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Home Range Size of the Hellbender (*Cryptobranchus alleganiensis*) in Missouri

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Knowledge of patterns of activity and use of space is important for understanding the natural history of a species (Weatherhead and Hosak 1989). Size, shape, and overlap of home range have been related to food density, metabolic needs, population density, and territoriality (Alberts 1993; Brown and Orians 1970; Schoener 1968; Simon 1975). Also, knowledge of home range is important to predict the effects of environmental disturbance on a species (Hill and Grossman 1987). The hellbender (*Cryptobranchus alleganiensis*) has declined in numbers or been extirpated in portions of its range due to human activities (Nickerson and Mays 1973; Trauth et al. 1992; Williams et al. 1981). The only published information on home range of hellbenders was provided for a population in western Pennsylvania (Hillis and Bellis 1971). However, nearly half of the estimates of home range size were based on two observations of an individual, and no individual was captured more than five times. We were interested in determining size of home range of hellbenders in Missouri based on numerous recaptures.

The study site was an 80 m long section of Niangua River, Missouri, USA. Maximum depth was 1.5 m. Along the southern bank, gravel extended 5–10 m into the river. Along the northern shore, areas of silt extended 3–5 m into the river. Large rocks were numerous in the center of the site. Bedrock was present at the downstream end with few large rocks. At the upstream end, gravel extended to midstream with bedrock and a few large rocks on the northern side. We sampled the site 33 times between 15 August 1989 and 31 January 1990 by turning rocks during daylight and catching hellbenders by hand. All rocks were repositioned whether or not they sheltered a hellbender. The mean and maximum intersample periods were 5.5 and 23 days.

The first time a hellbender was captured, it was anesthetized in a weak tricaine (3-aminobenzoic acid ethyl ester, Sigma Co.) solution, branded on the venter with a unique number, sexed, and measured for snout-vent length (SVL). It was then returned to the rock where captured. For all subsequent captures of a marked individual, the brand was noted, and the individual was immediately released under the rock where captured. The location of each rock that sheltered a hellbender was mapped. A brick with a number was placed beside the rock to identify it.

Home range size was estimated by determining the size of a minimum area convex polygon (MCP; Mohr 1947). Jennrich and Turner (1969) reported that the MCP method can have large bias if the number of observations is small. However, with enough observations, home ranges estimated by the MCP method should approximate the true home range (Schoener 1981). We did not determine the home range of any hellbenders captured fewer than 14 times. However, three individuals captured more than 15 times were found only under a single rock, and two individuals were captured under only two rocks. We assigned a home range size of zero square meters to the former three and determined a mean activity radius (MAR) to estimate a circular home range (Hayne 1949) for the latter two. A MAR was calculated for hellbenders captured by Hillis and Bellis (1971).

TABLE 1. Home range size for hellbenders captured 14 or more times.

Home Range (m^2)	SVL (cm)	No. Times Captured	Time Interval (days)	No. Rocks Used as Shelter
		Females, N = 14		
0.0*	30	33	169	1
0.0*s	32	33	169	1
0.4	28	31	159	3
1.8*	28	16	67	2
3.2	32	33	169	4
6.6	31	32	169	3
12.7	32	15	148	5
13.9	34	22	91	6
34.2	32	20	74	4
44.8	34	32	169	3
54.8	30	25	169	8
60.3	29	18	88	3
79.9	32	32	169	7
82.4	32	33	169	7
		Males, N = 12		
0.0*s	31	25	118	1
1.7	27	14	101	3
25.2*	31	22	112	2
41.0	29	32	169	5
61.6	31	20	77	6
73.2	32	30	169	8
80.1	30	16	54	6
80.9	35	33	169	4
97.7	29	14	59	8
121.1	28	19	74	9
177.1	28	28	155	10
211.4	30	32	169	13

* Hellbenders for which a minimum convex polygon could not be constructed. A mean activity radius was calculated to estimate the home range size for the two hellbenders captured under only two rocks.

Twenty-five adult females and 25 adult males were captured at least once. No juveniles were captured. Twenty-four hellbenders were captured nine or fewer times (19 were captured fewer than 5 times). The remaining 26 hellbenders were captured 14 or more times (Table 1). Five individuals were captured in all 33 samples, including two females each captured only under a single rock. Eighteen of the individuals in Table 1 were captured on the first day of sampling. Twelve hellbenders captured during the first sample were also captured during the last sample.

For females, average home range size was 28 m^2 (SE = 8.2). Median home range size was 13 m^2. If the three females caught under only one or two rocks (indicated by asterisks in Table 1) were deleted from the analysis, average home range size would be 36 m^2. For males, average home range size was 81 m^2 (SE = 18.7). Median home range size of males was 77 m^2. If the two males captured under only one or two rocks were deleted, average home range size would be 95 m^2. A Mann-Whitney U-test indicated that males had a significantly larger home range than did females ($U = 126$, $0.05 > P > 0.02$). There was no significant

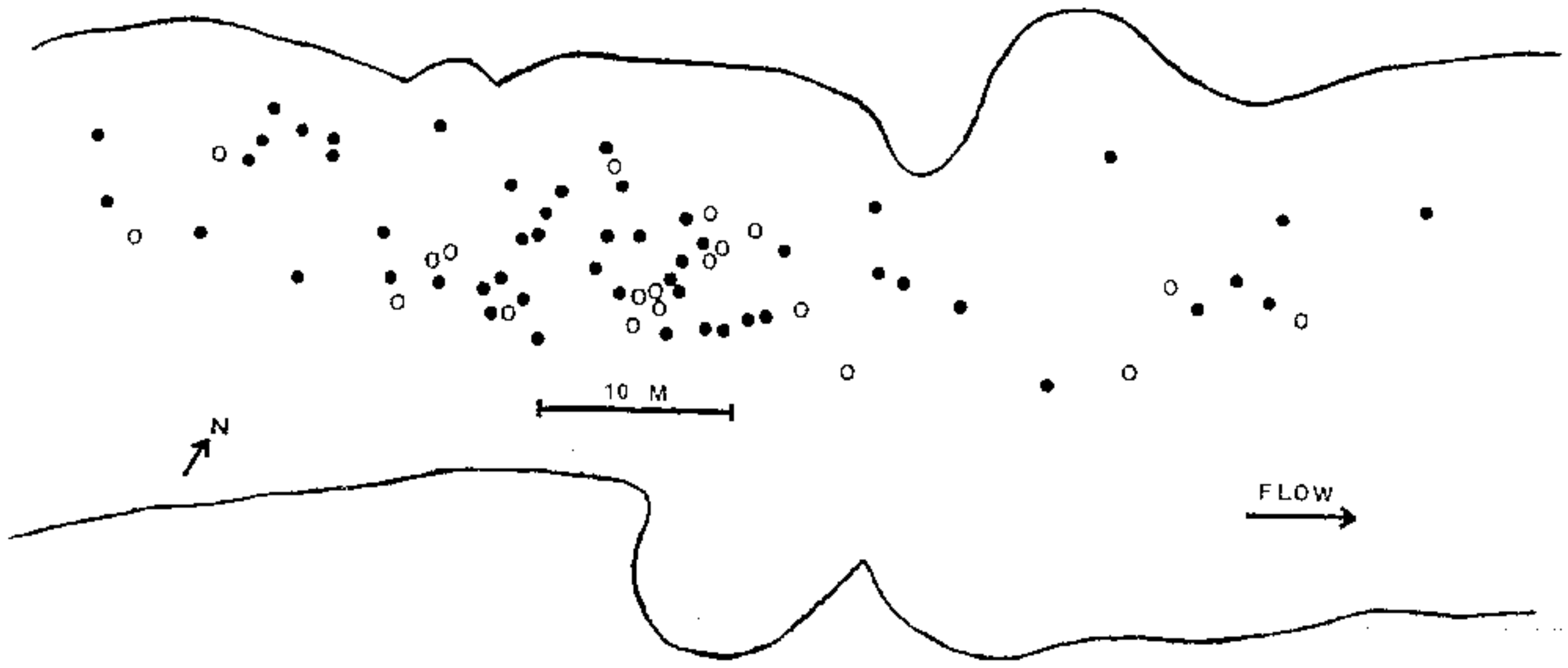

FIG. 1. Study site in Niangua River, Missouri. Dots indicate rocks used as shelter by hellbenders throughout the study. Open circles indicate rocks where hellbenders were captured during the first sample.

product-moment correlation between SVL and home range size for females (r = 0.20) or males (r = -0.12) or between home range size and number of times captured for females (r = 0.04) or males (r = 0.31).

There was considerable overlap in home ranges of both male and female hellbenders. All but three of the hellbenders in Table 1 sheltered at least once under a rock in the 10-m section indicated in Fig. 1. Also, some rocks served as shelter for more than one hellbender at different times. Thirty rocks were used by one hellbender only, 18 by two hellbenders, 10 by three hellbenders, six by four hellbenders, three by five hellbenders, four by six hellbenders, and one rock was used by seven hellbenders. However, we never observed more than one individual under the same rock during a sample. Only six captures of hellbenders were made away from shelters, and each such capture was made during September when breeding occurs (Peterson 1988; Peterson et al. 1989a).

Hillis and Bellis (1971) reported an average home range size of 346 m^2 (median = 113 m^2) for 73 hellbenders and found no significant difference in the MAR between sexes. We calculated only three home ranges as large as the median home range estimate of Hillis and Bellis (1971). The smaller estimates of home range we calculated may have been due in part to a smaller study area (80 m x 25 m compared to 220 m x 70 m) and the possibility that home ranges overlapped our upstream or downstream borders. However, we believe the major difference in estimates is due to the methods of calculating home range: circular versus MCP in a basically linear habitat. Also, Hillis and Bellis (1971) may have calculated home ranges for transients because only 13 of the 73 hellbenders were captured more than three times.

Coatney (1982) determined an elliptical home range size of 90 m^2 for seven Ozark hellbenders based on nocturnal telemetry over a period of at most two weeks. Again, our estimates are generally smaller, despite presumably greater disturbance of hellbenders due to capture by hand rather than telemetry. This may be due to the nocturnal habits of hellbenders and a tendency to return to a "home rock" at dawn (Coatney 1982). Perhaps this was the case with the three hellbenders we caught only under the same rock. However, because their diet is mostly crayfish (Nickerson and Mays 1973; Peterson et al. 1989b), hellbenders may be predominantly sit-and-wait predators.

We found considerable overlap in home ranges. Coatney (1982) thought that hellbenders with overlapping ranges avoid being in the area of overlap simultaneously, and rarely has more than one hellbender been found under the same rock except during the breeding season (Hillis and Bellis 1971; Nickerson and Mays 1973; Peterson 1988; Smith 1907). We have observed vigorous defense of shelters in aquaria by both sexes, and males similarly defended shelters containing eggs in natural habitats (Peterson 1988; Smith 1907). Hillis and Bellis (1971) also reported defense of a shelter, but stated that hellbenders were very opportunistic in occupying a cover rock recently vacated by another hellbender. Our data of multiple use of a rock by different hellbenders support their observation. We hypothesize that active defense in a home range is limited to a shelter.

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