Does the Density of Invasive Rusty Crayfish Affect Stream Macroinvertebrates?

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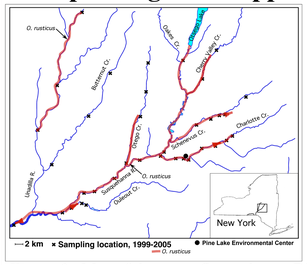
1. Introduction & Background

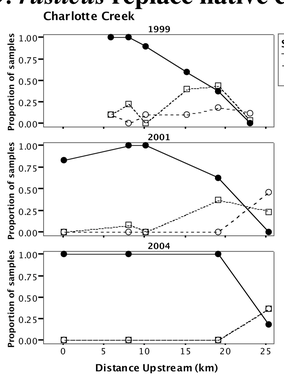
Introduced rusty crayfish (*Orconectes rusticus*) are expanding in the upper Susquehanna River[1]



O. rusticus

Figure 1. Map of the upper Susquehanna River catchment study area, showing the distribution of *O. rusticus* based on sampling during 1999-2005. Arrows indicate the documented direction of spread of the *O. rusticus* population.

O. rusticus replace native crayfish species[1]



O. propinquus

O. obscurus

Figure 2. Changes in crayfish distribution in Charlotte Creek, 1999-2004.

Crayfish density increases after *O. rusticus* invades

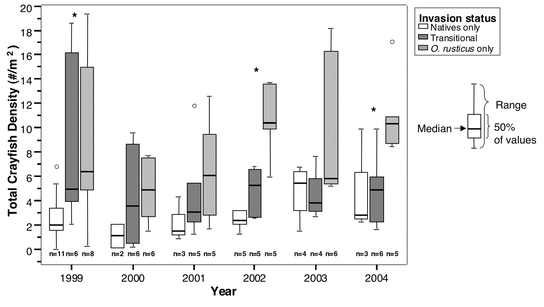


Figure 3. Total density of crayfish by site invasion status. Asterisks indicate years in which density ($\log_{10}$-transformed) differed significantly among invasion status categories: $^*P < 0.05$.

References:

1. Kuhlmann, M.L., and Hazelton, P.D. (2007) Invasion of the upper Susquehanna River watershed by rusty crayfish, *Orconectes rusticus*. *Northeastern Naturalist* 14, 507-518
2. Hauer, F.R., and Lamberti, G.A. (2006) *Methods in Stream Ecology*. Academic Press

Acknowledgements:

- Field help: P. Hazelton
- Logistical support: Pine Lake Environmental Center staff, Hartwick College Biology Dept.
- Financial support: Hartwick College Faculty Research Grants, Wandersee Scholar-in-Residence award, & Biology Dept.

2. Field Sampling: No Association Between Crayfish & Macroinvertebrates

Methods:

- In 2002, we sampled crayfish and macroinvertebrates at 13 sites (total) on 4 streams in the upper Susquehanna River catchment (see **Fig. 1**).
- **Crayfish**: semi-quantitative kick-netting (moving water) or quadrat sampling (still) (**Fig 4**), 6-16 samples/site.
- **Macroinvertebrates**: 6 Surber sample/sites, preserved, later sorted under dissecting scope to family, less common taxa grouped at higher taxonomic levels.

Figure 4. Sampling crayfish by kicknet (top) & quadrat (bottom)

Crayfish density and species composition covary

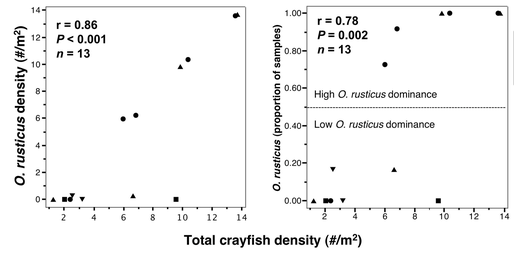


Figure 5. Relationship between total crayfish density and *O. rusticus* density (L) and relative abundance (R) at 13 sites in the Susquehanna River catchment sampled in 2002.

Macroinvertebrate density or diversity was not correlated to crayfish density

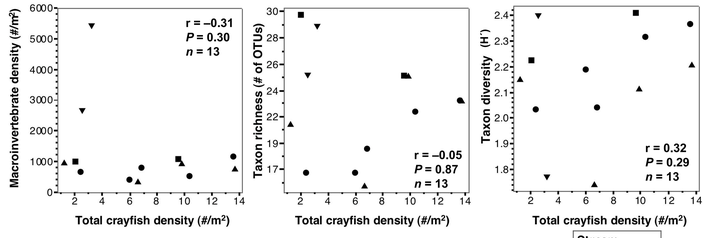


Figure 6. Relationship between total crayfish density and macroinvertebrate abundance and assemblage composition at 13 sites in the Susquehanna River catchment sampled in 2002.

Macroinvertebrate density or diversity did not change with rusty crayfish relative abundance

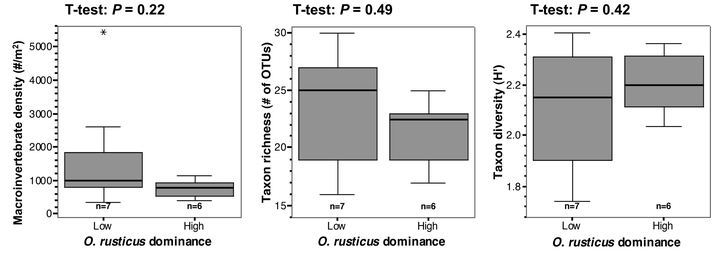


Figure 7. Macroinvertebrate abundance and assemblage composition at high and low *O. rusticus* relative abundance at 13 sites in the Susquehanna River catchment sampled in 2002. *O. rusticus* dominance categories are as shown in Figure 5.

3. Enclosure Experiment: Crayfish Density Affects Macroinvertebrates

Methods:

- Six 0.75-m² in-stream enclosures per trial (**Fig. 8**) in Charlotte Creek, adjacent to the Pine Lake Environmental Center, West Davenport, NY (see **Fig. 1**).
- Bottom covered with stream rocks, colonization by drift for 1 week.
- Treatments: 0, 3, or 8 *O. rusticus*/enclosure
- Macroinvertebrates sampled at start and end from enclosures and stream.
- Two trials in June & July, 2007 (n = 4); experiment continued in 2009
- No differences between treatments at start; only data from samples at end shown.

Figure 8. Experimental enclosure (top); 6 enclosures in place (bottom)

Increasing crayfish density reduced macroinvertebrate density

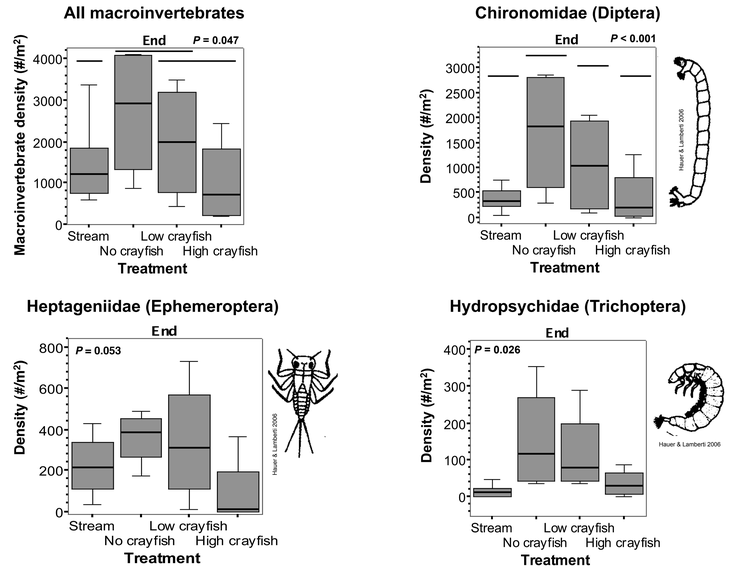


Figure 9. Effects of rusty crayfish density on density of all macroinvertebrates (upper left) and 3 abundant taxa after 3 weeks with experimental treatments (End). Data are from n = 3 Hess samples from Charlotte Creek and Hess or Surber samples from n = 4 enclosures per crayfish treatment. P-values are from ANOVA comparing all treatments; horizontal bars at the same height show treatments that are not significantly different by post-hoc means comparisons (S-N-K tests).

Increasing crayfish density did not affect macroinvertebrate diversity

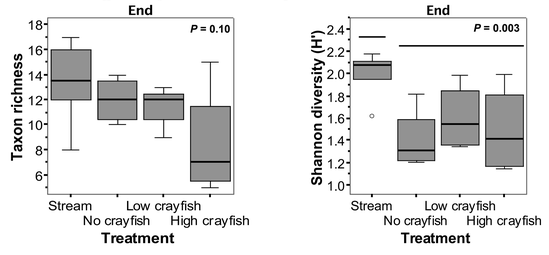


Figure 10. Effects of rusty crayfish density on richness (left) and diversity (right) of macroinvertebrate taxa after 3 weeks with experimental treatments (End). Richness and diversity were calculated using operational taxonomic units (family for common groups, larger taxa for rare groups). Sample sizes and figure elements are as in Figure 9.

Conclusions:

- Experiment (but not field survey) indicates that increased crayfish density following invasion by *O. rusticus* reduces overall macroinvertebrate abundance.
- Effects on diversity & less abundant taxa? – more replicates needed.
- *O. rusticus* invasion could have indirect effects: e.g., trout and juvenile smallmouth bass also eat macroinvertebrates.

Nature Proceedings : doi:10.1038/npre.2009.3701.1 : Posted 31 Aug 2009