REPORT OF ACTIVITIES
2007 TURTLE ECOLOGY RESEARCH REPORT
Crescent Lake National Wildlife Refuge
30 March to 18 June 2007

A report submitted to Project Coordinator Steve Knode and Refuge Manager Neil Powers
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PURPOSE: To continue studies of the natural history and population biology of the yellow mud turtle, the snapping turtle, the painted turtle, and the ornate box turtle on the Crescent Lake National Wildlife Refuge, and the spiny softshell turtle in Blue Creek on the Peterson Ranch near Oshkosh.

METHODS: Techniques were basically the same as those used in previous years, with both the Main Gimlet (900 meters) and Dike Road (200 meters) drift fences in operation throughout the study period. Fyke nets were employed to capture softshells. Two Earlham undergraduate students and one Miami University graduate student assisted me with the field work.

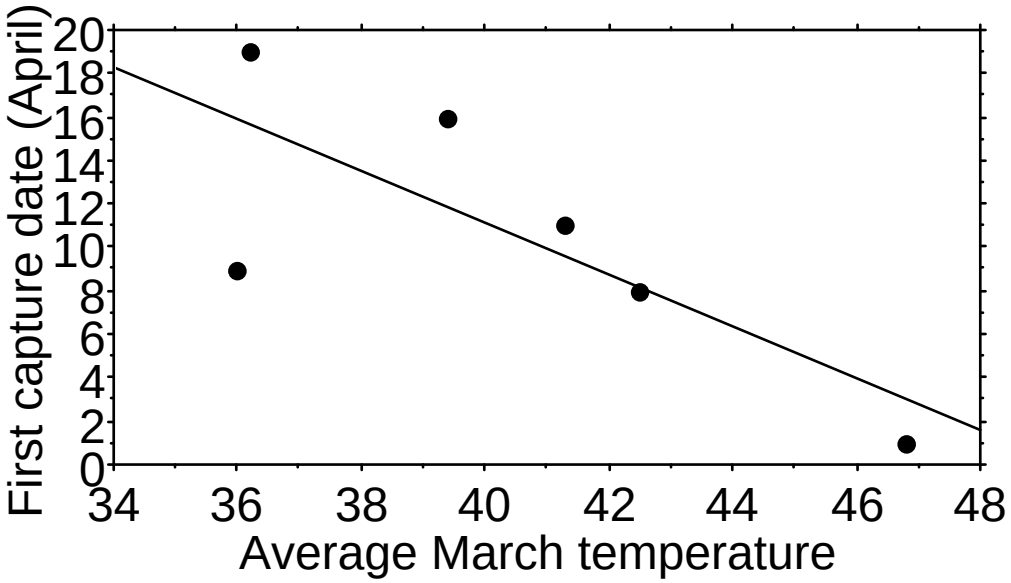
RESULTS:

Mud turtles

The erratic sandhills weather continues to set records which impact mud turtle biology. Besides the record warm March (see below), April was colder than normal and the third wettest April in 37 years (3.47"; versus the 37-year mean of 1.80"). May was the fourth warmest in 37 years, but with normal rainfall; and June was warmer than normal, but was the fifth driest June in 37 years.

As I do about every 7 years (sabbaticals), I arrived at the Refuge early (the end of March this year) in order to erect our fences before any mud turtles left their hibernation sites up in the Sandhills and headed for Gimlet Lake. In previous early years, our first mud turtles left hibernation on 11 April (2000), 16 April (1994), 19 April (1990), 9 April (1988), and 8 April (1986), and so I had hoped that a 30 March arrival would precede any emergence. Unfortunately, March 2007 was by far the warmest March in the last 37 years for which I have records (mean temperature 46.8 F; long-term mean, 37.1; next warmest, 43.6). We captured the first mud turtle on 1 April, followed by 13 more on 2 April and and two more on 3 April. A subsequent snow storm and much below temperatures delayed further emergences until 14 April. The unfortunate possibility exists that some adult mud turtles may have emerged before I

arrived; only future capture records can address that question. As the following figure illustrates, the first emergence from hibernation tends to be related to the average temperature in March ($r = 0.77$; $P = 0.07$).



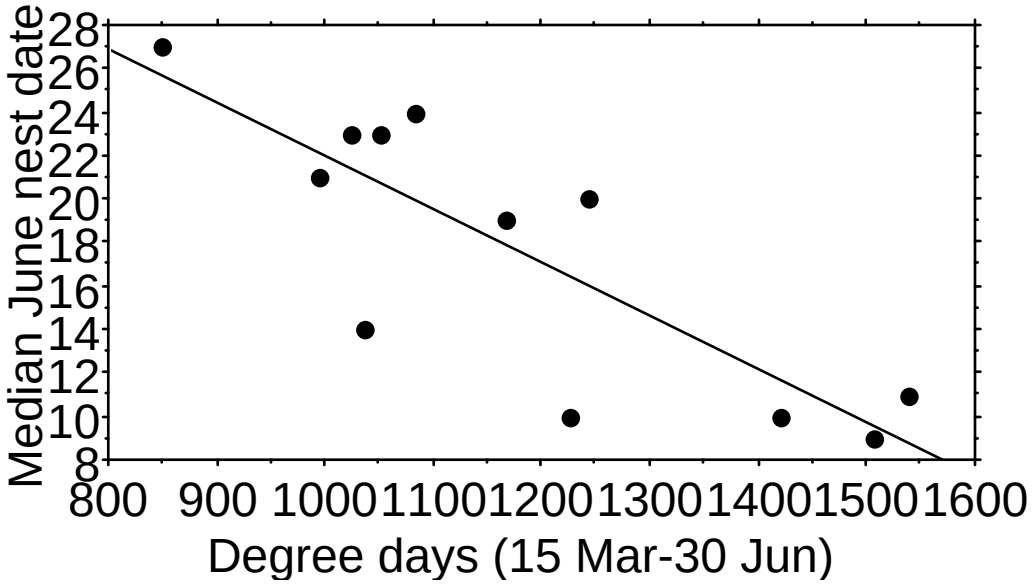
This year we made 1619 total captures of mud turtles, including 497 hatchlings (81 at the Dike fence and 416 at the Main fence), 59 yearlings that had emerged as hatchlings last year, and 65 newly marked turtles (most being juveniles that emerged from hibernation in 2001-2005 before our arrival in May or June those years). Since the study began in 1981, we have individually marked a total of 5008 mud turtles and accumulated 23749 total captures. Virtually all marked turtles less than 37 years of age are now accurately aged.

The first fully gravid females began moving up to nest on 4 June (compared to the long-term average first departure of 7 June (Table 1). Because we returned to Indiana before the nesting season was completed, we were not able to calculate overall nesting season averages this year.

Table 1. Yearly variation in dates of the first female moving to nest, and the median date for all females nesting in a given year.

Year	First female up to nest	Median date of females up to nest
1982	7 June	27 June
1986	29 May	19 June
1988	29 May	10 June
1990	9 June	23 June
1993	1 June	23 June
1994	28 May	9 June
1998	26 May	14 June
1999	9 June	21 June
2000	1 June	10 June
2004	27 May	20 June
2005	9 June	24 June
2006	26 May	11 June
2007	4 June	----

The median date that females leave Gimlet Lake on their nesting foray is related to the number of degree days (>60F) between 15 March and 30 June (see following figure; r = 0.83; P = 0.0009). Females nest earlier in years with warmer spring temperatures.



There has been considerable variation over the years in the number of hatchlings encountered at the fences (Table 2). In springtimes following cold summers (e.g., 1993 and 1994) there was almost no recruitment because the ground temperatures in the previous summer were not warm enough to allow that summer's eggs to hatch before winter (and the embryos died in their eggs). In warm summers, hatching success is greatly improved, and with warming winters there is presumably less over-winter mortality. The result is that despite the recent extremes and changes in climate, the Gimlet Lake mud turtle population is thriving, with good representation of all age classes.

Table 2. Numbers of hatchlings captured at various sections of our drift fences (for full May-June census years only).

Year	Number of hatchlings
1990	335
1993	7
1994	0
1998	728
1999	554
2000	403
2006	548
2007	497

Last summer we attached a Tidbit temperature logger to the shell of two male mud turtles in order to record their body temperatures for the rest of the summer and over the 2006-07 winter. We recaptured both males in April this year, and down-loaded the temperature profiles. The first male experienced its coldest temperatures from mid-January to mid- February when it hovered around 4 C (ca. 39 F). Sudden fluctuations in temperatures occurred on 22-23 March, suggesting that this turtle was beginning to dig toward the surface. It finally dug out completely on 2 April and came down the hill and was captured at our fence. The second turtle reached its coldest temperatures in late February, when it got down to 5 C (41 F). It apparently began digging upward on 28-29 March, and finally emerged on 18 April. The over-winter temperatures for both are quite high, suggesting that they must be buried well below the frost line.

We have observed that individual mud turtles are generally trapped at the same section of the drift fence year after year (some now for 27 years). We have also never had a mud turtle relocate from one of our fences to the other. This suggests that these turtles may have sophisticated orientation abilities. To test the basis of this ability in small mud turtles, we erected two 11 m-diameter circular arenas up in the sandhills where the turtles could not see Gimlet Lake directly. One arena was east of Gimlet and the other was to the north. We then released individually marked hatchlings and two-year old turtles that had been captured at the main and dike fences into the center of the arena. Paper cups buried at ground level around the perimeter of the arenas allowed us to recapture the turtles, and score the direction the moved. Our results suggest that hatchlings are using visual cues (specifically the brightness of the sky over the lake resulting from reflected light) to locate the lake. However, by their second year of life, they have developed a compass mechanism (as yet unknown), and migrate in the direction the would normally need to head to reach the lake, even if it leads them away from the lake in our arenas. The orientation abilities of these turtles are unappreciated and we hope to do further work on the subject in the future.

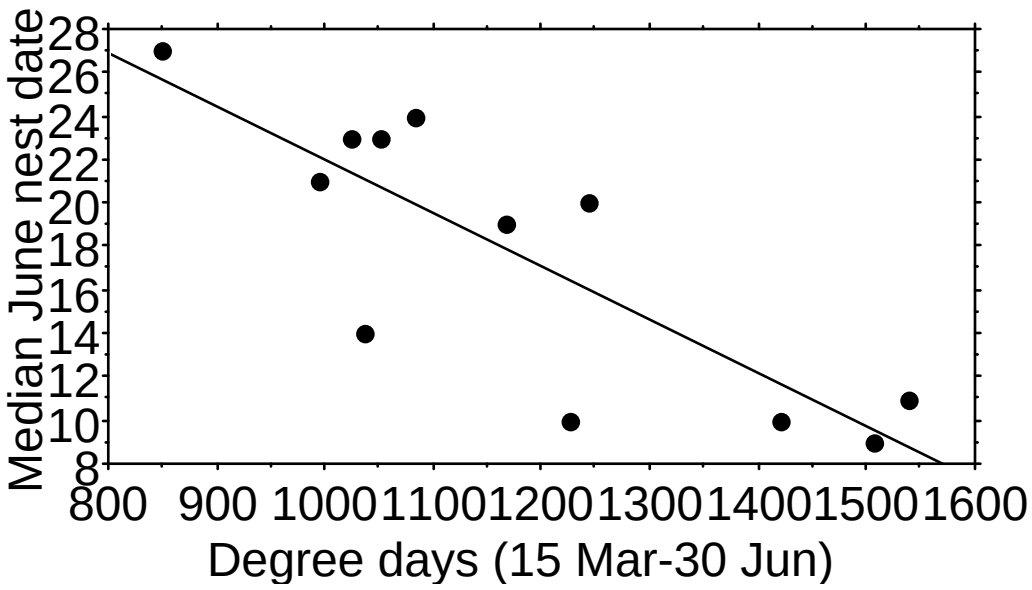
We also captured 30 hatchlings on the side of the Sandhill east of Gimlet as they emerged from hibernation, and marked them on their undersides with paint, and released them where captured. We intended to see how many of them survived until they reached the main fence, hypothesizing that bigger hatchlings would survive that migration better than smaller turtles. However, only two of the 30 did not make it to the Main fence, and they were not among the smaller turtles that we marked.

Snapping turtles

We attempted to capture as many nesting snappers at Gimlet and Island Lakes as possible this year, although this work was secondary to our mud turtle work. Nesting season again began for snappers earlier than usual, because of the warm spring (Table 3). The average nesting date this year (7 June) was also earlier than the long term average nesting date nesting on the Refuge (10 June). Average nesting date is related to how warm the spring is that year (see figure below). We checked clutch sizes in 32 nests at Gimlet and Island Lakes, and the average clutch size across all females seems to be declining in recent years (Table 3). However, because clutch size is positively related to female body size, this pattern is probaby related to the larger numbers of young females nesting in recent years.

Table 3. Variation in nesting season and reproductive output of Nebraska snapping turtles.

Year	Nesting neason (n)	Mean date	Clutch size range (n)	Clutch size mean
1990	11-28 June (7)	18 June	37-73 (6)	54.8
1993	12-28 June (36)	20 June	29-71 (23)	48.3
1994	1-13 June (32)	6 June	31-72 (28)	45.4
1998	6-23 June (14)	11 June	------	---
1999	4-22 June (29)	8 June	9-82 (27)	51.5
2000	29 May-12 June (21)	7 June	37-76 (19)	55.9
2004	29 May-15 June (15)	6 June	35-71 (12)	56.7
2005	7-21 June (36)	14 June	12-76 (33)	49.6
2006	1-11 June (29)	4 June	26-66 (24)	43.2
2007	29 May-14 June (91)	7 June	22-71 (32)	43.7



Painted turtles

During the summer of 2006 we followed 49 females to their nest sites. On completion each of these nests was covered with a wire screen to reduce depredation. On our return at the end of March 2007, we determined that 13 of these nests (26.5%) were depredated despite the wire screens. The remaining 36 nests originally contained a total of 422 eggs. 193 of those eggs hatched during the fall of 2006 (45.7%) and entered the winter in their nests. Because the coldest part of the winter produced nest temperatures as low as -14C, only 77 hatchlings survived the winter (39.9%). Thus, only 18.2% of the original eggs hatched and survived the winter. If the depredated nests are included in this survival calculation, the success rate is only about 13.4%.

Without screen covers, predation rates are generally at least 80%. Thus if 20% of nests are undisturbed in nature, and 45.7% of eggs hatch, and 39.9% of hatchling survive the winter, this suggests that only 3.6% of eggs laid during the summer survive until the following April. However, they still must dig out of the nest and migrate to the water (through a gauntlet of predatory birds), before they can begin to feed and grow.

In hypothetical numbers this means that if 50 nests are laid, each containing an average of 13 eggs (650 total eggs), only 23 hatchlings would be alive in the nest the following March. It is this high mortality that is responsible for the relatively small adult painted turtle population in Gimlet Lake.

We monitored the painted turtle nesting season intensively this year, but for only the first half of the nesting season (2-14 June). We also hand-captured a number of males at our fence lines. We captured a total of 63 individual painted turtles a total of 76 times, including 32 previously unmarked. We marked, protected, and mapped 18 nests for over-winter monitoring; a miniature temperature logger was buried next to each nest to record nest temperatures through incubation

and through the coming winter. As in the past, these nests will be excavated next March (2008) to determine hatchling and overwintering success.

Ornate box turtles

We captured only 88 individual box turtles a total of 178 times. Of these 60 were recaptures from previous years and 28 were newly marked. We have now marked a total of 519 box turtles (2349 total captures). A manuscript summarizing all of our 27 years of reproductive and growth data on this species is nearly completed.

Spiny softshell turtles

As time permitted we trapped for softshell turtles in the Blue Creek drainage near the Myron and Kay Peterson ranch (Campstool Cattle Company, NNE of Oshkosh). We were only able to trap from 25 May to 10 June this year, and were discouraged to capture only three softshells total in Rattlesnake Pond (all previously marked large adult females) despite intensive fyke netting (six 50' arrays). Two of the turtles bore claw or tooth wounds that we believe may be from river otters. We have not previously seen such injuries on turtles from this pond, and wonder if predation rates on softshells in the pond have increased in the last few years. We did collect 18 eggs from two of the females, incubated and hatched them, implanted them with passive integrated transponders (PIT tag), and sent them to the Petersons for release them into their pond. We hope to be able to recapture some of these turtles in the future to establish juvenile growth rates.

FUTURE PLANS:

2008: - late March [JBI and two students to Refuge for 3 days to check nest survivorship from 2007 nests]
- ca. 1 June to 1 July [JBI and wife and perhaps one or two students to monitor painted turtle and snapping turtle nesting seasons]

2009: - late March [JBI and two students to Refuge for 3 days to check nest survivorship from 2008 nests]
- Timing of summer field work in 2008 is still uncertain