Electrodeionization for the Production of Bicarbonate Enhanced Algae Growth

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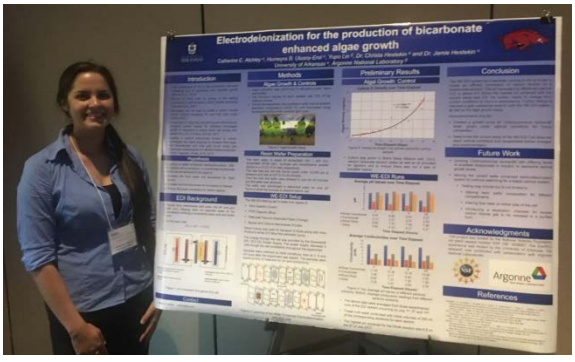
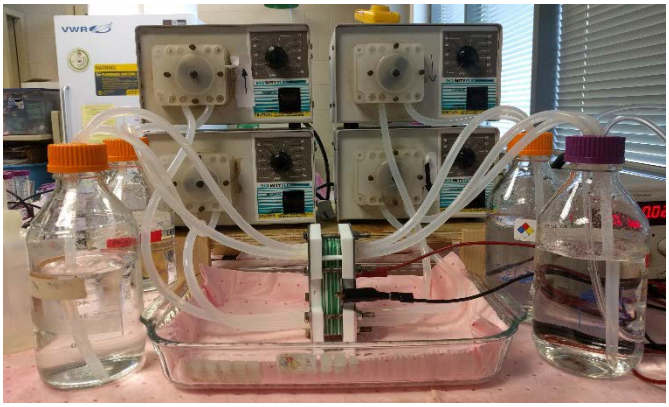
The natural systems that were stable and self-regulating before are continuously being pushed farther from their natural equilibrium state because of increased human population and increases in industrial activity throughout the world. There has been a continuous rise in the levels of CO_2 in the atmosphere. The increase in the atmospheric concentrations of CO_2 have multiple effects to the earth including increasing the average temperature of the planet, increasing the acidity of ocean waters and increasing dry periods for land crops. These effects call for a neutral strategy to be developed to limit further effects human life will have on the planet.

A significant start to this movement would be the development of a carbon neutral biofuel that absorbs as much carbon during its growth period as it releases upon use. Algae has arisen as a prime candidate for biofuel production since it does not compete for farmland and can grow in contaminated water sources not fit for other uses. By pairing a wafer enhanced electrodeionization system with a bioreactor: carbon dioxide, from an impure source such as an industrial plume, can be converted into bicarbonate, creating a concentrated inorganic carbon source that can be delivered to the bioreactor to feed the algal growth.

In industrial algae production, CO_2 is bubbled through the solution for algal growth. Since CO_2 is not soluble in water, it is easier for the algae to take up bicarbonate. This new system will be more cost effective and environmentally sustainable than current algal growth methods. We hypothesize that the algae will grow more densely in solution as well as with higher lipid ratios because of the direct delivery of concentrated bicarbonate solution to the growth medium. Preliminary results show that we are on the correct track to optimize this process but more experimentation is necessary.





Sorption of Benzobicyclon in Soils of Rice Growing Regions of Arkansas

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Arkansas is the United States' leading rice producer, accounting for over 50% of the rice produced in 2014. Over 40 counties in Arkansas cumulatively grow approximately 1.2 million acres of rice a year. Rice production contributes $4 billion annually to the state's economy while employing over 25,000 Arkansans. Common weeds in rice production systems develop resistance to available herbicides over time. Reduced yields due to the new resistance of weeds has prompted the U.S. release of benzobicyclon, a rice herbicide that has been used for decades in Asia. Benzobicyclon is not yet available to consumers in Arkansas and is under review by the EPA. Little is known about the fate and transport of benzobicyclon in Arkansas agricultural systems. The objective of this study is to use batch equilibration experiments to examine benzobicyclon and benzobicyclon hydrolysate (BH) sorption in soils with varying properties used to grow rice in Arkansas. The broad question addressed over the course of this experiment is, "Will the recommended use of benzobicyclon, a new rice herbicide, be uniform across the agricultural lands of Arkansas or will the recommendation vary according to soil properties?" Specifically, research determined how soil properties influence the sorption characteristics of benzobicyclon hydrolysate (BH), the active metabolite.

Modeling the effects of crayfish invasion and drought on hypothetical crayfish population dynamics

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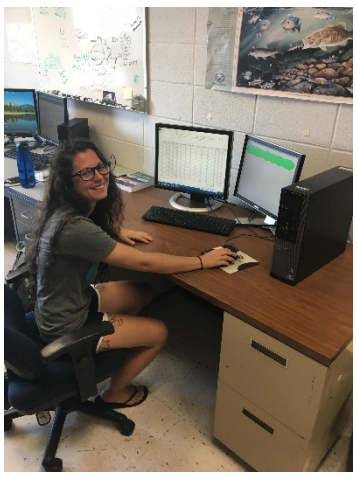
North American crayfish species face several environmental and ecological threats including limited natural ranges, invasive species, and intensified drought. Our objectives were to model the population dynamics of potential crayfish species with theoretical life histories and assess how these populations could be affected by the impacts of invasive species and drought. We used RAMAS-Metapop to construct stage-based demographic models using data obtained from various literature sources. We assessed population viability under various disturbance scenarios using estimates of terminal extinction risk, median time to quasi-extinction, and metapopulation occupancy. Models indicated that both r- and K-selected species appear to be highly susceptible to decline when under additive effects of reduced carrying capacity due to invasion and reduced vital rates due to drought. The terminal extinction risk for Species A and Species B were little affected by lower-level reductions in carrying capacity – most likely due to the high carrying capacities of both species. Under 80% reduction in carrying capacity, Species C and Species D experienced quasi-extinction in one year. Species D experienced a lower terminal extinction risk as vital rates were reduced, indicating that rates of competition had gone down. Median time to quasi-extinction for Species D was not affected at all by reductions in vital rates due to drought (time >100 years). This is most likely due to Species D's very high fecundity rates. Better estimates of stage-specific survival and fecundity could reinforce our findings and more accurately predict species outcomes. By constructing models that explore a wide variety of life histories and disturbance scenarios, we hope to provide managers with tools to develop broadly applicable conservation strategies.



The effect of non-native Fescue (*Festuca arundinacea*) grass on amphibian reproductive success

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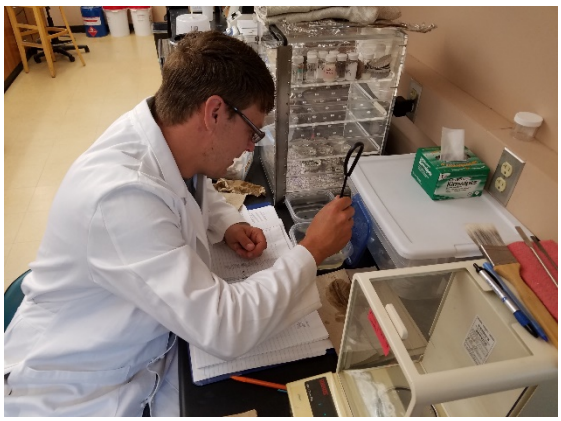
Non-native *Festuca arundinacea* is an agricultural grass used for grazing pastures and hey production, which often forms monculturals, outcompeting native Priaire vegitation after agricultural realted land-use change. This can alter the qulaity of nutrient subsidies into wetlands and can affect community processs which may be detrimental to biota that inhabit those systems. Existing research shows, amphibian larva can be effected by altered litter subsidies which may contain secondary plant compounds, higher N:P:K ratios, and alter community respiration processes. In order to determine the effect monocultures of non-native *Festuca arundinacea* may have on amphibian reproductive success, we exposed the eggs from *Lithobates sphenocephalus* to Low (0.5g/l), Med (1g/l), and High (2g/l) litter masses to non-native *Festuca arundinacea* and herbacous Prairie vegetations. We added 2 controls of high masses for each litter types with added aeration, hypothesized our aerated controls would eliminate mortality for each vegetation type in our controls. We found that dissolved oxygen concentrations(DO) were dramatically decreased within 24 hours of litter introductions, and that mean DO was lowest in our high *F. arundinacea* treatments(0.25mg/l) versus Prairie high litter mass treaments mean DO of 1.77mg/l. Medium litter masses of *F. arundinacea* treatments had similar DO concentrations to Pririe high litter masses, but the effect of lowering DO concentrations did not last as long as Prairie high litter masses , with *F. arundinacea* having higher mean dissolved oxygen levels (2.94mg/l). We had zero hatching success of *Lithobates sphenocephalus eggs* in high litter mass treatments containing *F. arundinacea,* and a large reduction of hatching succes in medium F. arundinacea treatments(35%) versus Prairie high litter mass treatments of 57.5%. Our aearted controls of high litter masses eliminated mortality saw in non-aerated treatments with both vegetation types, achieving greater than 93% hatching success. We also performed regression of percent survival of final larval masses to determine if body sizes differed among vegetations types. We found *F. arundinacea* medium litter masses produced the largest larva but our results were confounded by density dependence within our mesoscosms. We suggest that amphibian hatching success can be reduced when breeding activity occurs in wetlands with *F. arundinacea.*



Factors related to carbon dioxide evasion from Ozark forested streams

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Past global carbon budgets have modeled rivers as pipes transporting carbon (C) to the ocean; very little transformation was thought to occur within rivers. Stream biota can transform organic C to CO_2 which can be emitted to the atmosphere, meaning that they do not solely act as passageways for carbon to follow. Since biological carbon cycling in streams varies due to size and landscape position, factors related to evasion may also vary. We sampled over a range of discharges during June and July of 2017from 3 runoff flashy and 3 groundwater flashy streams that were all over 85% forested land cover. We sampled CO_2 evasion, dissolved inorganic carbon, pH, alkalinity, temperature, dissolved oxygen to calculate primary production and respiration, algal biomass, and discharge at each stream on each of three sampling dates. We used single linear regressions to determine which variables best explain variation in CO_2 flux across the six study sites. On the first sampling dates, May 30th and June 1st, daily GPP was positively related to average CO_2 flux ($P=0.04$ $R^2=0.93$). On the second sampling dates, June 13th and 15th, chlorophyll a was significantly related to average CO_2 flux ($P=0.02$ $R^2=0.80$). On the last sampling dates, July 1st and 5th, TOC was negatively related to average CO_2 flux ($P=0.05$ $R^2=0.78$). Discharge varies on each sampling date which may indirectly control other factors, leading to differences in significant factors on each sampling date. Groundwater streams were larger producers of CO_2 evasion, meaning that flux differed by flow regime. Excluding streams may lead to overestimates of the role of terrestrial systems as carbon sinks. Studying the factors influencing the net flux of CO_2 in streams can be beneficial for constructing carbon budgets and for future modeling.

A Viable Food Hub for Northwest Arkansas

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A Food Hub is a business or organization that actively manages the aggregation, distribution, and marketing of food from local producers to meet the demands of local wholesalers and retailers. Some models that work in a location have farmer's markets, classrooms, business planning, processing plants, financial offices, and so much more attached to their business. While many larger corporations can afford to handle all the expenses needed to effectively carry out the processing, packaging, and branding actions on their own, many small businesses can not. Noncommunicable disease rates are also a major fact as they are rising to far surpass the rates of communicable disease at an alarming rate. Among the 49 states that data has continuously been collected from 1994 to 2005, 27 have a fifty percent higher rise in the diagnoses of diabetes. Although, there are many Food Hub options that have been utilized, no one model has been able to be used and replicated throughout all of the United States. Its hypothesized that a private hybrid model is a viable food hub model that could work in Northwest Arkansas but also across the United States. However, it was found that while a Private-Hybrid Food Hub model will work in the United States, it would not be as viable in other locations.

The Effects of Low-Level Salinization on Bacterial Communities in Aquatic Environments

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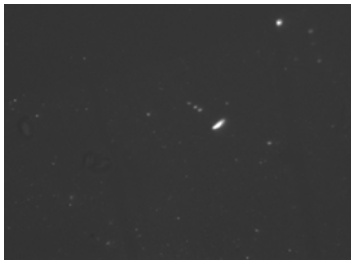
Global freshwater salinization has become an increasing problem due to road salting, resource extraction, and agricultural irrigation. Most salinization studies address lethal salt concentrations with a focus on vertebrate and macroinvertebrate species, so there is a paucity of studies involving aquatic microbes. Small inputs of salts may initially relieve limitations for aquatic microbes to encourage productivity. Current EPA standards are based on total salinity but not necessarily specific ion concentration, which may differentially affect microbes. Our study focuses on comparing how a gradient of sub-lethal salt concentration (3, 16, 32, and 64 mg/L) for 2 common sodium (Na) salts affects bacteria associated with leaf litter detritus. We hypothesized that bacterial abundance will increase with increasing salt concentrations. Though our data show no statistical significances, there are patterns suggesting biological significance. NaCl elicits subsidy response up to 32 mg/L for the overall bacterial community and cocci type alone; a stress response occurs at 64 mg/L. NaCl elicits a stress response at all concentrations for bacilli type bacteria. $NaHCO_3$ elicits a subsidy response up to 16 mg/L for the overall bacterial community and cocci and bacilli types individually; a stress response begins to occur at 32 mg/L. Our results suggest specific salt ionic regime, rather than total salinity alone, should be considered in aquatic systems because microbes may respond differently to similar levels of salinity depending on the ions present. These data suggest that specific salt ions could indirectly affect in-stream processes in different ways from the bottom up.



What Nutrient Limits Algal Growth at Cave Springs Lake?

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Abstract: Nuisance algal blooms are problematic, resulting in health and aesthetic concerns. The overall objective of this project was to understand what nutrient(s) was limiting algal growth at Cave Spring Lake. We compared algal growth (measured as chlorophyll-a concentrations) across nutrient treatments, including a control, nitrogen (N), phosphorus (P) and N plus P (NP). We used nutrient enrichment of cubitainers filled with lake water to evaluate nutrient limitation of phytoplankton, and we used nutrient diffusing bottles to evaluate nutrient limitation of periphyton in the lake. Periphyton revealed no significant difference in algal growth across treatments for two of three sites but large algal mats covered the periphytometers at the sites. The site near the dam showed that periphyton were P limited. Phytoplankton showed significant growth across treatments, suggesting P and Co-limitation. This information combined with high N:P ratios(>400) suggest P is the factor limiting algal growth.