Turtle Survey Summary from Silver Springs 2023

Prepared by the Florida Springs Institute

Introduction

The Southeastern United States has the one of the greatest diversities of turtles in the world (Mittermeier et al., 2015). Globally, 47% of turtle species are listed as Vulnerable, Endangered, or Critically Endangered. Florida's springs are an important habitat for freshwater turtles due to abundant feeding opportunities (Adler et al., 2018) and nursery habitat (Jackson, 1970). Long term monitoring projects of turtle communities have been established in many of Florida's springs such as Ichetucknee (Johnston et al., 2016), Rainbow River (Marchand, 1942; Meylan et al., 1992), Weeki Wachee (Munscher et al., 2017), Wekiva (Munscher et al., 2022), Volusia Blue (Riedle et al., 2016), Gilchrist Blue (Johnston et al., 2018), Hornsby and Poe (Johnston et al., 2016), Wekiva River (Hrczyzn, 2007), and more.

Due to clear water, springs make optimal habitat for studying turtles. As each species occupies a different niche, they can be useful as indicators of systems health (Meylan, et al., 1992). They are also popular with tourists and thus an important part of the tourism industry of springs which can greatly bring millions of dollars to local economies (Wu et al., 2018).

The goal of this project was to determine the species richness within Silver Springs, estimate the biomass and density of turtles within Silver Springs, and to report on the size, sex, and community demographics.

Materials and Methods

To study the population of freshwater turtles within Silver Springs, we conducted four types of surveys: spot surveys, discrete surveys, synoptic surveys, and basking surveys which are further described below. Turtles were hand captured by experienced turtle surveyors via mask and snorkel.

All turtles were measured using for carapace length max, carapace midline, plastron length max, plastron length midline, carapace width, and max thickness using aluminum tree calipers (Haglöf®). All turtles were massed using an electronic scale (Seattle Alki® 30 kg max capacity, or SurmountWay® 10kg max capacity).

Sex and species were visually determined by experienced scientists based on secondary sex characteristics (Ernst and Lovich, 2009). If the turtle was too young to be sexed, it was noted as a juvenile. Softshell sex was assessed based off if the cloaca extended past the carapace (Moler and Berish, 1995; Ernst and Lovich, 2009). Due to inconsistent results with this method, sex was noted as not definite and no analyses were conducted with Florida Softshell sex.

Sex ratios were based on the total number of captured turtles, excluding recaptures and juveniles. Chi-square goodness of fit tests were utilized to determine if the sex ratio was significantly different from 1:1. Analyses were conducted for *P. nelsoni*, *P. floridana*, *P. concinna*, *S. minor*, and *S. odoratus* based of capture data. A bonferoni correction was applied and sex ratio was considered significantly different from 1:1 when $p<0.01$.

Turtles were PIT tagged within the inguinal region following the methods of Runyan and Meylan, 2005. Snapping turtles were given two PIT tags: one in the inguinal region and one in the tail muscle following the methods of Trauth et al., 1998. PIT tags were read before and after insertion

to confirm operation. All Pond Sliders were removed from the site in accordance with Rule 68-5.001 (Florida Administrative Code). Due to the nonnative status and removal efforts, Pond Sliders were not analyzed as part of our results. Additionally, Suwannee Cooters are nonnative in the system. As Suwannee Cooters are listed by the Florida Fish and Wildlife Conservation Commission as a Species of Special Concern, and their large density (e.g. this study), they were treated as a native species.

We estimated biomass of turtles by first estimated population size using Lincoln-Peterson analyses for species with recaptures. We then multiplied the estimated population size by the average mass and divided by the survey area. For Loggerhead and Eastern Musk Turtles, we looked at capture abundance from a sympatric spring, Rainbow Springs (Meylan et al., 1992). We used the percent difference in captures rates multiplied by the 1990 estimated abundance to estimate abundance in this study. Biomass estimates were calculated using average masses from this study. For Florida Softshell, we followed the same methods as described previous with data from the Santa Fe River (Johnston et al., 2011). Biomass estimates were calculated using average masses from this study. Common Snapping Turtle density was estimated using the density of 0.34 (n/ha; Ichetucknee River) from Chapin et al., 2011. Biomass estimates were calculated using average masses from this study.

Population size estimates were conducted using data from synoptic surveys only (see details below). Total captures and morphological data were assessed from all survey types.

All analyses were conducted in Excel (Microsoft Corporation, Redmond, WA, USA) using the Real Statistics Resource Pack software (Release 8.9.1; copyright (2013-2023) Charles Zaiontz www.real-statistics.com).

Spot Surveys:

Spot surveys were conducted within pre-determined areas. The purpose of this survey technique was to mark and measure as many individuals as possible. Thus, effort was given in areas with anecdotally high densities of turtles. Surveys were not conducted with a time limit and deemed complete as decided by the surveyors.

Surveyors searched and hand captured turtles opportunistically within the predetermined area. Care was given to prevent turtles from escaping the area. If a turtle was seen within the survey area and then swam out, it was pursued and captured. Over 2024, thirty-six spot surveys were conducted.

Discrete Surveys:

A discrete survey was defined when a single or small number of turtles was captured based on the lead scientist's judgement. Reasons for a discrete sample may be unique behaviors or markings, species of special interest, times when we did not follow proper spot survey protocol, and others. During 2023, 15 discrete surveys were conducted for a total of 38 captures.

Synoptic Surveys:

A synoptic turtle survey was conducted from the headspring down to site SS23_36 (Figure 3). The purpose of synoptic surveys was to conduct basic mark-recapture estimates to estimate population makeup. The synoptic survey was conducted over December 2nd and 3rd, 2023. Surveys techniques were replicated over two consecutive days to minimize immigration and emigration of turtles in the survey area. Turtles were ferried back to land for measurements and PIT tags.

Effort was given to start and end the surveys at the same time. The December 2nd survey began at 9:07am and ended at 11:25am for a total survey time of two hours and eighteen minutes. The December 3rd survey began at 8:57am and ended at 11:29am for a total survey time of two hours and thirty-two minutes.

In water captures were conducted by eight swimmers experienced with freshwater turtle surveys.

Basking Survey:

A basking turtle survey was conducted on July 13th, 2023. Two surveyors started from the confluence of Silver River and the Ocklawaha and drove a boat at steerage way speed to the headspring. All basking turtles were recorded, and the species were identified. The surveyors recorded numbers in different sections of the river to compare makeup between the different locations along the river.

Results and Discussion

Between May and December of 2023, we captured and collected morphological data from 741 turtles. We observed four species within the family Emydidae: Suwannee Cooter (*Pseudemys concinna*), Peninsula Cooter (*Pseudemys floridana*), Florida Red Belly Cooter (*Pseudemys nelsoni*), and two subspecies of nonnative Pond Sliders (*Trachemys scripta scripta* and *Trachemys scripta elegans*), two species within the family Kinosternindae: Loggerhead Musk Turtle (*Sternotherus minor*) and Eastern Musk Turtle (*Sternotherus odoratus*), one species within the family Trionichidae: the Florida Softshell Turtle (*Apalone ferox*), and one species within the family Chelydridae: the Common Snapping Turtle (*Chelydra serpentina*). These species represent all of the established turtles that we would expect to see in the Silver Spring. There are additional turtles that may be present but unlikely have established populations such as the Chicken Turtle (*Deirochelys reticularia*) and the Three Striped Mud turtle (*Kinosternon baurii*). We estimated the total turtle density at Silver Springs to be 125 turtles per hectare and the total biomass to be 253.5 kg/ha (Table 14). Due to low recapture rates, the estimated population, density, and biomass of *S. minor*, *S. odoratus*, and *C. serpentina* were estimated using various methods from previous research. The estimations of *S. odoratus*, *S. minor*, and *A. ferox* come with the assumption that the relative capture rates are consistent between surveys. The estimates of *C. serpentina* come with the assumption that density is consistent between surveys. Future research should increase the number and intensity of surveys to more accurately assess the population within Silver Springs. The estimated density is around average compared to other rivers in Florida such as Ichetucknee (31 turtles/ha; Chapin, 2011), Santa Fe River (78.6 turtles/ha; Johnston et al., 2011), Rainbow River (236 turtles/ha; Meylan et al., 1992), and Wekiva River (385 turtles/ha; Hrczyzn, 2007). The Shannon Diversity Index of the estimated population size was 1.56. The species evenness of the estimated population was 0.80.

Community structure was estimated using capture data from discrete, spot, and synoptic surveys, observations from the basking survey, and Lincoln Peterson estimates from the synoptic survey. Capture data are stated and followed by relative abundance in parentheses. Utilizing capture data from discrete, spot, and synoptic surveys, we captured a total of 35 Florida Softshell Turtles (4.6), 3 Common Snapping Turtles (0.4), 244 Suwannee Cooters (33.0), 120 Peninsula Cooters (16.2), 193 Florida Red Belly Cooters (26.1), 106 Loggerhead Musk Turtles (14.3), 29 Eastern Musk Turtles (3.9), and 10 Pond Sliders (1.4). These data are biased by capture survey methods. Often, during hand capture surveys, the most conspicuous turtles are captures which biases the

surveys towards larger species such as the Suwannee Cooter and away from species that spend more time in vegetation such at the Loggerhead Musk Turtle or Florida Red Belly Cooter.

Basking survey data are stated and followed by relative abundance in parentheses. Utilizing data from basking surveys, we observed 115 Suwannee Cooters (41.2), 13 Peninsula Cooters (4.7), and 144 Florida Red Belly Cooters (51.6). These data are biased towards species that bask frequently (mainly Emydid turtles) and away from more aquatic species such as the Kinosternid's, Florida Soft Shell Turtles, and Common Snapping Turtles.

Synoptic survey data are stated and followed by relative abundance in parentheses. During our two-day synoptic survey, recapture rates were used to estimate abundance through Lincoln Peterson estimates. We only had recaptures for three species. The estimated abundance was 174 Suwannee Cooters (30.4), 45 Peninsula Cooters (7.9), and 353 Florida Red Belly Cooters (61.7). Lincoln Peterson estimates may be the best method for estimating abundance of species as they account for sampling bias, however, they cannot be conducted if turtles are not recaptured between sampling events.

We analyzed the sex ratios of *Pseudemys* and *Sternotherus* The male to female sex ratio of *P. nelsoni* was 2.32 which was significantly different than 1:1 (x^2=42.6, df=1, p<0.01). The male to female sex ratio of *P. concinna* was 1.53 which was significantly different than 1:1 (x^2=16.9, df=1, p<0.01). The male to female sex ratio of *P. floridana* was 1.50 which was significantly different than 1:1 (x^2=8, df=1, p<0.01). The sex ratio of *S. minor* was 1.67 which was significantly different than 1:1 (x^2=10.4, df=1, p<0.01). The sex ratio of *S. odoratus* was 1.67 which was not significantly different than 1:1 (x^2=1.3, df=1, p=0.25). Male biased sex rations are commonly observed in freshwater turtles and the divide is continuing to increase due to female road mortality (Gibbs and Steen, 2005). Thus, sex ratios should of turtles within Silver Springs should be studied over time and in response to environmental and anthropogenic variables.

These results suggest a relatively dense population of freshwater turtles within Silver Springs. Populations demographics including relative abundance, total abundance, biomass, and sex ratios should be analyzed over time to determine responses to environmental and anthropogenic variables.

Table 1. Table summarizing biomass and density estimates from synoptic survey data between species. Estimated population size is within the surveyed area. Subscript "A" denotes estimates of population size, density, and biomass were calculated using data from Meylan et al., 1992. Subscript "B" denotes estimates of population size, density, and biomass were calculated using data from Johnson et al., 2011. Subscript "C" denotes estimates of population size, density, and biomass were calculated using data from Chapin et al., 2011.

Species	Estimated Population Size (n)	Estimated Density (n/ha)	Estimated Biomass (kg/ha)
Pseudemys concinna	174	25	85.5
Pseudemys floridana	45	6	16.4
Pseudemys nelsoni	353	50	118.3
Sternotherus odoratus [A]	150	21	1.3
Sternotherus minor [A]	132	19	2.7
Apalone ferox [B]	23	3	25.6
Chelydra serpentina [C]	7	0.34	3.7
Total	884	125	253.5

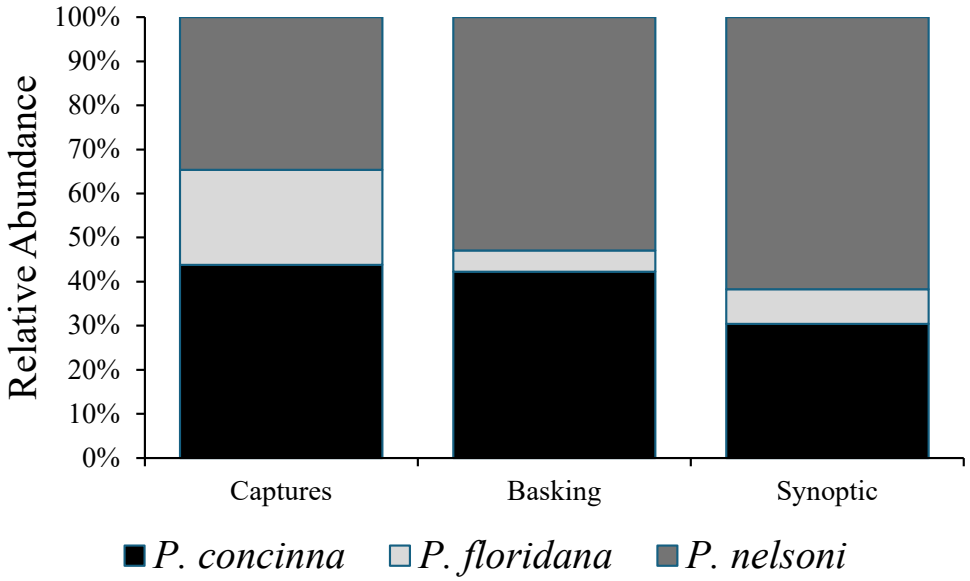

Figure 1. Estimate of Pseudemys relative abundance between survey types.

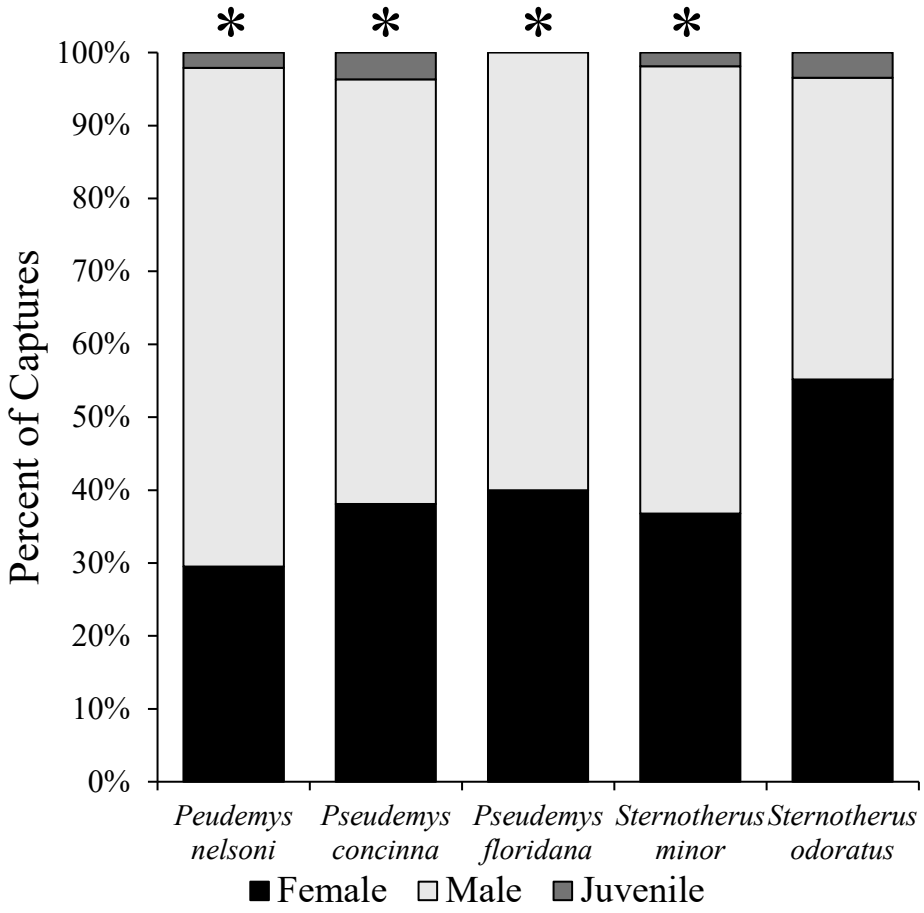

Figure 2. Sex Ratios of turtles captured within Silver Springs. Asterix denotes significant difference from 1:1.

References

Adler, J. M., Barry, S. C., Johnston, G. R., Jacoby, C. A. and Frazer, T. K. (2018) 'An aggregation of turtles in a Florida spring yields insights into effects of grazing on vegetation', Freshwater Science, 37(2), pp. 397-403.

Chapin, K.J. and Meylan, P.A., 2011. Turtle populations at a heavily used recreational site: Ichetucknee Springs State Park, Columbia County, Florida. *Herpetological Conservation and Biology*, *6*(1), pp.51-60.

Jackson Jr, C. G. (1970) 'A biometrical study of growth in *Pseudemys concinna suwanniensis*. I', Copeia, pp. 528-534.

Johnston, G.R., Lau, A. and Kornilev, Y.V., 2011. Composition of a turtle assemblage in a northern Florida blackwater stream. *Florida Scientist*, pp.126-133.

Johnston, G. R., Mitchell, J. C., Suarez, E., Morris, T., Shemitz, G. A., Butt, P. L. and Knight, R. L. (2016) 'The Santa Fe River in northern Florida: effect of habitat heterogeneity on turtle populations', Bulletin of the Florida Museum of Natural History, 54(5), pp. 69-103.

Johnston, G.R., Mitchell, J.C., Shemitz, G.A., Butt, P.L. and Adler, J.M., 2018. Origin and structure of a large aggregation of Suwannee cooters (Pseudemys concinna suwanniensis) in a Florida spring. *Chelonian Conservation and Biology*, *17*(1), pp.54-62.

Marchand, L. J. (1942) A contribution to a knowledge of the natural history of certain freshwater turtles. University of Florida.

Mittermeier, R. A., van Dijk, P. P., Rhodin, A. G. and Nash, S. D. (2015) 'Turtle hotspots: an analysis of the occurrence of tortoises and freshwater turtles in biodiversity hotspots, high-biodiversity wilderness areas, and turtle priority areas', Chelonian Conservation and Biology, 14(1), pp. 2-10.

Munscher, E., Walde, A.D., Walton, E.M., Salvatico, N., Butterfield, B.P., Osborne, W., McAvinchey, C. and Hauge, J.B., 2017. Turtle survey of Weeki Wachee Springs State Park reveals more than mermaid. *Herpetology Notes*, *10*, pp.601-609.

Munscher, E. C., Walde, A. D., Riedle, J. D., Hootman, T., Weber, A. S., Osborne, W., Brown, J., Ross, S., Butterfield, B. P. and Hauge, J. B. (2022) 'Population Metrics for the Perceived Common and Abnundant Pensinsula Cooter and Florida Red-Bellied Cooter in a Florida, USA, Springs Ecosystem', Herpetological Conservation and Biology, 17(1), pp. 51-66.

Riedle, J. D., Kuhns, E. H., Munscher, E. C., Walde, A. D., Salvatico, N., Keserauskis, M., Butterfield, B. P. and Hauge, J. B. (2016) 'The freshwater turtle community at blue spring state park, Volusia County, Florida, USA', Herpetological Conservation and Biology, 11(2), pp. 362-372.

Runyan, A. and Meylan, P. (2005) 'PIT tag retention in Trachemys and Pseudemys', Herpetological Review, 36(1), pp. 45-46.

Meylan, P.A., Stevens, C.A., Barnwell, M.E. and Dohm, E.D., 1992. Observations on the turtle community of Rainbow Run, Marion Co., Florida. *Florida Scientist*, pp.219-228.