Factors influencing the distribution of overwintered bullfrog tadpoles (Rana catesbeiana) in two small ponds

S. E. Hargis

M.-K. Harr

C. J. Henderson

W. J. Kim

Geoffrey R. Smith

Recommended Citation
Hargis, S. E., Harr, M.-K., Henderson, C. J., Kim, W. J., & Smith, G. R. (2008). Factors influencing the distribution of overwintered bullfrog tadpoles (Rana catesbeiana) in two small ponds. Bulletin of the Maryland Herpetological Society, 44(2), 39-41.

Factors Influencing the Distribution of Overwintered Bullfrog Tadpoles (*Rana catesbeiana*) in Two Small Ponds

Abstract.

We studied the effects of vegetation, temperature, dissolved oxygen, and depth on the distribution of overwintered bullfrog tadpoles, *Rana catesbeiana*, during the early spring within two small ponds (Spring Peeper Pond and Olde Minnow Pond) in central Ohio. Vegetation and water temperature significantly influenced tadpole distribution in Olde Minnow Pond, whereas oxygen significantly influenced tadpole distribution in Spring Peeper Pond. Water depth did not affect tadpole distribution in either pond.

In more northern populations, American bullfrog tadpoles (*Rana catesbeiana*) typically overwinter. Some observations suggest that bullfrog tadpoles shift their habitat use as they grow from the shallows along a pond's edge when small to the deeper waters at the center of a pond when larger (e.g., Werner, 1992; Smith and Rettig, 1996). We investigated the distribution of overwintered American bullfrog tadpoles within two small ponds in central Ohio, USA during the early Spring. We were particularly interested in determining if various physical and biotic characteristics could explain variation in tadpole distributions within and between these ponds. Within-pond distributions of anuran larvae can be a function of water depth, presence of aquatic vegetation, substrate type, dissolved oxygen content, and temperature (e.g., Noland and Ultsch, 1981; Alford, 1986; Warkentin, 1992; Nie et al., 1999; Ultsch et al., 1999; Smith et al., 2003).

Materials and Methods.

The two ponds we investigated, Spring Peeper Pond and Olde Minnow Pond, are located on the Denison University Biological Reserve, Granville, Licking Co., Ohio, USA (40°05'00N, 82°31'05"W; elevation = 308 m asl). The ponds are separated by 100 m. In a typical year, Spring Peeper dries up in late August or early September after a summer drought which typically lasts from June through August; however for 2 or 3 years prior to this study, Spring Peeper had not dried up and held water year round. Olde Minnow is a permanent pond. Both ponds are supplied by springs and run-off, and are known to support several amphibian species (Schultz and Mick, 1998; Smith et al., 2003).

We collected information on abiotic variables and bullfrog tadpole distributions once a week from 25 March to 11 April 2006. Each week we sampled up to 13 sites around the perimeter of each pond. We assumed that because of temporal changes in the pond and time between samples that the samples from different dates were independent (see Smith et al., 2003). We thus pooled data within each pond for our analyses.

In order to estimate the abundance of tadpoles at each site, We used dipnets to complete 3 1 m long sweeps at each site, with ample time between sweeps to allow for tadpoles to return to the site. The number of tadpoles was recorded after each series of sweeps. Vegetative cover for each site was visually estimated using a pre-determined scale from 1to 5, with 1 denoting no vegetation, and 5 denoting dense vegetation. Dissolved oxygen and water temperature were measured at each site using a YSI 550A meter. Each of these measurements was taken halfway between the surface of the water and the bottom of the pond. Depth was measured using a meter stick. Regression analyses were used to examine the relationship between the number of tadpoles and vegetative cover and abiotic factors within the ponds.

Results.

The number of bullfrog tadpoles was positively correlated with vegetative cover in Olde Minnow Pond (Bullfrog tadpoles = 0.037 + 0.889(vegetation index); $n = 27$, $r^2 = 0.183$, $P = 0.0026$) but not in Spring Peeper Pond ($n = 28$, $r^2 = 0.038$, $P = 0.32$). Tadpole abundance was positively related to water temperature in Olde Minnow Pond (Bullfrog tadpoles = -5.46 + 4.04(temperature); $n = 27$, $r^2 = 0.171$, $P = 0.032$), but not in Spring Peeper Pond ($n = 28$, $r^2 = 0.091$, $P = 0.12$). There was no significant relationship between dissolved oxygen and tadpole abundance in Olde Minnow Pond ($n = 23$, $r^2 = 0.012$, $P = 0.68$), but a significant positive relationship was found in Spring Peeper Pond (Bullfrog tadpoles = -20.6 + 5.99(DO); $n = 23$, $r^2 = 0.171$, $P = 0.0053$). Depth did not affect tadpole number in either Spring Peeper Pond ($n = 28$, $r^2 = 0.092$, $P = 0.12$) or Olde Minnow Pond ($n = 27$, $r^2 = 0.048$, $P = 0.27$).

Discussion.

Within each individual pond, different factors significantly affected tadpole distribution. Vegetation and water temperature significantly influenced tadpole distribution in Olde Minnow Pond, whereas dissolved oxygen had a significant influence on tadpole distribution in Spring Peeper Pond. Water depth did not affect tadpole distribution in either pond. Our results are partially consistent with previous laboratory experiments and field observations on the habitat use of bullfrog tadpoles. Overwintered bullfrog tadpoles from Ohio have been shown to prefer vegetation to bare areas in laboratory studies (Smith and Doupnik, 2005); however, overwintered tadpoles from Michigan did not (Smith, 1999). Oxygen concentration has been shown to be important in habitat selection of bullfrog tadpoles (e.g., Nie et al., 1999; Ultsch et al., 1999), as has temperature (Hutchison and Hill, 1978; Crawshaw et al., 1992; Ultsch et al., 1999).

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Stephanie E. Hargis[1], Mary-Katherine Harr[1], Christopher J. Henderson[1], Walter J. Kim[1], and Geoffrey R. Smith[1,2],

[1]Department of Biology, Denison University, Granville, Ohio 43023 USA,
[2]Corresponding author; E-mail: smithg@denison.edu

Received: 28 January 2008.
Accepted: 12 April 2008.