

**A maximum size and abundance record for
Cambarus subterraneus (Astacoidea: Cambaridae)**

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The Delaware County Cave Crayfish, *Cambarus subterraneus* Hobbs, 1993 is restricted to just three caves within a small region (6 km radius) of the Neosho River Basin in Delaware County, Oklahoma (Hobbs 1993; Graening and Fenolio 2005). The human accessible habitat includes two caves which consist of one pool each, 20 and five meters wide respectively, and a the third cave with six pools, which are a maximum of three meters wide (Graening and Fenolio 2005). The pools are connected by subterranean streams and undoubtedly these crayfish inhabit places that are not human accessible; however, the total extent of occurrence is formally estimated by the International Union for Conservation of Nature (IUCN) at 9 km² (Bergey et al. 2010).

This species is listed as ‘Critically Imperiled’ by NatureServe (2012) and ‘Critically Endangered’ by IUCN (Bergey et al. 2010) primarily due to its small population size, limited distribution, and vulnerability to habitat degradation. The following have been identified as causes of concern: (1) The Neosho River is listed as an impaired water body by Oklahoma under Section 303(d) of the federal Clean Water Act due to excessive nutrient loading, low oxygen, altered pH, organics, and metals; (2) confined animal feeding operations within the recharge areas of occupied caves which could result in the input of nutrients and contaminants into groundwater and cave ecosystems; and (3) and human development on the surface within the recharge areas of pertinent groundwater bodies (Hobbs 1993; Graening and Fenolio 2005; Bergey et al. 2010; Graening et al. 2012). The small population size and limited geographic distribution of this species has prompted regular surveys at each of its three known localities to obtain data on relative abundance, population profile, morphometric data, and life history (Graening and Fenolio 2005). Here, we report on size and relative abundance for populations of *C. subterraneus*. Information on maximum size can provide insight into the suitability and health of local environments and the relative lifespan of a species.

Biotic inventories of *C. subterraneus* were carried out on 24 February 2011 and 1 May 2012 in Twin Cave, Delaware Co., Oklahoma. During the 2012 survey, we observed an exceptionally large female in the cave stream, larger in size than previous reports (**Figure 1, Table 1**). Comparisons of this female with the largest female observed in the 2011 survey were made using carapace and chela measurements because data on the total length (tip of uropod to tip of rostrum) were not reported in previous studies (Mehlhop-Cifelli 1990; Hobbs 1993). Carapace length and carapace width of the female observed in 2012 were each 1.4 times greater than previously reported maxima. Chela length of the female observed in 2012 was 1.5 times greater than the maximum length reported previously, and chela width was 1.4 times greater

Table 1. Morphometric measurement records for *Cambarus subterraneus*. Abbreviations: Ave (S.E.) is the mean and standard error, Min is the minimum recorded, Max is the maximum recorded, and Count is the number of individuals sampled (n). Measurements are reported in mm.

Survey		Carapace		Chela		Total Length
Year	Gender	Length	Width	Length	Width	
2011	Female	26.7	14.5	26.7	7.62	57.9
2012	Female	36.4	17.4	44.6	10.6	70.1
Previous Studies [†]	Ave (S.E.)	17.4 (0.69)	7.8 (0.36)	8.0 (1.07)	3.4 (0.31)	-
	Min-Max	11.3–26.2	4.2–12.5	3.4–29.4	1.2–7.4	-
	Count (n)	29	29	26	26	-

[†]Hobbs (1993), Mehlhop-Cifelli (1990).

than previously reported maximum. Carapace and chela measurements of the 2011 female were similar to previously reported maxima.

Past surveys of the three caves (**Figure 2**) produced counts of 17 individuals from Star Cave in 1989, and 17 individuals from Twin Cave in 2001 (Mehlhop-Cifelli 1990; Graening and Fenolio 2005). During our surveys of Twin Cave, we encountered 16 crayfish in 2011 and 48 in 2012 (another group counted 20 crayfish in Jan 2012). In 2012, we observed 3 individuals in Jail Cave and one individual in Star Cave. In 1986, an ovigerous female was observed in Twin Cave (Puckette 1986; Graening and Fenolio 2005) which suggests a reproductively active population. Small individuals of *C. subterraneus* of less than 2 cm total carapace length were observed in Twin Cave during the 2000, 2001, 2011 and 2012 surveys, and we believe the presence of these young individuals indicates continued recruitment into this population.

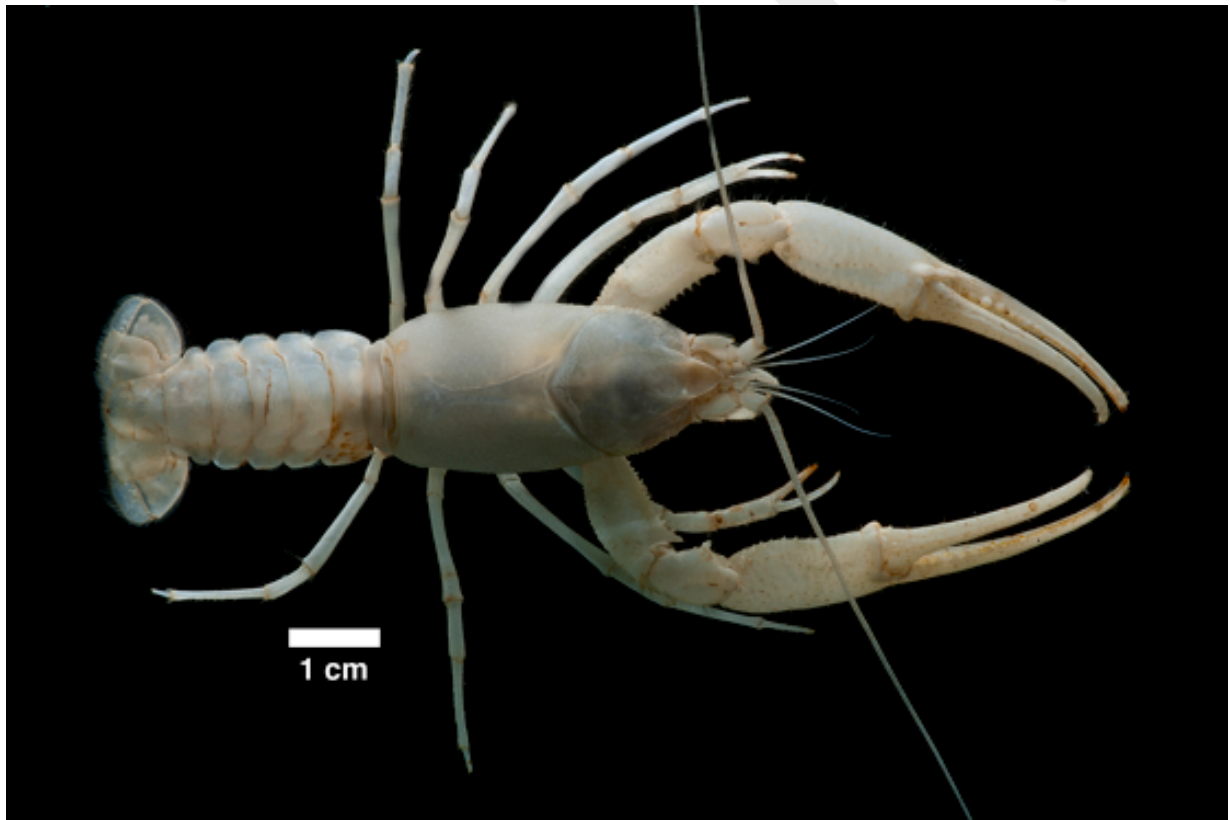


Figure 1. The largest recorded adult female Delaware County Cave Crayfish, *Cambarus subterraneus* (carapace length 70.1 mm) from Twin Cave, Delaware County, Oklahoma, USA.

Cambarus subterraneus is known from just three cave systems within a small geographic area. The confirmation of reproduction in *C. subterraneus*, at least in Twin Cave, is encouraging and suggests that this population likely is healthy with continued

recruitment. Some individuals also are attaining large sizes and presumably old ages. Conservation efforts at each of the three caves also are encouraging. The Nature Conservancy owns and manages a preserve that contains the main entrance to Twin Cave and about 10 hectares of oak-hickory forest surrounding the entrance. Management agreements with the owners of the other two caves allow for periodic monitoring of the populations within these caves. The groundwater recharge areas for all three caves also have been delineated. Nonetheless, species with small populations and a limited geographic distribution, such as *C. subterraneus*, tend to be especially susceptible to habitat loss and degradation, and environmental catastrophes. Consequently, monitoring of this species and the caves and groundwater in which it occurs should continue in order to gain valuable data on population trends and to help ascertain responses to stressors and conservation efforts.

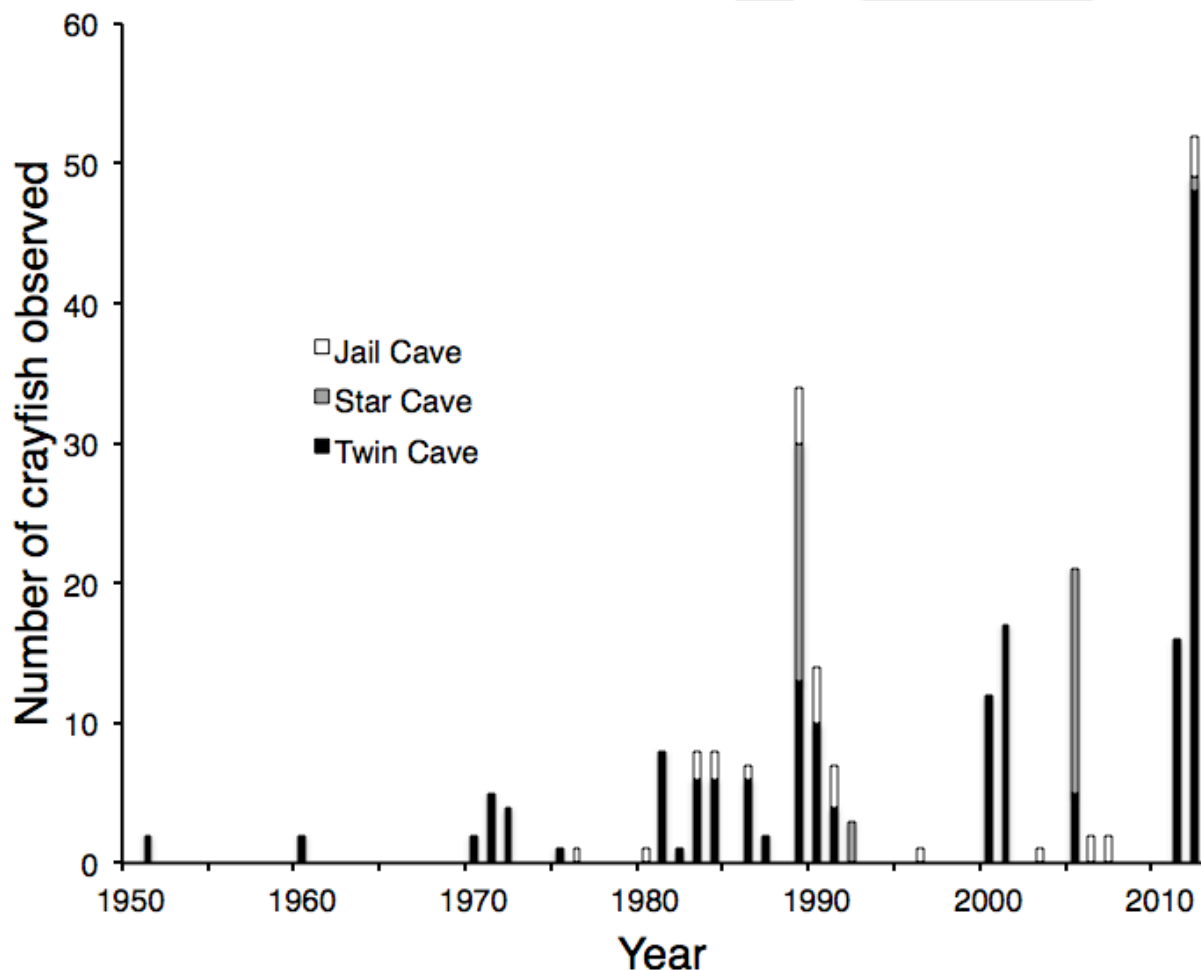


Figure 2. Number of *Cambarus subterraneus* observed at each of the three known localities from 1951–2012. Count data were compiled from literature sources, recent surveys, and unpublished records of the United States Fish and Wildlife Service, Oklahoma Ecological Services Field Office, Tulsa, Oklahoma, USA.

The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

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