Are rusty crayfish aggression and activity affected by anthropogenic sounds

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Kent State University/Holden Arboretum Ecology REU 2013 - Terrestrial-aquatic linkages in urban impacted ecosystems
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Introduction

Animal behavior scientists study the causes, functions, development, and evolution of animals' actions over the organism's lifetime. I studied factors including anthropogenic sounds that could affect Rusty crayfish (*Orconectes rusticus*) behavior. This species is native to the Ohio River basin and Kentucky, but it has spread throughout North America by dumping of bait buckets and aquariums and commercial aquaculture (See Fig.1). Adult Rusty crayfish are 7-12 cm long, with large smooth claws that have an oval gap when closed. The sides of their carapace have two rusty colored patches near the abdomen (see Fig. 2). Rusty crayfish inhabit lakes, rivers, streams and wetlands where they cause extensive ecological problems by outcompeting native species, hybridizing with native crayfish, and feeding on native plants.

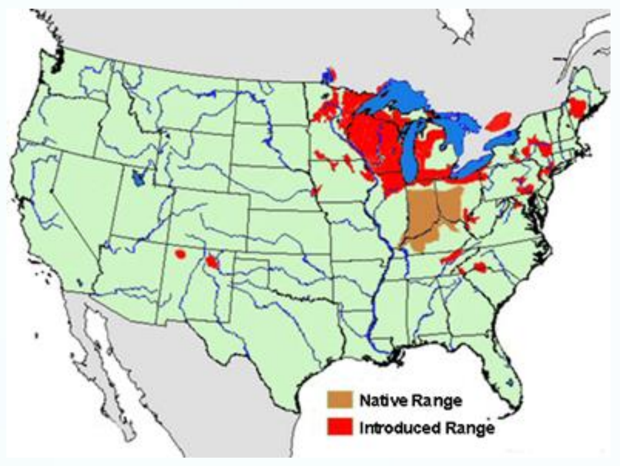


Fig. 1. Range of *Orconectes rusticus* native and introduced areas. (SOURCE: United States Geological Service Rusty Crayfish Fact Sheet 2007)

Fig. 2 – Rusty crayfish used in this study

Rusty Crayfish behavior has been studied; they are very aggressive and often attack and displace less aggressive native crayfish. They can even drive off fish predators and eat their young. A different crayfish species, *Procambarus clarkii*, was recently shown to make sounds during aggressive encounters. They found *P. clarkii* walking activity was not affected by anthropogenic sound but aggression was reduced probably because they cannot hear each other (Celi et al. 2013). However, little is known about factors that alter Rusty crayfish aggression or other activities in natural or human disturbed environments.

The hypotheses I tested in this study were:

1. Rusty Crayfish will be less aggressive during anthropogenic sounds.
2. Walking time and shelter use will not be affected by anthropogenic sounds.
3. Aggression and walking by Rusty Crayfish will be affected by their size and sex.

Methods

I used seines, nets and traps to collect 44 *Orconectes rusticus* (18 male, 26 female) from Breakneck Creek over a 3 week period. Average weight for males was 8.15g and for females 9.99g, there was not a significant difference between males and females (p=0.401) Crayfish were held in plastic tubs (17.8 x 30.7 cm - height x width; 2 animals per tub), with an air pump and 2 PVC pipe shelters, and were maintained with a 12:12 light:dark cycle. PVC shelters were 5 cm X 10 cm (diameter, length) PVC pipe cut lengthwise in half and placed with the hollow side down. Crayfish were fed every other day, but crayfish used in a trial were deprived of food two days before their trial.

The experiments were conducted in the laboratory of Dr. Kershner in Cunningham Hall, Kent State University. Experimental arenas (see Fig. 3) were 31.5 x 41.4 cm (h x w) plastic tubs with a layer of gravel and cool water. Each trial had 2 arenas: one arena contained a single crayfish and one PVC shelter, and the second arena held five crayfish with three PVC shelters. I monitored behaviors in the crayfish group arena including number of aggression/victim events. I also measured time spent in shelter and walking for a randomly chosen crayfish in the group. In the single crayfish arena, I recorded time spent in shelter and walking for the lone crayfish.

After I added the crayfish into each arena, I let them rest 1 hour. In the Sound treatment, I monitored them for 15 minute portions in each of three periods: 1) Before Sound (30 min), 2) During Sound (30 min), 3) After Sound (30 min).

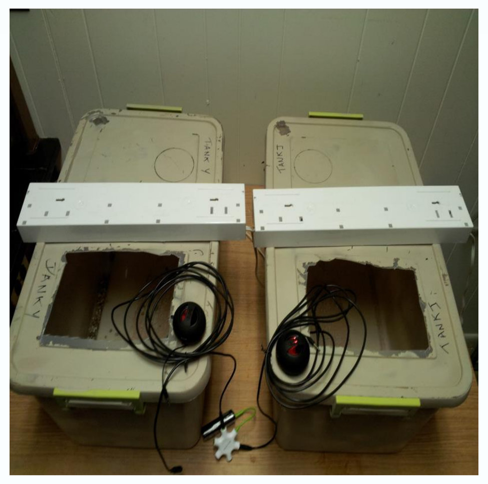
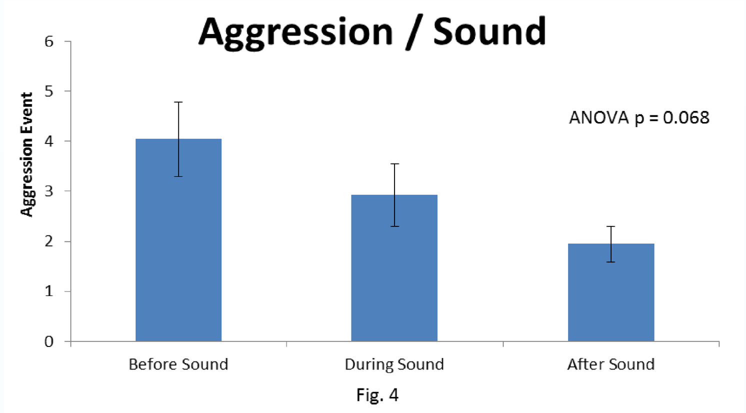


Fig. 3 - Experimental arenas

During the Sound period, I played recordings of 12 anthropogenic sounds (motor boats and jet skis), ranging from 3,000 to 6,000 Hz and 30dB to 75dB. The sound files were played through an underwater speaker on a continuous loop during the entire 30 minute period. In the No Sound treatment, all conditions were the same except no sound files were played on the speakers and the monitoring periods were termed: 1) Before No Sound, 2) During No Sound, 3) After No Sound. I analyzed my data with ANOVAs and T-tests run on SPSS Statistics software.

Results



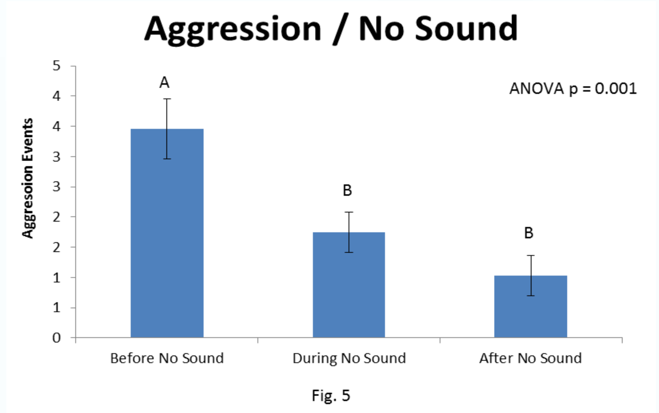
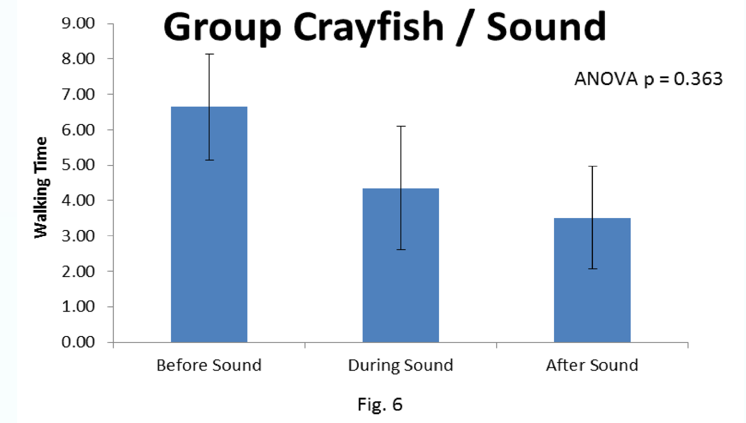
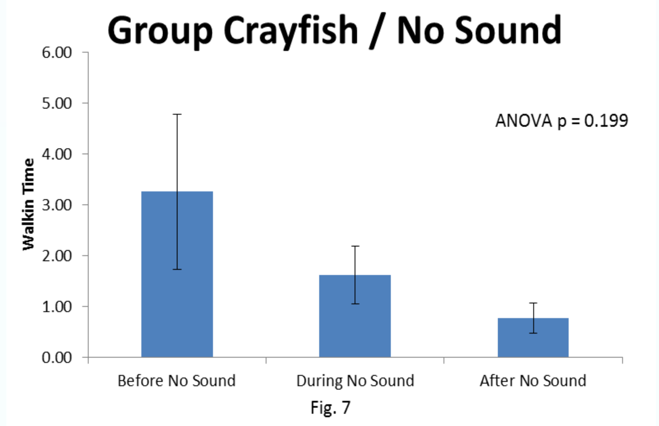
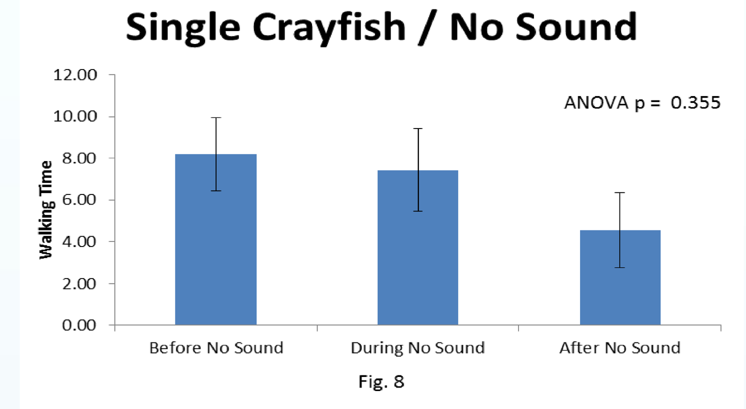


Figure 4 -5. Number of aggression events of a group of 5 crayfish during sound and no sound trails. Values are the periods before, during and after no sound and sound play back. Columns with different letters are significantly different.







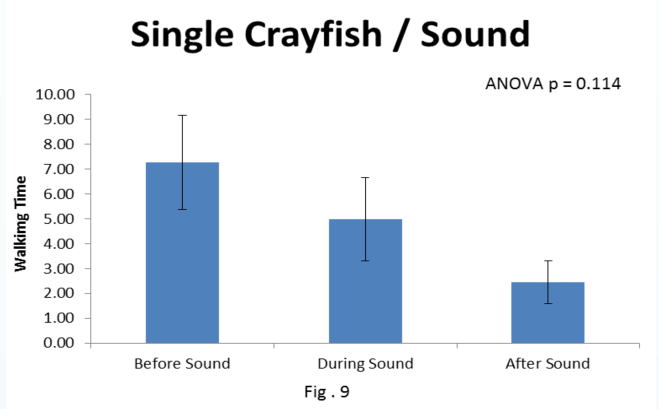
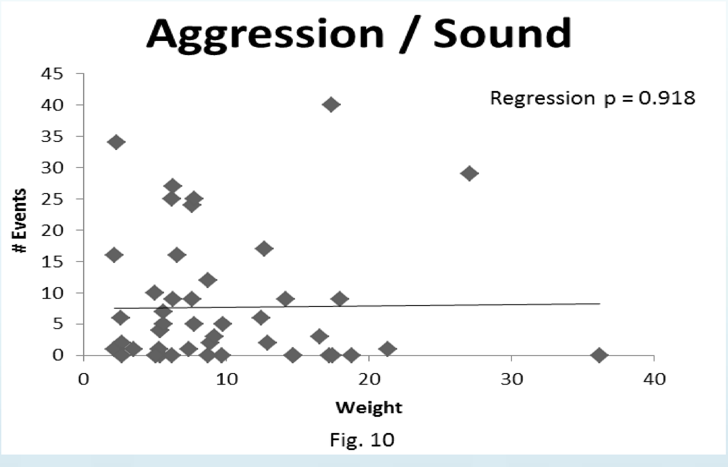


Figure 6 – 9. Time spent walking (minutes) of a group of 5 crayfish and a single crayfish during sound and no sound trails. Values are the periods before, during and after sound and no sound playback.



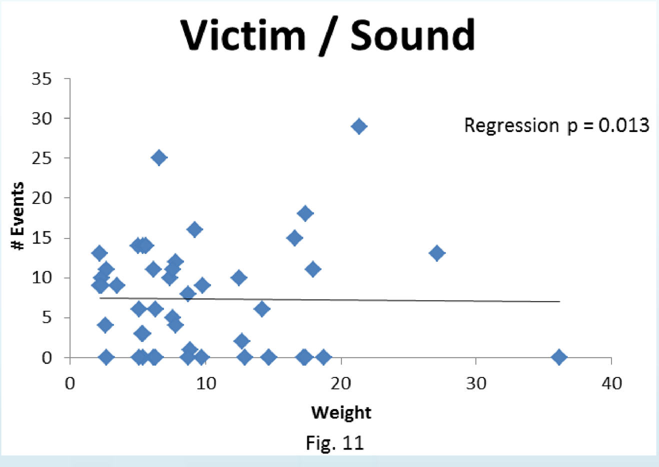


Figure 10 – 11. Scatterplot of crayfish weight versus number of aggression and victim events.

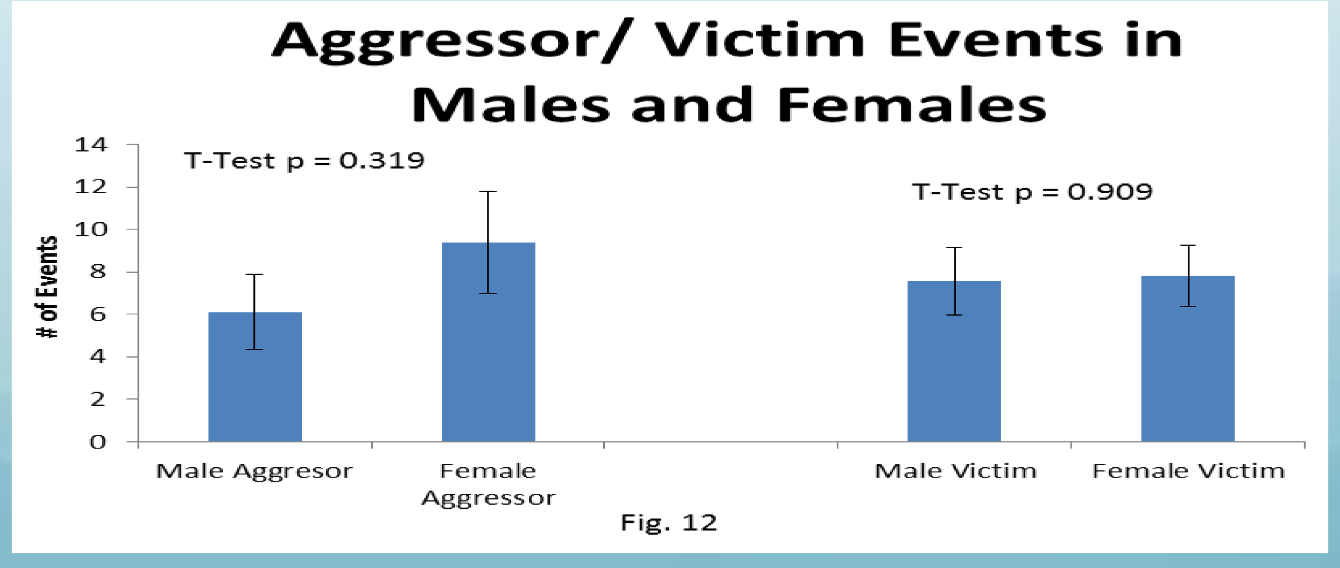


Figure 12. Number of aggression and victim events from male and female crayfish.

For the study 16 trails were analyzed, 8 replicates for sound and 8 replicas for no sound. Regression data analysis were done to compare aggression and victim events for sound (Figures 10 and 11) and no sound trails (not significant, resulting in aggressor p value of 0.158 and a victim regression p value of 0.686). We also conducted T-test for aggression impact for sound versus no sound over 3 time intervals (before, during, after), and we obtained the following p values; p= 0.484 for before, p = 0. 101 for during and p = 0.053 for after (data not shown).

ANOVA tests were completed to evaluate shelter use in 3 time intervals (before, during and after), between a single crayfish and the group crayfish. The ANOVA p values were the following; p = 0.636 for a single crayfish in sound, p = 0.782 for a single crayfish in no sound, p= 0.152 for the group crayfish in sound and p = 0.073 for the group crayfish in no sound (data not shown).

ANOVA test were also completed to evaluate walking time in 3 time intervals (before, during and after) between a single crayfish and a random crayfish from the group (Figures 6 to 9), a single ANOVA test was done to calculated the walking time of a single crayfish versus a random crayfish from the group, the p value for this test was 0.054 (data not shown).

Discussion

The amount of aggression events was not different between the no sound period and the sound period, which indicates that anthropogenic sound did not directly affect aggression. However, aggression declined significantly during the study in the no sound trails but not in the sound trails. Furthermore, aggression events were almost significantly different when we compared the sound and no sound trails during and after the playback period. Aggression did not seem to decline as fast during sound as during no sound trials.

Walking and shelter use were never different between the no sound and sound treatments, this was true in all periods during the experiment, as well as for single crayfish and crayfish in a groups. Overall this indicates that rusty crayfish will have the same activity levels in habitats with human sound pollution as in unaffected habitats.

We also found that sex and size did not affect aggressive behavior, this is somewhat surprising because smaller animals are usually less aggressive than larger animals and sex often plays a role in aggressive behavior. This may be a reason why this species is more invasive and often displaces native crayfish.

Acknowledgements

This project was funded by the National Science Foundation. I would like to thank Adrienne Hopson, DeShawn Johnson, Brendan Morgan and Emma Kelly for field and lab support. Assistance with research design was provided by Dr. Mark Kershner and Dr. Patrick Lorch. At CUNY, Prof. Heather Sloan and Prof. Vicki Flaris plus Dr. Gannet Hallar. I would like to credit Kenny and Bob the first two crayfish that I gathered in the field.