawling in and out of the water, was used to determine if the Bog Turtles easily recognized other species of turtles, as well as their own kind. The Bog Turtles housed in this enclosure were very tame and accustomed to being handled during feeding time.

The author began by gently removing the Bog Turtles from the pool and placing them a distance away, out of sight of the pool. The turtles initially reacted by looking around for food, as previous handling usually meant feeding time. When the turtles realized that they were not going to be fed, they returned to the pool and immediately entered it. The author then gently removed all but one of the Bog Turtles from the pool, and again placed them a distance away and out of sight of the pool. Again, when the turtles realized that they were not going to be fed, they all returned to the pool. However, this time when they returned to the pool, they were able to clearly see the head and yellow temple markings of the Bog Turtle that had not been removed from the pool. All the returning Bog Turtles saw that Bog Turtle in the pool, but none hesitated before entering the water. Finally, the author gently removed all the Bog Turtles from the pool for the third time, and again gently placed them some distance away and out of sight of the pool. The author then placed a tame young adult Wood Turtle in the pool, and waited for the Bog Turtles to return. Within minutes, realizing that they were not going to be fed, the Bog Turtles began to return to the pool for the third time. However, this time, upon seeing the head of the young Wood Turtle above the surface of the pool's water, the Bog Turtles hesitated and would not enter the pool. It was only after the Wood Turtle submerged it's head, that a bold male Bog Turtle entered the pool. And it was only after that male Bog Turtle remained in the pool for a time, that the other Bog Turtles entered the water. Using a Spotted Turtle in a similar experiment with those Bog Turtles in that same enclosure, resulted in similar behavior by the Bog Turtles.

The author believes that in these experiments, the Glyptemys muhlenbergii recognized that both Glyptemys insculpta and Clemmys guttata were species different from their own, even when the Wood and Spotted Turtle were almost completely submerged and hidden from view. These and other experiments with wild and captive Bog Turtles, resulted in the author determining that Glyptemys muhlenbergii uses head blotches for visible recognition of it's own and other species of turtles at a distance, and combines sight with scent as a means of recognition when closer to other turtles.

It should be noted that Glyptemys muhlenbergii, like many other species of wildlife, does not always behave or function in captivity as it would in the wild. Normal territorial reactions of females and other behavior recorded during field research, sometimes becomes more acute or else is lost in captivity. For example,

in captivity, some males become so aggressive that they must be housed alone. On the other hand, other males, usually older individuals, become quite docile and will not react in a hostile manner, even towards others of their own sex. Abnormal behavior in captive specimens is not uncommon.

Hibernation

Glyptemys muhlenbergii hibernates in the deeper water areas of the bog land, usually under water buried in mud or in underwater retreats such as muskrat burrows. Turtles found during the winter months are normally under at least a foot of water, buried within six to eighteen inches of mud. Turtles in these hibernation areas are almost always older juveniles and adults. The deeper water hibernation areas of the bog lands are best described as the lower sections of the bog, where the bog land rivulets increase in flow and size before entering into larger waterways.

The winters of 1973 and 1974 found the author and the late Richard J Holub in the field, recording the hibernating status of wild and captive (confined in Holub's outdoor natural habitat enclosure) Glyptemys muhlenbergii. Observations and research concluded that hatchlings and young juveniles usually over wintered in the vicinity of nesting sites, and that some hatchlings even over wintered within the nest site, depending upon where that site was located. It was determined that immature Bog Turtles did not hibernate within the deeper water areas of bogs until they were at least 45-50 mm in size (straight line carapace measurement) and at least two to three years of age.

Entering hibernation for the winter normally occurs in October in northern New Jersey, but the beginning of hibernation depends upon weather. Bog Turtle activity was almost over in Sussex County, New Jersey by October 20, 1973. And, by October 29 of that year, no active Glyptemys muhlenbergii could be found by the author.

Again depending upon weather, Bog Turtles usually begin to emerge from hibernation during mid April in northern New Jersey. After many years of record keeping, the late Richard J Holub had recorded April 4, 1974, as the earliest date for Bog Turtles emerging from hibernation in Branchville, New Jersey.

Estivation

Estivation by Bog Turtles within dry habitat and during drought has been noted by other authors. However, during this study no estivating Glyptemys muhlenbergii were recorded by this author.

This author speculates, based upon his research, that Bog Turtles previously noted as being in a state of estivation by other authors, were turtles found within disturbed or deteriorating habitat, and that those turtles were behaving abnormally.

During the summers of 1976 and 1977 in northern New Jersey, unusually dry conditions forced some Bog Turtle populations to seek relief in the deeper water of the bog lands and/or seek relief by becoming almost subterranean in their behavior. Burrowing mole like just inches beneath the exposed mud bottom of rivulets, the turtles remained active within a network of tunnels filled with or partially filled with water. Turtles emerged from these tunnels periodically to feed above ground or to wander, only resuming less underground behavior when rains once again caused the rivulets to fill with water. Such activity allowed the Bog Turtles to adapt to dry situations, but was not unusual considering their normal burrowing behavior.

During one extremely dry period, the author noted that the Bog Turtles within one bog had even abandoned their usual tunnel systems and foraging behavior, in order to congregate in the only remaining wet area. Again, however, since no bog land under study became completely dry, the possibility of observing estivation under natural conditions was never realized.

Deterioration or destruction of Bog Turtle habitat may cause unusual or abnormal behavior. During 1973 through 1975, and again during 1977, the author noted the destruction or alteration of a number of bog lands harboring Glyptemys muhlenbergii within northern New Jersey.

In three of these cases the bogs were destroyed during the construction of ponds, and in the other cases the bogs were destroyed by draining and filling in the acreage during land development activities. In the cases of the draining and land filling, Bog Turtles that were not initially killed did retreat to drainage ditches, puddles and other areas that seemed to offer refuge. However, by the time the excavation work was completed, all traces of Glyptemys muhlenbergii had been eliminated.

In cases of pond construction, after excavation and the filling of the new ponds, adult Bog Turtles were seen along the edges of the new ponds for some time, before eventually disappearing.

In one case of pond construction, the author found that some of the former Bog Turtle colony had survived. After the excavation and the new pond had filled with water, the author observed numerous adult Bog Turtles adapting to and living in the wetland below the pond dam.

Populations

Ideal bog land habitat, suitable for Glyptemys muhlenbergii but devoid of the species is, in the opinion of the author, almost always the result of the species having been exterminated by environmental deterioration, pollution and/or other activities of humans.

The largest populations of Glyptemys muhlenbergii recorded by this author were always found within ideal habitat in open countryside with few trees. In northern New Jersey and other areas of the Bog Turtles range, such habitat is almost always within rural, farming areas where the wetlands are kept open and

grazed, but not over grazed, by livestock. The same situation will also hold true for farmland that is no longer in use. However, when these open, ungrazed farmlands fill in with brush and trees, the habitat begins to deteriorate for the Bog Turtles, causing a rapid and serious decline in turtle populations.

During this study, population densities of five to forty adult Bog Turtles per acre were recorded, and were noted (depending upon habitat) as being within the normal density range of healthy Glyptemys muhlenbergii colonies. After much research, this author concluded that the average, healthy Bog Turtle colony, that was breeding properly in order to maintain it's numbers, had a population density of twenty to twenty-five adult turtles per acre. Since Bog Turtles usually congregate along certain bog land rivulets and within certain bog land areas, the actual number of turtles per acre within the average Bog Turtle colony will vary greatly. Glyptemys muhlenbergii is never evenly distributed throughout the bog land nor throughout any given acre of bog land. Depending upon the habitat, the time of year, weather conditions and the like, actual turtle densities within a Bog Turtle colony might range from zero to 150 individuals per acre.

Reproduction

In the wild, Glyptemys muhlenbergii has been recorded copulating during March, April and May. However, the vast majority of matings recorded during this study occurred in late April and early May.

In captivity, adult male Bog Turtles may attempt copulation at almost any time of year. This abnormal behavior is just another example of how Bog Turtle behavior can be altered by a captive situation.

Both adult male and female Bog Turtles are capable of numerous matings during the copulation season. Males will attempt to copulate with as many females as are chanced upon, with females often accepting more than one male in a season.

Young adult males are normally aggressive during the mating season and continue to act aggressively before and during copulation. Aggressive mating behavior seems to decrease with age, however, and older, more mature males tend to be more at ease and calmer both in their mating approach and during actual copulation.

Young adult females tend to retreat from males that are intent upon mating, and may actually flee from an aggressive male, even after he has mounted her carapace. The actions of these younger females parallel those of older females that have, after copulating one or more times, become unreceptive to breeding males. As female Bog Turtles grow older, they are less apt to reject a male, or to behave in an unreceptive manner. In fact, some older female Bog Turtles have been observed taking the initiative, and approaching males in order to copulate.

To list all the copulations observed during this study would be too consuming for the purposes of this paper. However, in order to best describe the two most commonly observed forms of mating behavior, the following examples are given:

The first example of copulation occurred with an air temperature of 72 degrees F, at 5:15 PM on April 22, 1974 within a Frankford Township (Sussex County), New Jersey bog land. A young adult male Glyptemys muhlenbergii sights a female Bog Turtle and moves rapidly towards her with neck extended. When the male is within a few inches of her, the female retreats into her shell. The male then circles the female, nipping first at one of her front legs, then at her head and side, before attempting to mount her carapace. Upon shell contact with the male, the female rapidly crawls away under the overhanging grasses of a sedge grass clump, emerging on the other side of the clump with the male in close pursuit. Pausing for a moment, the female is overtaken and mounted by the male, who anchors himself with all four feet by gripping the edge of her carapace. At this point, the female begins to crawl away again, but is bitten by the male on her neck and head until she stops. The male then extends his own neck and head over the female's carapace, causing her to withdraw into her shell by nipping at her head and front legs. As the female withdraws more into her shell (an action that causes her tail and back legs to be momentarily extended), the male gains entry and actual copulation begins.

During copulation, both specimens are relatively still with two exceptions. The male occasionally nips at the female's head and front legs in order to keep her withdrawn, and the tails of both individuals move slightly from time to time. Some seventeen minutes after the male first gained entry into the female, additional tail movement occurs for the male. This movement causes him to cease his nipping and causes the female to extend her neck. After pausing a moment or two with her head up, the female begins to slowly crawl forward, while at the same time the male releases the grip of his front feet on her carapace. The female then pauses, and the male, still joined to her, slides sideways off her carapace. Within minutes, the female moves slowly forward again, this time dragging the male for a few inches before his organ is released and copulation ends. At this point, neither individual shows any interest in the other, with each going it's own way.

The entire mating procedure only lasted twenty-three minutes, a relatively brief period of time, from when the male Bog Turtle first approached the female until copulation ended. This mating description is rather typical of many matings observed in the field, at least as far as behavior is concerned. It is not typical, however, as far as the time involved. Over the years, the majority of copulations observed often lasted for much longer periods of time. In fact, some copulations, including the initial sexual behavior, lasted two, sometimes three or more hours.

The second example of Bog Turtle copulation was observed with an air temperature of 65 degrees F at 9:20 PM on May 3, 1977. This mating took place in Holub's outdoor natural habitat enclosure in Branchville (Sussex County), New Jersey and, although different from the first, is not uncommon and may even be considered typical for copulations involving older male Bog Turtles. In this second example of copulation, an adult female Glyptemys muhlenbergii emerged from her burrow, and upon seeing an adult male Bog Turtle partially submerged in the enclosure's pool, crawled into the pool and slowly circled the male. Submerged, the female investigated the male's neck, legs and tail, briefly pausing

now and then to lift her head above water and look about. During this time, the male withdrew his head under water, but otherwise remained still. Circling the male once more, the female Bog Turtle twice attempted to crawl underneath the male. During the second attempt to crawl underneath him, the male began to show interest in the female. When the female stopped her activity and withdrew her head, the male Bog Turtle mounted her carapace and after extending his neck, casually nipped at her head and front legs. When the female extended her tail and rear legs, the male curled his tail under her carapace and gained entry. With that, copulation began. Actual copulation proved rather uneventful, with the male occasionally and casually nipping at the female's head, and the female occasionally bringing her head above water in order to breathe. The first sign that the copulation had ended came when the female began to slowly crawl from the pool to her nearby burrow. This caused the male to release his grip and slip from her carapace onto his own carapace, and be dragged by the female (while still joined to her) to her burrow entrance. There, while the female paused, his organ was released and he slowly righted himself. Within a minute or so the female was in her burrow and the male had returned to the pool.

This second example of copulation lasted for a longer period of time than did the previously described copulation. It was also a less aggressive mating, and as such was also typical of many observed matings. This same pair of Glyptemys muhlenbergii mated again in the same pool a few days later. The male then mated again with another female some days after that.

After observing many Bog Turtle matings during the years of his research, the author learned that initial sexual behavior and copulation may be an aggressive or non aggressive event, and that there can be much variation in the time spent during initial sexual behavior and copulation. The author also learned that not all adult Bog Turtles mate every year. He found that successful matings depended upon a number of variables, including opportunities, how aggressive males were and whether or not females were receptive to a male's advances.

With some adult Bog Turtles not mating every year, some adult female Bog Turtles end up not nesting every year. In fact, this study found that approximately twenty-five percent of the breeding age females do not nest each year.

In addition, during three summers of this study, when lack of rain caused a drastic drop in bog land water levels (and lack of water became a stress factor for the bog land inhabitants), it was found that less than fifty percent of the breeding age females nested during those years.

Nesting

During this study, note was made of the theory that Glyptemys muhlenbergii migrated. Since it was formerly a widespread belief among turtle enthusiasts, special attention was paid to determine if and when migration might occur.

In the end, it was learned that the only activity which might be described as a migration occurred during the height of the nesting season in June. At that time, many females were sometimes observed becoming restless, leaving their network of home tunnels and crawling up rivulets towards the spring source and

higher ground. At first this migration of sorts is slow and often deterred by searches for food, but within a relatively short period of time, female turtles are seen crawling in a determined manner, steadily moving forward around, through and over obstacles. These females rest at night, dug in where they are, but in the morning resume their journey, not stopping to feed nor otherwise delay their trip until they reach their nesting destination.

Why a certain nesting area is sought is a mystery. The author has observed some female Bog Turtles lay their eggs within the vicinity of their network of tunnels and burrows, while other females make the long journey to a distant egg laying location as much as 60 or so yards away. Perhaps females return to the area where they hatched or perhaps there is another reason. Whatever the case may be, it is interesting that some females within fifty feet of a well used nesting area, may journey some fifty yards uphill to a more distant nesting site, or may pass through a number of well used nesting areas in order to nest in an area that appears less suitable.

Regardless of the particular nest site chosen, all nesting females have something in common. They always choose a nesting site that is uphill or towards the source of a bog land rivulet, or choose a site on higher ground, such as in the top of a sedge grass clump.

During this study, nestings were recorded for the months of May, June and July for wild Bog Turtles, and for the additional month of August for some captive females. However, the vast majority of nestings occurred between mid May and the last week in June.

After female Bog Turtles have chosen a general nesting area, they seek out and select a particular spot that will receive a lot of sunlight and is safe from the possibility of flooding. Such a site may be in easily worked soil above a spring source, in the top of sedge grass clumps or even in the area of an old railroad bed. Female Bog Turtles may deposit their eggs next to or even within the nest of other female Bog Turtles. This same double nesting has been found to contain both the eggs of Glyptemys muhlenbergii and Clemmys guttata. This study found that nesting almost always occurs during the late afternoon or early evening hours.

Of the many recorded captive and in the field nesting observations made during this study, the following example is fairly typical of the species and serves to describe the nesting behavior.

At approximately 8:00 PM on June 21, 1973, a female Bog Turtle, that later measured 85 mm (straight line carapace measurement), was observed crawling upstream within a narrow rivulet in a Frankford Township (Sussex County), New Jersey bog land. By approximately 8:15 PM, the turtle had arrived at a location that was four and a half feet above or uphill from the spring's beginning. Here in an area of open, dry land covered with short pasture grass recently grazed by cattle, the female slowly crawled in a circular pattern, pausing periodically to nose the soil. At about 8:30 PM, the turtle seemed to find a nest site to her liking in the loamy ground and after repeatedly nosing the soil, began excavating a nest cavity

with her hind feet. Earth was removed by a scooping action whereby the dirt was removed by the bottom of her hind feet and scooped to the side of the cavity that was opposite of the foot being used. The turtle dug the cavity by alternating the hind feet being used. First one foot scooped and removed dirt one to three times, then the other foot did the same. With each scoop the female moved slightly. During the nest cavity excavation the Bog Turtle's neck was somewhat extended and her head was held slightly above the front edge of her carapace. Her head moved very little during digging, and she did not look behind to observe her own progress.

At approximately 10:10 PM, the female Glyptemys muhlenbergii paused from her digging when the depth of the cavity was a bit deeper than her hind feet could reach. At this point, the turtle had moved, due to her digging efforts, to a spot about one and a half inches to the right of her position when she first started excavating the nest site. The completed cavity had a circular bottom slightly larger than the opening at ground level. After completing her excavation, the female turtle rested for a minute or so, then after moving her head first to one side then the other, paused and rested again. Some five or so minutes later, at approximately 10:16 PM, the female moved slightly and slowly expelled an egg into the nest cavity. Upon dropping the egg, the female's right hind foot extended into the hole and gently moved the egg to the left of the bottom of the cavity. Within less than a minute after withdrawing her right hind foot from the nest cavity, another egg was expelled into her nest. This time the turtle used her left hind foot, in order to gently move the second egg to the right of the bottom of the cavity. Approximately one minute after the second egg was expelled, a third egg was expelled and within seconds a fourth egg was expelled into the nest cavity. Upon expelling the fourth and last egg, the female Bog Turtle paused some three minutes. During the expulsion of each egg, the rear of the female's shell would rise slightly, through the effort of at least one hind leg. At the same time, her head would withdraw in an almost unnoticeable fashion, before she extended her neck again after an egg was dropped.

Some nine minutes after the first egg had begun to be expelled, the female Bog Turtle had finished laying her eggs and began to fill in the nest cavity. This was accomplished by first scraping the cavity's inner wall with one hind foot and then with the other hind foot, causing the nest chamber to cave in. This was followed by her filling in the hole with the dirt that was originally removed. The final covering of the eggs was a procedure that copied the initial excavation, that is the hind feet were used alternately in order to scoop the dirt and backfill the nest cavity. The covering of her eggs and the filling of the nest cavity was completed by 11:15 PM. During the filling of the nest cavity, the female Bog Turtle rested five times, with each pause lasting an average of three minutes. When the filling of the nest was completed, the turtle turned to her left in a circular motion, pressing the rear portion of her plastron to the ground. This pressing the ground with the rear portion of her plastron and turning to her left was repeated after a brief pause, and caused the ground covering the nest to be smoothed and somewhat compacted. At approximately 11:30 PM the female paused, nosed the soil in two

different locations and then began to crawl in a slow, determined manner back to the rivulet from which she had come.

The entire nesting procedure lasted two hours and forty-five minutes, and was typical of the nesting behavior and of the average nesting time consumed by Bog Turtles observed by the author.

This study also revealed that Bog Turtles will nest in the top of sedge grass clumps, a nesting site also used by some female Clemmys guttata. These nests take less time due to the effort often being minimal.

Investigation of Glyptemys muhlenbergii nest sites by the author over the years, revealed that the average Bog Turtle clutch contained three eggs, with some clutches containing only two eggs, some containing four eggs and one clutch containing five eggs. Older females lay more eggs than younger females.

Bog Turtle eggs are white when not soiled and average 29 mm in length. Egg incubation depends upon weather, nest location and material and other variables, and ranges from forty-five to eighty days.

Bog Turtle hatchlings usually begin to appear during the beginning of August, however, some hatchings occur as early as late July, and some as late as early September. Hatchling Glyptemys muhlenbergii have an almost circular carapace. Their coloration and markings closely resemble those of the adults.

From the information compiled during this study, it was determined that the average female Bog Turtle will produce approximately 55 eggs during her lifetime, if she lives to be thirty years old. The older females still in their sexual prime produce, as previously stated, the greatest number of eggs at each nesting. With this in mind, the illegal collecting of older adult female Bog Turtles can have an extremely negative impact upon wild populations of this species, and can, in fact, lead to the eradication of those populations.

Food

Glyptemys muhlenberii can and will eat on land as well as in the water. In the wild, Bog Turtles feed upon many of the insects found within their environment, and also prey upon such creatures as snails, earthworms, tadpoles, young frogs, small crawdads and even newborn mice. Feeding upon carrion has been claimed by others, but has not been observed nor confirmed by this author. Bog Turtles also include plant life such as sedge seeds, duckweed and wild berries in their diets.

In captivity, Glyptemys muhlenbergii can be persuaded to eat cut up apples, peaches, pears, melons, cucumbers, grapes, romaine lettuce, bananas, string beans, beef hearts, chicken hearts, liver and canned dog food.

Bog Turtle appetites are large for such a small turtle, and both wild and captive specimens seem forever on the prowl for food.

Glyptemys muhlenbergii make use of their front feet and legs during feeding, either for securing struggling prey or in a scooping action for bringing food closer

to their mouths. For example, a small piece of apple that is in a position making it difficult for the turtle to pick up in it's jaws, is scooped into a better position to be eaten and almost pushed into the mouth by use of the top part of one or both front feet.

Bog Turtles recognize various prey species and have specific ways of handling specific prey. Such a feeding procedure is described as follows, just as it was observed.

A large nightwalker (earthworm) is attacked by an adult Bog Turtle by the turtle first biting the closest portion of the worm's body, then dragging the worm into an area where it is less prone to escape. The Bog Turtle then releases the worm, seeks it's head and repeatedly bites down on the worm's head. Each bite is delivered savagely and the worm's body is almost severed with each bite. Four or five bites to the head curtails the worm from burrowing or crawling away. The Bog Turtle then bites the worm's mid and tail sections, further disabling the worm. The turtle then moves to the worm's head, grasps it in it's jaws and through a series of continuous biting motions, swallows most if not all of the worm. Swallowing is periodically aided by the use of the front legs and feet, in order to control the struggling prey or to push the worm into it's mouth.

This method of first attacking the worm's head in order to prevent it from escaping is interesting, because it shows that the adult Bog Turtle not only recognizes a worm as prey, but apparently knows the best procedure for disabling that prey. It also shows that a Bog Turtle seems to be able to recognize one end of a nightwalker from the other.

During the early years of this study, it was sometimes necessary to get wild Bog Turtles to feed upon items (such as melons) that they were not familiar with. The late Richard J Holub and the author resolved this dilemma by having new captive turtles housed with turtles already accustomed to eating melons or other unfamiliar food items. It was noted that new captives would become interested in food items that they saw other turtles eating, and would more readily sample and eat those items.

For years, Holub successfully maintained a captive Bog Turtle breeding colony in an outdoor natural habitat enclosure, using the following food items for his adult turtles: beef heart and lean stew beef strips fortified with vitamin A, D and bone meal, earthworms, romaine lettuce, various cut up fruit and newborn (pinkies) mice. Hatchling Bog Turtles were also fed lean stew beef and beef heart strips fortified with Vitamin A, D and bone meal, along with tubifex worms, earthworms and fruit. The care Holub gave his turtles during the 1970s, including the healthy environment he provided and maintained for them, resulted in a captive breeding colony that regularly produced juvenile Glyptemys muhlenbergii for release into the wild.

Senses

Glyptemys muhlenbergii's sense of hearing is good. Both wild and captive specimens respond to a combination of sounds and vibrations during their daily activities. Within the turtles' bog land habitat, wild Bog Turtles become motionless, withdraw into their shells or attempt to hide at the approach of humans as far away as twenty-five feet. Captive Bog Turtles can be taught to associate a particular sound or sounds (or the voice and activities of their keepers) with food and feeding. Such turtles learn to rapidly approach their keepers during feeding time.

The eyesight of Glyptemys muhlenbergii is also good, and is used (along with their sense of smell) to recognize prey, enemies and other turtles of their own kind. With an unobstructed view, Bog Turtles can clearly recognize earthworms as prey from a distance of three feet. Bog Turtles can see, and become aware of larger moving objects and animals from even greater distances.

A Bog Turtle's sense of smell is good. Glyptemys muhlenbergii use their sense of smell when hunting for food among the black mud bottomed rivulets of their environment. Bog Turtles can locate earthworms and other prey items through their sense of smell, when their underwater vision is hampered by silt and water discoloration.

Glyptemys muhlenbergii can sense a feather being brushed across it's carapace. Individuals react in distress to having their carapace cut or filed during procedures used to mark individuals for identification.

Much has been learned about herptile intelligence during the past few years, and there is much more to learn. However, it is this author's opinion (based upon many years of observations and some experimentation) that Glyptemys muhlenbergii may be as intelligent as Glyptemys insculpta, the Wood Turtle.

Enemies

This study has shown that Bog Turtle eggs, hatchlings, juveniles and adults are consumed by a variety of predators. Within New Jersey bog lands, the author has found evidence of a long list of predators that includes skunks, opossums, raccoons, fox, coyotes, domestic and feral dogs and cats, king snakes, snapping turtles, crows, wild turkey, swans, geese and more. In recent years with their populations climbing, the black bear has become a serious threat to turtle populations within northwestern New Jersey, northeastern Pennsylvania and portions of southern New York. Recent records of black bears foraging through the bog lands, meadows and woodlands in those areas show that bears are a major predator of Bog Turtles, Spotted Turtles, Wood Turtles and Eastern Box Turtles. For example, during 1999, the author and some fellow researchers observed an adult black bear foraging along a small, shallow stream within Sandyston Township (Sussex County), New Jersey, stopping now and then to consume the Bog and Spotted Turtles it found. Such a large predator can have

a devastating impact upon the few remaining Bog Turtle populations. Multiplying that impact by hundreds of bears, and the already rapidly declining Glyptemys muhlenbergii populations may even disappear from well protected lands, such as the Delaware Water Gap National Recreation Area.

Of all the Bog Turtle enemies encountered during the many years of study, however, one stands head and shoulders above the rest, and that is mankind. Land alteration and development, human generated environmental deterioration and pollution and human predation (collecting) of Glyptemys muhlenbergii, has been and still is the greatest threat to this rare turtle's existence. Mankind is the only predator that can claim the distinction of having exterminated entire wildlife species and populations within a brief period of time.

Preservation/Conservation

Although protected by law throughout much of it's range, Glyptemys muhlenbergii continues to lose ground and decline in numbers. Alteration and development of Bog Turtle habitat, environmental deterioration and pollution, intentional and unintentional encounter killing by people, illegal collecting for the domestic and foreign pet trade and for private turtle collections, and even personality clashes and ego fueled disagreements among conservationists have all combined to eradicate Glytemys muhlenbergii from much of the eastern United States. Thirty years ago, this author and his colleagues called for drastic conservation and management measures, in order to preserve the then rapidly declining Bog Turtle populations. At that time, for example, researchers in New Jersey could still visit dozens of Bog Turtle colonies within Passaic, Morris, Warren and Sussex Counties, easily observing fifty or more adult Bog Turtles during a weekend spent conducting field studies.

Today, in spite of those calls for drastic preservation action years ago, an estimated eighty percent of the 1970s Bog Turtle populations are gone, with most of the remaining colonies soon to follow. Even within areas with suitable habitat, such as northwestern New Jersey, the Bog Turtle is in decline (or has been eliminated) in places where it thrived as recently as 1979. For example, during the 1990s, extensive land clearing and other excavation work took place on farmland containing small colonies of Bog Turtles along Route 565 in Sussex County, New Jersey. The work was conducted on acreage along the east side of Route 565, north of Pellettown Road and south of Roy Road, in preparation for a proposed golf course. The golf course was never completed, however, and the excavation work ended, but not before it had erased all traces of those small Bog Turtle colonies, along with the habitat and populations of Wood, Spotted and Eastern Box Turtles formerly found there.

Now this author again calls for those charged with the protection of Glyptemys muhlenbergii, to take the measures necessary to protect this species. To delay will result in the species becoming extinct outside of zoological parks and protected lands, that extinction only being a matter of time.

This study has shown that habitat preservation, pollution prevention and limiting human access to wild Bog Turtle populations are all a must if the species is to be around for our children and grandchildren to see and appreciate. Land harboring healthy Glyptemys muhlenbergii colonies must be acquired, with enough acreage acquired in order to protect not just the Bog Turtle's immediate wetland home, but the lands surrounding it. If necessary, bog land must be maintained as bog land (in order to prevent environmental deterioration due to the encroachment of trees and brush) through methods that prevent stress to and protect the individual turtles living in that environment. Bog Turtle numbers are presently so low, that drastic predator management measures are needed. Control of major Glyptemys muhlenbergii predators (such as black bears, raccoons, feral hogs and humans) within Bog Turtle habitat is now needed. In addition, the importance of educating the public about wildlife conservation and specifically Bog Turtle conservation efforts cannot be underestimated. Bringing the plight of Glyptemys muhlenbergii to schools, pre-schools, libraries and other organizations through wildlife educational programs should be encouraged and supported. Public education and the hopefully supportive public opinion that follows can play a major role in ensuring Glyptemys muhlenbergii's future.

Captive Breeding

Years ago, this author was only half heartedly supportive of Bog Turtle captive breeding colonies. For the most part, the author believed that preserving existing wild Glyptemys muhlenbergii populations and habitat offered the greatest benefit to the species. Today, however, after being witness to the elimination or decline of so many wild Bog Turtle populations over the years, the author now believes that the captive breeding of this endangered turtle should be encouraged and supported.

As with anything people do, captive breeding colonies are subject to the whim of people, along with being subject to time, housing and economic factors, any one of which might cause a private breeding colony effort to be terminated. Due to that, the author believes that captive Bog Turtle breeding colonies should only be established and maintained by recognized and responsible organizations, zoological parks and universities that are less apt to terminate or be unable to continue a breeding colony.

During the late 1960s and 1970s, there was a rush by a number of individuals and organizations to be the first to successfully breed and maintain captive Glyptemys muhlenbergii. These people and groups initially relied upon wild Bog Turtle populations to supply their captive colonies with gravid female turtles and to replace adult turtles lost due to incorrect husbandry and the like. These private captive breeding start up efforts not only added to the drain on Bog Turtle populations already under great collecting pressure, but were often abandoned when people became dismayed or bored by lack of breeding success.

Happily, this was not always the case, and during the early 1970s a number of

people with the time, money and patience needed, began and maintained very successful captive Bog Turtle breeding populations.

Although there were exceptions, the majority of those breeding programs were housed in outdoor natural habitat enclosures that were subject to seasonal changes (an important factor when breeding Glyptemys muhlenbergii). The habitats closely simulated the natural bog lands of Glyptemys muhlenbergii, including flowing rivulets, hibernation and nesting sites, and were of the sizes necessary to ensure that the turtles were not stressed and did not exhibit the abnormal behavior that sometimes comes from being confined in close quarters. Those breeding operations sought to make sure that every turtle received a proper diet and the best of care by providing everything they needed, including complete protection from predators.

Selection of the initial breeding stock was an important aspect in establishing those successful breeding colonies. Whenever possible, older males and females were obtained in order to decrease the chances of unproductive, overly aggressive mating behavior, and increase breeding productivity through the use of older, calmer more successful breeding males and older females that produced more eggs than younger females would have. Care was given in order to establish and maintain proper sex ratios, nesting sites, hibernation areas and a clean and healthy environment. Years of breeding success resulted from not only the proper establishment of those breeding colonies, but from the knowledge gained through experience for captive habitat requirements. To overlook what was learned by those early turtle breeders, is to invite difficulties and lessen the chances of establishing and maintaining a breeding colony of Glyptemys muhlenbergii that is healthy, productive and self sustaining.

Some of the earliest captive Bog Turtle breeding colonies included that of Fred Wustholz during the 1960s, in New Jersey's Bergen County, and that of Richard J Holub during the early 1970s in Sussex County, New Jersey. Both men successfully bred Bog Turtles, incubated their eggs and raised up and released back into the wild scores of Bog Turtles annually for many years. And, both men contributed greatly to the information now available about Bog Turtle mating and nesting behavior. In fact, it was Fred Wustholz who (more than any other one person) helped establish, encourage and maintain this author's passion for and interest in Glyptemys muhlenbergii.

During 1977, when this paper was first published, the author knew of a number of small, indoor Bog Turtle collections established by good intentioned people who wanted to breed the species. However, as the years passed, all these indoor captive collections were eventually abandoned. For that reason, and because this author does not support the keeping of Bog Turtles in private turtle collections, information about maintaining Bog Turtles in captivity indoors is not included in this revised paper.

Recent Updates

Hybridization between Glyptemys muhlenbergii and Clemmys guttata was recorded in 1983 by the respected turtle authority, Carl H Ernst. In that case, the mating of a Spotted Turtle and a Bog Turtle resulted in a hybrid female turtle with both Bog and Spotted Turtle traits.

The author and two colleagues also recorded hybridization between Glyptemys muhlenbergii and Clemmys guttata, and these turtles also showed traits of both the Bog and Spotted Turtle parents. During 1998 and 1999, hybrid turtles were found inhabiting an isolated bog land within Lafayette Township (Sussex County), New Jersey. Although photographed, none of the hybrids were removed from that wetland acreage.

While not officially recorded as being native to that state, recent reports indicate that Glyptemys muhlenbergii may inhabit (or may have inhabited) a portion(s) of southern West Virginia that borders areas known to harbor Bog Turtles in Virginia. Additional field research will be needed in order to confirm the existence of Glyptemys muhlenbergii within West Virginia, and to eliminate the possibility of turtles found there having been released or having been escaped captives.

About The Study

During the years of this study, the author observed and recorded hundreds of Glyptemys muhlenbergii. Thus, when the average size of hatchling Bog Turtles or the average number of eggs in a clutch are noted, these numbers are the result of measuring many, many hatchlings and recording the number of eggs in many, many nests. This holds true for all other statements, as well. For example, over the years the late Richard J Holub and the author measured scores of large male Glyptemys muhlenbergii, in order to find that any male over 98 mm (straight line carapace measurement) was large indeed. So when the 101 mm turtle Holub discovered in 1974 is noted as the largest male recorded during this study, the measurements of many male Bog Turtles (over the years) confirm that.

Regarding feeding, mating, nesting and other descriptions, these resulted from years of field research observations of Glyptemys muhlenbergii populations, and were observations preserved by meticulous notes, journals and photography that often documented events in a step by step manner.

With regards to statements about Bog Turtle conservation and suggested preservation methods, these statements are the result of the author's many years of experience, research and observations in the field. For instance, the author noting that black bears may be having a devastating impact upon some of the remaining Bog Turtle populations, does not come from speculation, but from direct observations of such predation.

And finally, due to the rapidly declining Glyptemys muhlenbergii populations and the present difficulty of being able to study them, or of being able to locate

enough wild turtle populations or even enough individual turtles to study, the author realizes that duplicating research such as this, today or in the future, may no longer be possible. With that in mind, the distribution of this information becomes more important than ever.

The author in Pennsylvania, with a Wood Turtle he rescued from a highway and then released.

About The Author

Tom J Bloomer has lived and worked within almost every region of the United States, including Hawaii. He continues to explore, photograph and write about wild lands that he has loved and wandered through since boyhood.

MEETING NOTICES SEPTEMBER/OCTOBER 1977

DATE: Saturday, September 24, 1977
TIME: 10:30 a.m.
PLACE: Bronx Zoo - Heads and Horns Building
PROGRAM: *REPTILE RESEARCH IN EASTERN KANSAS*

Mr. Richard Lattis, Curator of Education, N.Y. Zoological Society

Rich Lattis is involved with educating the public and publicizing new happenings at the Bronx Zoo. Besides that, he is into herpetology. He will relate some of his still unpublished research on lizards and the ring-necked snake while studying at the University of Kansas. You will enjoy his down-to-earth manner of delivery about some unusual discoveries.

EASTERN SEABOARD HERPETOLOGICAL LEAGUE (ESHL) MEETING

DATE: October 8, 1977
TIME: Registration of attending members and member organizations, 12:30 p.m.
PLACE: The FRANKFORD PLAINS COMMUNITY HOUSE, located on Plains Road, Augusta, N.J. 07822, next to the Frankford Plains United Methodist Church.
PROGRAM:

1:00 p.m. Welcoming Address - Mal Skaroff (PHS), ESHL coordinator
Invocation - The Rev. James Van Der Wall (TMG)
Opening Statement - Tom Bloomer (TMG, ACTT), TMG coordinator

1:30 p.m. Herptile Conservation - Al Root (NOAH)
The Bog Turtle - Robert Zappalorti (NYHS, TMG), Staten Island Zoo
Sea Snakes - Martin Rosenberg, Case Western Reserve University
Presentation of Awards for Dedication and Work with Herpetological Organizations and Herptile Conservation Efforts - Sponsored by TMG *(NOTE: This will be the first Annual Award Presentation to be sponsored by TMG. This year five awards will be presented.)*
The Wood Turtle - Tom Bloomer (TMG, ACTT)
... Other speakers yet to be scheduled.

5:40 p.m. Roast Beef Dinner, $5.00 per person

5:40 p.m. ESHL Executive Officers' Meeting

ROAST BEEF DINNER. Excellent food for an 'after the meeting' dinner at only $5.00 per person. Those attending this dinner must register with TMG by October 1, 1977 in order that TMG can arrange the amount of food needed.

DIRECTIONS. *From the North and New England*, take Route 95 South to Route 80 West to the Route 15 North exit; take Route 15 North to Route 565 North to Linn Smith Road, turn left, then turn right at Plains Road to the Community House.

From the West, take Route 80 East to the Route 15 North exit; take Route 15 North to Route 565 North to Linn Smith Road, turn left, then turn right at Plains Road to the Community House.

From the East, take Route 80 West to the Route 15 North exit; take Route 15 North to Route 565 North to Linn Smith Road, turn left, then turn right at Plains Road to the Community House.

OR, take Route 23 North to the Boro of Sussex; take Route 565 South to Linn Smith Road, turn right, then turn right again at Plains Road to the Community House.

From the South, take a route that applies above; *OR* take Route 206 North to Route 565 North; take Route 565 North to Linn Smith Road, turn left, then turn right at Plains Road to the Community House.

DATE: Saturday, October 29, 1977
TIME: 10:30 a.m. SHARP
PLACE: American Museum of Natural History - Education Hall
PROGRAM: *GUIDED TOUR OF THE NEW HALL OF REPTILES AND AMPHIBIANS*

Mr. Eugene Bergmann, Designer, Dept. of Exhibitions and Graphics
Dr. Richard Zweifel, Chairman, Dept. of Herpetology

The meeting will begin at the Education Hall with a brief introduction of the project by Mr. Bergmann and Dr. Zweifel. From there the group will be taken upstairs to The Hall of Reptiles and Amphibians for a private tour. The exhibit is not yet open to the public so this is your chance to get an inside look at the planning and culmination of this interesting and educational accomplishment. Bring your questions and please be on time.

ESHL

NEWSLETTER

NOVEMBER 2, 1977

ESHL NEWSLETTER is the official non-publication of the Eastern Seaboard Herpetological League. It is non-published by the ESHL Secretary, with a great deal of help from the Coordinator and other ESHL members. ESHL NEWSLETTER is sent to designated representatives of constituent organizations and to certain other interested herpetologists. Member organizations are: MHS, CHS, NYHS, PHS, MdHS, WHS, VHS, ACTT, FHS, GHS an NOAH. ESHL Coordinator is Malvin L. Skaroff, 1025 Lakeside Ave., Philadelphia, PA 19126; ESHL Secretary is Veralynne Bosko, 1302 Irving Ave., Cleveland, OH 44109. EDITORIAL AND FINANCIAL CONTRIBUTIONS ARE ALWAYS WELCOME.

THE NEXT ESHL MEETING WILL BE SPONSORED BY PHS.

THE MEETING WILL BE HELD AT THE EDUCATION AND ADMINISTRATION BUILDING OF THE PHILADELPHIA ZOO AT NOON ON MARCH 11, 1978.

FURTHER PROGRAM DETAILS WILL FOLLOW.

PLEASE PRINT THIS INFORMATION IN YOUR GROUP'S NEXT NEWSLETTER!

FROM THE COORDINATOR:

The ESHL meeting of October 8, 1977 is now history. Approximately 80 people attended a well-planned meeting. A special vote of thanks is owed to Tom J. Bloomer who is an organizer par excellence. He has my personal thanks as well as that of the others in attendance.

Tom also announced the disbanding of TMG. I assume this might have been influenced by the recent tragic death of his friend and colleague, Richard Holub. We all join Tom in his sorrow. TMG members will be joining other societies in their areas and, of course, Tom continues to serve ACTT as Vice-President.

Another change is the acceptance of NOAH as a member of ESHL and the election of Veralynne Bosko, NOAH President, as ESHL Secretary-Treasurer and Newsletter Editor in place of Gopher Kuntz, who resigned.

Gopher has served ESHL for many years, but since moving to Florida from Connecticut, her life has become even more crowded and hectic. She has been the moving force in the FHS, has married, borne a son (a tiny preemie with the attendant problems of premature birth) and, with her husband, Paul, has been caring for an ever-increasing collection of reptiles. And that's only part of it. Because of all of these duties, she has found it impossible to come to ESHL meetings since moving to Florida. Accordingly, I have had her resignation in hand, ready to use when an acceptable successor could be found.

I think we have found such a person in Veralynne Bosko.

Gopher deserves the highest praise and thanks for her contribution to ESHL.

-- M.L.S.

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Bog Turtle - ... 1989). Behavior: The **bog** turtle is primarily diurnal, although nocturnal feeding, breeding, and nesting have been reported (Holub and **Bloomer** 1977). ...
http://www.wes.army.mil/el/emrp/turtles/species/bog.html

Wetland Turtle Group - ... Holub, RJ, and **Bloomer**, TJ (1977). "The **bog** turtle, Clemmys muhlenbergii . . . A natural history," Herpetological Bulletin New York ...
http://www.wes.army.mil/el/emrp/turtles/wetland.html
[More results from www.wes.army.mil]

Ecology of Bog Turtles - ... augmented. Copeia 1955(3):159-165. One of the earliest comprehensive studies on **bog turtles**. **Bloomer**, TJ and RJ Holub. 1977. The ...
http://www.wsi.nrcs.usda.gov/products/piedmont/c-2.pdf

ADW: Clemmys muhlenbergii: Information - ... Home ranges reported for **Bog Turtles** range from less than ... total available habitat for the **turtles** may not ... 1994; Harding, 1997; Holub and **Bloomer**, 1977; Morrow ...
http://animaldiversity.ummz.umich.edu/site/accounts/information/Clemmys_muhlenbergii.html

Conservation Needs of Bog Turtles in Maryland - ... In New Jersey Holub and **Bloomer** (1977) found that **bog turtles** entered winter retreats in late October and emerged in early to mid-May. Ernst et al. ...
http://www.tortoisereserve.org/Research/Lee_Norton_Body2.html

Bog turtle final report.mdi - ... 49 Web sites (as of 2001) with information on **Bog Turtles** • www.tortoisereserve.org • www.projectbogturtle.org • http://web.ncusfws.org/reptile/bogtur ...
http://www.tortoisereserve.org/Research/Bog_Turtle_Report/Bogturtlefinalreport_46-61.pdf

MOVEMENTS, HOME RANGE, AND HABITAT PREFERENCE ASSESSMENT OF BOG ... - ... However, Holub and **Bloomer** (1977) noted continued activity throughout the summer season. The extreme secretiveness of **bog turtles** and an increased density of ...
http://scholar.lib.vt.edu/theses/available/etd-7597-194728/unrestricted/Full_Thesis_20_20ETD.pdf

Care of North American Wood Turtles @ WoodTurtle.com - ... Harding & **Bloomer**. ... This includes wood, spotted, Blanding's, and **bog turtles**. Turtle Forum has over 1,000 registered users and 150,000 archived posts! ...
http://www.woodturtle.com/Care.html

WOOD TURTLE Glyptemys insculpta - ... of shallow wetlands, such as swamps and bogs may also ... early April and mid-May (Harding and **Bloomer** 1979 ... Wood **turtles** tend to hibernate in bodies of water that ...
http://herpcenter.iphw.edu/outreach/accounts/reptiles/turtles/Wood_turtle/WoodTurtleFactSheet.pdf

NJDEP Wood Turtle - ... 25(1): 1-9. Harding, JH and TJ **Bloomer**. ... **Bog turtles** have traditionally been regarded as an exclusively emergent wetland species (Barton and Price 1955; Nemuras ...
http://www.njfishandwildlife.com/ensp/landscape/woodturtle.htm

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Wood Turtle - ... **Wood** turtle density estimates for New Jersey range from 9.9 to 11.4 **turtles**/hectare (Farrell and Graham 1991) and 12.5 **turtles**/hectare (Harding and **Bloomer** 1979 ...
http://www.wes.army.mil/el/emrrp/turtles/species/wood.html

Wetland Turtle Group - ... Harding, JH, and **Bloomer**, TJ (1979). "The **wood** turtle, Clemmys insculpta...a natural history," HERP, Bulletin New York Herpetological Society 15(1):9-26. ...
http://www.wes.army.mil/el/emrrp/turtles/wetland.html
[More results from www.wes.army.mil]

WOOD TURTLE Glyptemys insculpta - ... Female **Wood Turtles** lay a single clutch of eggs per year, and clutch size may range from 5 to 18 eggs (Harding and **Bloomer**, 1979, Ernst et al., 1994). ...
http://herpcenter.iptw.edu/outreach/accounts/reptiles/turtles/Wood_turtle/WoodTurtleFactSheet.pdf

Care of North American Wood Turtles @ WoodTurtle.com - ... means to be a **wood** turtle was a paper entitled: "The **Wood** Turtle, Clemmys insculpta ... With the permission of authors Jim Harding and Tom **Bloomer**, as well as the ...
http://www.woodturtle.com/Care.html

North American Wood Turtle Publications @ WoodTurtle.com - ... **Bloomer**, TJ 1978 ... Previously unrecognized original type specimens of American **turtles** collected by ... **Wood** turtle, Clemmys insculpta, research in northern Wisconsin ...
http://www.woodturtle.com/Library2002.html

Wood Turtle - ... swimming (Harding and **Bloomer** 1979).The **wood** turtle's apparent intellect has boosted its popularity in the pet industry, but, like most other **turtles**, it does ...
http://www.uraame.edu/wetlands/FGwoodt.htm

Home range and movements of a wood turtle (Clemmys insculpta) ... - ... **Wood turtles** live near streams, and individuals occupy relatively small areas (<25 ha) (Carroll and Ehrenfeld 1978; Harding and **Bloomer** 1979; Barzilay 1980 ...
http://article.pubs.nrc-cnrc.gc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&journal=cjz&volume=80&calyLang=eng&articleFile=z02-013.pdf

Habitat selection by the wood turtle (Clemmys insculpta) at the ... - ... Habitat characterization Because **wood turtles** are easily disturbed (Harding and **Bloomer** 1979; Garber and Burger 1995), we sampled each turtle sighting 1 **week** ...
http://article.pubs.nrc-cnrc.gc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&journal=cjz&volume=82&calyLang=eng&articleFile=z04-012.pdf
[More results from article.pubs.nrc-cnrc.gc.ca]

ADW: Clemmys muhlenbergii: Information - ... a behavior common in the related **Wood** Turtle (Clemmys insculpta ... years but taper off as the turtle nears maturity ... al., 1994; Harding, 1997; Holb and **Bloomer**, 1977 ...
http://animaldiversity.ummz.umich.edu/site/accounts/information/Clemmys_muhlenbergii.html

NJDEP Wood Turtle - ... The 322m buffer represents a mean distance **wood turtles** traveled from their hibernation ... Burt and Collins nd; Ernst 1986; Harding and **Bloomer** 1979; Strang 1983 ...
http://www.njfishandwildlife.com/ensp/landscape/woodturtle.htm

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Clemmys guttata spotted turtle - ... Ernst 1982). **Spotted turtles** have been found to hibernate in congregations of up to 12 individuals (**Bloomer** 1978). **Spotted turtles** ...
http://web4.msue.msu.edu/mnfi/abstracts/zoology/Clemmys_guttata.pdf

Wetland Turtle Group - ... Holub, RJ, and **Bloomer**, TJ (1977). ... Joyal, LA (1996). "Ecology of Blanding's (Emydoidea blandingii) and **spotted** (Clemmys guttata) **turtles** in southern ...
http://www.wes.army.mil/el/elpubs/turtles/wetland.html

WETLAND.CHP:Corel VENTURA - ... Holub, RJ, and **Bloomer**, TJ (1977). ... Ecology of Blanding's (Emydoidea blandingii) and **spotted** (Clemmys guttata) **turtles** in southern Maine ...
http://www.wes.army.mil/el/elpubs/pdf/wl04.pdf
[More results from www.wes.army.mil]

ADW: Clemmys muhlenbergii: Information - ... 1993; Ernst et al., 1994; Harding, 1997; Holub and **Bloomer**, 1977; Herman ... Bog **Turtles** are reported to hybridize with the **Spotted** Turtle, Clemmys guttata ...
http://animaldiversity.ummz.umich.edu/site/accounts/information/Clemmys_muhlenbergii.html

Wood Turtle - ... swimming (Harding and **Bloomer** 1979).The wood turtle's apparent intellect has boosted its popularity in the pet industry, but, like most other **turtles**, it does ...
http://www.umaine.edu/wetlands/FGwood.htm

Care of North American Wood Turtles @ WoodTurtle.com - ... Harding & **Bloomer**. ... This includes wood, **spotted**, Blanding's, and bog **turtles**. Turtle Forum has over 1,000 registered users and 150,000 archived posts! ...
http://www.woodturtle.com/Care.html

Habitat selectivity of Clemmys guttata in central Ontario - ... Hibernating in congregations has already been reported for other popula- tions of **spotted turtles** (**Bloomer** 1978; Litzgus 1996), as well as for other species of ...
http://article.pubs.nrc-cnrc.gc.ca/ppv/RPViewDoc?_handles_=HandleInitialGet&journal=cjz&volume=77&calyLang=eng&articleFile=z99-009.pdf

Natural Heritage Information Centre – Tracks and maintains data ... - ... characters of a population of **Spotted Turtles** and a ... Fossil Blanding's **Turtles**, EMYDOIDEA BLANDINGI (Holbrook), and ... Late **Bloomer**: The shy Blanding's turtle is ...
http://www.mnr.gov.on.ca/MNR/nhic/elcmnats/el_report.cfm?elid=180752

Conservation Needs of Bog Turtles in Maryland - ... between bog **turtles** has been noted, particularly toward smaller conspecifics (Holub and **Bloomer** 1977), they seem less aggressive that **spotted turtles** or wood ...
http://www.tortoisereserve.org/Research-Lee_Norton_Becky2.html

Ecology of Bog Turtles - ... head is usually speckled with black and the lower jaw may be **spotted** with red ... One of the earliest comprehensive studies on bog **turtles**. **Bloomer**, TJ and RJ Holub ...
http://www.wsi.nrcs.usda.gov/products/piedmont/c-2.pdf

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Acknowledgements

Special thanks are extended to Diane Emily Krown, James Williams and all the others involved with the creation and distribution of this booklet.

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