Response of Macroinvertebrate Communities to Fire in Agricultural Watersheds

Introduction and importance of insects:

There are 1.5 million species of insects. They are abundant and although small, are crucial to our (human) existence. It is estimated that there are 10 quintillion insects that are part of the food chain. Aquatic entomology is the study of aquatic insects. For my study, I performed a bioassement assay on river ecosystems in which I examined benthic macroinvertebrates to examine river heath. Benthic macroinvertebrates live within the substrate of a river and primarily and are affected by water quality measures. They are also situated in a location within a river ecosystem where we typically see debris and pollutants being accumulated. Different species respond differently to differing levels of nutrients within the water.

There are two treatments that I examine which are the effects of fire, as well as agricultural activity on macroinvertebrate communities in rivers. Studying aquatic invertebrates is important because it can tell us a lot about the structure and functioning of a food web. As insects comprise much of the foundations of a food web, we can look as these macroinvertebrates as an indicator of ecosystem health because much of the energy exchange that happens from producer to consumers begins with insects. Looking at biodiversity and community structure of macroinvertebrates in an area is also important to better understanding the flows of energy which can give us a bigger picture view of a particular region's ecosystem health.

Background

My research is a one-year project which involves a societal look at farming in Taiwan as well as the real life environmental impacts. I will be focusing mostly on the environmental impacts in my talk as this is what I spent the majority of my summer working on. It is important however to understand the history of my research area to understand the importance of my ecological study of the rivers. My research area is located within the Shei-Pa National Park which is in Central Taiwan about five hours away from Taipei. Although this is a protected area by the government, there is a lot of farming being conducted by aboriginal Taiwanese people. There have been numerous studies that have looked at the loss of biodiversity as well as health impacts that have been attributed to the overuse and misuse of pesticides (Chao, 2008). As we can see that there is a struggle between preservation of wildlife and protection of farms that is happening. This is better illustrated by the fact that there are large federal stream restoration projects happening in the National Park to be able to successfully reintroduce and maintain the native salmon species *Oncorhynchus masou formosanus* (Lin, 2004).

For my study, I am looking at the effects of the agricultural activities on stream and ecosystem health by looking at macroinvertebrate community structures in relation to farm density and nutrient level. In the month of April 2016, there was a fire that erupted in the

National Park which I believe is a significant event that could have effects on ecosystem health. Since this fire happened within my research area and time of study, it is important to look at its effects as well as the effects of farming activities.

Research design

To be able to examine my two treatments – agricultural activities as well as fire, I decided to examine two streams that are within the same watershed (Appendix 1). I examined the Gaoshan and Yousheng Creeks. Within each river, I isolated two sites- one upstream site (far upstream from agriculture and fire, near the headlands), and one downstream site (which lie beneath the agricultural area and the fire). This allows me to look at the variances in the macroinvertebrates and how they are affected by the farming activities based on farm land density as well as the fire. To look at the effects of fire, I would compare my site's data from before and after the fire at a given testing site, and to look at the effects of agriculture I can look to the differences in between my upstream and downstream sites.

Methods

In the field, I used the EPA protocols for rapid bioassement to collect samples and data. At each sample site, I performed a habitat assessment looking at parameters that are not limited to: substrate, canopy coverage, humidity, and riparian cover. I also took data on the atmospheric conditions looking at humidity and temperatures. Water samples were taken for water analysis for pesticides as well as nutrient loads. At the sites, I took water quality measurements such as dissolved oxygen, total dissolved solids, and conductivity. The benthic macroinvertebrate samples were taken across the stream transect using a surber sampler catcher with six samples at a given site for a total of twenty-four macroinvertebrate samples. Each sample was preserved in 75% EtOH to ensure minimal degradation from time between the field and lab procedures.

Within the lab, we performed GC-MS assays on the water samples to obtain pesticide as well as nutrient level data. The macroinvertebrate samples were sorted by sample and identified by species. They were then counted and catalogued for data analysis. The data analysis for this project is still ongoing, but I have used spreadsheets to organize data and stats tools such as R and various ecological packages to examine the differences in community structures based on different parameters.

Results

As my research is still ongoing, I currently only have my preliminary data analysis completed. I performed a NMDS (non-metric dimensional scaling) on data set of invertebrates to examine the rank order of species in a community. This is basically a way of plotting the species not in terms of their absolute abundance but their rank order. The advantage of this method is that it doesn't not run into issues of sensitivity to transformation which can happen in a linear depiction model. NMDS can tell us a lot about a community composition and is a way of

visually representing changes in community structures based on specific treatments. My treatments are fire (based on time) and agricultural effects (which is seen between upstream and downstream sites). For my preliminary analysis, I used long term data from 2012 until present to look at the effects of fire and agriculture. The long term data can help to observe the trends within the communities without having significant interference from the seasonal differences. If we look at the figure in Appendix 2, we can see that by comparing the two sites before and after the fire, the relative sites at the two streams shifted, but not to a significant amount in comparison to looking at the upstream in comparison to downstream sites which shifted a large distance. This signals that farming has a larger effect on the macroinvertebrate communities than the effects of fire.

Next Steps

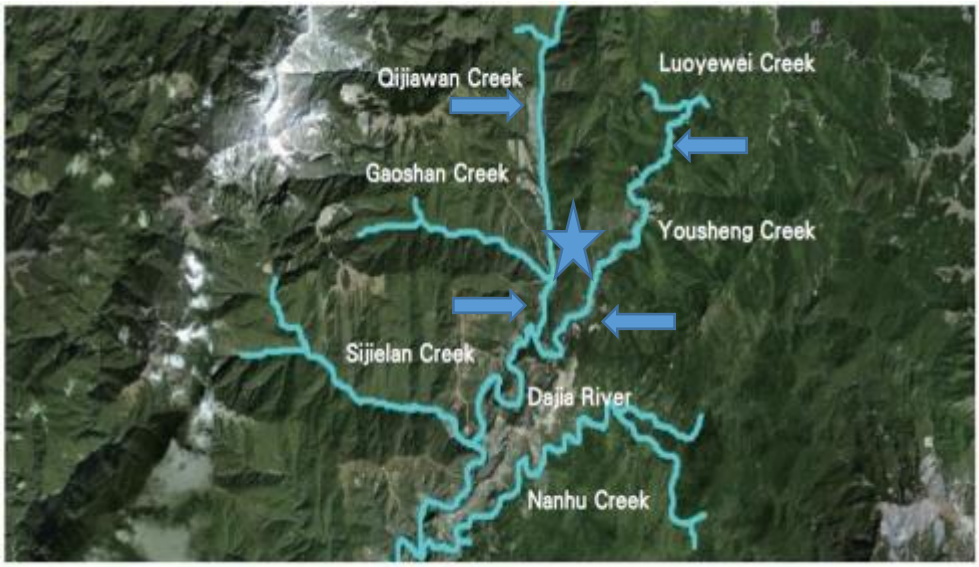
Now that I know that there are significant affects from the upstream to downstream sites as well as before and after the fire, I need to try to figure out why this is. Now what I need to do is run ANOVA (analysis of variance) tests for each of my nutrients (such as phosphorus, nitrates etc.) as well as habitat assessment data such as stream substrate to see what has influenced the changes that we observed in the communities.

References

Chao, Jung-Tai & Lee, Ling-Ling. "Impact of Losing Pollinator Diversity: A case study in Taiwan". National Taiwan University. 2008.

Lin, Jen-Yang et al. "Stream Physical parameters and habitat requirement: the case of the Formosan Salmon". Ecological Engineering. July 2004.

Appendix 1



Sample sites indicated with arrows. Star indicates zone of fire.

Appendix 2

NMDS Graph of Long Term Macroinvertebrate Data (Species in red, treatments in boxes)