

# Assessment of Crayfish Populations in Six Tributaries of the West Branch of the Susquehanna River



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Above: The Appalachian brook crayfish was the only native species found in the West Branch watershed.

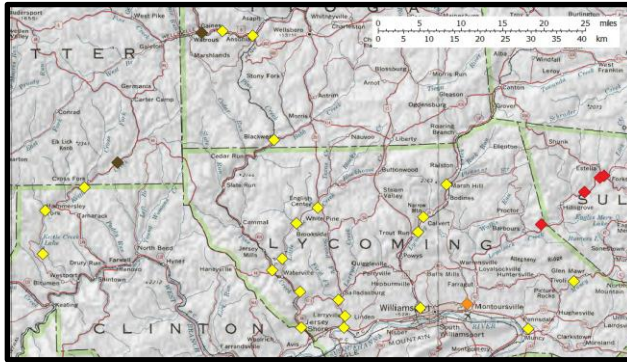
Above: The exotic rusty crayfish was the only crayfish species found in the main stem of Loyalsock Creek.

## Introduction

Since Ortmann's (1906) classic study of PA crayfish, there has been little effort to determine the current species composition in various regions despite common knowledge that invasive species are appearing in some watersheds. Leib *et al.* (2011) resurveyed southeastern PA and identified five exotic crayfish species that had displaced most of the native crayfish. Aggressive and prolific invaders, such as the rusty crayfish (*Orconectes rusticus*), have the potential to drastically alter the aquatic food web (Leib *et al.*, 2011). New survey work is needed to assess species composition, abundance, and the degree to which invasive species have penetrated watersheds and what their effect is on native crayfish species.

Ortmann (1906) reported that the native spiny-cheeked crayfish (*Orconectes limosus*) and the native Appalachian brook crayfish (*Cambarus bartonii*) were the only species in the upper reaches of the Susquehanna River watershed. Kuhlmann and Hazelton (2007) and Mangan *et al.* (2009) observed that the exotic rusty crayfish now predominates in the North Branch, while our study provides current information on crayfish occurrence in six tributaries of the West Branch Susquehanna River.

**Abstract:** We sampled crayfish populations in six tributaries of the West Branch of the Susquehanna River to determine the extent of invasion by non-native species. Our methods included use of seines in fast water and snorkeling in waterways where seining was not practicable. The predominate species captured was the exotic Allegheny crayfish (*Orconectes obscurus*), which occurred in five of six tributaries, but not in Loyalsock Creek where the invasive rusty crayfish (*Orconectes rusticus*) was the sole species inhabiting the waterway. The native Appalachian brook crayfish (*Cambarus bartonii*) sometimes coexisted with *O. obscurus* in the upper reaches of waterways, but was generally less abundant. Use of a standard seining protocol permitted semi-quantitative estimates of crayfish abundance, with densities as high as 3.38 crayfish per square meter and as low as 0.43 crayfish per square meter. Sex ratios were often disparate, ranging from females being six times as abundant as males, to males being four times as abundant as females. We conclude that native crayfish species have been displaced, largely by *O. obscurus*, and to a lesser extent by *O. rusticus*, an aggressive exotic species that has not yet spread beyond Loyalsock Creek.



Above: Map showing our 27 sampling locations across six West Branch tributaries.

Map Key: Yellow = *O. obscurus*; Brown = *O. obscurus* and *C. bartonii*; Red = *O. rusticus*; Orange = *O. rusticus* x *obscurus* (probable hybrids).

Left: Use of a 10'x4' seine for semi-quantitative sampling in fast-flowing tributaries.

Below: The exotic Allegheny crayfish was the predominant species in 5 of 6 watersheds.



## Methods and Materials

Mangan *et al.* (2009) found trapping to be the most efficient method of collecting crayfish from the Susquehanna River, but that it provided only relative abundance data. The faster water in tributary streams made trapping difficult, so we used a 10'x4' seine with 3/8" mesh to collect semi-quantitative estimates of abundance by scouring a circular area above the seine to discharge crayfish into the seine and by measuring from pole-to-pole to obtain the diameter of the circular area. Since diameter varied with water velocity (fast water = shorter diameter), we measured diameter every time the seine was set. Crayfish from each haul were identified using Rogers and Hill (2008). All crayfish were sexed and the ten largest males and females were collected for detailed measurements of size and mass (Table 1). The others were released at the sample site. We sampled at 27 locations (see map) across seven waterways in six different watersheds in north-central Pennsylvania (Table 1).

Waterways	Blotted Weight (mg)	Total Body Length (mm)	Carapace Length (mm)	Areola Length (mm)	Areola Width (mm)	Palm Width (mm)
KETTLES (n=36)	Mean	9.03	62.38	29.80	8.28	1.58
	Min	2.70	42.10	20.90	5.20	0.80
	Max	23.70	78.70	39.30	10.80	2.20
LARRY'S (n=50)	Mean	8.42	62.13	29.62	7.62	1.62
	Min	4.90	52.70	25.30	6.00	0.80
	Max	16.20	74.00	34.50	11.20	2.90
LYCOMING (n=9)	Mean	8.43	60.63	29.73	7.83	1.93
	Min	1.50	35.40	18.60	4.20	1.00
	Max	20.10	80.10	40.10	12.00	2.90
MUNCY (n=40)	Mean	13.93	70.63	34.53	9.23	3.33
	Min	5.20	55.60	27.10	6.80	1.20
	Max	25.80	89.40	45.60	13.20	2.40
PINE (n=50)	Mean	12.43	70.13	33.93	9.03	3.60
	Min	6.10	55.30	26.00	5.60	1.00
	Max	22.10	84.00	41.40	14.00	2.60
LITTLE PINE (trib. of Pine)	Mean	8.82	63.62	30.82	8.12	2.20
	Min	5.40	54.50	26.50	6.00	1.30
	Max	15.50	76.40	37.70	10.30	2.60
LOYALSOCK (n=8)	Mean	11.28	66.38	31.88	8.38	2.48
	Min	2.80	45.60	21.60	4.70	0.90
	Max	20.90	79.20	40.10	14.70	2.90
Total (n=560)	Mean	10.58	65.58	31.68	8.48	2.38
	Min	1.50	35.40	18.60	4.20	0.80
	Max	25.80	89.40	45.60	14.00	2.90

Waterway	Sample Site	Density per Square Meter	Male:Female Sex Ratio	
			Mean	SD
Kettle	B0001	0.670	1:5.91	
	TR01	ND	1:0.65	
	BUN02	0.44	1:0.70	
Larry's	LAR01	3.26	1:0.84	
	LAR02	2.02	1:0.96	
	LAR03	0.94	1:1.42	
Lycoming	CSU01	ND	1:0.37	
	PSB01	ND	1:0.31	
Muncy	MUN02	1.35	1:1.18	
	MUN01	ND	1:0.22	
Pine	TOR01	0.48	1:1.56	
	RAM01	1.02	1:2.24	
	UPB01	0.88	1:6.11	
	BLW01	3.38	1:4.61	
	UPC01	0.46	1:0.84	
Little Pine (trib. of Pine)	UPC02	0.43	1:1.41	
	LPC01	ND	1:0.47	
	LPC02	ND	1:0.35	
Loyalsock	MTR01	0.95	1:0.76	
	LW01	ND	1:0.44	
	SR01	ND	1:1.00	
	FRK01	ND	1:0.23	

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## Results

Results from this study show that the exotic *O. obscurus* predominates in five of six watersheds, but not in Loyalsock Creek where the exotic rusty crayfish are the sole species inhabiting the waterway (see map). In the upper reaches of Kettle and Pine creeks, we found co-occurrence of the native *C. bartonii* with the exotic *O. obscurus*, but in the other waterways, the native species was rarely encountered.

The density of crayfish varied from a high of 3.38 crayfish per square meter to a low of 0.43 crayfish per square meter (Table 2). Density increased in an upstream direction in Larry's Creek, but the pattern did not hold in other watersheds. Male-to-female sex ratios were disparate and varied from 1:6.11 to 1:0.23, and only a few approached the expected sex ratio of 1:1 (Table 2).

## Discussion

Because of rapid and progressive invasion of the North Branch by *O. rusticus* (Mangan *et al.*, 2009; Kuhlmann and Hazelton, 2007), we expected similar invasion of West Branch tributaries. However, we found *O. rusticus* in just one tributary and in none of its feeder streams. Rusty crayfish may be more successful in larger streams than in first- and second-order streams, but the reason for their absence from smaller streams is not clear.

Ortmann (1906) reported the native *O. limosus* and the native *C. bartonii* as the only species in the upper reaches of the Susquehanna River watershed, but we found no *O. limosus* during this study. The native *C. bartonii* is currently restricted to the upper reaches of several waterways where it co-occurs with the exotic *O. obscurus*.

Future studies are needed to determine the ecological factors that limit the invasion of exotics as they move into a watershed and the effects that exotics have on the aquatic food web.

## Literature Cited

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