Food Habits of *Macrochelys temminckii* (Alligator Snapping Turtle) from Arkansas and Louisiana

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Abstract - Food habits of 109 *Macrochelys temminckii* (Alligator Snapping Turtles) collected from Arkansas and Louisiana were studied by examination of stomach and intestinal tract contents from harvested turtles. There was a positive correlation between the turtle carcass mass and the gastrointestinal tract content mass ($r = 0.39106$, $p < 0.0001$). The most commonly occurring prey item was fish, followed by *Procambarus clarkii* (crawfish), molluscs, turtles, insects, and *Myocastor coypus* (nutria). Other mammalian species occurred infrequently, as did snakes, birds, and crabs. Several species (*Dasypus novemcinctus* [armadillo], *Didelphis virginiana* [opossum], *Sciurus* sp. [squirrel], and *Sus scrofa* [hogs]) that have not previously been reported as prey items for Alligator Snapping Turtles were noted. Some prey items were recovered in intestinal tracts that were not observed in stomachs, illustrating the importance of examination of the entire gastrointestinal tract when evaluating food habits in this species. The results suggest Alligator Snapping Turtles are opportunistic scavengers able to consume a wide variety of prey species.

Introduction

Macrochelys temminckii Harlan (Alligator Snapping Turtle) is a large, secretive freshwater turtle found in rivers of several southeastern states (Ernst et al. 1994, Lovich 1993, Pritchard 1989). Limited population data exist, but all range states have enacted laws to limit commercial take of this species, valued for its meat (Buhlmann and Gibbons 1997, Levell 1997, Roman et al. 1999) and thus possibly over-harvested. Recent work in several states has been undertaken to conduct intensive surveys on distribution and population status, including Arkansas (Wagner et al. 1996), Florida (Moler 1996), Georgia (Jensen and Birkhead 2003), Louisiana (Boundy 2003, Boundy and Kennedy 2006), and Oklahoma (Riedle et al. 2005). Alligator Snapping Turtles are difficult to study in the wild due to their rarity, secretive nature, and tendency to remain dwelling on the bottom in aquatic habitats with only infrequent basking (Zappalorti 1976). It is thought that increased harvest in the last several decades has depleted populations throughout the range (Roman et al. 1999). The United States Fish and Wildlife Service (USFWS) listed the Alligator Snapping Turtle as an Endangered Species Act Candidate in 1991 (USFWS 1991), although in mid-1999, the USFWS concluded that *M. temminckii* did not warrant

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listing under the Endangered Species Act (Boundy 2003). As of December 2004, when a ban on commercial take of *M. temminckii* was enacted in Louisiana, this species cannot be harvested from the wild commercially anywhere in its range (Boundy and Kennedy 2006). The species is now listed as CITES Appendix III.

Numerous anecdotal reports exist on the food habits of this rare species, but few detailed studies have been published on the diet of the Alligator Snapping Turtle. It has been said that "there is astonishingly little scientific information on the food of this species" (Pope 1939), and in particular "few stomachs of wild juvenile *Macroclemys* have been examined" (Pritchard 1989). Dobie's dissertation (1966) on the reproduction and growth of the Alligator Snapping Turtle included a table listing food analyses of 32 of 231 *M. temmincki* from several states, although the majority were collected from two sites in Louisiana (Manchac and Jonesville). Sloan et al. (1996) evaluated stomach contents from 65 adult *M. temminckii* collected from March to October 1986. Most specimens were harvested in Louisiana; a few were from Arkansas and Mississippi. Harrel and Stringer (1997) evaluated the fish species recorded as Alligator Snapping Turtle prey by identification of otoliths collected from scats of 24 turtles live-captured in northeast Louisiana and held in captivity.

Prior to the ban on commercial harvest of Alligator Snapping Turtles in Louisiana, we had the opportunity to collect viscera from processed wild-caught Alligator Snapping Turtles, including juveniles from several sites. Any additional detailed information on this species might be useful to wildlife biologists attempting to manage or enhance habitats to conserve the Alligator Snapping Turtle.

Materials and Methods

Alligator Snapping Turtles were caught by commercial trappers in southeastern Arkansas (n = 52: 19 males [M], 32 females [F], 1 unknown sex [U]) and Louisiana in June, July, and August of 1993, and from Louisiana in 1994. Eighteen samples were obtained from Louisiana in 1993; fourteen (6M, 5F, 3U) were categorized as being from north Louisiana, six of these were caught in the Lake Providence area in East Carroll Parish. Four *M. temminckii* were trapped near the Pearl River (1M, 1F, 2U), which borders Mississippi. All samples from 1994 (n = 38: 10M, 15F, 13U) were trapped near Venice, LA in Plaquemines Parish during May. A single sample of unknown sex was obtained in spring 1997 from the Atchafalaya River system near Butte LaRose in St. Martin Parish. Body mass was obtained on 92 of the 109 specimens (average as follows [kg ± SEM]: 19.72 ± 1.00 [SE Arkansas], 17.57 ± 2.30 [Venice], 15.28 ± 3.22 [North Louisiana], and 5.57 ± 1.72 [Pearl River]). No body mass was available for the Atchafalaya River specimen.

All specimens (except the one Atchafalaya River specimen) were obtained from commercial processors in Louisiana. Interviews with trappers and processors revealed turtles were generally caught in baited hoop nets or on baited hooks or trotlines. Often, a number of turtles were delivered to a processor and held in a storage tank for several days prior to processing. Viscera were collected and frozen for later analysis. Viscera were later thawed, and the stomach and intestinal tracts were examined separately for content analyses. Contents were rinsed over a sieve and items (prey and non-food) identified, sorted, and weighed to the nearest 0.01 gram. If present, endohelminths were counted and preserved in 70% ethanol for another study (West et al. 2000). Often, exact identification of prey items was impossible due to extensive digestion having occurred, but stomach/intestinal contents could be sorted into general categories (turtle, mollusc, etc.). Miniscule stomach and intestinal contents were categorized as unidentifiable.

Table 1. Alligator Snapping Turtle stomach and intestinal contents by site. Results are shown as the percent frequency occurrence, and the sample size or number of occurrences is in parentheses.

Prey item	Southeast Arkansas (52)	Venice (38)	North Louisiana (14)	Pearl River (4)	Atchafalaya River (1)
Invertebrates					
Crab		5.26 (2)			
Crawfish	30.77 (16)	92.11 (35)	35.71 (5)		
Mollusc	42.31 (22)	68.42 (26)	14.29 (2)	50.00 (2)	
Insect	15.38 (8)	39.47 (15)		25.00 (1)	
Vertebrates					
Carp	40.38 (21)		28.57 (4)		
Catfish	5.77 (3)				
Gar	9.62 (5)	42.11 (16)			100.00 (1)
Fish, unidentified	75.00 (39)	86.84 (33)	85.71 (12)	50.00 (2)	100.00 (1)
Bird, unidentified		10.53 (4)	7.14 (1)	25.00 (1)	
Snake	5.77 (3)	10.53 (4)			
Turtle	42.31 (22)	15.79 (6)	28.57 (4)	25.00 (1)	
Armadillo	1.92 (1)				
Muskrat	1.92 (1)				
Nutria		60.53 (23)			
Opossum	1.92 (1)				
Hog	3.95 (2)				
Raccoon	1.92 (1)				
Squirrel	1.92 (1)				
Mammal, unidentified	11.54 (6)	2.63 (1)	25.00 (1)		
Bones, unknown	13.46 (7)	18.42 (7)	14.29 (2)		
Eggs/membranes	1.92 (1)	15.79 (6)			
Other					
Vegetation	100.00 (52)	100.00 (38)	92.85 (13)	100.00 (4)	100.00 (1)
Unidentifiable matter	92.31 (48)	100.00 (38)	100.00 (14)	100.00 (4)	100.00 (1)
Endohelminths	67.31 (35)	76.32 (29)	42.86 (6)	75.00 (3)	
Non-food	15.38 (8)	36.84 (14)	35.71 (5)	25.00 (1)	

Results

Fifteen of the 109 stomachs examined were empty; only one intestine was empty. As expected, there was a positive correlation between the body mass and the gastrointestinal tract content mass (Pearson correlation coefficient $r = 0.39106$, $p < 0.0001$, $n = 93$ pairs). The percent frequency occurrence (percentage of samples containing the prey item) for prey items at each site is shown in Table 1. Table 2 shows the percent frequency occurrence for all sites combined, as well as the average prey mass and range for each prey item (stomach and intestinal contents combined).

Fish were the most common prey items at all sites (Tables 1 and 2) and occurred in 79.82% of the gastrointestinal tracts examined. Some of the fish species found were *Cyprinus* sp. (carp), *Lepisosteus* sp. (gar), and *Ictalurus* sp. (catfish). Fish were almost certainly overrepresented, as fish (including carp; B. Harrel, US Fish and Wildlife Service, Frankfort, KY, pers. comm.) are often used as bait to trap turtles; however, fish are clearly an important food item for this aquatic species.

Table 2. Alligator Snapping Turtle stomach and intestinal contents combined, for all sites combined.

Prey type	Percent frequency occurrence (of 109 samples)	Prey mass	
		Average (g) ± SEM	Range (g)
Invertebrates			
Crab	1.83	0.94 ± 0.59	0.35–1.53
Crawfish (*Procambarus clarkii*)	51.38	9.32 ± 1.82	0.01–59.32
Mollusc	47.71	3.53 ± 1.93	0.01–97.46
Insect	22.02	0.30 ± 0.10	0.01–1.78
Vertebrates			
Carp (*Cyprinus* sp.)	22.94	110.95 ± 26.39	3.31–477.84
Catfish (*Ictalurus* sp.)	2.75	21.96 ± 20.36	0.18–62.60
Gar (*Lepisosteus* sp.)	20.18	68.09 ± 19.90	0.07–334.23
Fish, unidentified	79.82	26.47 ± 6.73	0.01–387.12
Snake	6.42	16.74 ± 6.40	1.84–50.62
Turtle	30.28	16.66 ± 6.58	0.11–184.82
Bird	5.50	3.51 ± 2.00	0.02–12.59
Armadillo (*Dasypus novemcinctus*)	0.92	123.62 (n = 1)	123.62 (n = 1)
Muskrat (*Ondatra zibethicus*)	0.92	133.80 (n = 1)	133.80 (n = 1)
Nutria (*Myocastor coypus*)	21.10	273.76 ± 41.73	18.15–647.00
Opossum (*Didelphis virginiana*)	0.92	44.33 (n = 1)	44.33 (n = 1)
Hog (*Sus scrofa*)	1.83	18.81 ± 16.85	2.01–35.61
Raccoon (*Procyon lotor*)	0.92	26.68 (n = 1)	26.68 (n = 1)
Squirrel (*Sciurus* sp.)	0.92	252.26 (n = 1)	252.26 (n = 1)
Mammal, unidentified	7.34	5.53 ± 2.78	0.01–20.30
Bones, unidentified	14.68	10.08 ± 7.67	0.08–123.96
Eggs/membranes	6.42	3.21 ± 0.89	1.24–8.12
Other			
Vegetation	99.08	40.12 ± 8.27	0.01–662.07
Unidentified matter	96.33	9.49 ± 1.21	0.01–75.89
Non-food	25.69	2.71 ± 0.58	0.02–12.15

Procambarus sp. (Crawfish) were the next most commonly taken prey category (51.38% occurrence; Table 2). This was due to the high occurrence from the Venice samples (92.11%, Table 1), with only 30.77% and 35.71% of the SE Arkansas and North Louisiana samples, respectively, having crawfish.

Molluscs and turtles were the third and fourth most frequent prey items (Table 2) and occurred at all sites (Table 1), with the exception of the single sample from the Atchafalaya River. One specimen from SE Arkansas contained remains of at least six turtles, another contained remains of at least three turtles, and several had consumed at least two turtles. In general, only portions of the carapace or mandible remained, thus precluding further identification; however, one *Graptemys* sp. was recovered, and two specimens thought to be *Trachemys scripta* were noted.

Unidentified insect remains occurred in 22.02% of all gastrointestinal tracts studied, but as expected, amounted to a very low amount of the average prey mass (average = 0.30 ± 0.10 g, range = 0.01–1.78 g).

Myocastor coypus Kerr (nutria) was the sixth most frequently occurring prey item (21.10% of all 109 samples; Table 1), but only occurred in the samples from Venice (60.53% of 38 samples). Nutria was also highest in terms of the average prey mass (273.76 ± 41.73 g, range 18.15–647.00 g) and was the single heaviest prey item consumed (Table 2).

Several mammalian species were rarely taken, and only in the samples from SE Arkansas. Mammals that were found once included: *Dasypus novemcinctus* Linnaeus (armadillo), *Ondatra zibethicus* Link (muskrat), *Didelphis virginiana* Linnaeus (opossum), *Procyon lotor* Storr (raccoon), and *Sciurus* sp. Linnaeus (squirrel). *Sus scrofa* Linnaeus (hogs) were found in two of the 52 specimens from SE Arkansas, and a few instances of unidentified mammals occurred from SE Arkansas, Venice, and North Louisiana (Table 1). Unidentified bones were often seen (Table 1 and 2) that were probably mammalian, but could have been turtle remains and were thus categorized separately.

Snakes occurred in 6.42% of all samples; four instances were seen in the Venice samples (10.53%), and the other three were from SE Arkansas turtles (5.77%). Due to their soft body parts and state of digestion, snakes generally could not be more specifically identified, except two samples thought to be *Nerodia* sp. (by the remaining scales) and one *Regina rigida* Say (Glossy Crayfish Snake).

Birds were also taken infrequently (5.5% of all samples); four were recovered from the Venice collections and one each from North Louisiana and the Pearl River. In one sample from the Venice subset, the lobed bird's foot suggested the bird taken was a marsh wading bird, possibly a gallinule or rail.

Crabs were rare findings, with only two instances from the Venice samples, and accounted for only 0.94 ± 0.59 g prey mass.

A few cases of eggs/inner eggshell membranes were also noted; presumably they were from turtles or birds, but due to digestion they could not be classified further.

Vegetation was seen in 99.08% of samples examined, and may have been purposefully ingested (acorns) or taken incidentally while foraging for other prey. Various stems, sticks, leaves, seeds, roots, vines, and acorns were recovered; one stomach contained 662.07 g of vegetative material.

Non-food items were seen in 25.69% of all samples. Usually, this consisted of string and a fishing hook, which was the means by which the specimen was caught. Rocks, pebbles, stones, and/or mineral fragments were seen in one stomach and eight intestinal tracts. One stomach contained about half of an artificial fishing bait (plastic worm). Two intestines contained pieces of glass, one contained a piece of black thread, and another contained a 4.18-g piece of aluminum foil.

Endohelminths were noted in 73 of the 109 samples examined; the highest number recorded in a single turtle was 338 in the intestine of a turtle from SE Arkansas. The percent frequency occurrence of endohelminths is shown in Table 1. The actual numbers of endohelminths present by location (stomach and intestinal contents combined) were 49.74 ± 11.54 (n = 35, SE Arkansas), 23.07 ± 4.06 (n = 6, Venice); 20.00 ± 8.34 (n = 3, Pearl River), and 9.66 ± 4.06 (n = 6, North Louisiana). Endohelminths were recovered in far higher numbers from intestinal contents (35.21 ± 6.21 endohelminths per intestine, n = 70) than stomachs (7.88 ± 2.52 endohelminths per stomach, n = 8) for all sites combined. Endohelminths identified were three species of acanthocephalans and four nematode species; all except one were new records for *M. temminckii* (West et al. 2000).

The average number of different prey item types (excluding unidentified matter and non-prey items) observed in stomachs was 2.28 ± 0.12 (n = 90), and 4.13 ± 0.17 for intestines (n = 108). Thus, *M. temminckii* in this study consumed a variety of items, many of which would have been missed or underrepresented if only stomachs were examined.

Discussion

In agreement with prior studies (Ernst et al. 1994, Harrel and Stringer 1997, Pritchard 1989, Sloan et al. 1996), my results suggest Alligator Snapping Turtles are opportunistic scavengers, and fish is an important component of their diet. Fish occurred in nearly 80% of the samples in our study; as mentioned above, fish was used as an effective bait to catch the turtles in many cases, and fish are therefore overrepresented as prey for this species. Sloan et al. (1996) found fish in 56.9% of the adult *M. temminckii* in their study; likewise, Dobie (1966) noted fish in 59.4% of the 32 stomachs he examined.

Crawfish were seen more frequently in our study (51.38% overall, and in 92.11% of the samples from Venice) than other reports (26.2% frequency occurrence in Sloan et al. study [1996] and 43.75% in Dobie [1966]).

Molluscs (freshwater mussels and snails) were the third most commonly seen item in this study and occurred in 47.71% of all 109 samples. Dobie (1966) found molluscs in 21.9% of 32 samples; Sloan et al. (1996) noted only one snail recovered in their study. Other authors have noted Alligator Snapping Turtles feed on molluscs (Dundee and Rossman 1989, Ernst et al. 1994, George 1987). Pritchard (1989) states that the jaws of large *M. temminckii* show considerable adaptation to a molluscivorous diet, due to their breadth, shortness, blunt crushing surface, and strength.

My findings of turtles as *M. temminckii* prey are in agreement with prior studies; no new species of turtles were noted as prey. Although smaller turtles are very frequently consumed by *M. temminckii* (B. Harrel, pers. comm.), turtles may be somewhat overrepresented as a diet component, since each one's heavy dermal bone is probably very slowly digested as compared to soft body parts of other species such as small fish or amphibians.

Surprisingly, insect parts were seen in 22% of the samples in this study, but were not reported either by Dobie (1966) or Sloan et al. (1996). The expected very low prey masses recovered (range 0.01–1.78 g) suggest insects add little in terms of the overall nutrient intake of the Alligator Snapping Turtle.

Nutria were the sixth most frequently occurring (21.1% overall, but 60.53% from Venice) prey in this study, but the highest in terms of average prey mass. Sloan (1996) found 15.4% of their samples contained mammals (raccoons, muskrat and rabbits), but none were nutria. Dobie (1966) recovered mammal remains in 28.1% of his samples; only two of which were identified as nutria.

Rare mammalian parts seen were armadillo, opossum, squirrel (one case each) and hogs (two cases). To my knowledge these have not been reported as prey items for *M. temminckii*. These uncommon mammals were all noted in samples from SE Arkansas; Sloan et al. (1996) included a few samples from Arkansas. Dobie (1966) used 231 *M. temminckii* from several states for his reproductive study; the state of origin for the 32 samples selected for food analyses was not specified. These mammalian species might have been consumed as carrion; it seems less likely that a slow-moving *M. temminckii* would catch some of these mammals as live prey.

Snakes were seen in 6.42% of all samples in this study; Dobie (1966) noted snakes in at least 15.6% of the 32 samples he examined (one listing of unidentified reptile), and none were recovered by Sloan et al. (1996). Species noted by Dobie (1966) were *Lampropeltis g. holbrookia* and *Nerodia* sp. The Glossy Crayfish Snake found in this study appears to be a new prey-item record.

Birds were uncommonly seen (5.5%) in this study; similarly, Dobie (1966) saw only two cases of bird remains, and Sloan et al. (1996) saw birds in only three stomachs. In the present study, eggs/inner eggshell membranes were seen in seven cases; at least one of these appeared to be avian in origin.

Vegetation, which sometimes included acorns, was seen in 108 of the 109 gastrointestinal tracts examined. Of interest, Sloan et al. (1996) noted acorns alone were the most abundant food item by weight (average = 129.7 g, range = 1–643 g) and volume in their study. Dobie (1966) also noted plant material in all 32 samples he examined.

Endohelminths were found in 67% of the gastrointestinal tracts in this study, a far higher frequency than the single case of leeches noted by Sloan et al. (1996) in one stomach. Cahn (1937), as noted in Pope (1939), stated as many as 250 specimens of the same species of nematode were taken from a single large intestine of an Alligator Snapping Turtle. In this study, one intestine from SE Arkansas contained 338 endohelminths.

The finding that *M. temminckii* stomachs contained an average of 2.28 different prey items and intestines contained 4.13 different prey items illustrates that *M. temminckii* are adaptable to preying on a variety of species. Of great importance, numerous prey items (some of which are new findings for *M. temminckii*) would have been missed if only stomachs (and not intestines) were evaluated.

The ability of Alligator Snapping Turtles to consume such a varied diet of prey species which are readily available to them may be advantageous in allowing it to adapt to a variety of aquatic habitats. Recent measures undertaken by numerous southeastern states (prohibition of commercial harvest and additional efforts to study population status and distribution), along with habitat preservation and enhancement, may lead to maintenance or improvement in Alligator Snapping Turtle populations.

Acknowledgments

Thanks are extended to Don Delesdernier, Harvey Kliebert, and Homer Wiley for access to their seafood processing sheds and assistance with data collection. Several Louisiana Department of Wildlife and Fisheries employees (especially Melvin Bertrand and Donna Bowman) assisted with field carcass collections and lab dissections. Mr. W. Parke Moore III is acknowledged for administrative support, and the late Dr. Barry Moser conducted statistical analyses. Dr. Jeff Boundy reviewed an earlier draft of the manuscript and provided several helpful references. I thank Karen McCall for technical assistance in preparation of the manuscript.

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