Sustainable RIVER REU 2019
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Project Overview

The primary objectives of the Sustainable RIVER project: Create student scientists who will become leaders in interdisciplinary research and leaders in creating a more sustainable society through their appreciation of multi-perspective, systems-thinking approach to understanding and addressing challenges.

About Sustainable River

This REU Site awarded to the University of South Dakota, located in Vermillion, SD, will support the training of 11 students for 10 weeks during the summer. The dates for 2019 are 28 May through 2 August. REU students participating in the Sustainable RIVER project will examine the functioning and management of the Missouri River as a lens through which to study complex, interdisciplinary systems. Through individual research projects with faculty mentors from USD's multi-disciplinary Missouri River Institute, students will address the question of how invasive elements in the also meet as a team weekly to integrate their knowledge gained from the individual projects to create a team project to address the question of how we can cultivate a more resilient Missouri River that meets the needs of multiple stakeholders and sustains diverse, functioning ecosystems.

There will be an explicit focus in the Sustainable RIVER project on the critical pedagogy of place, where students learn how to live sustainably in places that have been disrupted while learning to recognize and address the causes of such disruptions. The Sustainable RIVER project will create student scientists who will become leaders in interdisciplinary research and leaders in creating a more sustainable society through their development of a multi-perspective, systems-thinking approach to understanding and addressing complex challenges.
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Introduction

As lead personnel for this project, my goal was to analyze polyunsaturated fatty acids (PUFA) and other essential nutrient transfer between trophic levels along the Missouri River basin and how PUFA levels fluctuate across time. To do this, I collected a variety of aquatic and terrestrial insects at four different backwater sites around Vermillion. Insects were identified and divided according to taxa. To collect data pertaining to bird nutritional content, I collected bird blood for different sites, including measurements related to fat abundance, age, tarsus length, wing length, mass, and distance collection was away from water. The blood was then analyzed data from approximately 20 sources for fatty acid content in aquatic insects. This information will be used in conjunction with the results I will find on fatty acid levels in aquatic insects in the Missouri River basin. Throughout the rest of this year, I will be working on analyzing the data which will result in published papers.
In addition to this project, I helped extensively with the capturing and gastric-lavage process of fish and counting and analysis of aquatic insect emergence for the size-specific flexibility in stage-structured feeding of fishes project which benefitted Lexi Culley’s REU project, Abraham Kanz’s Master’s Thesis, and Dr. Jeff Wesner. For this project, I would go into the field 2-3 times a week to collect data and spent time in the lab sorting insect emergence samples.

**Best Memory**
Early morning bird collections with Dr. Swanson and reaching the top of Black Elk Peak on the Black Hills/Badlands trip.

**Hypotheses**

**Hypothesis 1:** Aquatic insects have higher levels of DHA and EPA than terrestrial insects along the Missouri River.

**Hypothesis 2:** DHA and EPA levels in aquatic and terrestrial insects vary spatially and over time.

**Hypothesis 3:** Riparian birds with higher levels of aquatic insect-derived carbon also have elevated levels of DHA and EPA.

**Hypothesis 4:** HUFA content in aquatic insects vary according to the chemical structure of HUFA and taxa (Global Literature Analysis)
Neonicotinoid Contamination in Northern Leopard Frog Brains

The widely practiced agricultural system tile drainage may have a negative impact on non-target organisms like Northern Leopard Frogs (*Lithobates pipiens*) in the Prairie Pothole Region of South Dakota. Other possible non-target organisms are humans, domestic animals, and bees. Farm crops are sprayed with an insecticide called neonicotinoids that dissolve well in water. One neonicotinoid is imidacloprid. Imidacloprid has been found in fish brains (Iturburu et al., 2017). Amphibians have skin extremely absorbent skin (Lanctot et al., 2017). That could make leopard frogs an indicator of how much imidacloprid is in wetlands. Our study exposes fifty leopard frogs collected from Wetland Production Areas in Eastern South Dakota to 0, 0.1, 5.0, and 10.0 µg/L of imidacloprid over a twenty-one-day testing period. After the testing period, we will collect the frogs’ brains and send them to the University of North Dakota for analyzing. Once the samples are analyzed we will draft and submit for publishing a paper on imidacloprid impacts.

**Hypothesis:**
The level of contamination will increase as the amount of imidacloprid becomes more potent.
Selenium Concentration in American Toads and Tiger Salamander Larvae Livers

American Toads (*Anaxyrus americanus*) and Tiger Salamander Larvae (*Ambystoma tigrinum*) are indicative species like Leopard Frogs. We were looking for Selenium concentrations in their livers. We collected toads from a few sample sites, some of them were controlled and some were tile drain sites. Tile drains are an agricultural technique to improve crop yield. The installation process involves digging trenches 3-4 feet into the field and placing drain pipe at the bottom then covering them up again to be planted over. The drains all lead to the nearest water source, in the prairie pothole region that source is wetlands. Selenium is naturally found in soil but this process results in excess amounts being deposited into wetlands.

We also tested wetland water, invertebrates in addition to toad and salamander larvae liver to track the Selenium concentration up the food web. My job was to capture the toads and salamanders and then remove their livers, an organ that was found to be indicative of Selenium concentrations in other studies. Those livers will be sent to the University of North Dakota for analysis.

References


A Changed River's Effects on Native Turtle Distribution

The Missouri River has a long history of heavy modification including channelization, and most notably damming. False Map Turtles (*Graptemys pseudogeographica*), have specific and unique habitat requirements that are frequently lost through such modifications. River modification has been shown to have negative effects on turtle populations by restricting habitat available.

Despite this, few studies have been conducted which highlight False Map Turtle distribution along the Upper Missouri River and ask what makes them the way they are. To fill this research gap my project looks to understand and investigate where false map turtle populations are highest and what ecosystem characteristics most heavily influence false map turtle populations.

Utilizing Esri’s ArcGIS software, various ecosystem elements are layered with United States Army Corps of Engineers (USACE) presence data of false map turtles along the Missouri River. I compared deadwood presence, water temperature, water depth and water flow to understand what is influencing false map turtle populations the most. Most of these elements other than the deadwood presence which were collected from Google Earth satellite imagery, were collected by myself and other students in the Kerby Lab along a stretch of the Missouri River, south of Clay county. Deadwood was selected as an ecosystem element due to the high level of importance they hold for basking areas, an activity which is important for the prosperity of most turtle species including false map turtles.
Hypothesis: There is an anticipated correlation between the presence of deadwood and the density of false map turtles. I predict that there will be higher densities of false map turtles in areas where there are higher levels of deadwood, therefore creating higher quality habitat.

These ecosystem elements are meant to represent habitat suitable for false map turtles that still remain following modification of the Missouri River. The ecosystem elements will be analyzed and compared with where the highest concentrations of false map turtles have been spotted since 2011. The project investigates if deadwood abundance or one of the other ecosystem elements, could be the main factor in creating habitat for false map turtles. Due to the fact that the amount of habitat remaining after modification is a significant predictor of species health, this project will help to make predictions about how much remaining habitat is available despite modification. Furthermore, this project could inform the state how to better manage for false map turtles.

Favorite Memory: Learning about and working closely with turtles all summer under the hot sun and camping in Lake Oahe collecting setting turtle traps and eating camp food!
The American beaver, (*Castor canadensis*), can be viewed as an ecosystem engineer due to the effects it has on its environment through the construction of dams which creates wetlands (Ruys et al., 2011). *Castor canadensis* can also either reverse or hasten the succession of riparian vegetation through its selectivity of plant species (Haemig, 2012). Previous studies have demonstrated that *C. canadensis* modify vegetation structure and succession through dam construction, tree cutting and removal, and eventual abandonment of sites (Broschart et al., 1989). The preferred food of *C. canadensis* is the plant family *Salicaceae*, or *Populus* (aspen, cottonwoods, poplars) and *Salix* (willows), and by selecting certain vegetation over others, *C. canadensis* can change the relative frequency and abundance of these tree species in riparian settings (Haemig, 2012). *Castor canadensis* also prefer to go for trees that have a DBH (diameter at breast height) between 2.0 and 9.9 cm but avoided anything smaller or greater than that size category (Raffel, 2009).

The aim of this study was to determine how the tree community differed between sites with and without beaver activity. We hypothesized that:

1. Sites with beaver activity would have a greater abundance of *Populus* and *Salix* species,
2. Plots with beaver activity will have a higher number of individual trees that have a DBH less than 10 cm, and
3. Tree canopy cover would be greater in sites where beaver activity was present.
We measured tree species identity, number, size, and cover at sites with and without beaver activity at three locations along the Missouri River near Vermillion, SD in June-July 2019. At each of the 18 plots the beaver chew site, dam, or random GPS coordinate was used as a point of origin and a 20x20 m quadrat was measured out. Using a two tailed t-test our statistical analysis suggests that there is a positive correlation between average canopy cover (tree density) and beaver activity. Our results support the predictions that species richness of *Populus* and *Salix* diversity can affect the distribution of the *C. canadensis*. There is more beaver activity in areas where their preferred food (*Populus* and *Salix*) can be found. There was a higher density of *Populus* and *Salix* in areas where beaver chews were present as well. It is essential to understand habitat requirements for *C. canadensis* in order to develop sound management and conservation plans for the species.

**Best memories (Ashley & Kyle):** Without a doubt the best memory of South Dakota is definitely the Black Hills and Badlands. The scenery was amazing! And the animals! Bighorn sheep, bison, prairie dogs, marmots, pronghorn and so many birds. Hiking to the top of Black Elk Peak was thrilling! It has also been awesome meeting new friends!

**References**
Background
As the rise of technology and the internet has increased society’s ability to store and gather information, the amount of available data has grown exponentially. However, much of this data exists in different formats relative to each individual source. This lack of a universal format hinders scientists’ ability to work with data from multiple sources due to formatting conflict and frequently adds time to meta-analyses. This project refines a method to reformat, or tidy, this large amount of messy data into a universal format to create easy to use online databases for future reference in scientific research. Data on fish diets taken from primary and gray (e.g. theses, dissertations, reports) literature was tidied and combined to create a single database through the programs Able2Extract, Microsoft Excel, and R.

Methods
Data from tables within PDF files of scientific papers were scanned in with Able2Extract and stored in an Excel document (step 1-2). These documents were then edited to a standard format with information relevant to the database from each paper (step 3). These edited Excel files were then tidied, or reformatted, in R to create a database (step 4).
Results
A total of 452 papers potentially relevant to freshwater fish diets were found. Of those papers, 71 were analyzed, with 39 containing relevant, extractable data. The remaining 32 papers had no relevant data or an issue with extraction. In total, 99 tables were extracted, yielding a database with 14572 observations of 22 variables.

Best memory
My best memory was working with and experiencing field work. I met new people, learned many things, saw cool locations, and made many fish puke!
Nest predation has a major influence on the productivity of bird communities, and nest-, patch- and landscape-level characteristics may play important roles in mediating nest success. However, invasive plants may alter habitat features, predation, and nesting success. We examined whether invasive trees, Russian olive (*Elaeagnus angustifolia*) and eastern red cedar (*Juniperus virginiana*), in Missouri River riparian habitats influenced bird nesting success by monitoring nests during the summer of 2019. At the nest-scale, we tested the impact of nesting in invasive versus native substrates on nesting success. Preliminary nest-scale data from the 2019 field season suggest that birds used Russian olive for nesting more than any other nest substrate, and nesting success was generally lower in Russian olive than in native plants for individual bird species and for all bird species combined. The generally lower nesting success in Russian olive in 2019 is consistent with data from these same sites in 2017, but 2018 nesting success at these sites was generally higher for Russian olive than for other nest substrates. Thus, Russian olive may have a negative impact on bird nesting success in Missouri River riparian forests during some years, but the effect does not appear to be consistent across years.
One of my (Jacob) favorite parts of this project was hiking around the sites. Honestly just being outside every day was pretty awesome, though it got pretty hot some days. Over the course of the summer, I also tripped over many things: logs, vines, holes, trees, etc. I must have stumbled hundreds of times. But it was great to be in the woods searching for birds. I now understand much more about bird behavior than at the beginning of this project.

One of my (Sierra) favorite parts of this project was being outside everyday, and the large array of wildlife we encountered. From birds, to frogs and toads, to mammals, it was truly amazing. A funny moment was when I slipped on a wet log and fell into a patch of thorny vines and dead trees. I got the hair from my bun wrapped around a branch, couldn’t move my head and Jake had to save me.
Suspended sediment contributions of Nebraska tributaries along the 59-mile reach of the Missouri National Recreational River

Suspended sediment loads in the 59-mile reach of the Missouri National Recreational River (MNRR) have declined since the completion of the Gavin’s Point Dam in Yankton, SD. Suspended sediment cannot travel past the dam as the water in the reservoir is not moving fast enough to keep the particles entrained in the flow (Jacobsen et al. 2009). All sediment within the reach comes from either bank erosion within the river itself, or from the various tributaries that drain into the reach. Previous REU students have studied the South Dakota tributaries, the James, Vermillion and Big Sioux Rivers, but no studies had been done on the smaller Nebraska tributaries, Bow, Lime, Turkey and Aowa creeks. My project featured sampling on rivers on both sides of the border.

Sampling on the bigger, non wadeable streams was conducted with a heavy brass sampler we nick-named “the beast.” We lowered the beast off the side of a bridge with a rope and slowly dropped it into the stream. When we felt it hit bottom, we would pull it back up. We did this for all of the South Dakota rivers, as well as for Aowa creek in Nebraska because there was no way to get in and out of the creek. In the other smaller, wadeable creeks in Nebraska, samplers were taken with a smaller, handheld sampler. These samples were then taken back to the lab, where the conductivity, salinity and total dissolved solid loads of the water were taken. Then the samples were placed in an oven to dry out in order to accurately determine how much suspended sediment was in the sample. This was then used to determine the concentration of sediment (g/L) within that stream. Concentration and discharge, either determined from field measurements or taken from USGS gaging stations, were then used to determine total suspended load for each stream.

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It was determined that the nebraska tributaries are responsible for around 14% of the total suspended sediment load in the Missouri River at Sioux City, IA. Sediment in the Missouri River is critical to building nesting habitats for birds like the piping plover and the least tern, as well as for fish like the pallid sturgeon. It is important to consider all sediment sources when managing for sediment regimes that build habitat for these species (Wohl et al. 2015).

**Best Memory:** Going to the Ashfall Fossil Beds and seeing all the rhino fossils.

**References**
Perceptions of Multifunctional Landscapes Along the Missouri National Recreational River

Ann McGehrin
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The communities along the Upper Missouri River Basin (UMRB) are among the least densely populated regions in the contiguous United States, and primarily utilize the land for agriculture and energy production. Considering the UMRB region is home to many people of rural and urban areas, it would be anticipated that people in particular sized communities may value their landscapes differently. The purpose of this research was to evaluate whether land-use values were different among residents in rural, micropolitan, and metropolitan communities in the UMRB. This research focuses on the top three most common values consistent among all communities, which were agricultural, recreational, and conservation/stewardship. This research analyzed data from 1,019 in-person surveys that took place in rural, micropolitan, and metropolitan communities in North Dakota, South Dakota, Wyoming, and Montana from June 2018 through July 2019. Survey participants were asked to assign 100 total points to up to four value choices out of a list of 11 choices to evaluate what people value the most for the land in their area. The top three land-use values were consistent among metropolitan, micropolitan, and rural communities, though the extent to which each category was valued differed among the community sizes. Metropolitan communities valued recreation the most, while micropolitan and rural communities valued agriculture the most. The results show that values for rural and metropolitan communities had the most contrast, with micropolitan communities often being intermediate between the two. These results may be linked to the most prevalent occupations or average length residence in each community. In conclusion, social values impact the ways in which people engage with their natural environment; therefore, recognizing what people in different locations value is important in our understanding of how social and ecological systems are interconnected.
Historically, the Yankton Sioux were an equestrian, nomadic, hunter-gatherer group of Sioux Indians whose territory was east of the Missouri in the prairies of South Dakota. In my research, I explored traditional Yankton Sioux ecology, most specifically in regards to their lives along the Missouri River. From an anthropological perspective, ecology is observing how a group of people interacted with their surroundings. Interactions include those such as relationships with plants cultivated, how they hunted, fished, and other subsistence patterns are all looked at. I heavily looked at the impact of the reservation system in addition to how Yankton were impacted by the damming of the Missouri River, most specifically the impact of Fort Randall, which not only inundated cultural sites, but farmland as well. Lastly, in my research, I explore and observe the continuity and change in Yankton culture since the nineteenth century. The modern day practices aren’t quite the same as they used to be, but Yankton have worked to make sure their culture stays alive despite the hardships they have faced, which have made maintaining cultural practices difficult. My research was done from my apartment in Vermillion where I read multiple different articles and books.
Best memory:
Visiting Ponca State Park was one of my favorite parts of the summer. Even though it was right at the beginning, the views were amazing and the temperature was really nice that day. A lot of our group field trips were a lot of fun for me actually since my research was spending a lot of time reading on my own. Monday outings allowed for more socialization than I got to do otherwise. I also really enjoyed learning about the other student’s projects and hearing about their adventures in the field.

References: