

Evidence of Predation on Nestling Birds by Eastern Gartersnakes (*Thamnophis sirtalis sirtalis*)

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Diet is an important aspect of the natural history of all animals, but diet can vary through space and time because of variations in prey availability. The diet of the Common Gartersnake (*Thamnophis sirtalis*) consists mainly of earthworms and frogs, but other prey items might be important when they are locally abundant. I report an observation of a female Eastern Gartersnake (*Thamnophis sirtalis sirtalis*) regurgitating 2 nestling birds in Ottawa, Ontario, Canada. Birds are seldom present in the diet of the Common Gartersnake. This rare food choice highlights the opportunistic nature of foraging by adult Common Gartersnakes and, further, demonstrates that diet depends not only on prey preference, but also on prey availability.

Key Words: Diet; Eastern Gartersnake; *Thamnophis sirtalis sirtalis*; nestling; predation; prey preference; prey selection; Eastern Ontario

Prey preference and diet are important aspects of the natural history of all animals. Diet often depends not only on the prey preference of the species, but also on the availability of prey, which changes with space, time, and ontogeny (Carpenter 1952). If the preferred prey is less available, then diet may consist of a less preferred but more available prey item (Gregory and Nelson 1991).

The diet of the Common Gartersnake (*Thamnophis sirtalis*) consists mainly of earthworms and frogs (Rowell 2012), although it often contains many other prey items, including fish, small mammals, slugs, leeches, and occasionally birds and other snakes (Table 1). When the prevalence of prey species is averaged across studies, Common Gartersnakes show a strong preference for frogs, followed closely by earthworms, while salamanders, fish, and mammals occur in their diet less frequently, and all other prey items can be considered rare (Table 2). Studies of prey preference demonstrate that Common Gartersnakes almost exclusively eat earthworms when they are small and incorporate larger food items, such as amphibians, into their diet as they grow larger (Carpenter 1952; Gregory 1978; Halloy and Burghardt 1990; Gregory and Nelson 1991), a practice that is likely related to gape-size limitation (Halloy and Burghardt 1990; Rodriguez-Robles *et al.* 1999).

The diet of Common Gartersnakes is constrained by prey availability. Gregory and Nelson (1991) compared the diets of Common Gartersnakes living near fish hatcheries and those living at reference sites away from hatcheries. Fish were the dominant prey item in stomachs of snakes from the fish hatchery, and amphibians and earthworms were the dominant prey items in snakes from reference sites. A similar pattern has been observed on islands with nesting colonies of birds (Fetterolf 1979;

Greenwell *et al.* 1984), although these researchers did not compare the diets of Common Gartersnakes, but rather observed Common Gartersnakes eating nestling birds at locations where they were abundant. One of these studies (Greenwell *et al.* 1984) examined the prey preference of Common Gartersnakes in the laboratory by presenting them with various food items, including birds. Common Gartersnakes from the island that had been observed eating nestling terns had a similar prey preference to snakes from the mainland: both populations preferred frogs, followed by earthworms and fish; birds were rarely consumed. This study suggests that prey preference in Common Gartersnakes is engrained, but increased availability of a non-preferred food item can increase its prevalence in their diet.

Here, I document an example of an Eastern Gartersnake (*Thamnophis sirtalis sirtalis*) that ate nestling birds. In July 2015, I encountered a female Eastern Gartersnake (snout–vent length: 536 mm; mass after regurgitation: 64 g; Figure 1) moving along the shore of the Ottawa River near Britannia Conservation Area, Ottawa, Ontario, Canada (45.375036°N, 75.786887°W; WGS 84). The snake was in a habitat dominated by ferns and forbs no more than 50 cm tall. I noted that it had a large food bulge. After I handled the snake, it regurgitated 2 nestling sparrows: 1 was partly decomposed and the other was mostly intact (body length: 58 mm; wing length: 23 mm; mass: 8 g; Figure 2). I was unable to identify the birds confidently to species because of decomposition and incomplete plumage, but they were likely a species that nests on the ground or in low shrubs, which would increase the chances of a gartersnake coming across the nest.

Based on the rarity of birds in the diet of Common Gartersnakes and the fact that in almost all reported

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TABLE 1. Review of studies examining the diet of the Common Gartersnake (*Thamnophis sirtalis*).

Author(s)	Location	Prey items	Sample size
Brodie and Brodie 1990	Oregon	Rough-skinned Newt	Unknown
Brown 1928	Ontario	Earthworm, Red-backed Salamander	2 snakes
Brown 1979	Michigan and New York	70% amphibians, 14.8% earthworms, 1 Meadow Vole, minor fish and bird remains. Two birds were nestling Yellowthroats, and the third was a nestling Hermit Thrush; all three were taken from their nest.	Stomach contents of 98 snakes
Carpenter 1951	Michigan	Goldfinch nestlings, 1 adult Song Sparrow	Stomach contents of 2 of the 230 snakes providing samples
Carpenter 1952	Michigan	80% earthworms, 15% amphibians, small number of mammals, fish, leeches, caterpillars. No birds.	Stomach contents of 178 snakes (28% of all captured snakes)
Catling and Freedman 1980	Ontario	6 earthworms, 2 Leopard Frogs, 3 American Toads	11 snakes
Dalrymple and Reichenback 1981	Ohio	10% of collected snakes regurgitated earthworms in spring, but only frogs in summer.	Unknown
Fetterolf 1979	Ontario	2 nestling Rings-billed Gulls in a gull colony	1 snake
Fitch 1982	Kansas	25 Plains Leopard Frogs, 10 American Toads, 8 earthworms, 7 Cope's Gray Treefrogs, 4 Woodhouse's Toads, 4 Northern Cricket Frogs, 4 American Bullfrogs, 3 White-footed Mice, 3 unknown frogs, 2 Prairie Voles, 1 Western Harvest Mouse, 1 Western Chorus Frog	Stomach contents of 72 snakes
Gilhen 1984	Nova Scotia	Maritime Gartersnakes are known to eat earthworms and Red-backed Salamanders as juveniles; small fish, Yellow-spotted Salamanders, American Toads, Green Frogs, Northern Leopard Frogs, Woods Frogs, and Meadow Voles as adults.	Review
Greenwell <i>et al.</i> 1984	Michigan	Personal observations of snakes eating many nestling terns and other Larids	Unknown
Gregory 1978	British Columbia	41 amphibians, 24 earthworms, 1 bird, 1 leech, 18 unidentified	Stomach contents of 179 snakes (280 snakes sampled)
Gregory 1984	British Columbia	53 amphibians, 29 earthworms, 1 slug, 2 mammals, 4 birds, 1 leech	Stomach contents of 90 snakes (241 snakes sampled)
Gregory and Nelson 1991	British Columbia	Compared diet of snake population at hatchery versus reference sites. Hatchery: 151 fish, 0 amphibians, 12 earthworms, 2 mammals	Stomach contents of 107 snakes at the hatchery and 54 at reference sites
Gregory and Stewart 1975	Manitoba	Reference: 4 fish, 146 amphibians, 31 earthworms, 1 slug, 1 mammal, 1 bird 227 frogs, 16 earthworms, 5 dragonfly nymphs, 4 nestling sparrows, 1 snail, 2 slugs	Stomach contents of 267 snakes (1059 snakes sampled)
Hamilton 1951	New York	57% earthworms, 28% amphibians, 4% insects, 3% mammals, 2% molluscs, 2% fish, 2% crayfish, 1% snakes (1 case of cannibalism by neonates, and 2 adults ate <i>Storeria dekayi</i>), 1% birds (2 nestling Song Sparrows).	Stomach contents of 241 snakes
Kephart and Arnold 1982	California	99 frogs, 2 fish, 9 leeches	Stomach contents of 18 snakes (36 snakes sampled)

TABLE 1. Review of studies examining the diet of the Common Gartersnake (*Thamnophis sirtalis*). (continued)

Author(s)	Location	Prey items	Sample size
Lagler and Salyer 1945	Michigan	46% earthworm, 34% frogs, 14% insects, 11% fish, 9% toads, 3% salamanders, 3% leeches, 3% snails	Stomach contents of 109 snakes (151 snakes with food in stomach out of 238 snakes sampled) 1 snake
Logier 1925	Ontario	1 nestling sparrow from nest	Review
Rossmann <i>et al.</i> 1996: 70–73	North America	Earthworms, slugs, leeches, fish (rare), amphibian larvae, amphibians, birds (rare), mammals	Review
Rowell 2012	Ontario	Primarily earthworms and frogs. Occasionally, small snakes, toads, salamanders, mice, nestling birds, bird eggs, fish, leeches, slugs, snails, millipedes, isopods, spiders, crayfish, insects, insect larvae.	Review
Walkinshaw 1943	Michigan	1 nestling Chipping Sparrow taken directly from nest, 1.2 m off the ground.	1 snake
White and Kolb 1974	California	55% treefrogs, 21.8% suckers, 11.5% dace, 5.4% meadow voles a few leeches, 1 toad	Stomach contents of 160 snakes

incidents of such prey, the birds have been nestlings or fledglings, I hypothesize that large Common Gartersnakes are opportunistic foragers that will eat any vertebrate or invertebrate they encounter as long as they can successfully swallow it and it is within their range of food choices. The gape-size limitation has been demonstrated in captive Common Gartersnakes, where larger snakes were able to consume larger fish (Halloy and Burghardt 1990). However, this is not to negate the frequently observed preference of Common Gartersnakes for earthworms and amphibians (Table 2). Given the relatively recent introduction of earthworms to North America (Hendrix and Bohlen 2002), the preference of Common Gartersnakes for earthworms is a clear example of opportunism in diet selection.

Greenwell *et al.* (1984) conducted an interesting trial in which 12 Common Gartersnakes were presented with bird carcasses, and none consumed the birds. Yet when the researchers infused the bird carcasses with the smell of fish, 9 of the 12 Common Gartersnakes ate the birds. This novel result suggests Common Gartersnakes do not generally consider birds to be a prey item, but do so when they smell like other preferred prey items. In the case of nestling birds, if their parents are feeding them worms frequently, then perhaps the smell of worms on the birds makes them a preferred prey of gartersnakes.

The natural history of most birds likely makes them an inaccessible prey for Common Gartersnakes. Most adult birds are likely quick and agile enough to escape predation by gartersnakes. Many birds also nest in trees, making them largely inaccessible to gartersnakes. Conversely, amphibians and earthworms are often abundant in habitats occupied by Common Gartersnakes, likely because of a shared habitat preference (Halliday, unpublished data) and their terrestrial habit. Thus, amphibians and earthworms are an easily accessible prey item for Common Gartersnakes. Birds, on the other hand, spend most of their time off of the ground and are, therefore, usually inaccessible to Common Gartersnakes; however, nestling birds in ground nests and fledgling birds are exceptions to this. Nestlings and fledglings can potentially become part of the diet of Common Gartersnakes for a short time every year, just as smaller frogs become part of the Common Gartersnake diet when they metamorphose and leave the water body in which they developed (Carpenter 1952; Gregory 1984). It is possible that Common Gartersnakes evolved a general preference for earthworms and amphibians because of their accessibility throughout the active season.

In conclusion, nestling and fledgling birds are a part, however rare, of the diet of Common Gartersnakes. In areas with a high density of ground nests and fledglings, young birds could make up a substantial part of the Common Gartersnake diet during part of the summer (Fetterolf 1979; Greenwell *et al.* 1984).

TABLE 2. The diet of Common Gartersnakes (*Thamnophis sirtalis*), based on 25 reviewed publications (see Table 1). Slugs and snails were combined into 1 category (Molluscs), and caterpillars and dragonfly nymphs were combined into 1 category (Insects).

Prey	No. studies*	Mean rank†	Absolute rank‡
Frogs and toads	16	2.1	1
Earthworms	14	4.1	2
Salamanders	12	6.1	3
Fish	10	6.5	4
Mammals	9	6.5	4
Leeches	8	7.9	6
Birds	13	8.5	7
Insects	5	8.5	7
Molluscs	6	8.8	9
Crayfish	2	10.8	10
Snakes	2	10.9	11

*Number of references (including review articles and books) that mention each prey item.

†Mean rank order (1 = highest preference) of prey items in the diet of Common Gartersnakes based on the 15 studies that sampled stomach contents of multiple snakes. Mean rank order was calculated by ranking prey items based on their prevalence in each study, from 1 to 11 (total number of possible prey items), then calculating the mean for each prey item across all 15 studies. Prey items not found in a study were given a rank of 11.

‡Absolute rank was calculated as the rank of the mean ranks for each prey item.



FIGURE 1. Female Eastern Gartersnake (*Thamnophis sirtalis sirtalis*) encountered in Ottawa, Ontario, Canada, that regurgitated 2 nestling birds. Snout-vent length = 536 mm, mass = 64 g. Photo: William D. Halliday.



FIGURE 2. Nestling bird regurgitated by an Eastern Gartersnake (*Thamnophis sirtalis sirtalis*) encountered in Ottawa, Ontario, Canada. Body length = 58 mm, wing length = 23 mm, mass = 8 g. Photo: William D. Halliday.

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