

# Population structure of freshwater turtles across North America: An Ecological Research as Education Network (EREN) collaborative project



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## Abstract

**Background/Questions/Methods:** Freshwater turtle populations can be profoundly impacted by urbanization. Adult females may experience high mortality with increased road density near nesting sites, leading to a male-biased population. Juvenile recruitment can be reduced by the high density of predators that often exist in human-dominated landscapes, resulting in an adult-biased population. To determine if the population structure of freshwater turtles follows these patterns at widespread sites with varying degrees of urbanization, over 30 faculty and their students at 26 institutions extending from Massachusetts to Oklahoma conducted a mark-recapture study of turtles inhabiting lentic ecosystems. The research was conceived, organized, and operated through the Ecological Research as Education Network (EREN, [www.erenweb.org](http://www.erenweb.org)). EREN facilitates research and collaboration among students and faculty at primarily undergraduate institutions. Between August and early October 2012, each participant placed a minimum of four hoop traps in each of their respective ponds for at least two consecutive days and marked, measured, and released any captured turtles. We sampled a total of 34 ponds. For each pond with a minimum of ten individuals per species, we used chi-square goodness-of-fit tests to analyze whether the adult sex ratio differed from parity and the juvenile:adult ratio differed from 1:5 for each species.

**Results/Conclusions:** We caught the painted turtle (*Chrysemys picta*), pond slider (*Trachemys scripta*), common snapping turtle (*Chelydra serpentina*), common musk turtle (*Sternotherus odoratus*), smooth softshell (*Apalone mutica*), and common map turtle (*Graptemys geographica*) across 34 ponds. Turtles were not caught in the other five ponds. Only the painted turtle was caught in sufficient numbers per pond to permit the statistical analysis of age-sex class ratio. It was detected in 29 of the ponds, with 17 ponds yielding captures of at least ten individuals. The adult sex ratio was significantly biased towards adult males in 9 ponds and did not differ from parity in the remaining 7 ponds where at least ten adults were caught. The proportion of adult female painted turtles increased with development. A significant deviation from expectation for the juvenile:adult ratio was detected in 3 of the 17 ponds. Significantly more juveniles than expected were caught in 2 ponds. Faculty and students will continue the turtle sampling in fall 2013. As the research continues, we will be able to assess more thoroughly how the population structure of freshwater turtles varies with urbanization across much of eastern North America.

## Introduction

- Freshwater turtle populations are often male or adult-biased [1,2].
- Habitat alterations from human activity are likely causes [3].
  - Raccoons and other generalist predators thrive in suburban areas, which may increase the loss of turtle nests to predation [4].
  - Road-side nesting could make both female and juvenile turtles more vulnerable to road mortality [5].
- Aquatic turtles are vulnerable to population changes because they have low reproductive output, late maturation, and particular habitat requirements of both wetland and terrestrial habitats [4].

We are using the Ecological Research as Education Network (EREN, [www.erenweb.org](http://www.erenweb.org)) to conduct project TurtlePop. Our goal is to determine how the population structure of freshwater turtles varies along an urbanization gradient by engaging faculty and students in collaborative, authentic research.

## Hypotheses:

1. Populations will contain fewer adult females as urbanization increases.
2. Populations will contain fewer juveniles as urbanization increases.



Figure 1. Academic institutions participating in the EREN pilot project TurtlePop in 2012.



Figure 2. Students checking traps and measuring a painted turtle (*Chrysemys picta*) at Elizabethtown College, PA.



## Methods

- Faculty and students at 25 primarily undergraduate institutions and one high school (Figure 1) are conducting a mark-recapture study of turtles as a component of a course lab or independent research.
- Nylon hoop traps (Figure 2) baited with sardines were checked over two consecutive days for each trapping period.
- Each captured turtle was measured, marked, and assigned an age-sex class (adult male, adult female, juvenile).
- Chi-square Goodness of Fit test was used to determine if adult sex ratio differed from parity and the juvenile:adult ratio differed from 1:5.
- Landscape Analysis (ArcGIS 9.3) within 100, 250, 500, 1000, & 2500 m of each pond. Variables included: A) Proportion developed land (National Land Cover Dataset 2006) [6], and B) Road density (State Department of Transportation road layer)

## Preliminary Results

- In our first field season (Fall 2012), several hundred students were introduced to turtle research by sampling a total of 34 ponds.
- We detected 6 species: painted turtle (*Chrysemys picta*), pond slider (*Trachemys scripta*), common snapping turtle (*Chelydra serpentina*), common musk turtle (*Sternotherus odoratus*), smooth softshell (*Apalone mutica*), and common map turtle (*Graptemys geographica*).
- At least 10 individuals of *Chrysemys picta* were detected in 17 ponds. All analyses were based on this species. We excluded a pond if within 1000 m of another studied pond.
  - 9 ponds contained significantly fewer females than expected (Table 1)
  - 3 ponds significantly deviated from the expected juvenile:adult ratio, two having more juveniles than expected (Table 1).
- Landscape attributes were correlated by distance and so only 100 m buffers were analyzed.
- As development within 100 m increased, there were proportionally more adult females in populations ( $F_{1,14} = 6.75, p = 0.02$ , Figure 3a). Road density had no significant effect.
- Proportion of juveniles in the populations was not significantly related to development ( $F_{1,15} = 1.07, p = 0.32$ , Figure 3b) or road density.

Table 1. Results of Chi-square Goodness of Fit test in which adult *Chrysemys picta* female:male ratios were expected to be 1:1 and juvenile:adult ratios expected to be 1:5. Significant deviation from expected is assessed at alpha of 0.05. "NA" refers to too few adults caught to be analyzed.

Institution	State	Number adults caught	Proportion adult female	Significant	Number juveniles caught	Proportion juvenile	Significant
Bridgewater State University	MA	33	0.27	Yes	6	0.15	No
Bridgewater State University	MA	20	0.20	Yes	0	0.00	Yes
Bridgewater State University	MA	22	0.14	Yes	2	0.08	No
Bridgewater State University	MA	11	0.09	Yes	0	0.00	No
Bridgewater State University	MA	22	0.14	Yes	9	0.29	No
Bridgewater State University	MA	21	0.19	Yes	2	0.09	No
Bridgewater State University	MA	34	0.18	Yes	2	0.06	No
High Point University	NC	10	0.10	Yes	3	0.23	No
Hope College	MI	32	0.13	Yes	12	0.27	No
Anoka Ramsey Community College	MIN	13	0.69	No	0	0.00	No
Augustana College	IL	20	0.40	No	3	0.13	No
Beloit College	WI	12	0.58	No	37	0.76	Yes
Elizabethtown College	PA	24	0.50	No	3	0.11	No
Lebanon Valley College	PA	19	0.53	No	0	0.00	No
Moravian College	PA	19	0.47	No	11	0.37	Yes
Mount St. Mary's University	MD	12	0.50	No	6	0.33	No
Rider University	NJ	9	0.56	NA	2	0.18	No

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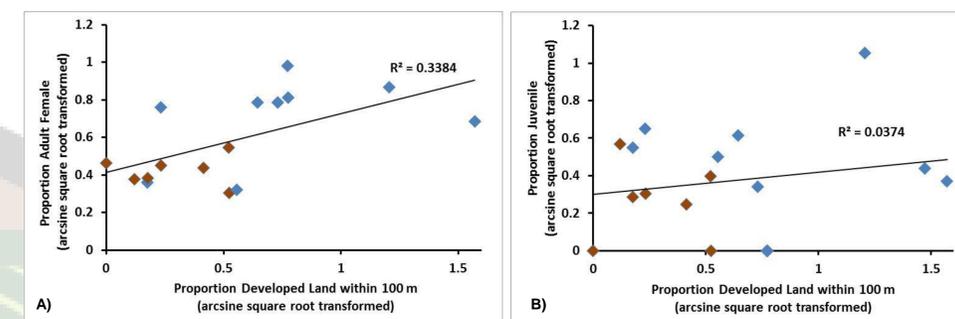


Figure 3. Impact of developed land within 100 m of pond on (A) proportion of adult females and (B) proportion of juvenile *Chrysemys picta*. Points in red represent data from Bridgewater State University in Massachusetts.

## Discussion

**Hypothesis #1:** Populations will contain fewer adult females as urbanization increases.

**Not supported.** We detected the opposite pattern. Adult female *C. picta* were more common in more urbanized landscapes.

**Hypothesis #2:** Populations will contain fewer juveniles as urbanization increases. **Not supported.** We found no relationship between development, road density, and proportion of population that are juvenile *C. picta*. A few ponds contained more juveniles than expected.

Both of these results are counter to much of the literature. These published studies were conducted in single geographic regions of the country. Our study is the first to directly examine how population structure of freshwater turtles varies over a large area, the eastern United States. Our preliminary results are however, strongly influenced by data from multiple ponds in southeastern Massachusetts and may not accurately reflect broader spatial patterns. We will continue turtle trapping in fall 2013 to determine if our results are species-specific, a consequence of relatively small sample size and trapping bias, and if patterns detected at local sites hold true over the eastern United States.

EREN is proving an effective means to gather data on turtles over a large area of the United States. Through TurtlePop, undergraduate students are being introduced to authentic, collaborative ecological research.

## References

1. Browne, C. L., and S. J. Hecnar. 2007. Species loss and shifting population structure of freshwater turtles despite habitat protection. *Biological Conservation* 138:421-429.
2. Gibbons, J. W., D. E. Scott, T. J. Ryan, K. A. Buhlmann, T. D. Tuberville, B. S. Metts, J. Greene, T. Mills, Y. Leiden, S. Poppy, and C. T. Winne. 2000. The global decline of reptiles, déjà vu amphibians. *BioScience* 50:653-666.
3. Marchand, M. N., and Litvaitis, J. A. 2004. Effects of habitat feature and landscape composition on the population structure of common aquatic turtle in a region undergoing rapid development. *Conservation Biology* 18:758-767.
4. Congdon, J. D., Dunham, A. E., and R. C. van Loben Sels. 1993. Delayed sexual maturity and demographics of Blanding's turtles (*Emydoidea blandingii*): implications for conservation and management of long-lived organisms. *Conservation Biology* 7:826-833.
5. Freedburg, S. and D. R. Bowne. 2006. Monitoring juveniles across years reveals non-Fisherian sex ratios in a reptile with environmental sex determination. *Evolutionary Ecology Research* 8:1499-1510.
6. National Land Cover Database. <http://www.mrlc.gov/index.php>.