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# CEDAR BOG SYMPOSIUM II



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# **CEDAR BOG SYMPOSIUM II**

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# THE SPOTTED TURTLES OF CEDAR BOG: HISTORICAL ANALYSIS OF A DECLINING POPULATION

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Spotted turtles, *Clemmys guttata*, are small, semi-aquatic turtles that typically inhabit shallow bodies of water such as marshes, bogs, and small streams. The species is widely distributed in suitable wetland habitats in North America from southern Ontario and Maine, southward (primarily east of the Appalachian Mountains) into northern Florida, and westward through Pennsylvania, northern Ohio and Indiana, and southern Michigan (Ernst, 1972). Throughout this extensive distribution, spotted turtle populations are localized and continue to decline because of habitat destruction and over-collecting (Table 1). In Ohio, for example, spotted turtles once occurred throughout most of the glaciated portions of the state (Morse, 1904; Conant, 1951). Subsequent habitat destruction resulting primarily from agricultural practices has restricted them to an unknown number of widely scattered relict populations. As a result, the spotted turtle is now listed as endangered in Ohio by the Ohio Division of Wildlife.

One site where spotted turtles have declined dramatically is Cedar Bog State Memorial in southern Champaign County, Ohio (Lovich and Jaworski, 1988). Early in this century more than 20 were collected at Cedar Bog in a single day (Conant, 1951). Franks (1931) found the species to be "common" in the bog stream habitat, and Conant (1951) reported them as "very common," including Cedar Bog in his list of well populated localities for Ohio. Recent sightings have declined dramatically and only three live turtles were located during intensive surveys in 1984 and 1985 (Lovich, 1985). This paper discusses factors that may have contributed to the observed decrease and presents an historical analysis of the rate of decline based on data from live animals and museum specimens.

## Description of Study Site and Methods

Cedar Bog is a relict boreal fen located in the Mad River Valley of Champaign County, Ohio, 8 km SSW of Urbana. The preserve was established in 1941 when the state set aside 98 acres. Today, approximately 425 acres are protected within the boundaries of Cedar Bog State Memorial. Wetland habitat at the preserve has declined dramatically during this century as a result of dredging operations (Cavender and Yoder, 1974) and ecological succession (Collins et al., 1982), and only about 49 acres remain of what was once a 6900 acre complex of wetlands and forest (Collins et al., 1982). The unique physical characteristics and cool microclimate of the preserve produce conditions that sustain an unusual diversity of plant species within several well-defined microhabitats. Plant associations include bog meadow, marl meadow, arbor vitae (white cedar) forest, swamp forest, hardwood forest, and shrub communities (Frederick, 1974). More detailed descriptions of the site are given by Collins et al. (1982), Forsyth (1974), and Frederick (1974).

Data reported in this paper are based on seven living and 65 preserved specimens of *C. guttata* (see Appendix). Turtle surveys were conducted in May and June of 1984 and 1985 (Lovich, 1985). These months were selected since seasonal activity of *C. guttata* in Ohio is highest at that time (Lovich, 1988). The sample includes four *C. guttata* that were captured incidentally in 1986 and 1987.

A variety of previously proven techniques were utilized in an attempt to locate spotted turtles, including more than 100 man-hours of visual searching, "muddling" (Ernst, 1976), and the use of terrestrial drift fences (Gibbons and Semlitsch, 1981) with funnel traps similar to those shown in Fitch (1951). However, only hand collecting was successful. All turtles were sexed using characters outlined in Blake (1922) and Ernst and Barbour (1972), and aged by counting growth annuli (Sexton, 1959) or by using growth curves given in Ernst (1975). Straight line measurements of the greatest carapace lengths (CL) were taken with dial calipers accurate to the nearest 0.1 mm. Each specimen was carefully examined for predator-related injuries, and live turtles were permanently marked for future recognition by notching the marginal scutes (Ernst et al., 1974). Statistical techniques such as Chi-square, Student's t-test, ANOVA and contingency table analysis were used when appropriate (Zar, 1984). All tests are considered significant if  $P < 0.05$ .

## Results

### Scientific Collecting

A total of 65 spotted turtle specimens from Cedar Bog were located in museum collections (see Appendix). Of these 62 (95 percent) were collected prior to 1960, including 24 captured on a single day in 1929 (Figure 1). Scientific collecting began in 1898 and continued

**Table 1.**

List of references citing probable reasons for the decline of spotted turtles in various parts of their range.

State/Region	Reason for Decline	Reference
Ohio	Over-collecting	Conant (1951)
	Over-collecting and habitat destruction	Smith et al. (1973)
	Over-collecting, habitat destruction, and increased predation	Lovich and Jaworski (1988)
Indiana	Heavy grazing, cultivation	Minton (1972)
	Habitat destruction, pet trade	Minton et al. (1982)
Florida	Habitat alteration	Berry and Gidden (1974)
Ontario	Drainage of marshland	Cook et al. (1980)
NE United States	Over-collecting, drainage and filling of swamps, and possibly pollution	DeGraff and Rudis (1981)

sporadically until 1967. Specimens collected after 1976 represent the remains of winter or predator kills. The vast majority of specimens were sexually mature when collected. One hatchling is the smallest specimen on record from Ohio (Conant, 1951). Two out of 11 preserved females examined by X-ray photography were gravid. These specimens (collected on May 16, 1948) are 92.2 and 88.5 mm CL, and contain two and three eggs respectively (Figure 2). The mean carapace length of specimens for which data are available is 89.0 mm (standard error = 1.5 mm). The mean CL of spotted turtles collected at Cedar Bog prior to 1967 is 87.8 mm. After 1967, when collecting efforts presumably stopped, the mean CL is 95.8 mm. The difference between these values is almost statistically significant ( $F = 3.79$ ,  $P = 0.056$ ). The proportion of known males (22) and females collected (45) is significantly different from 1:1 ( $\chi^2 = 7.9$ ,  $P < 0.005$ ). There is presently no evidence of previous exploitation by the pet trade.

#### Distribution Patterns

The earliest reference to the distribution of spotted turtles at Cedar Bog is given by Franks (1931). He recorded them in the east branch of Cedar Run and in ditches leading into Cedar Run, implying that they were distributed throughout the wetter portions of the preserve. All recent sightings have occurred in and along the east and west branches of Cedar Run north of Woodburn Road (Figure 3). Sightings or records south of Woodburn Road are not known. There have been no sightings in the west branch since June 1978.

#### Predation

A total of 22 (31 percent) of the specimens examined exhibited signs of suspected predator-related injuries. Most injuries were represented by teeth marks on the shell. One live female collected at Cedar Bog in 1985 lacked her tail. The proportion of females (36 percent) with injuries relative to males (22 percent) is not significantly different ( $\chi^2 = 1.14$ ,  $P > 0.10$ ). Prior to the establishment of the preserve in 1941, only 5 (13 percent) show signs of injury. After 1941, 17 (55 percent) specimens show predator-related injuries. A contingency table analysis found this difference to be statistically significant ( $\chi^2 = 14.3$ ,  $P < 0.001$ ).

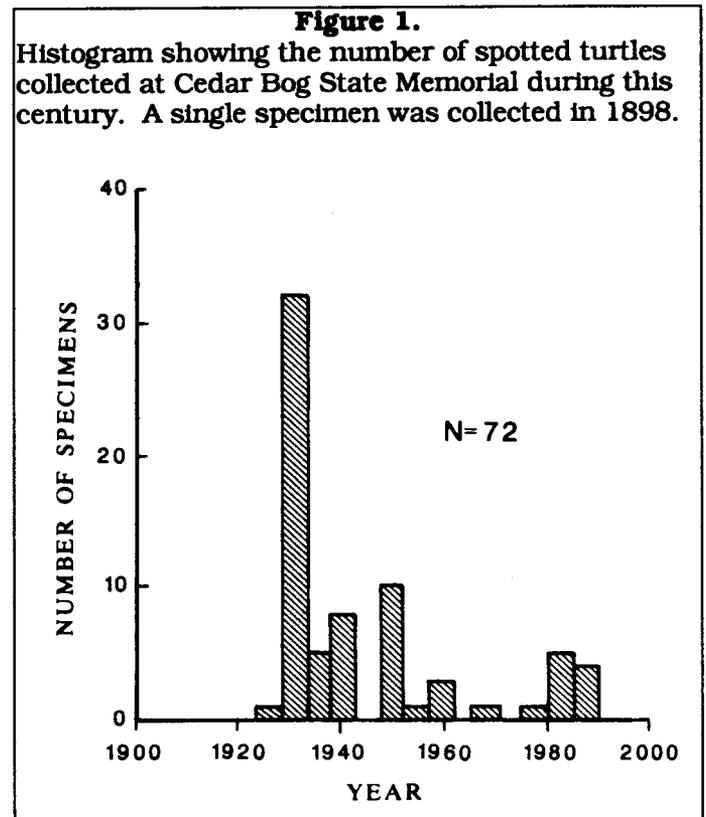
#### Historical Abundance

Estimates of animal abundance are usually determined by mark-recapture techniques, but because of the rarity of spotted turtles at Cedar Bog this method is not applicable. Another approach to estimating population size is to apply previously published densities to an estimate of suitable habitat remaining at Cedar Bog. The assumption here is that the number of turtles actually present approximates the number that could be present. In ideal habitat, densities range from 16-32 individuals per acre (Ernst, 1976). Assuming that only one-half of the 6900 acre wetland complex reported by Collins et al. (1982) was suitable habitat for *C. guttata*, and using the lower density value reported by Ernst (1976), an estimate of more than 50,000 turtles is obtained. At present, suitable habitat probably totals no more than two and one half acres. In my opinion, the predicted range of 40-80 turtles is extremely optimistic in light of the number actually located during 1984-85.

The actual rate at which spotted turtles have declined at Cedar Bog is unknown because of the lack of previous estimates of population size. However, some trends can be identified (Figure 1). To a certain extent, the values given represent changes in the collecting effort of various museums and possibly year-to-year variation in seasonal activity levels, but the data do indicate a previous abundance of turtles relative to recent records. A certain amount of reliable information can be obtained for intervening years by estimating the age of an animal at capture and determining its birth date. For example, the animal collected in 1898 was about eight years old when captured. Thus, it can be assumed that this turtle was present in the population from 1891-1898. The results of this analysis provide an estimate of the minimum number of turtles present at Cedar Bog during this century (Figure 4).

**Figure 1.**

Histogram showing the number of spotted turtles collected at Cedar Bog State Memorial during this century. A single specimen was collected in 1898.



#### Discussion

The results of this study confirm previous observations by refuge personnel, Lovich (1985), and Lovich and Jaworski (1988) that the spotted turtle population at Cedar Bog has declined dramatically during this century to what may be a critical level. A variety of factors probably contributed synergistically to the observed decline, and they are discussed below. The most important factors appear to be over-collecting, habitat alteration due to ecological succession, and increased predation. Of these, only the last two pose a significant threat to the continued survival of this species at Cedar Bog.

#### Scientific Collecting

The number of turtles collected at Cedar Bog is trivial in comparison with the number that must have

been present before 1900. However, most were taken in a brief time interval during the height of habitat destruction. Removal of large numbers of mature specimens, especially females (Figure 1), from a severely degraded habitat undoubtedly had a negative impact on the population. The combination of these factors may have adversely affected reproduction in the population since fewer juveniles and other small size classes are known after 1967. Conant (1951) observed:

"In the interests of conservation it should be pointed out that there is now a considerable number of spotted turtles in museum collections from the cedar swamp in Champaign County. *Clemmys* is an interesting element in the fauna of this relict boreal bog, and it would seem needless to deplete the population further in this locality."

#### Habitat Alteration

The restricted distribution presently observed may be a result of ecological succession. In 1910, and again in the early 1930s, Cedar Run and its west branch were dredged in an effort to drain the bog, and this dramatically lowered the water table (Forsyth, 1974). Evidence of the level of destruction is provided by the fact that 15 species of fish were eliminated from the local fauna (Cavender and Yoder, 1974). Succession toward drier habitats accelerated along these streams following dredging, and marshy areas where spotted turtles prefer to forage (Ernst, 1976) are now virtually absent. Although the east branch was not dredged, evidence suggests that the bog meadow in that area has decreased in size over the years as a result of invasion by woody plant species, such as northern white cedar (Collins et al., 1982). Thus, as suitable habitat in the meadow decreased, spotted turtles may have been forced into wetter areas in or near streams, where they presently appear to be restricted.

Concentration of displaced *C. guttata* into relatively small areas may have been responsible for the large collections made earlier in the century. Ernst (1976) observed that spotted turtles abandoned marshes that were drying up and moved into small tributary brooks. He attributed this behavior to "normal ecological succession." Wilbur (1975) reported that a marsh population of painted turtles (*Chrysemys picta*) declined to 18 percent of its previous level during the 18 years following dredging operations. He concluded that habitat degradation superimposed on succession was the main reason for the reduction.

#### Predation

The evidence suggests that the raccoon (*Procyon lotor*) population at Cedar Bog has increased substantially during this century. In the 1920s and 1930s they were considered rare at Cedar Bog (Franks, 1931). During this study, raccoons were observed frequently and their tracks were always numerous. This proliferation appears to be the result of a decrease in hunting pressure, and an increase in denning sites, since the number of raccoons in a given area is proportional to the number of dens available (Twitchell and Dill, 1949; Dorney, 1954). Suitable sites include large tree cavities and the burrows of some ground dwelling mammals (Glysel, 1961). However, these are generally scarce in marshy areas. The absence of old den trees and dry ground at Cedar Bog early in this century was noted by

Franks (1931). Ecological succession and maturation of surrounding forests have provided an increase in the number of den sites available to raccoons, and their response appears to have been an increase in population size.

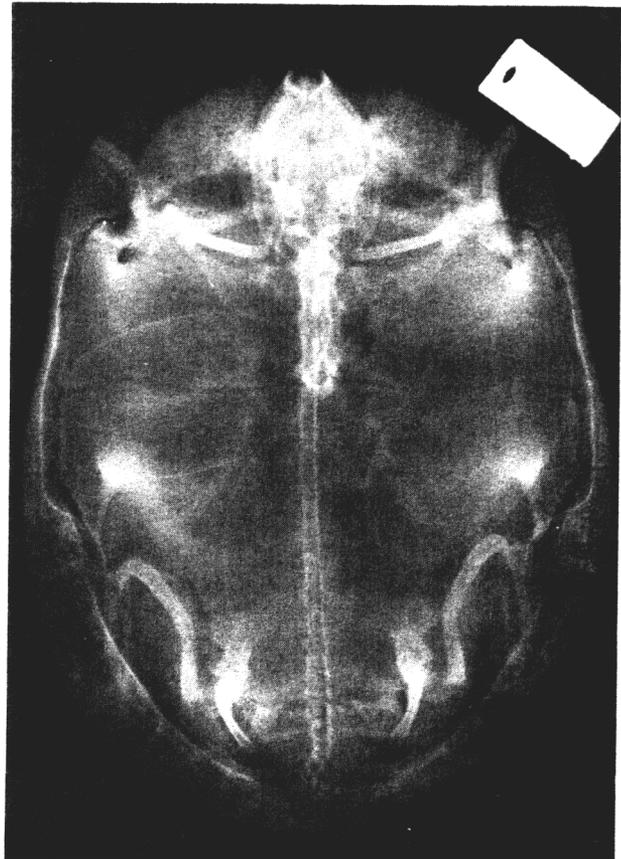
The frequency of predator-related injuries has been used by others to estimate predatory intensity (Rand, 1954; Schoener, 1979; Schoener and Schoener, 1980). However, caution is advised in interpretation since injuries may be more indicative of predatory efficiency than intensity (Schoener, 1979). Raccoons are known to be frequent predators of spotted turtles at all stages from egg to adult (Ernst, 1976). Although raccoons were never directly implicated in the decline of spotted turtles at Cedar Bog, they are considered prime suspects because of their abundance and propensity for eating turtles and eggs (Congdon et al., 1983, 1987; Seigel, 1980).

#### Historical Abundance

Interpretation of Figures 1 and 4 can only be speculative because of collecting bias, but several prominent features are worthy of note. The peaks between 1915 and the 1940s confirm previous statements (Franks, 1931; Conant, 1951) as to the abundance of spotted turtles earlier in this century. Dredging operations in 1910 and the 1930s probably exerted a negative effect, but fairly large numbers could still be collected in 1948. The decrease between 1950 and 1964 probably reflects a lack of intensive collecting

**Figure 2.**

X-ray photograph of UMMZ 112221 (see Appendix) taken 38 years after preservation. Three large eggs can be seen.



effort, and the increase in observations from 1964 through 1977 likely represents a renewed interest and concern for the turtles resulting in increased field work. Given the acute interest in spotted turtles at Cedar Bog after 1977, the decline observed after that date is probably real and not due to any biases.

### Management Recommendations

The historical significance of *C. guttata* at Cedar Bog (Conant, 1951), coupled with the endangered status of the species in Ohio, warrants immediate consideration of viable management programs. This is especially important since the population appears to be declining despite earlier efforts by state officials to preserve what little was left of Cedar Bog. Maintenance of a viable population of spotted turtles at Cedar Bog may depend on a vigorous program of raccoon live trapping and removal. Predator control programs have already proven their effectiveness in decreasing nest destruction and hatchling predation in other turtle species (Christiansen, 1983). However, trapping must be continued on a regular basis to prevent re-establishment of a large raccoon population.

The survival of *C. guttata* at Cedar Bog as elsewhere, depends on maintenance of suitable habitat (Table 1). Invasion and maturation of woody plant species in the bog meadow areas could be arrested by cutting or controlled burns, thus regulating the rate of succession. Small log dams could be placed across tributaries in the upper bog meadow to create more suitable marsh habitat for spotted turtles. Additionally, turtles from nearby localities with more stable populations could be transplanted to Cedar Bog. This approach has already been used successfully in West Virginia (Knight, 1985), where spotted turtle populations are also declining. Finally, these suggestions must be carefully considered in light of the needs of other rare and delicate species at Cedar Bog.

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### Appendix:

Museum specimens of spotted turtles from Cedar Bog, examined by the author.

Museum acronyms are as follows:

AMNH = American Museum of Natural History; CU =

Cornell University; DMNH = Dayton Museum of Natural History; OHS = Ohio Historical Society; OSUM = Ohio State University Museum; FSM = Florida State Museum; UMMZ = University of Michigan Museum of Zoology. Catalog numbers are given and numbers of specimens are in parentheses.

AMNH: 120791-97. CU: 5837. DMNH: 2263, 3194-200. OHS: 15185-87. OSUM: 821-22, 856, 859, 866C(24), 867(4), 952, 1193(2). FSM: Uncatalogued. UMMZ: 112221-230.

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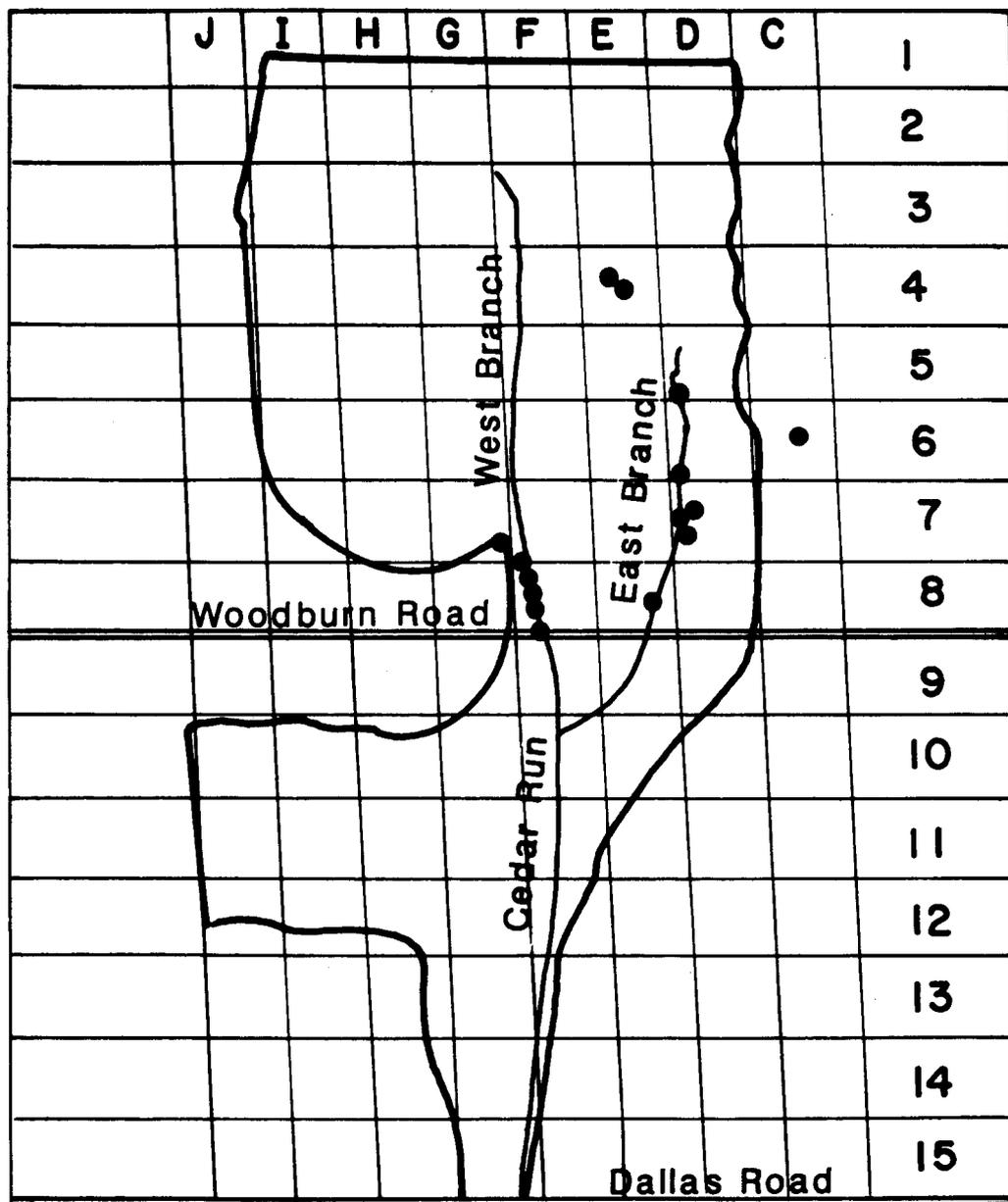
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**Figure 3.**

Map of Cedar Bog State Memorial. Dots indicate locations of sightings and captures of spotted turtles between 1977 and 1987. A questionable record in quadrant C-5 is not included. Records are based on specimens reported in this study and sightings recorded by the refuge manager.



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Figure 4.

Estimated minimum number of spotted turtles at Cedar Bog State Memorial for the years indicated. Dashed line connecting dots is for reference only and does not represent interpolation. Refer to text for further details.

