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Ecology and Status of a Wood Turtle (*Clemmys insculpta*) Population in West Virginia

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ABSTRACT. – Ecological observations were made on wood turtles, *Clemmys insculpta*, from May 1991 to March 1993 in eastern West Virginia. Along a 1.7 km length of river, population structure was estimated to be 46% juvenile, 26% female, and 28% male. Population size was estimated at 287–337, with an estimated density of 19.1 turtles/hectare total habitat. Wood turtles showed rapid growth during their first 7 years, after which growth gradually declined through year 16. Turtles used a variety of habitats, including intensively farmed fields, and overwintered in pools of the river. Mating occurred primarily in water at cool temperatures (< 15°C) during fall or early spring. Most activity from May through September was terrestrial. Feeding began with emergence from water in April and appeared to cease in fall when turtles returned to water. Food items included a variety of invertebrates and vegetation.

KEY WORDS. – Reptilia; Testudines; Emydidae; *Clemmys insculpta*; turtle; ecology; growth; food habits; population density; mating behavior; habitat; West Virginia; USA

Wood turtles, *Clemmys insculpta*, are moderately sized (200 mm carapace length) semi-aquatic turtles of the family Emydidae, which inhabit areas of the northeastern United States and adjacent parts of Canada (Ernst, 1972). They prefer clear-flowing streams or rivers of sandy and rocky substrates, with woodlands or meadows in close association (Harding, 1991; Kauffman, 1992a). Wood turtles overwinter and typically mate in water but during warmer months are primarily terrestrial.

Clemmys insculpta is in decline throughout much of its range due to urban development, habitat destruction, and commercial collecting (Harding, 1991). Most range states have enacted protection for this species and during the last decade its population status has been described in various parts of the range (Lovich et.al., 1990; Harding, 1991; Farrell and Graham, 1991; Quinn and Tate, 1991; Ross et al. 1991; Kauffmann, 1992a; Tuttle and Carroll, 1997).

In West Virginia, *C. insculpta* has been reported only from counties in the eastern panhandle, including Berkeley, Hampshire, Hardy, Jefferson, Mineral, Morgan, and Pendleton (Green and Pauley, 1987; Niederberger, 1993). This represents the southernmost extreme of the wood turtle's range but little has been documented of its ecology or population status in West Virginia, other than anecdotal reports (Llewellyn, 1940; Green, 1948, 1969; Czarhowsky, 1980). The purpose of the present study is to characterize the habitat, movements, growth rates, food habits, and population structure of *C. insculpta* at one site in West Virginia, which may serve as baseline data for future monitoring of its status there.

STUDY AREA AND METHODS

Wood turtles were studied from May 1991 to March 1993. Most observations were made along a 1.7 km length of river in eastern West Virginia. The river flows north to the Potomac River through the foothills of the Ridge and Valley Region east of the Allegheny Front. The exact location of the site is being withheld to discourage commercial exploitation. Turtles were collected by dip net in the river and by hand in terrestrial habitats.

Habitat substrate in the study area is mostly Berks–Weikert association (Curry, 1978); weathered shale, siltstone, and sandstone. During normal flow, this section of the river is a cool, clear-flowing stream with a series of pools 50–100 m long, up to 30 m wide, and 1.0–1.7 m deep. The pools, connected by short riffles, have steep banks, sandy or silty shorelines, and rocky bottoms in the main channel. Most of the terrestrial area near the river is modified by agricultural activity. Cool season grass/legume combinations, alfalfa, and field corn are the major crops, and cattle grazing is common. Some of the pasture and hay fields close to the river support small groves of black walnut (*Jugans nigra*). These create savannah-like overstories with very thick herbaceous understories dominated by orchard grass (*Dactylis glomerata*) in summer. The immediate riparian areas are dominated by a variety of trees including sycamore (*Plantanus accidentalis*), red maple (*Acer rubrum*), and yellow poplar (*Liriodendron tulipifera*). Outer riparian areas also include black walnut (*J. nigra*) and hickory (*Carya* spp.) among others. The mid-understory is dominated by multiflora rose (*Rosa multiflora*) and spicebush (*Lindera benzoin*). The lower understory contains a mix of small herbaceous plants dominated by ground ivy (*Glechoma hederacea*) and bluebells (*Mertensia virginica*) in spring, and reed canary grass (*Phalaris arundinacea*) throughout the summer.

Data recorded for each turtle captured included date, location, weather conditions, air temperature, and water temperature. Sex was determined by presence or absence of

male characteristics including plastral concavity, broad squared head, robust limbs with large scales, and broad tail with cloacal opening posterior to the rear margin of the carapace. These characteristics are evident in males 160–170 mm carapace length or larger. Females generally retain juvenile external characteristics (Harding and Bloomer, 1979). Identification of females was based on age (annulus counts) combined with absence of male characteristics. Turtles less than 9 years old were considered juvenile, although sexual maturity in wood turtles may not be achieved until 13 years (Farrell and Graham, 1991). Age was determined by counting annuli on the medial border of the right abdominal scute. This is a useful aging estimate for wood turtles up to about 16 years, and has been frequently applied in other studies (e.g., Harding and Bloomer, 1979), although the accuracy of this technique in snapping and painted turtles (genera *Chelydra* and *Chrysemys*) has recently been questioned (Brooks et al., 1997). Wood turtles were weighed with a triple beam balance or a Terraillon electronic scale. Maximum straight-line carapace length, width, height, and plastron length were measured with calipers. Each turtle was numbered and marked following a modification of Cagle (1939). Small holes were drilled along the anterior or posterior edge of the carapace or plastron representing a numerical code.

Feeding habits were examined by the stomach flushing technique described by Legler (1977). Specific movement patterns of four adult turtles were observed by means of small (30 g) radio transmitters (Holohill Systems). These were secured to the posterior carapace with nylon straps passing through small drilled holes. Turtles with transmitters were released at their capture site and tracked weekly from June 1992 through January 1993. A hand-held radio receiver (Telonics TRZ) and directional antenna were used to track the signal. Courtship behavior was observed by holding turtles for 1–3 hrs in a wire mesh enclosure (2 m x 0.6 m) placed in the stream so that the floor was approximately 0.3 m under water. Activities were recorded with a video camera. Growth, indicated by carapace and plastron lengths, was determined by direct measurement of recaptured turtles and by age classes which were estimated by counting growth annuli. Population estimates were calculated following Schnabel (1938) and density was estimated for river area and total area (terrestrial and aquatic). The ratio of males to females was tested by chi-square goodness-of-fit.

RESULTS

A total 187 wood turtles was marked and released within the 1.7 km section of the study area from September 1991 through May 1993. Based on number of growth annuli, the youngest individuals which could be distinguished as males were 9 years old. The marked sample was 46% (86) juvenile, 26% (49) female, and 28% (52) male (Fig. 1). Sex ratio, tested by chi-square, was not different from 1:1 ($p > 0.05$). Of 103 recaptures in the study area 45 occurred after sufficient elapsed time (> 2 months during the growing season) to potentially demonstrate growth (Table 1). The growing season was considered to be May through October based on turtle activity, observed feeding, and previous reports (e.g., Farrell and Graham, 1991). Direct measurement of recaptures was obtained for 12 juveniles in eight age classes, 9 males or females in seven age classes, and 24 adults of unknown age (Table 1). Growth estimates were plotted for plastron length and carapace length versus estimated age based on growth rings (Fig. 2). As expected, the curve indicates rapid initial growth which sharply decreases after year 7.

Population size, calculated by the Schnabel index, was estimated to be 200 juveniles (0–8 years), 73 females, and 64 males for a total of 337 turtles. Using the same recapture data for juveniles and adults collectively, the index produced an estimate of 287 turtles. Water surface area of the study area is approximately 0.17 ha, and based on 287 turtles, the density would be 1688 turtles/ha river or 169 turtles/km river. Movements and habitat preference indicated that the terrestrial area utilized was about 15 ha, which suggests a density of 19.1 wood turtles/ha total habitat.

Turtles did not appear evenly dispersed throughout the study area. This was especially evident during winter when

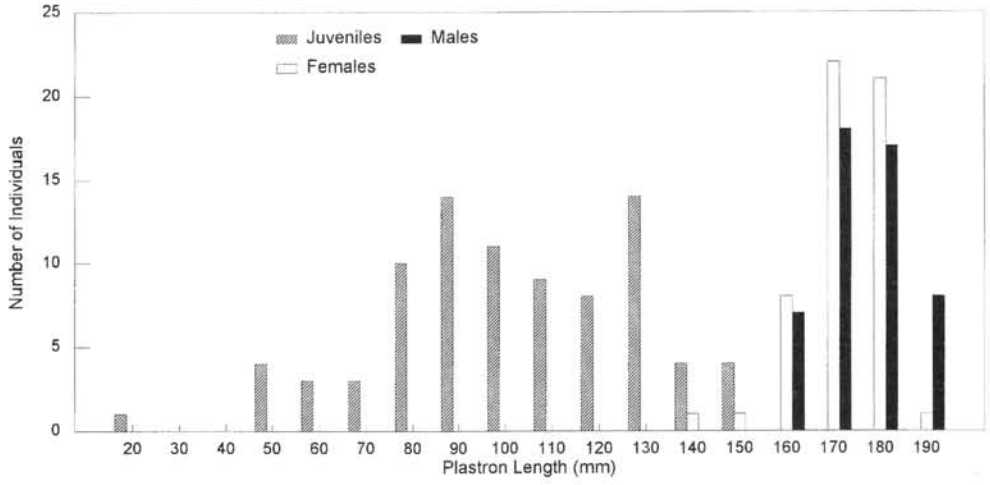

Figure 1. Population size structure (length – frequency distribution) of 187 *C. insculpta.*

Table 1. Growth (mm plastron length) of *C. insculpta* based on 45 recaptures in West Virginia. Twenty-four of the recaptures were undetermined-age adults (plastron lengths 175–222 mm) which showed no measurable growth.

Growth Period Age	Sex	Capture Date	Recapture Date	Elapsed Time (mo)	Plastron Length Capture (mm)	Recapture (mm)	Percent Increase
1	J	06-92	08-92	2	57	70	23
3	J	06-92	08-92	2	86	92	7
3	J	04-92	07-92	3	90	95	6
4	J	10-92	12-92	2	97	97	0
4-5	J	04-92	09-92	5	94	130	14
5-6	J	04-92	12-92	8	114	124	9
5-6	J	04-92	12-92	8	131	140	7
5-6	J	04-92	10-92	6	122	142	8
5-6	J	04-92	10-92	6	130	137	5
6	J	10-91	04-92	6	133	135	2
6-7	J	03-92	10-92	7	137	142	4
7-8	J	03-92	04-93	13	151	159	5
8-9	F	03-92	12-92	9	124	130	2
8-9	F	03-92	12-92	9	163	166	2
9-10	M	04-92	12-92	8	170	175	3
10-11	M	10-91	12-92	14	160	163	2
12	M	03-92	06-92	3	170	170	0
12	F	10-91	03-92	5	178	178	0
12-13	F	10-91	12-92	14	165	165	0
13-14	M	03-92	12-92	9	172	175	1
14-15	M	08-91	10-92	14	165	165	0

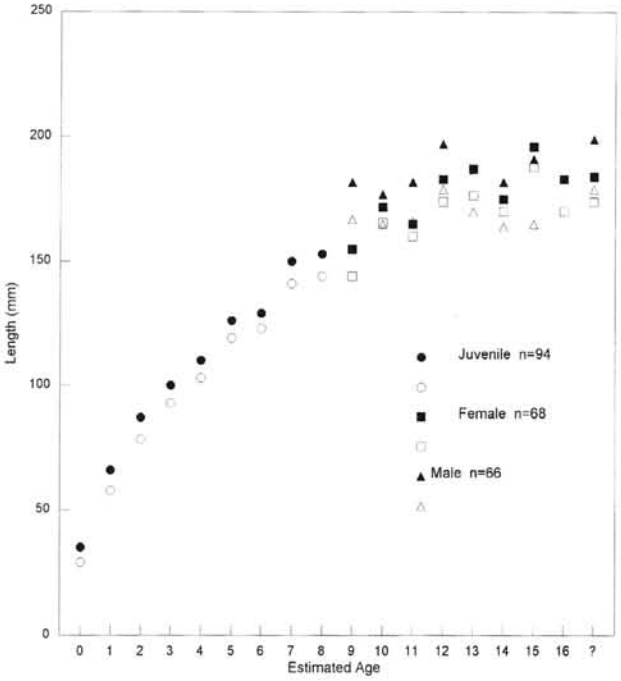

Figure 2. Mean plastron length (open symbols) and carapace length (solid symbols) for each age class (estimates based on numbers of annuli for all *C. insculpta* captured).

the population was strongly concentrated in pools of the river. They were observed wintering (October – March) in water 2–9°C and 0.7–1.0 m deep. Turtles were frequently seen partially covered with silt and laying dormant on the bottom or along bank undercuts with exposed tree roots. During spring and fall sampling, 0.5 km of river accounted for 75% (145) of the captures, including nearly all of the recaptures. Turtles in water were often (> 50%) parasitized by the leech *Placobdella parasitica*. These were usually attached along the anterior plastral seam or at the base of the tail near the cloaca. Brewster and Brewster (1986) also noted leech parasitism in *C. insculpta*. Wood turtles were not observed in terrestrial habitats until early March when air temperature reached 22°C and the river was 9–10°C. Through March and April, turtles periodically returned to the river during cool periods. From May through September in 1991 and 1992, 57 turtles were located in terrestrial habitats (93% of the captures during those time periods) whereas only 4 (7%) were found in water. Overall capture by month was heavily skewed toward spring and fall when turtles were concentrated in or near the river. From June through August, female captures were higher than males (22F:14M) and from September through December more males were located (18F:49M). This appears to coincide with different reproductive activities of the sexes. Females are most active out of water when traveling to nesting sites in the summer and males are more active in fall and winter as they search in the river for mates (Harding and Bloomer, 1979). No apparent difference in frequency was observed during other months.

Four adult *C. insculpta* (two males and two females) were radio-tracked in the study area starting in June and July 1992. Individuals were located approximately every week through October and less frequently through January (Fig. 3). From June through August, these turtles were frequently found in wooded riparian areas and cornfields. Only two sightings (of a single male in August) were in water. After periods of rain, turtles with transmitters made longer movements farther from the river. The greatest perpendicular distance traveled from the river was approximately 200 m, recorded for the two males. During September, all four turtles were located at least once in the river (44% of sightings; water temperature 18–22°C). From October through January all sightings were in water (1–14°C) or on banks immediately adjacent to the river, except for one male located 20 m from the river on 23 October. During winter, turtles with transmitters were generally dormant on the bottom of the river about 1 m deep or lodged in undercuts along the bank. All four turtles changed location within a single pool from December through January, but movements were very limited.

Stomach contents of 16 adults were examined. All 13 turtles examined in terrestrial habitats (May through August) had food in their stomachs. Earthworms were found in 6 (46%) and were the major component in 3 (23%). Beetles, millipedes, and slugs were found in 5 (38%) and were also the major component in 3 (23%). Vegetation was found in 9 (69%) and was the major component in 2 (15%) which contained mostly greenbrier (*Smilax*) leaves. Carrion was the major component in 3 (23%), one of which could be identified as avian. Stomachs of 3 males captured in the river in October, November, and March were all empty.

Mating observed during the study was mostly in water, or at the edge, suggesting that the female had dragged the

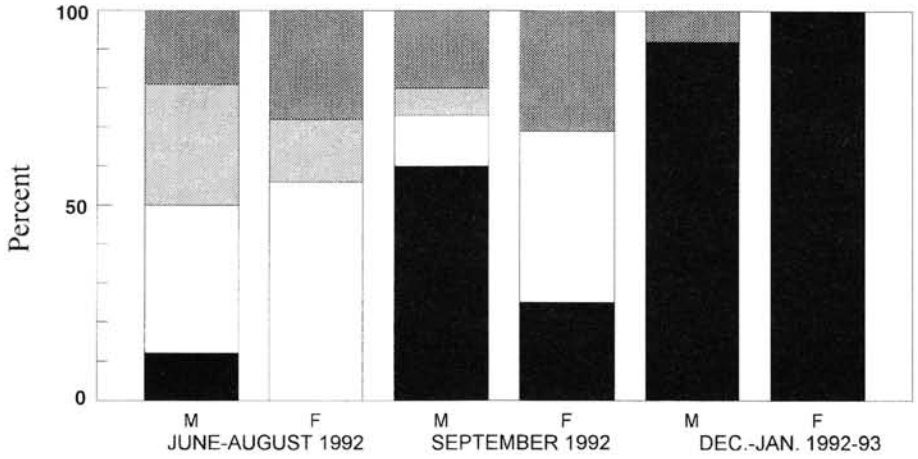

Figure 3. Graph of habitat use shown as percentage of sitings in each habitat for 2 females and 2 males followed weekly by radio-tracking. Black = river; white = riparian hardwoods; dark gray = corn field; light gray = unmowed pasture field.

mounted male out of water. However, one pair of wood turtles was found 14 September (air temperature 30°C) copulating 30 m from the river. Nineteen courting pairs were observed from September through December and four courtship events were seen in March and April. Water temperatures were usually near 10°C. However, one mating was observed in mid-winter (18 January) at 1°C water temperature. Courtship behavior observed for two pairs of turtles held in a wire enclosure in water 14°C indicated males aggressively pursue females by grasping their shell with all four feet, and use a variety of head and neck displays. These displays consist of male turtles "posing" for 30 sec to a minute with the head fully extended, then the head turned to one side or another, exposing the prominent orange skin of the neck, similar to the behavior reported by Barzilay (1980a). In subsequent trials, aggression was noted between males, with one male dominating with open mouth displays and pursuing another apparently subordinate male which moved away. Although nesting was not observed, one female killed by an automobile on a nearby roadway on 9 June contained fully developed eggs.

DISCUSSION

Density of wood turtles (19.1/ha total habitat) at our study site in West Virginia appears to be greater than found for this species in other states. For New Jersey populations, Harding and Bloomer (1979) reported 12.4 turtles/ha and Farrell and Graham (1991) reported 10.7/ha. Tuttle and Carroll (1997) reported 2.6 turtles/ha in New Hampshire but stated their figure may be conservative. Population structure (frequency of juveniles, males, and females) in West Virginia appears to be similar to the New Jersey population reported by Farrell and Graham (1991) and the New Hampshire population reported by Tuttle and Carroll (1997). Males and females are about equal and recruitment indicated by the relatively high percentage of juveniles (46%) appears to be strong. Lower frequency of juveniles in other states (e.g., Michigan; Harding and Bloomer, 1979) presumably indicates populations with lower recruitment and less stable populations.

Habitat utilization by West Virginia *C. insculpta* is similar to that of wood turtles in more northern areas. Wood turtles throughout the range overwinter from October or November through March, mostly in deep pools of streams or rivers (Harding and Bloomer, 1979; Ernst, 1986; Farrell and Graham, 1991; Kauffman, 1992b). Movement from water in late March or early April appears to be mostly influenced by ambient temperature, as is presumably the return of wood turtles to streams in October. The solitary, wide-ranging terrestrial activity observed during summer in West Virginia is fairly typical of turtles in other regions, although northern populations may be somewhat more aquatic (Carroll and Ehrenfeld, 1978; Harding and Bloomer, 1979; Barzilay, 1980b; Ernst, 1986; Brewster and Brewster, 1991).

Clemmys insculpta in West Virginia probably enter winter dormancy with empty stomachs and feed very little or not at all while passing the winter in streams. There are no reports of wood turtles feeding from October through March. During warm periods of the year, when these turtles are primarily terrestrial, earthworms are seemingly the most common food item of West Virginia turtles. Other studies have shown that plant material is much more common (Harding and Bloomer, 1979; Strang, 1983). Considering the relatively small sample, this difference might be the result of moist conditions and availability of earthworms during our sampling periods.

As with wood turtles in Pennsylvania (Lovich et al., 1990), turtles in West Virginia show rapid initial growth to age 9, then slower growth through year 16, with little if any growth thereafter. Farrell and Graham (1991) reported that *C. insculpta* in New Jersey show an increase in growth at ages 8 and 9. We found no evidence for this in West Virginia. Overall, it appears that turtles in West Virginia grow somewhat faster than turtles from more northern populations (Brooks et.al., 1991). Mean plastron length of age classes in West Virginia was about 20 mm longer than those found for the same age turtles in New Jersey (Farrell and Graham,

1991). Faster growth in West Virginia might be attributed to a slightly longer growing season and/or greater abundance of food.

In conclusion, the wood turtle population we studied seems to be robust compared to populations elsewhere, however, the occurrence of *C. insculpta* in West Virginia, even within favorable habitats such as this site, appears to be localized (Niederberger, 1993). The future of this species in West Virginia, as elsewhere, depends upon prohibiting collecting activities as well as habitat protection.

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