

Switch in foraging behaviors by *Nerodia* at a drying pond, and other interesting observations of snakes feeding in southern Kansas

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Foraging Behavior Switch between Months

- At a drying pond in Barber Co., Kansas (Fig. 1), we observed Plain-bellied Watersnakes (*Nerodia erythrogaster*) foraging with open mouths on the surface of the water on 12 August 2022 for Western Mosquitofish (*Gambusia affinis*).



Fig. 1. Small drying pond on the Z Bar Ranch in Barber County, southcentral Kansas, where snakes foraged on Western Mosquitofish. Photo was taken in late September 2022, but in early August the pond was a few meters larger in all directions. (Yes, there is a mist net to capture bats in the picture that measured 9 m in length.)

- Upon return 24 September 2022, all *N. erythrogaster* foraged underwater with closed mouths. The pond shrunk in size by a few meters during that period.
- Why the change in behavior?
- Our plausible explanation: (Do you have others? We would like to know.)
- Density of fish likely increased over the month due to the shrinking area of the pond, assuming the fish population was similar in Aug. and Sept. Less water would result in more fish more fish per unit area during the 2nd observation in September. A higher density of fish per area would make it more profitable now to feed underwater, instead of only atop the water, where top-feeding mosquito fish commonly reside. Success of capturing a fish underwater likely increased with a greater density of fish, potentially leading to a change in behavior.
- During the same length of time (~1.5 h) in Aug. and Sept., starting at dusk at the pond, we observed 4 snakes in August feeding for fish but 12 snakes in September, which also suggested greater or more profitable food resources in September compared to August, hence the increase in snakes.

“Open-mouth” Foraging on Surface

- On 12 August 2022, all 4 *N. erythrogaster* foraged with open mouths on the surface of the water for Western Mosquitofish.
- Four other species of *Nerodia* are known to forage underwater with open mouths (Evans 1942, Gillingham and Rush 1974), but not on the water surface.
- These are the first observations of watersnakes with open mouths foraging on the water’s surface, which make sense as Western Mosquito fish generally concentrate near the water surface.

New Foraging Technique (The Loop)

- Nerodia rhombifer* are noted to locate prey by olfaction and sight (Czaplicki 1975). This and other *Nerodia* also are known to forage with open-mouths to detect fish underwater when in high densities (Evans 1942, Gillingham and Rush 1974).
- We observed *N. rhombifer* and *N. erythrogaster* foraging for fish underwater, at night, with closed mouths. This begs the question “How do they detect fish if it is dark and olfaction likely is impractical with such a high density of fish?”
- We observed a new technique for *Nerodia* to detect fish. Snakes formed a loop just behind their head with their neck, and with a spiraling/sweeping downward motion, changing sides regularly, created a “loop of detection” that when a fish touch the side of the loop, snakes likely can sense and capture their prey in total darkness underwater (Fig. 2). These photos were captured as snakes surfaced.
- This somewhat resembles the behavior of encirclement of fish by *N. rhombifer* (Kofron and Dixon 1980).



Fig. 2. Screen captures from a video of the “foraging loop” created by the head and neck of Plain-bellied Watersnakes while fishing for Western Mosquitofish underwater.

Feeding on Mosquitofish in Kansas

- Three species of snake were observed feeding on Western Mosquitofish at the pond.
- All 3 species are known to eat Western Mosquitofish in other states, but this is the first observation for these 3 species eating Western Mosquitofish in Kansas (Fig. 3-5).



Fig. 3. Plain-bellied Watersnakes eating Western Mosquitofish in Barber County, Kansas.



Fig. 4. Western Ribbonsnake eating Western Mosquitofish in Barber County, Kansas.

Fig. 5. Diamond-backed Watersnake from Barber County, Kansas. We observed this individual feeding on Western Mosquitofish, but we did not get a photograph of it in action, consuming these fish.

No Aggression during Foraging

- Three species of snakes foraged in the pond for Western Mosquitofish on 24 September 2022, the Western Ribbonsnake (*Thamnophis proximus*), Diamond-backed Watersnake (*N. rhombifer*), and Plain-bellied Watersnake.
- Although some species of *Nerodia* and Western Ribbonsnakes consume other snakes (Ernst and Ernst 2003), we saw no aggressive behaviors between the 3 snake species that night (Fig. 6).



Fig. 6. Upper left, a Western Ribbonsnake resting upon a Plain-bellied Watersnake. In other 3 photos, two Plain-bellied Watersnakes touching or near one another while feeding in a drying pond for Western Mosquitofish.

- Other studies show Watersnakes foraging together without aggressive behaviors (Gillingham and Rush 1974), and snakes of different species commonly hibernate together communally ().

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