AGENDA ITEM or FINAL CONTRACT REVIEW SUBMITTAL FORM

AgendaTitle:
Visitors; Western State Colorado University, Department of Natural and Environmental Science Representatives Corbin Bennetts and Kevin Alexander; Assessment of Potential Impacts Associated with Adult Mosquito Abatement Spraying on Macroinvertebrate Drift in Streams near Gunnison, Colorado, 2013

Action Requested: Discussion

Parties to the Agreement:

Term Begins: **Term Ends:** **Grant Contract #:**

Summary:
Please see the attached report prepared by Corbin Bennetts and Kevin Alexander

Fiscal Impact:

Submitted by: Katherine Haase **Submitter's Email Address:** khaase@gunnisoncounty.org

Finance Review: ○ Required ◉ Not Required

Comments:

Reviewed by: Discharge Date:

County Attorney Review: ○ Required ◉ Not Required

Comments:

Reviewed by: Discharge Date: Certificate of Insurance Required

Yes ○ No ○

County Manager Review:

Comments:

Reviewed by: GUNCOUNTY1\mbirnie Discharge Date: 8/4/2014

○ Consent Agenda ○ Regular Agenda ◉ Worksession Time Allotted: 30 mins

Agenda Date: 8/26/2014 Follow Up Agenda Date:

Revised April 2013

AN ASSESSMENT OF POTENTIAL IMPACTS ASSOCIATED WITH ADULT MOSQUITO ABATEMENT SPRAYING ON MACROINVERTEBRATE DRIFT IN STREAMS NEAR GUNNISON, COLORADO, 2013.

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SUMMARY

Concern had been expressed by some citizens that the aerial application of the insecticide, permethrin, that is used to kill adult mosquitoes, was negatively affecting the aquatic ecosystems of Tomichi Creek and the Gunnison River. The aerial application of permethrin supplemented the use of larvacides which is the dominant means of mosquito control in the Gunnison, Colorado area. A policy shift by the Gunnison County commissioners in 2013, moved from a mosquito control plan involving airplane based spraying to a plan using only larvacides coupled with truck and backpack application of permethrin for adult mosquito control. In July 2013, drift samples were taken to determine if truck and backpack based spraying of permethrin to control adult mosquitoes increased the number of drifting insects from permethrin entering streams and poisoning the non-target aquatic insects. By comparing rates of drifting insects upstream to downstream, as well as before and after the truck and backpack based application of permethrin, we were not able to detect any changes in the drift of aquatic insects with that application on July 16, 2013.

Drift samples were also used to examine the aquatic insect community in areas where aerial spraying had occurred with potential aquatic insect kills in July 2012. We found that overall drift was higher in areas that were sprayed by airplane in 2012 but that these drifting insects were predominantly Midges, which are short lived aquatic insects that can increase after disturbance. When the Midges are removed from analysis, there was a statistically significant decline in longer lived aquatic insects (example; Stoneflies, Caddisflies, Mayflies) in Tomichi Creek and suggestions of a similar trend in the Gunnison River. This also corresponds to a decline in a large charismatic stonefly, *Claassenia sabulosa*, in those same areas of the Gunnison River and a decline in quality of macroinvertebrate based water quality samples that were collected in 2013 along both Tomichi Creek and the Gunnison River, both below and above areas where airplane based spraying occurred in 2012. This indicates that there was a change in the aquatic community of Tomichi Creek and the Gunnison River where airplane based spraying of permethrin occurred after 2012. The airplane based spraying of permethrin may have played a role in that change.

INTRODUCTION

Mosquitoes (Diptera: Culicidae) inhabit riparian zones and irrigated hay meadows throughout the upper Gunnison River Valley. Due to public concerns, including the spread of diseases, such as West Nile virus (Knight *et al.,* 2003), for both livestock and humans, Colorado Mosquito Control is contracted to monitor mosquito populations and reduce the mosquito population by applying larvacides to aquatic habitats and through the application of the adult mosquito control agent BIOMIST® or similar insecticides. Insecticides These insecticides targeted at adult mosquitoes are aerially applied and occasionally applied manually from the ground by trucks or with backpack sprayers in the upper Gunnison River valley in an attempt to reduce the number of adult mosquitos and the impacts of hatches and outbreaks that occur in proximity to livestock and human activity (personal communication, C. Kruthaupt, Colorado Mosquito Control).

The larvacides are specific to mosquitoes and control their populations prior to the mosquitoes reaching adulthood. However, permethrin, the active ingredient in BIOMIST® and similar insecticides, is a pesticide that is used in various insect control measures and is a known toxin to all insects and aquatic organisms so it can have effects on non-target orgranisms. The introduction of permethrin to local stream systems via unintentional airborne drift of these insecticides during application to associated riparian areas and /or through return irrigation waters after application to irrigated meadows are possible ways that permethrin could enter into streams. Upon entering a stream, permethrin has the potential to negatively impact aquatic insect populations and reduce productivity within local streams. The aquatic insect 'die-offs' that have been recently observed (Figure 1) along local streams may be an indication that the introduction of permethrin through aerial drift or irrigation return to streams may be causing the reduction of aquatic insect populations in affected streams. A substantial decline of aquatic macroinvertebrates (large aquatic invertebrates such as aquatic insects) is harmful to trout, birds, wildlife and aquatic vegetation due to changes in the stream ecosystem. These impacts reduce the quality of streams as well as the quality of stream based recreational and ecotourism activities including wildlife watching, river rafting, and fishing. A reduction in stream ecosystem quality can have negative impacts to local business and tourist based industry that is associated with recreational and guided fishing as well as other eco-tourism activities that are a part of local commerce. Additionally, a substantial decline of macroinvertebrates could cause local streams to fail State of Colorado Water Quality Control Division's aquatic life standards, potentially resulting in the streams listed as provisionally impaired.

Figure 1. Photograph of dead aquatic insects in the Gunnison River on the morning after aerial spraying of a permethrin in Summer 2012.

During the summer of 2012, the Gunnison Country-Times reported aquatic insect kills and we have received personal accounts and photographs (Figure 1) from local citizens and fishing guides of aquatic kills and reduced fishing quality in proximity to annually scheduled aerial application of permethrin in the upper Gunnison River valley. However, there are conflicting accounts on if and how the stream communities are affected near the City of Gunnison, Colorado. We did document a substantial decline (about 85%) of a large charismatic stonefly in the Gunnison River near the City of Gunnison, in July 2012 (Figure 2). Although this decline coincided with and is consistent with a possible macroinvertebrate kill from the aerial application of permethrin, our data at this time was inconclusive and personal accounts, although credible, remain unsubstantiated.

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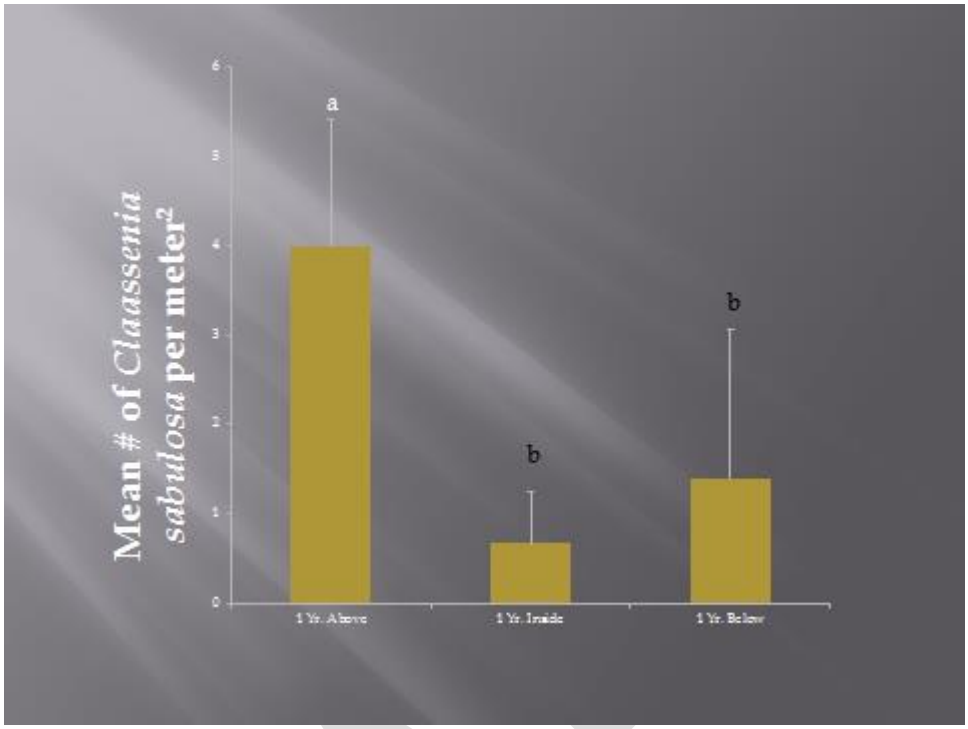

Figure 2. Data from a study by Tyler Patterson and Kevin Alexander in fall 2012 documenting a significant decline in the large charismatic stonefly, *Claasenia sabulosa*, nymphs inside and downstream of the aerial mosquito spray zone.

Drift is a phenomenon of macroinvertebrates entering the water column and travelling downstream in the water current. This event can occur by active choice of the macroinvertebrate such as moving to a region with more food, as a response to disturbance such as a flood or toxin, or as they die. If substantial amounts of permethrin enter into these streams and have a negative effect, then macroinvertebrate drift will significantly increase above background levels immediately after the application. This would indicate a response to unfavorable conditions such as the introduction of permethrin potentially resulting in toxic conditions. If the 2013 application does not have a negative impact, stream drift will not change significantly, indicating that the aquatic insects and the stream community are not substantially affected by the event.

Our study aimed to determine how the aerial spraying of permethrin in the summer of 2013 affects the macroinvertebrate drift and consequently the aquatic macroinvertebrate communities in the Gunnison River and Tomichi Creek since these streams are directly or indirectly exposed to the application of permethrin. We hypothesize that the quantity and diversity of macroinvertebrates drifting downstream will increase significantly ($p < 0.1$) after the aerial application of permethrin, if the permethrin enters into the stream and kills or negatively affects the macroinvertebrates. Monitoring stream macroinvertebrate drift is an effective and

economical means to monitor the effects of aerial spraying since if the macroinvertebrates are poisoned they will not be able to maintain their positions on the streambed and be entrained into the stream flow where they are intercepted by the drift nets.

However, due to concerns, a decision was made to not aerially spray BIOMIST® in the summer of 2013. Instead a ground application was applied manually. We continued to do our study, on historically sprayed areas versus areas that are not historically sprayed, as well as pre-ground application versus post-ground application.

METHODS

To determine how the 2012 and 2013 adult mosquito spraying is affecting the aquatic macroinvertebrates in the Gunnison Valley, the number of macroinvertebrates drifting downstream was determined along historically sprayed areas of the Gunnison River (Gunnison River Gauge Station) and Tomichi Creek (Tomichi Creek Preserve) and compared to upstream sites that are historically not sprayed which serve as our control sites (Rockey River Resort on the Gunnison and Coldharbour Sustainable Living Center on Tomichi Creek). Along the Gunnison River, we also compared drift immediately before and after ground based permethrin application on July 16th in Dos Rios by sampling macroinvertebrate drift just downstream (McCabe's Lane) from the application site. We also used a site at the Gunnison Gauge Station, upstream of the ground based application of permethrin as a control site for this portion of the study.

To determine the number of macroinvertebrates drifting downstream, we deployed four 12" height by 18" width, 363µm mesh drift nets that were suspended above the stream bed on stainless steel stakes and followed standard protocol for sampling drift (Smock, 2007). These were placed at predetermined locations as described above. At the end of each sampling period, the macroinvertebrates were collected from the nets and preserved in ethanol. Later in the laboratory, the macroinvertebrate samples were sub-sampled, sorted, enumerated, identified and categorized into taxonomic or functional groups. Water velocity at each drift net was also measured to determine volume of water flowing into each net to quantify drift density.

To analyze the data, an ANOVA statistical test was done to compare the density of drifting macroinvertebrates within each taxonomic or functional group, before the mosquito spraying to the density of drifting macroinvertebrates collected after the mosquito spraying. A p value less than 0.1 obtained from this research would indicate that there is a difference of macroinvertebrate drift before and after spraying, otherwise the data would indicate no difference in macroinvertebrate drift before and after spraying. An ANOVA statistical analysis was also used to compare historically sprayed sites to site that are not sprayed historically. A p

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value less than 0.1 obtained from this research would indicate that there is a difference of macroinvertebrate drift in areas historically sprayed verses areas not historically sprayed, otherwise the data would indicate no difference in macroinvertebrate drift in the two areas. A large amount of Midges and terrestrial insects were obtained in the drift samples, especially on Tomichi creek, so the same data analysis as explained above was done a second time without Midges and terrestrials. Midges tend to have short life cycles and can increase dramatically in disturbed areas.

RESULTS

The drift at the Tomichi Creek and Gunnison River study sites were dominated by Midges with lesser amounts of Mayflies and Caddisflies. Midges, Mayflies and Caddisflies constituted over 85% of the macroinvertebrate drift and Stoneflies constituted less than 1% of the drift. The drift densities range from near five macroinvertebrates per cubic meter to over 30 macroinvertebrates per cubic meter (Figures 5 through 8).

In the Gunnison River, there was no significant difference between the upstream control site and the downstream site that was potentially impacted from the aerial application of permethrin in 2012 (Figure 9). However, when Midges and terrestrial insects were removed from the analysis (Figures 5 and 7) there was a significantly lower number of drifting macroinvertebrates (ANOVA $p = 0.08$) at the lower site that had been aerially sprayed in 2012. There was no significant differences in Gunnison River Gauge Station sampled on July 8-9 (prior to truck based spraying) and the Gunnison River Gauge Station on July 16-17 (during truck and backpack spraying) indicating that this functions as an acceptable control site to evaluate the effects of the truck and backpack based spraying in 2013. Additionally, there was no significant difference in macroinvertebrate drift between McCabe's Lane and the upstream control sites both with and without the Midges and terrestrial insects included (Figure 9).

In Tomichi Creek, there was a near significant difference between the upstream control site and the downstream site that was potentially impacted from the aerial application of permethrin in 2012. However, when the Midges and terrestrial insects are removed from the analysis there were significantly fewer (ANOVA, $p = 0.06$) drifting insects at the lower site that had been aerially sprayed in 2012.

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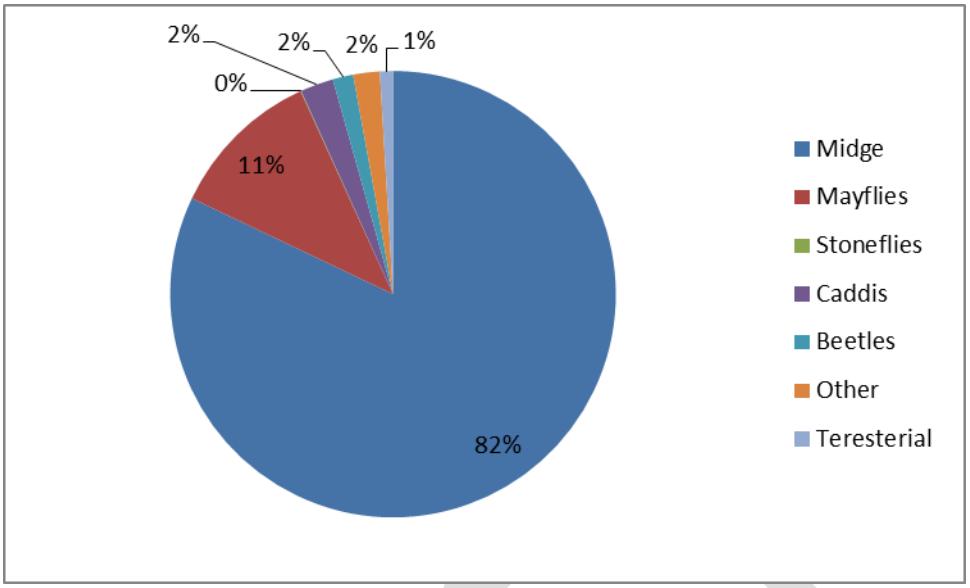

Figure 3: Total percentage of each type of drifting macroinvertebrate for Tomichi Creek, 2013.

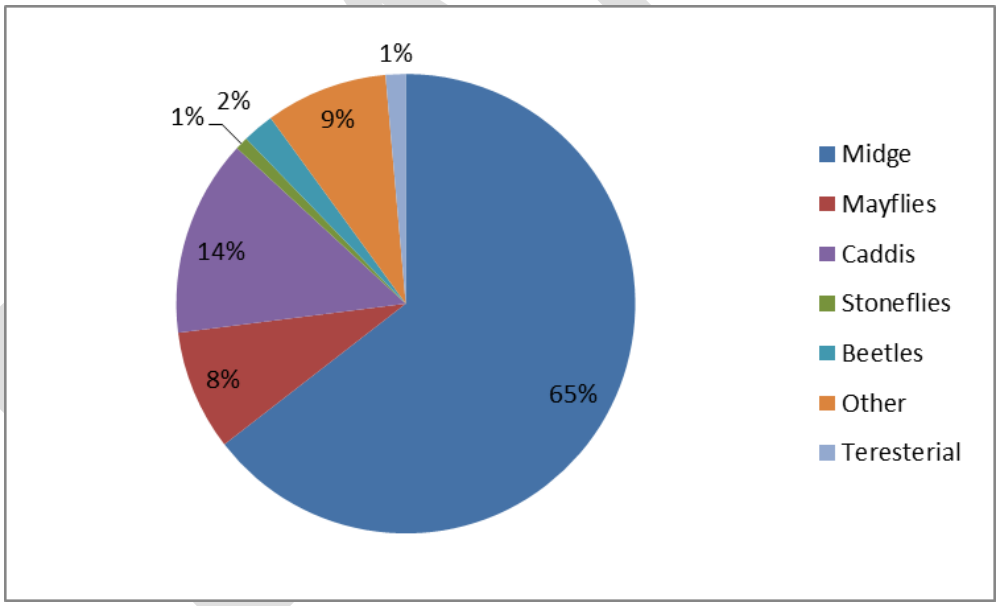

Figure 4: Total percentage of each type of drifting

macroinvertebrate for the Gunnison River, 2013.

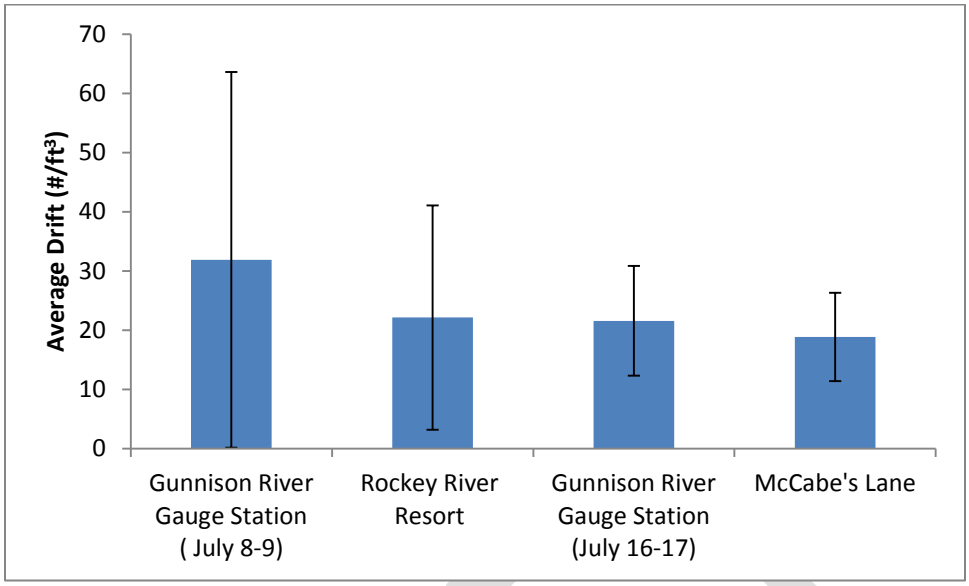

Figure 5: Graph of the mean (±standard deviation) drift density of all macroinvertebrates from the four sites along the Gunnison River, 2013.

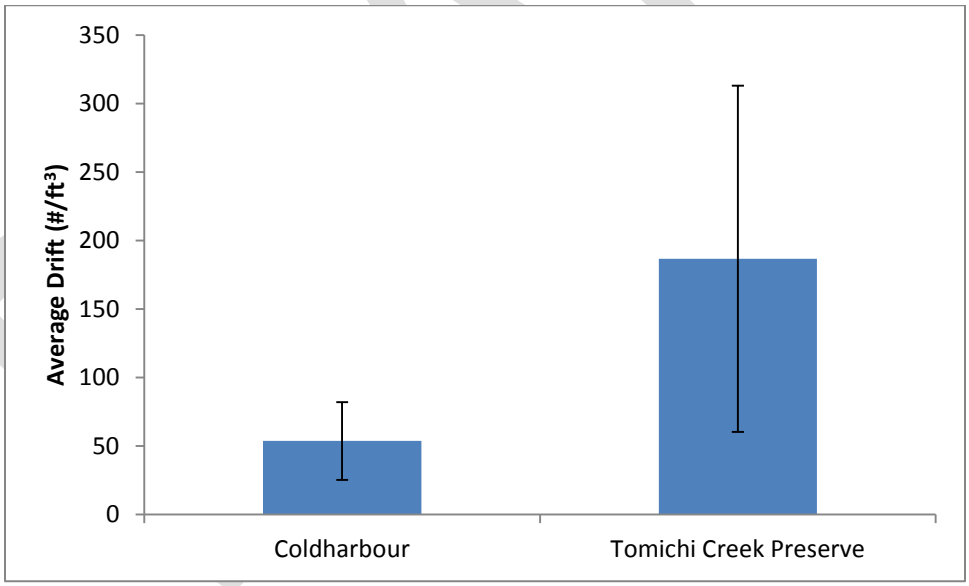

Figure 6: Graph of the mean (±standard deviation) drift density of all macroinvertebrates from the two sites along Tomichi Creek, 2013.

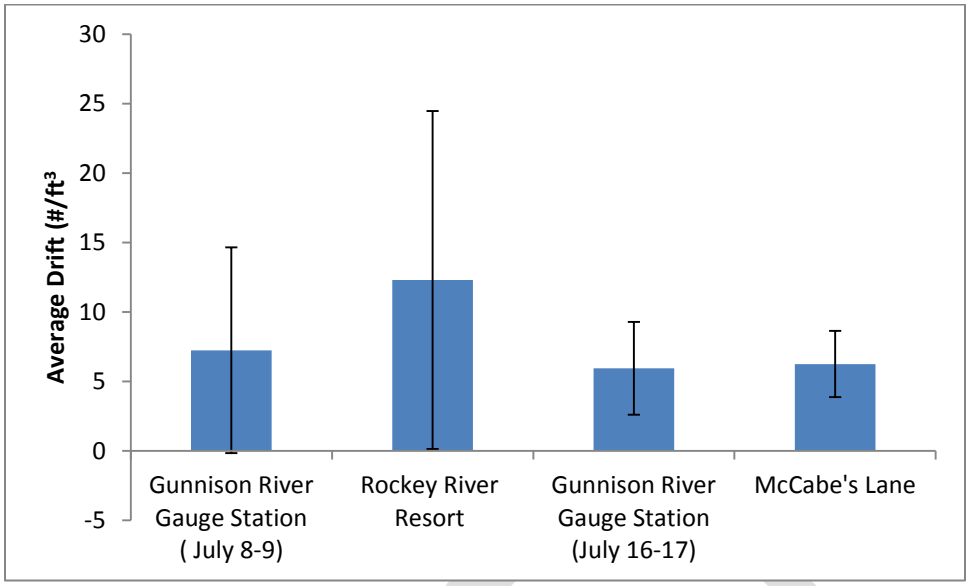

Figure 7: Graph of the mean (±standard deviation) drift density of all macroinvertebrates **except** Midges and terrestrials from the four sites along the Gunnison River, 2013.

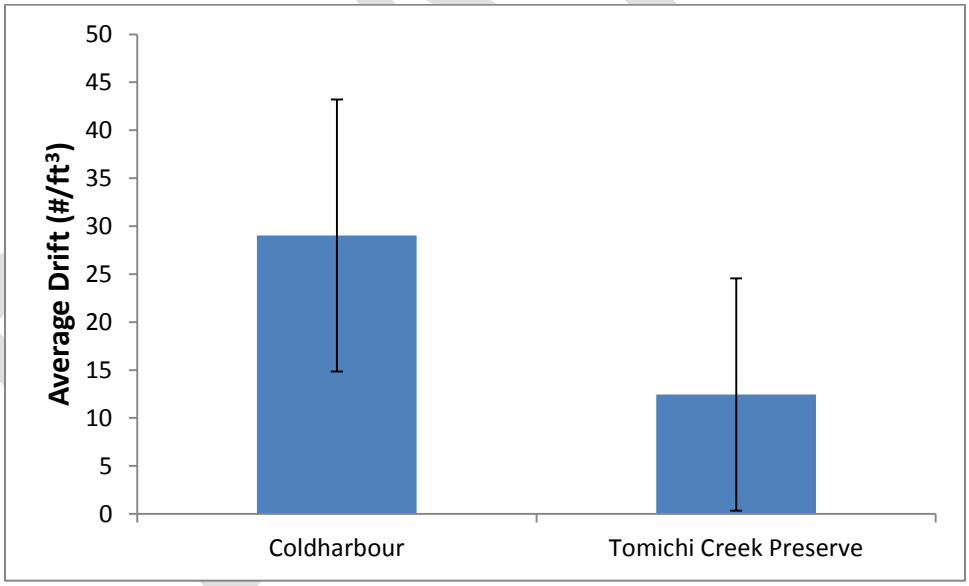

Figure 8: Graph of the mean (±standard deviation) drift density of all macroinvertebrates **except** Midges and terrestrials from the two sites along Tomichi Creek, 2013.

SITE	P-VALUE (with midge & terrestrials)	P-VALUE (without midge & terrestrials)
Gunnison River Gauge Station (July 8-9) and Rockey River Resort	0.35	0.08
Gunnison River Gauge Station (July 8-9) and Gunnison River Gauge Station (July 16-17)	0.43	0.17
Gunnison River Gauge Station (July 16-17) and McCabe's (July 16-17)	0.82	0.47

Figure 9: Table showing analysis obtained from an ANOVA test comparing all net drift densities between indicated sites/dates along the Gunnison River.

DISCUSSION

With less than 1% of our samples being composed of Stoneflies, including those drift samples taken immediately below the truck and backpack based spraying in 2013, the substantial numbers of drifting and dead Stoneflies from 2012 (Figure 1), was a highly unusual event. The study by Patterson and Alexander (2012), show a decline in the large charismatic stonefly, *Claassenia sabulosa*, (Figure 2) which would support that the decline in Stoneflies occurred in areas that were sprayed aerially with permethrin. Conversely, we could not detect any measurable change in drift from the truck and backpack based application of permethrin indicating that truck and backpack based spraying at this one location and on this one date did not have an impact similar to the aquatic macroinvertebrate deaths photographically recorded in 2012 (Figure 1).

We did detect a stream macroinvertebrate composition shift from upstream control sites to downstream sites that were potentially impacted by the aerial spraying of permethrin. The shift was a decrease in percentage of the long lived and charismatic macroinvertebrates (e.g.; Mayflies, Stoneflies, Caddisflies) and an increase in the percentage of more short lived and less charismatic macroinvertebrates (e.g.; Midges). This can indicate areas of recent disturbance because the Midges with short life spans can colonize and exploit disturbed areas more quickly than the macroinvertebrates such Mayflies, Stoneflies and Caddisflies (Merritt and others, 2008).

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Likewise, when we analyzed macroinvertebrate based water quality data from the upper Gunnison River basin, we found declines between 2012 and 2013 in biological based water quality measures at Tomichi Creek at Gold Basin Road and at the Gunnison River at the Gauging Station. These declines were substantial and at the Tomichi Creek site were of substantial enough decline to indicate that Tomichi Creek may be provisionally impaired (Colorado Department of Public Health and Environment, Water Quality Control Division, 2010). Additionally, when other sites around the upper Gunnison River basin are examined between 2012 and 2013, there are not similar declines in macroinvertebrate based measures of water quality indicating that these declines are relatively site specific and occurred between 2012 and 2013.

In conclusion, there was a measurable decline in the quality of the aquatic macroinvertebrate community of Tomichi Creek and the Gunnison River where airplane based spraying of permethrin occurred after 2012 as measured by this drift study and corroborated with Colorado Department of Public Health and Environment, Water Quality Control Division, aquatic life data. This indicates that the airplane based spraying of permethrin may have played a role in that decline. Additionally, we could not detect any change in macroinvertebrate drift associated with the truck and backpack based application of permethrin on July 16 indicating that this method of the application of permethrin may be less negatively impactful to the stream macroinvertebrate community.

References

Colorado Department of Public Health and Environment, Water Quality Control Division. 2010. Aquatic Life Use Attainment. Methodology to determine use Attainment for Rivers and Streams. Policy Statement 10-1. Approved October 12, 2010.

Knight, Robert L., W.E. Waltonb, G.F. O'Mearac, W.K. Reisend, R. Wass. 2003. Strategies for effective mosquito control in constructed treatment wetlands. Ecological Engineering 21:211-232

Smock, L.A. Chapter 21: Macroinvertebrate Dispersal (pages 465-487) in F.R. Hauer and G.A. Lamberti. 2007. Methods in Stream Ecology, 2nd edition. Academic Press. 877 pages.

Merritt, R.W., K.W. Cummins and M.B. Berg. 2008. An Introduction to the Aquatic Insects of North America, Fourth Edition. Kendall Hunt Publishing Company. Dubuque, IA. 1158 pp.

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