



A Pilot Inventory of Crayfish in Shenandoah National Park

Natural Resource Data Series NPS/SHEN/NRDS—2014/671



ON THE COVER

Cambarus bartonii bartonii

Photograph by: Shenandoah National Park

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Abstract

This report describes results from a 2011 pilot crayfish inventory of Shenandoah National Park. The objective of the inventory was to document crayfish species that inhabit park waters within each of the three large watersheds that drain Shenandoah N.P.: the James, Rappahannock, and Shenandoah subbasins. At least three streams within each subbasin were surveyed for crayfish during the summer season. Surveys included visual searching of all stream habitats in the lower reaches of individual streams for 3-person hours and all crayfish that were observed (n=287) were collected and identified. Five species were documented in the park including *Cambarus bartonii bartonii* (within the James, Rappahannock, and Shenandoah subbasins), *Cambarus longulus* (within the James subbasin), *Cambarus sp. C.* (within the Rappahannock subbasin), *Orconectes obscurus* (within the Shenandoah subbasin), and *Orconectes sanbornii* (within the Shenandoah subbasin). With the exception of *O. sanbornii*, these species are thought to be native and are considered to be relatively common within their respective ranges. *O. sanbornii* is native to Ohio, Kentucky, and West Virginia.

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Introduction and Methods

In North America, freshwater crayfish (Decapoda) constitute a diverse group of freshwater crustaceans, with over 363 species documented in the United States and Canada (Taylor et al. 2007). Within forested headwater streams, crayfish can function as keystone species due to their capabilities at processing detritus and organic matter (Nyström 2002, Creed and Reed 2004). A variety of non-native invasive stream dwelling crayfish have been documented within the mid-Atlantic region of the United States, including National Park Service (NPS) units, potentially threatening native crayfish diversity as well as stream ecosystem function (Lieb et al. 2007a, Jastram et al. 2013). Despite their diversity and important ecosystem role, formal inventories of crayfish within Shenandoah National Park have not been completed. During current NPS aquatic inventory and monitoring efforts crayfish are incidentally collected, but due to specific sampling methodologies associated with aquatic monitoring programs in Shenandoah N.P., only a limited number of crayfish have been collected and identified. Therefore, in the summer of 2011, additional targeted surveys were conducted to characterize the crayfish fauna of the park.

Native aquatic biota distributions (including crayfish) are often structured by large scale watershed boundaries. Therefore, sample sites where crayfish were surveyed were selected from each of the three major watersheds draining Shenandoah N.P. (i.e. James River, Rappahannock River, and the Potomac River; Figure 1). At a minimum, three streams within each watershed were selected for sampling during the summer seasons. In general, within each watershed, the largest streams (as determined by wetted width) were selected for sampling as these streams were presumed to have more diverse aquatic habitat, and thus potentially greater crayfish diversity. It should be noted that all streams sampled were considered headwater streams (i.e. 2nd or 3rd order) and crayfish diversity *a priori* was expected to be low. At each sample site, dip-net sampling was initiated at the park boundary with the collection proceeding upstream. Sampling continued for a minimum of 3-person hours at each survey site. Field crew personnel disturbed substrate via moving rocks or debris, visually assessed the habitat for crayfish, and then captured observed crayfish using dip-nets. In some cases, multiple sampling events occurred in response to logistical constraints. All crayfish captured were immediately preserved in 70% ethanol. Water quality information (temperature and pH) was also measured during each sampling event. Crayfish were identified with a dissecting microscope using keys from McGregor (2002) and Swecker et al. (2010). Considering the season of sampling and the likely species list, we assumed that Form I males would be rare, but that all species that were likely to be present would be identifiable without Form I male characteristics using rostral and chelae morphology. Preliminary identifications occurred at Shenandoah N.P. and were verified at West Liberty University.

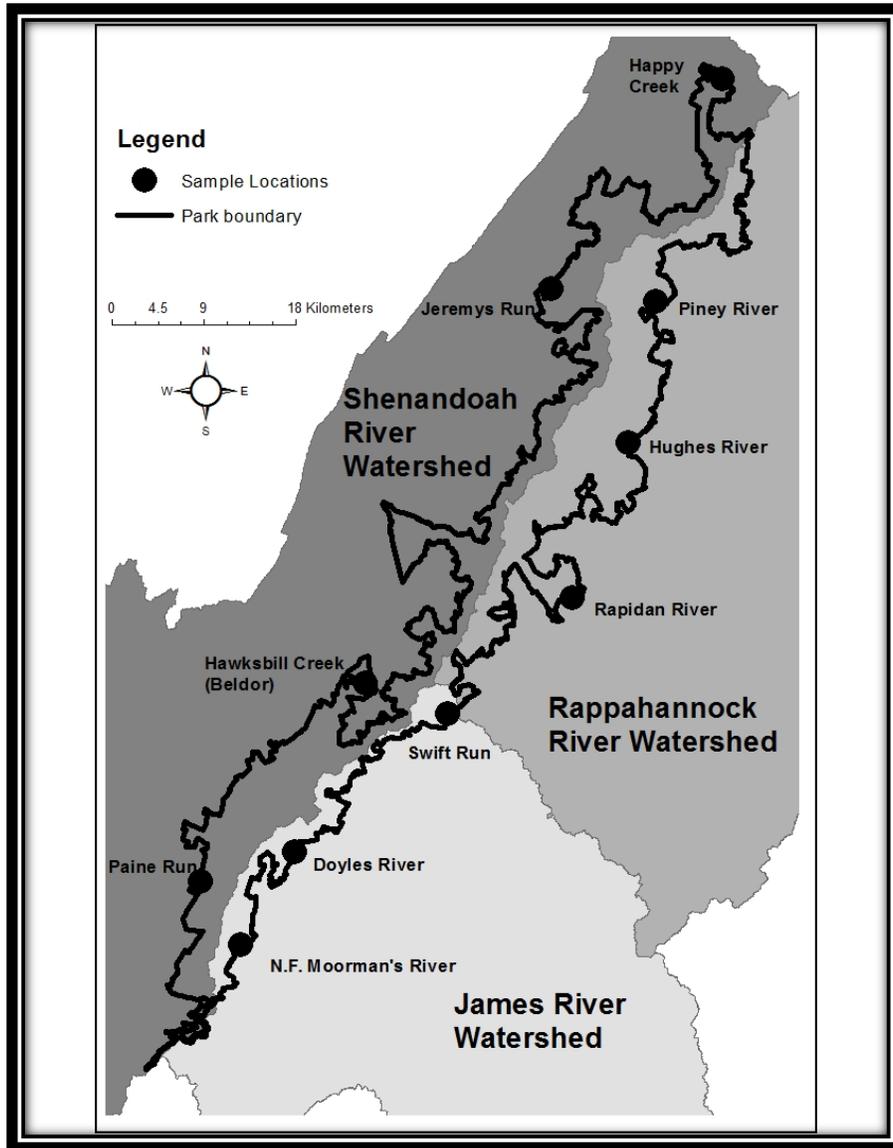


Figure 1. Map of sampling locations and associated watersheds from crayfish inventory in Shenandoah N.P., 2011

Results and Discussion

Ten streams were surveyed for crayfish and a total of 287 individuals were captured. Five species of crayfish were identified from ten streams throughout Shenandoah N.P. (Figure 1, Table 1, and Table 2). The maximum number of species observed at any site was two. The James and Rappahannock

Table 1. Sampling locations, sampling dates, and crayfish species observed during a baseline inventory in Shenandoah N.P., 2011.

Subbasin	Stream	UTM E	UTM N	County	Date	Species Observed
Shenandoah	Happy Creek	744454.3	4309091.8	Warren	8/2/11	<i>Cambarus b. bartonii</i> <i>Orconectes obscurus</i>
Shenandoah	Jeremy's Run	727668.4	4288476.0	Page	7/5/11	<i>Cambarus b. bartonii</i>
Shenandoah	Hawksbill Creek (Beldor)	709468.2	4249692.6	Rockingham	8/4/11	<i>Cambarus b. bartonii</i> <i>Orconectes sanbornii</i>
Shenandoah	Paine Run	693223.4	4230165.7	Augusta	7/12/11, 7/25/11	<i>Cambarus b. bartonii</i>
Rappahannock	Piney River	737982.5	4287212.7	Rappahannock	7/5/11	<i>Cambarus b. bartonii</i>
Rappahannock	Hughes River	735233.4	7273342.3	Rappahannock	8/8/11	<i>Cambarus b. bartonii</i> <i>Cambarus sp. C</i>
Rappahannock	Rapidan River	729725.6	4258053.4	Madison	7/11/11, 7/14/11	<i>Cambarus b. bartonii</i> <i>Cambarus sp. C</i>
James	Swift Run	717500.3	4246705.8	Greene	7/14/11	<i>Cambarus b. bartonii</i> <i>Cambarus longulus</i>
James	Doyles River	702506.0	4233059.3	Albemarle	8/9/11	<i>Cambarus b. bartonii</i> <i>Cambarus longulus</i>
James	N.F. Moorman's River	697213.1	4223956.9	Albemarle	7/7/11	<i>Cambarus b. bartonii</i> <i>Cambarus longulus</i>

had two species present in the park while three species were observed in the park in the Shenandoah system. *Cambarus b. bartonii* (common crayfish) was observed in every stream that was sampled during the inventory. The other four species documented were confined to individual subbasins. Within the Shenandoah subbasin, *Orconectes obscurus* (Allegheny crayfish) and the non-native *Orconectes sanbornii* (Sanborn's crayfish) were each observed in an individual stream. Within the James subbasin, *Cambarus longulus* (Atlantic slope crayfish) was observed in all streams surveyed at varying relative abundance when compared to *C. b. bartonii*. Within the Rappahannock subbasin, *Cambarus sp. C* was observed in two of the three streams sampled and was generally less abundant than *C. b. bartonii*. At two sample sites (Jeremy's Run and Paine Run), both in the Shenandoah subbasin, only one species of crayfish was captured (*C. b. bartonii*). The other sites in the subbasin also contained either *O. obscurus* or *O. sanbornii*.

Prior to this survey, no official surveys of crayfish had occurred in Shenandoah National Park and survey records in the counties surrounding the park are also rare (B. Watson, personal communication). With the exception of introduced *Orconectes sanbornii*, species observed in this survey have relatively widespread distributions in the mid-Atlantic, and their presence in the park is not unexpected. *Cambarus b. bartonii* is thought to have a very wide distribution across the east coast of the United States where it persists in cold mountain streams (Hobbs 1989, Guiasu 2002). *Cambarus b. bartonii* is a G5 species that is considered stable across its range by the American Fisheries Society (AFS) (Taylor et al. 2007). Of relevance to Shenandoah N.P., where acid

deposition can lead to pH impairment of streams (Jastram et al 2013), *C. b. bartonii* is relatively tolerant of low pH environments (Guiasu 2002).

Table 2. Crayfish species, count of reproductive form, gender, and relative abundance and water quality data observed in ten streams in Shenandoah N.P., 2011.

Stream	Species	Male Form 1	Male Form 2	Female	Total	pH	Temp (°C)
Happy Creek	<i>Cambarus b. bartonii</i>	0	0	1	1	7.75	23.3
	<i>Orconectes obscurus</i>	8	0	12	20		
Jeremy's Run	<i>Cambarus b. bartonii</i>	1	17	0	18	6.78	25.3
Hawksbill Creek (Beldor)	<i>Cambarus b. bartonii</i>	0	1	3	4	7.72	23.6
	<i>Orconectes sanbornii</i>	8	1	6	15		
Paine Run	<i>Cambarus b. bartonii</i>	2	36	9	47	5.58	23.8
Piney River	<i>Cambarus b. bartonii</i>	0	19	0	19	6.68	20.1
Hughes River	<i>Cambarus b. bartonii</i>	0	7	6	13	6.32	22.1
	<i>Cambarus sp. C</i>	0	3	3	6		
Rapidan River	<i>Cambarus b. bartonii</i>	2	11	8	21	6.31	21.6
	<i>Cambarus sp. C</i>	0	7	7	14		
Swift Run	<i>Cambarus b. bartonii</i>	NA	NA	2	2	6.58	18.7
	<i>Cambarus longulus</i>	1	29	13	43		
Doyles River	<i>Cambarus b. bartonii</i>	3	22	14	39	6.36	21.9
	<i>Cambarus longulus</i>	NA	NA	2	2		
N.F. Moorman's River	<i>Cambarus b. bartonii</i>	0	7	0	7	6.37	21.3
	<i>Cambarus longulus</i>	0	14	2	16		

Cambarus longulus is distributed within the mountains and piedmont from the James River drainage in VA to the Yadkin River drainage in NC and is also considered stable by AFS (Hobbs 1989; Taylor et al. 2007). According to Smart (1962), who collected *C. longulus* in Swift Run less than a mile from the current sample site on Swift Run, *C. longulus* prefers riffles and areas of higher current velocity. Smart (1962) also indicated that *C. acuminatus* was present in Swift Run during the 1960's though no *C. acuminatus* were observed in Swift Run (or any other James River tributaries in the park) during this 2011 survey.

What was previously referred to as *C. acuminatus* in Virginia is now referred to as *Cambarus sp. C.*, given *C. acuminatus* represents a species complex whose distribution is believed to extend from southern Pennsylvania to the Saluda River in South Carolina (Leib 2007b, Hobbs 1989). *Cambarus sp. C* is Virginia's member of the complex, and occurs throughout all Virginia Atlantic Slope basins (Cooper 2001). Its taxonomic status has undergone significant review in certain portions of its range with multiple new species named from the complex in the past decade (Cooper 2001, Cooper and Cooper 2003, Cooper 2006a, Cooper 2006b). The ecology of the species is poorly understood and its

true distribution is unknown - recent discoveries have occurred north of its previously accepted range (Leib 2007b).

Orconectes obscurus is relatively widespread from the mid-Atlantic north to Ontario, Canada (Loughman 2010). It is considered to be a stable G4 species (Taylor et al. 2007).

Non-native crayfish are an issue of conservation concern on an international scale (Lodge 2000) and have been documented as recent invaders into national parks in the mid-Atlantic region (Lieb et al. 2007a). *Orconectes sanbornii*, a species native to Ohio, Kentucky, and West Virginia and found throughout the Middle Ohio River Drainage (Loughman and Simon 2011; Taylor and Schuster 2004), was documented in this survey and is now known to be widespread in the S.F. of the Shenandoah River in Virginia (R. Thoma, personal communication). In the stream where *O. sanbornii* was observed, no native *O. obscurus* crayfish were captured and it's possible that *O. sanbornii* has displaced them. Given its widespread distribution in the S.F. Shenandoah, it is possible that this species will expand into other Shenandoah tributaries in the park and may threaten native species. A variety of other non-native crayfish can be found in the waters surrounding Shenandoah N.P., including *Orconectes virilis* (Virile crayfish) in the Rivanna River (within the James subbasin) and in multiple locations in the Shenandoah system, and *Procambarus clarkii*, which has been observed at The Virginia Department of Game and Inland Fisheries Fish Hatchery in Front Royal, VA (Brian Watson, personal communication). Rusty crayfish (*Orconectes rusticus*), another non-native species, have been documented in the Potomac River, approximately 10 miles upstream from the confluence of the Shenandoah and Potomac Rivers.

In multiple samples, crayfish sex ratios were highly skewed, and in three sampling locations (Jeremy's Run, Piney River, and N.F. Moorman's River), no female *C. b. bartonii* were captured. These sampling locations were the earliest three streams to be sampled, and it is possible that female *C. b. bartonii* were still reproductively active during this time and were therefore less available for capture due to burrowing habits during reproductive seasons (Guiasu 2002, Lieb 2007b).

All species observed in this survey are secondary or tertiary burrowers, which are generally stream dwelling crayfish species (Hobbs 1989). Other species (primary burrowers) can be found in wetlands or other locations where the water table is accessible. That being said, these locations are extremely rare in Shenandoah N.P., and no crayfish burrows (or associated mounds) have been observed by park staff that spend substantial times in the backcountry and in the limited wetland habitats in the park. It is very unlikely that any non-stream dwelling crayfish are present within park boundaries.

This effort represents a pilot inventory of the crayfish fauna of Shenandoah National Park.

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