Dietary Aspects of an Urban Turtle Community in a Missouri River Tributary: A Stable Isotope and Fecal Approach

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Abstract

Urban streams are influenced by a wide variety of anthropogenic resources. Rush Creek (Platte County, Missouri), a tributary of the Missouri River, has both agricultural and urban inputs in its watershed. Healthy streams should support a robust community of aquatic organisms. In 2021 and 2022, we started monitoring the aquatic turtle community of Rush Creek to determine species composition, morphometrics, and diets within this urban stream. In 2021, four turtle species were collected: red-eared slider (*Trachemys scripta*), western painted turtle (*Chrysemys picta*), common snapping turtle (*Chelydra serpentina*), and spiny softshell turtle (*Apalone spinifera*). Stable isotope analysis of $\delta^{13}C$ and $\delta^{15}N$ of turtle nails showed trophic relationships among species. Softshell turtles fed at the highest trophic level, while painted turtles occupied the lowest trophic level. Snapping turtles and red-eared sliders had a generalist diet with isotope values falling between soft shelled and painted turtles. In 2022, fecal analysis was being incorporated with $\delta^{13}C$ and $\delta^{15}N$ stable isotope of nails. Indigestible material in feces (bones, seeds, and exoskeletons) could show why specialized diets of softshell and painted turtles are widely different, while giving insight into why generalist diets of snapping turtles and sliders span a wider trophic range.

Introduction

Urban streams can be rapidly changing environments showing impacts of climate change and the anthropogenic influence around them (Nelson, et al., 2009). For many aquatic species, climate and anthropogenic manipulation have a negative impact (Nelson, et al., 2009). Unfortunately, it is difficult to predict how climate change and anthropogenic changes combined will affect waterways because both occur on a large scale and are difficult to replicate (Nelson, et al., 2009). Urbanization increases sediment levels and adds chemical pollutants to the water which creates low biotic diversity among macroinvertebrates, a main food component for many organisms (Gál, et al., 2019). Turtles offer insight into stream dynamics as multiple species vary in their dietary habits. Foraging in aquatic systems shows the state of streams, therefore organized diets can be used to assess the quality of waterways.

Aquatic turtle communities possess a variety of foraging strategies from generalists to herbivore and carnivore specialists (Ernst, et al., 1994). Many generalists are opportunistic, giving a high probability for a turtle community to consume a representative sample of prey available in an area.

Aquatic turtles have a limited home range (Rowe, et al., 2010) which implies diets are assessing a limited specific range.

Non-invasive sampling methods such as fecal analysis and stable isotope analysis give clues to overall diet availability. Diets determined by euthanization and dissection do not work well in smaller urban streams because of limited population sizes and potential impact on community dynamics. Fecal analysis gives a single snapshot into turtle diet based on indigestible animal and plant material, i.e. arthropod exoskeleton, seeds, etc. (Caputo and Vogt, 2008). Dietary snapshots will help interpret broader observations obtained from stable isotopes of tissues. Stable isotope analysis of δ^{13}C and δ^{15}N gives an overall look on turtle diets at the time period when tissues were formed. Stable isotope valves of carbon and nitrogen together can show specific diets (Hobson and Clark, 1992), while nitrogen alone gives estimates of trophic levels (Hobson and Welch, 1992).

The goal of my research is to survey aquatic turtle diets in an urban stream. The species focused on are the red eared slider, western painted turtle, common snapper, and spiny softshell. A combination of stable isotope and fecal analysis from a diverse aquatic turtle community should reflect stream prey biodiversity. Although specific prey might not be identified, an overall view of why each turtle species is found at a specific trophic level will show how stream prey diversity changes over time.

Field Methodology and Turtle Processing

Turtle trapping was done from June to September 2021 and June to August 2022 in Rush Creek, a tributary from Weatherby Lake into the Missouri River in Parkville, Missouri (Platte County). Rush Creek is a shallow stream with a muddy bottom. Hoop nets and minnow traps were set approximately 0.5km upstream from the Missouri River. Traps were baited with sardines, and were checked every 24 hours, constituting one trap per night. Turtles were transported to Park University for processing, held overnight to collect fecal matter, and were released the next day at site of capture.

Morphometric data collected from turtles were sex, mass, carapace length, carapace width, carapace depth, and palpated for eggs. Sex was determined by morphological characteristics, such as tail length, whether or not the cloaca went past the carapace, and front nail length. Mass was taken using a spring scale. Carapace width was measured at the frontal plane at bridge, carapace length was measured at the sagittal plane from nuchal scute to posterior edge, and carapace depth was measured from central carapace to central plastron. Nail tips were collected for isotope analysis of $\delta 13C$ and $\delta 15N$. Turtles were marked using a modified shell notching methodology from Cagle (1939, Fig. 1). A 12m PIT tag (Biomark) was also injected with a 12-gauge needle (Buhlmann and Tuberville, 1998).

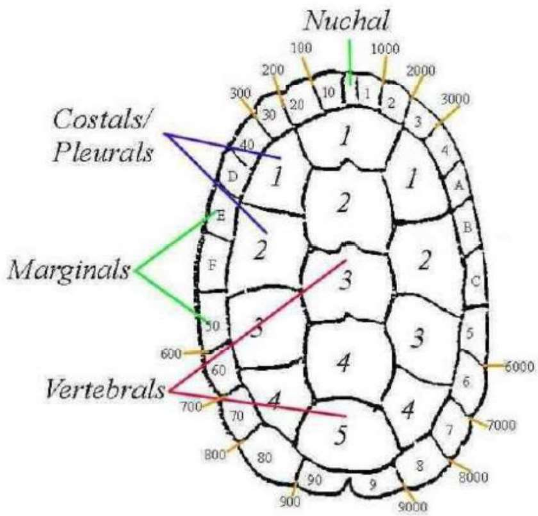


Fig 1. Cagle (1939) notching system.

Fecal Collection

Turtles were kept overnight in plastic tubs with enough water to cover their carapace to collect fecal material. Fecal material was strained from the water and subsequently frozen for later identification. Using a dissecting microscope, qualitative observations were made, and the contents of the fecal matter were sorted into the following categories: plant, animal, and unknown.

Nail Isotope Preparation

Nail clippings were washed twice in a 2:1 dichloromethane methanol solution for 1 minute to remove debris and lipids. Samples were allowed to air dry in a fume hood for 24 hours. Samples were shipped to the University of Arkansas Stable Isotope Laboratory (UASIL) for $\delta 13C$ and $\delta 15N$ analysis.

Results

In 2021, we analyzed the nail clippings for $\delta 13C$ and $\delta 15N$ in red eared sliders (n=40), western painted turtles (n=6), common snappers (n=10), and spiny softshells (n=3). There was no significance in carbon (f=0.45, df=3, p=0.72) or nitrogen (f=1.75, df=3, p=0.174) between the turtle species. There was a trend in nitrogen of western painted<red eared slider, common snapper<spiny softshell (Fig. 2). We compared $\delta 13C$ to mass and $\delta 15N$ to mass and found no correlation (Fig. 3).

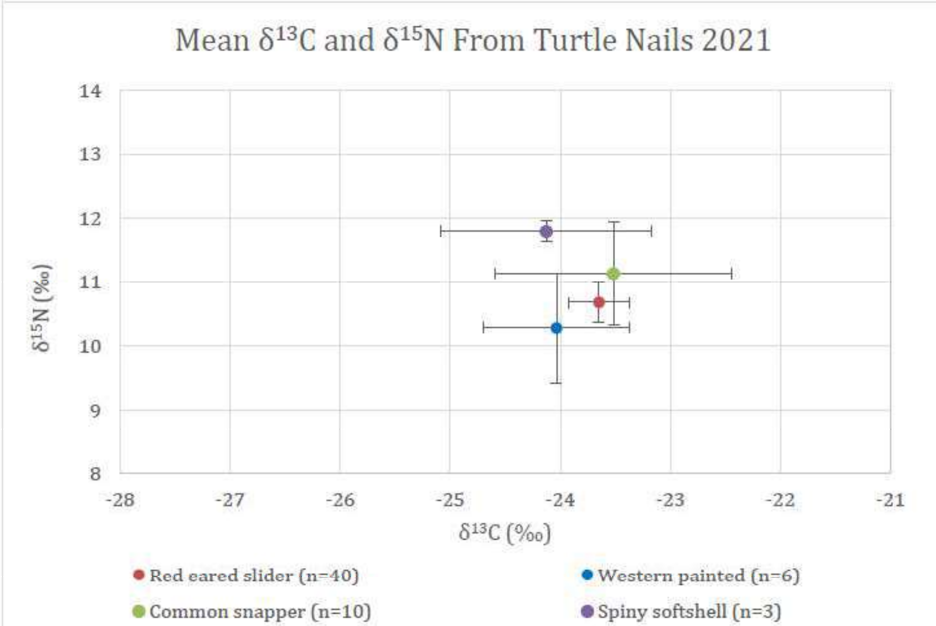
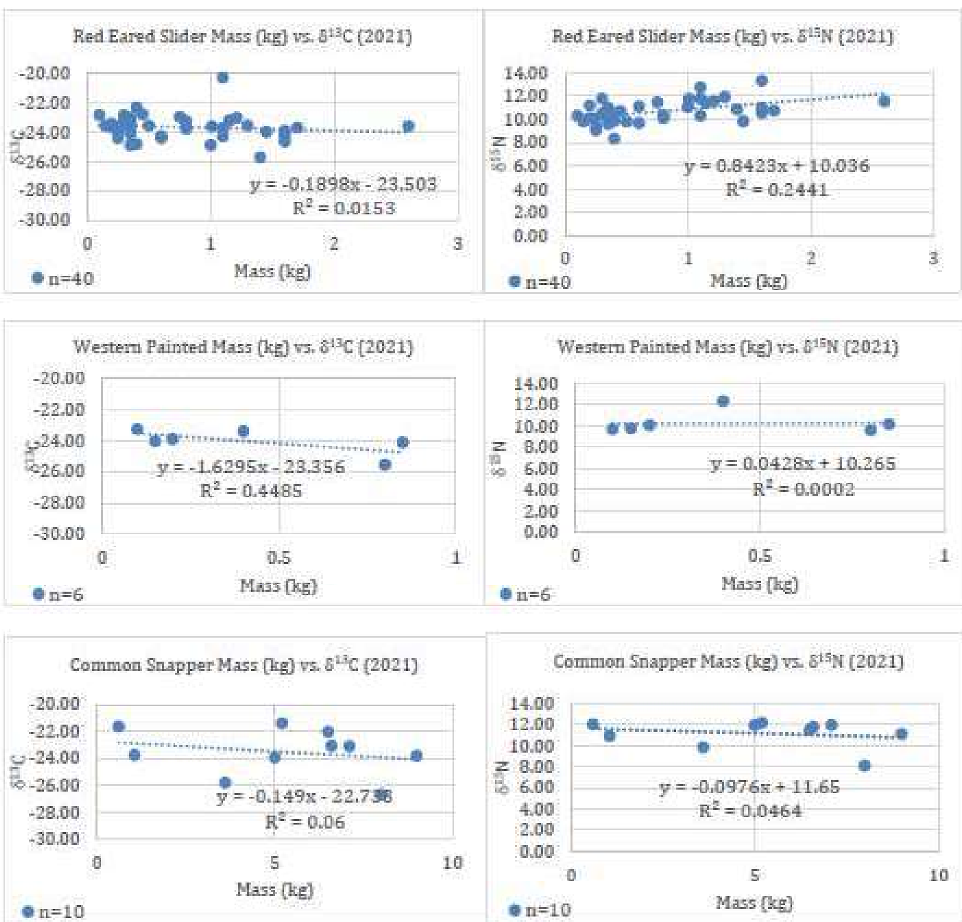


Fig. 2. Mean $\delta^{13}C$ and $\delta^{15}N$ from 2021 turtle nails. 2 standard error bars were used.



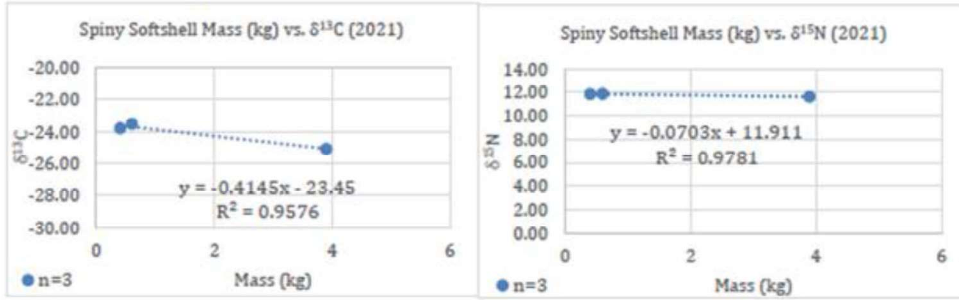


Fig. 3. Mass versus isotopic values, 2021. The left column is Mass (kg) vs. $\delta^{13}C$ and the right column is Mass (kg) vs. $\delta^{15}N$. Rows (from top to bottom) are red eared slider, wester painted, common snapper, and spiny softshell.

In 2022, we analyzed nail clippings for $\delta 13C$ and $\delta 15N$ in the same species: red eared slider (n=30), western painted (n=5), common snapper (n=2), and spiny softshell (n=3). There was no significance in carbon (f=0.23, df=3, p=0.875) or nitrogen (f=2.27, df=3, p=0.096) between the turtle species. There was a trend in nitrogen of red eared sliders<western painted<spiny softshell<common snapper (Fig. 4). We compared $\delta 13C$ to mass and $\delta 15N$ to mass and found no correlation (Fig 5).

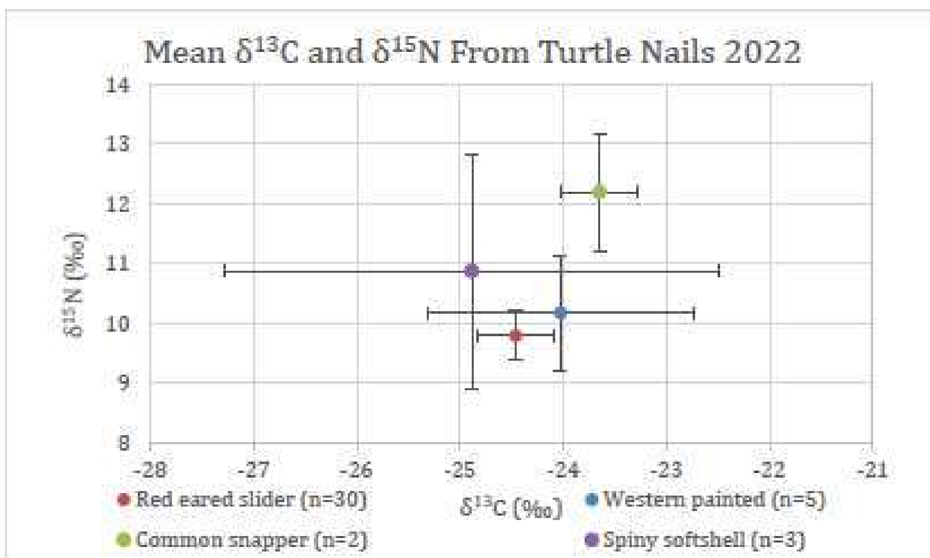


Fig. 4. Mean $\delta^{13}C$ and $\delta^{15}N$ from 2022 turtle nails. 2 standard error bars were used.

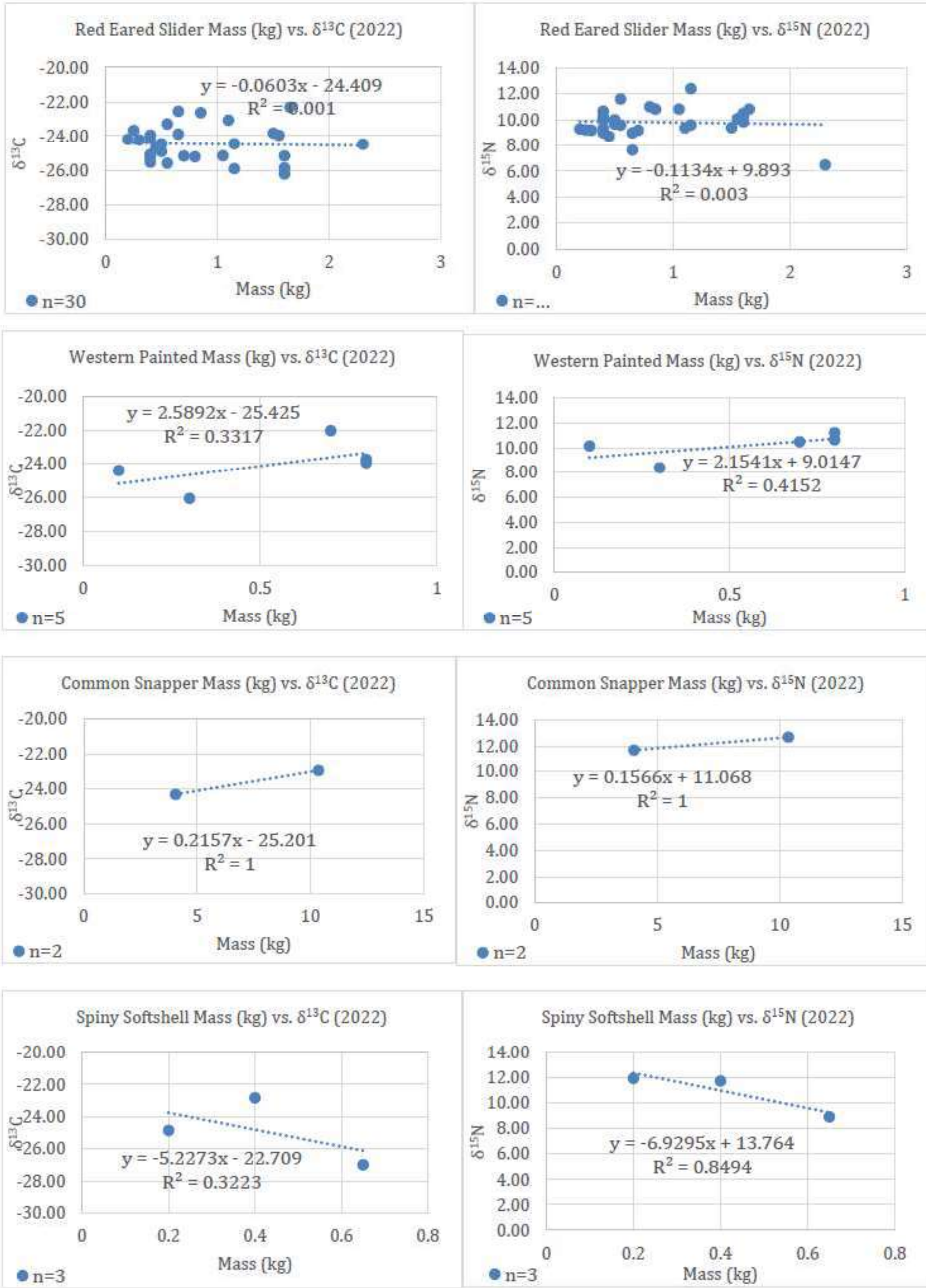


Fig. 5. Mass versus isotopic values. 2022. The left column is Mass (kg) vs. $\delta^{13}C$ and the right column is Mass (kg) vs. $\delta^{15}N$. Rows (from top to bottom) are red eared slider, wester painted, common snapper, and spiny softshell.

Red eared sliders showed a significant difference between the years 2021 and 2022 for carbon ($t=2.15$, $df=71$, $p=0.035$) and nitrogen ($t=3.92$, $df=71$, $p<0.001$). They experienced a trophic level decrease from 2021 to 2022 (Fig. 6).

Fecal samples from 2022 revealed various invertebrates were eaten, such as insects, mollusks, worms, and crayfish. Some plastic pieces were consumed as well. There was evidence of vertebrates being consumed, and this was seen by bone shards found, as well as two different types of vertebrae. 100% of samples collected contained vegetative material, and seeds and insect parts were found in each species (Fig. 7). Mollusk and crayfish parts were found in red eared slider and western painted samples, worms were found in red eared sliders, and vertebrate parts were found in red eared sliders and common snappers (Fig. 7)

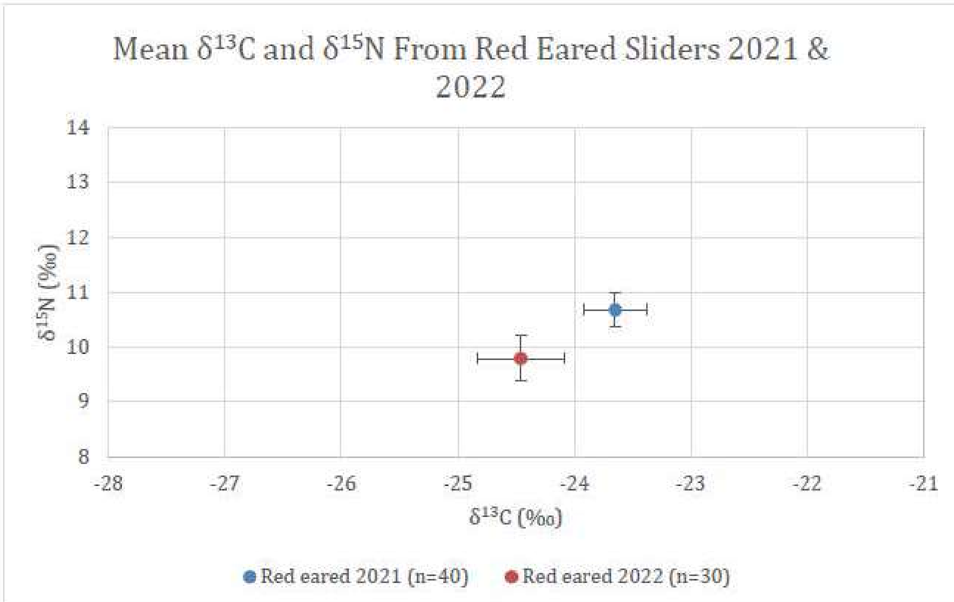


Fig. 6. Mean $\delta^{13}C$ and $\delta^{15}N$ from red eared sliders 2021 and 2022. 2 standard error bars used.

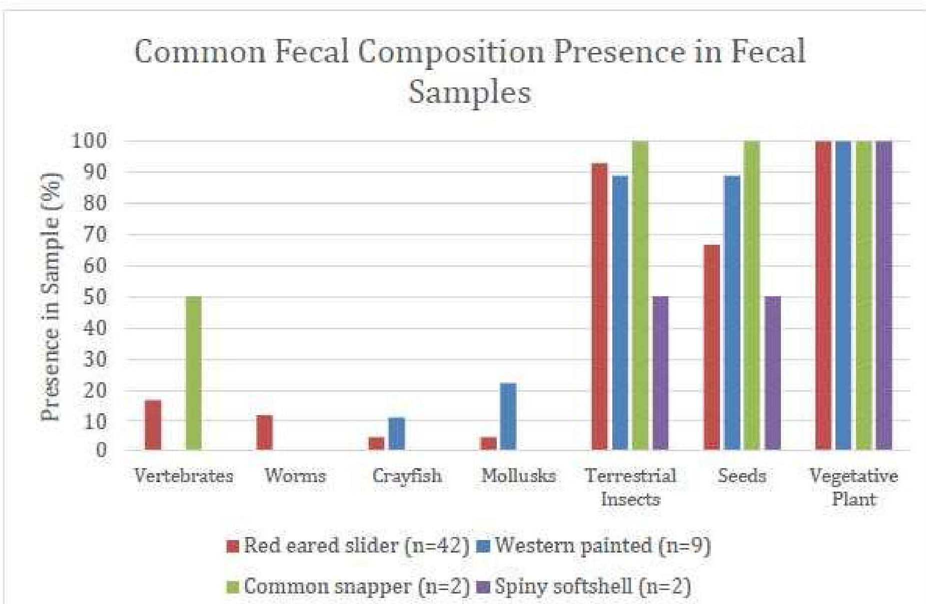


Fig. 7. Common fecal composition presence in fecal sample from 2022.

Discussion

The nitrogen trends seen in 2021 did not remain the same in 2022, and there are a few possibilities for that. This could be a very dynamic community, meaning diets may change from year to year. It is also important to consider the smaller sample sizes some species had.

In both 2021 and 2022, there were low R^2 values when comparing isotope values to mass, meaning there is no correlation between diet and size. It can be implied then that the large variance seen in our isotope analysis graphs is due to diet choice. There were a few species with very high R^2 values, such as the spiny softshell in 2021 and the common snapper in 2022, but this was due to small sample sizes (2021 spiny softshell: n=3; 2022 common snapper: n=2), meaning nothing can be inferred from these graphs.

A statistically significant trophic shift was seen in the red eared sliders, with a decrease in trophic level from 2021 to 2022. We are unsure why this occurred, but the fact that these were adequate sample sizes is promising. More research is needed in the future.

In our fecal snapshot, spiny softshells stayed around the plant level, western painted and sliders were seen consistently eating mollusks and crayfish, while our snapper was seen consuming vertebrates. The only thing that doesn't necessarily make sense was the spiny softshell, as they are a carnivorous species (Ernst, et al., 1994). These results may be odd due to the small spiny softshell sample size, as well as the fact that fecal analysis is just a single snapshot into a meal.

The differing results between the years provide a base of knowledge for these turtle diets. Research will be continued through stable isotope analysis and fecal analysis in the summer of 2023 to continue to build on what is known. Catching more potential prey items for isotope analysis will aid in defining the food web of our environment.

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