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Flood-Associated Activities of Some Reptiles and Amphibians at Carlyle Lake, Fayette County, Illinois

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ABSTRACT

Heavy rains in November of 1993 caused extensive flooding of the upstream portions of Carlyle Lake, a 26,000 acre impoundment on the Kaskaskia River. Nine species of reptiles and amphibians were displaced by this flood event. Species found displaced included six species of anura, *Acris crepitans blanchardi*, *Bufo americanus*, *B. woodhousii fowleri*, *Hyla versicolor* complex, *Pseudacris triseriata*, and *Rana sphenocephala*; one species of salamander, *Ambystoma texanum*; and two species of snake, *Storeria dekayi wrightorum* and *Thamnophis sirtalis*. We found no evidence of mortality directly attributable to late fall displacement. Because mobility of the displaced animals was limited by low temperatures, predation may be an important source of mortality among displaced animals. Winter kill could result from such displacements if hibernacula are rendered useless by flooding for extended periods during more severe winter temperatures. Upstream flooding during the fall flood pulse when it is exacerbated by reservoir development and operation may be an important source of mortality for vertebrates that overwinter in flood plain forests.

INTRODUCTION

Flooding of the Mississippi River during the summer of 1993 reached record levels. This flood not only had an impact on the Mississippi River but also altered water levels in tributary streams due to flood waters backing into and flooding the tributaries. The flood also affected water management strategies adopted at reservoirs along major tributaries. Carlyle Lake, a 26,000-acre impoundment on the Kaskaskia River, is an example. Pool levels in this lake were maintained at higher levels than usual to provide flood relief downstream. Heavy rains (5 inches [12.5 cm] fell at Carlyle Lake dam between November 12 and November 14) resulted in significant flooding of the Kaskaskia River upstream of the reservoir (Fig. 1A). The flood peaked on 21 November 1993, when Carlyle Lake reached a record pool level of 455.53 feet National Vertical Geodetic Datum (NVGD). The previous Carlyle Lake pool record set 7 January 1973, which was also a major flooding year on the Mississippi River, was 455.48 feet NVGD (Pickard, 1993).

On November 21, one of us (JBH) noted many specimens of reptiles and amphibians stranded on objects floating in the flood waters in the forested area near Carlyle Lake known as the subimpoundment. The subimpoundment is not flooded when Carlyle Lake is at normal pool levels but does flood when pool levels exceed 451 feet (D. Connors, U. S. Army Corps of Engineers, pers. comm.). It is the area of the reservoir that is farthest upstream from the dam and acts to absorb flood waters to lessen economic damage from upstream flooding.

Few studies (Dowling, 1987; Trauth, 1990) describe the effects of late-season flooding on snakes. We herein report our observations on the result of late-season flooding on two species of snakes, *Storeria dekayi wrightorum* and *Thamnophis sirtalis sirtalis*. We also list the amphibians found active in the same area.

MATERIALS AND METHODS

Our studies were conducted in the subimpoundment of Carlyle Lake near the banks of the Kaskaskia River at SW$^1/_4$ Sec. 26, T5N, R1W. This location is 8 km WSW of Shobonier in Fayette County, Illinois. We collected only selected specimens of each snake species on the initial collecting trip (21 November) even though other specimens of snakes and anurans were observed. We made three subsequent collecting trips (24 and 25 November and 1 December). On these trips, we collected all reptiles and amphibians encountered because specimens with late fall/early winter collecting dates are seldom available for study.

The site where we found snakes is slightly elevated and covered an area of about 500 m^2 on either side of an unpaved road through timber. The ground cover consisted of thick stands of grasses and other forbes on the roadway and piles of deadfall branches and logs within the timber. The animals were found on tufts of grasses and on deadfall piles protruding above the water surface.

Measurements of pool level, daily high and low air temperatures, and precipitation are from the Carlyle Lake office of the U. S. Army Corps of Engineers (LMS form 89) and were measured at that office near the dam (Fig. 1B). We then converted these temperature and precipitation values to metric equivalents. Water temperatures (11°C on each trip) were recorded at the site with a LabComp SCT 100 conductivity meter on 24 and 25 November and 1 December.

We identified all reptiles and amphibians collected to species (Smith, 1961). Following fixation in 10% formalin, all specimens collected were preserved in 70% ethanol. We determined sex for the snakes through eversion of the hemipenes in males during preservation. Sex was not determined for the amphibians. We measured snout to vent length (SVL) to the nearest 1.0 mm with a metric rule for each animal collected 24 hours after preservation. Specimens are deposited in the collections of the Illinois Natural History Survey (INHS 11110-INHS 11182).

RESULTS

Water temperatures on 24 and 25 November and 1 December 11.0°C throughout the study area. We collected 94 specimens of nine species of reptiles and amphibians consisting of six anurans (*Acris crepitans blanchardi*, n = 1; *Bufo americanus*, n = 11; *B. woodhousii fowleri*, n = 4; *Hyla versicolor* complex, n = 3; *Pseudacris triseriata*, n = 6; and *Rana sphenocephala*, n = 23), one salamander (*Ambystoma texanum*, n = 2), and two snakes (*Storeria dekayi wrightorum*, n = 15 and *Thamnophis sirtalis*, n = 29). *T. sirtalis*, the most commonly collected species, made up 30.8% of the total specimens collected and 65.9% of the snakes collected. *R. sphenocephala*, the second most commonly encountered species, accounted for 24.5% of the total specimens collected and 47.9% of the anurans collected. Because not every specimen seen was collected each day and because frogs were more difficult to catch than snakes or other anurans, the relative abundance of each species in the collections does not reflect the relative abundance of these species at the site.

Sex ratios for the two snake species do not differ significantly ($p > 0.05$) from unity. For *Storeria dekayi wrightorum*, the ratio is 0.67 males : females with a chi-square of 1.6. For *Thamnophis sirtalis*, the ratio is 0.71 males : females with a chi-square of 0.86.

The broad range of SVL for both snake species suggests that both young of the year and older snakes were contained in the sample. Length frequency distributions for both species (Fig. 2) support this conclusion. We consider *S. dekayi wrightorum* with SVLs less than 180 mm to be young of the year (Noble and Clausen, 1936). Five (33.3%) of the *S. dekayi wrightorum* collected are less than 180 mm SVL whereas ten (67.7%) are larger. For *T. sirtalis*, we consider specimens less than 260 mm to be young of the year snakes (Fitch, 1965). We collected 18 *T. sirtalis* that were less than 260 mm SVL, which account for 62.1% of the total specimens of *T. sirtalis* collected. The remaining 11 specimens (37.9%) exceeded 380 mm SVL.

DISCUSSION

When we initiated this study we expected to document flood related mortality among reptiles and amphibians, particularly for the snake species. We attempted to time our collecting trips accordingly. We made the comprehensive collecting trip on 24 November to establish a baseline collection of the species that appeared to be forced into exposed situations by the flooding before a period of cold weather could set in. The trip of 25 November, which produced no specimens coincided with the start of six days (25-30 November) with daily low temperatures below freezing (Fig. 1B). We made the final trip on the first warmer day (1 December) after this cold snap in the expectation that we would find numerous casualties due to exposure to the cold nights.

Although we searched the area diligently for evidence of mortality, we found very little. We found but two dead leopard frogs and one salamander that appeared to be frost bitten but still alive. We found no dead snakes. We believe that these animals were able to avoid freezing temperatures by entering the water, which was much warmer (11°C) than the night air. Therefore we conclude that displacement by late fall/early winter flooding did not directly cause excessive mortality due to exposure because freezing temperatures were easily avoided by most animals. This conclusion is consistent with reports of winter kills such as for turtles (Christiansen and Bickham, 1989), which occur where freezing conditions cannot be escaped.

Even though this flood event may not have directly caused mortality, the affected animals were likely exposed to increased risk of predation. The sluggish movements of the snakes and the relative ease with which we were able to catch leopard frogs suggests this possibility. The snakes made no effort to escape even though they were completely exposed to view. When touched, they moved slowly and, in some cases, merely thrashed about rather than attempting to hide.

We also observed predators or their scats in the relatively restricted study area. On one occasion, four Great Blue Herons (*Ardea herodias*) noisily flew from the study area as we approached. We also observed numerous scats of the raccoon (*Procyon lotor*) at the study area on each of our trips. Both of these animals are known to prey upon snakes (see Fitch, 1965, for instance). One of the dead leopard frogs had been partially eaten further suggesting that predation was a factor at this site.

Since at least *T. sirtalis* is known to be able to hibernate submerged (Carpenter, 1953; Costanzo, 1985, 1986, 1989a, and 1989b; Ultsch, 1989) in water and possibly with less mortality (Costanzo, 1989b) than individuals hibernating exposed to air, we wonder why the snakes left their hibernacula at all. We suspect that the relatively high water temperature (11°C) caused the snakes to abandon their hibernacula. Costanzo (1989b) found that at 12°C submerged hibernating *T. sirtalis* consumed lipid and protein reserves at much higher rates than they did at lower temperatures. However, no data exists on whether *T. sirtalis* or *S. d. wrightorum* hibernates submerged in Illinois.

We believe that the snakes in our example were displaced from one or at most a few hibernacula because the area in which we found snakes was only a small part of the area that we covered looking for snakes. In many cases, several snakes of the same species were found immediately adjacent to each other. This is consistent with previous reports on use of communal hibernacula in both *T. sirtalis* and *S. dekayi* (MacMillan, 1988; Carpenter, 1953; Macartney et al., 1989; Bailey, 1948; Noble and Clausen, 1936) and scent trailing of conspecifics by both species (Noble and Clausen, 1936; Larsen, 1987; Costanzo, 1989c).

While we cannot determine if these snakes were all using a single hibernaculum, it is noteworthy that young of the year snakes and older snakes were found together. Previous authors (Aleksiuk and Gregory, 1974; Gregory, 1974 and 1977; Gregory and Stewart, 1975; Larsen and Gregory, 1989; Larsen and Hare, 1992) working with migratory northern populations of *T. sirtalis* report that young of the year and juvenile snakes are not found hibernating with adults (but see MacMillan, 1988, for an exception). They suggested that young of the year and juvenile snakes were unable to make the long distance migrations necessary to move from feeding ranges to hibernacula. We suspect that this is not applicable to the situation that we encountered because the hibernaculum or hibernacula are located in habitat suitable for summer occupation by garter snakes. Consequently, the snakes using the hibernaculum or hibernacula probably did not have to make a long range migration to reach it.

Our conclusion that flooding, while possibly not the proximal cause of mortality, may increase mortality from other causes, and is quite similar to the case reported by Trauth (1990) for *Nerodia cyclopion* in Arkansas. In Trauth's (1990) study flooding forced the snakes from hibernacula onto roads where they were killed. Tucker (in press) found large numbers of snakes killed on a road in Jersey and Madison Counties apparently as a result of habitat alterations due to the summer flood of 1993 along the Mississippi River.

There are other similarities between our observations and those reported from Arkansas by Trauth (1990) and from Illinois by Tucker (in press). In Trauth's example, the area that flooded was also upstream of a lake. Heavy November rainfall was the proximal cause of flooding in his example as it was in ours. Forced from their hibernacula, the Arkansas snakes became vulnerable to predation due to low air temperatures that prevented their escape. In Tucker's (in press) example, snakes had to cross a road to reach hibernacula uneffected by summer flooding. Similarly, we suspect that the Carlyle Lake flooding rendered hibernacula useless for at least some period of time. While predation may be the primary proximal threat facing the snakes that we studied, winter kill of poorly protected animals may become important if hibernacula cannot be reoccupied before temperatures fall well below freezing.

Flooding in flood plain forests is a natural event and flood pulses in the spring and fall frequently occur in natural systems (J. Nelson, pers. comm.). However, we wonder if the development of reservoirs such as Carlyle Lake might not exacerbate the situation and make the impact more detrimental to reptiles and amphibians than would be the case if the lake were not there. Although the species that we observed are common snakes in Illinois (Smith, 1961), other less common species are known from Fayette County including *Clonophis kirtlandii* (Holman and Arai, 1962) and *Sisturus catenatus* (Smith, 1961), species that are now listed as threatened in Illinois (Herkert, 1993). Both species occur in the vicinity of Carlyle Lake (S. Ballard, Illinois Dept. Conservation, pers. comm.) and occupy wetland habitats (Smith, 1961).

Two reports (ours and Trauth's, 1990) document impact of late season flooding upstream from lakes or impoundments. Managers of such lakes and particularly those that effect habitats of endangered or threatened species should strive to mimic summer low water levels. Return to a more natural hydrology would reduce the duration and magnitude of fall floods by lowering impoundment water levels prior to fall flood pulses. Our study is consistent with that of Kushlan and Jacobsen (1990) who reviewed a number of studies showing that departures from natural hydrological patterns are detrimental for organisms ranging from the apple snail (*Pomacea paludosa*) to the alligator (*Alligator mississippiensis*) in the southern Everglades of Florida.

Finally, we believe that our study and Trauth's (1990) indicate that late season flooding can provide the herpetologist with an opportunity to sample flood plain reptiles and amphibians when the proper conditions exist. Herpetologists should make every effort to enter and survey flooded areas if the temperatures are not significantly below freezing at night and if the air temperature during daylight hours is warmer than the flood water temperature.

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Figure 1. (A) Hydrology for the month of November and 1 December showing extent and duration of subimpoundment flooding at Carlyle Lake, Fayette County, Illinois. (B) Daily high and low air temperatures (C) and precipitation (cm) for the same period.

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Figure 2. Length frequency distribution of specimens of two snakes collected at Carlyle Lake.

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