Project Title: Hydrology Alterations in the Illinois River Watershed and Potential Impact on Aquatic Species of Conservation Concern

Project Summary: The overall objective of this project will be to determine if increasing urbanization (and as a result, an increase in impervious surfaces) is impacting the hydrology of the Upper Illinois River Watershed (UIRW). Secondly, if there is an impact on hydrology, is the altered hydrology increasing stream instability. And lastly, if there is a degradation of the stream, how it might impact mussel species of greatest conservation need (SGCN) located within the UIRW. The project will be carried out over two phases and this proposal seeks to implement phase one of this project. Our goal in phase one will be to collect and analyze stream data and relate hydrology change to land use change. Our second phase will be partnering with local stakeholders (i.e., government, business, agriculture, construction, and education leaders) to create an action plan to maintain and/or improve segments of the UIRW for the continued survival and health of our local mussel SGCNs.

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Project Budget:
SWG amount requested: $46,620
Match amount provided: $42,574
Total amount of project: $89,194

Project Statement:

Need:

The UIRW has experienced rapid urbanization over the last 20 years, which has resulted in a large increase of impervious surface across the region and the watershed. There is a need to study if and how these impervious surfaces have altered hydrology in the downstream, more rural parts of the watershed. Observations from local landowners indicate that, while base flows are relatively steady (probably in part to the presence of upstream waste water treatment plans), relatively small rains have resulted in higher occurrences of bank full conditions over time. Separately, changes in stream velocity and discharge across the watershed have not been recently assessed. These hydrology changes may in turn contribute to unstable streambanks and impacts to SGCNs that are present across the UIRW.

This proposal will focus on SGCNs as defined by 2018 State Wildlife Grant priorities: Neosho Mucket, Rabbitsfoot, Elktoe, "Elongate" Pigtoe, Ellipse, Round Pigtoe, Rainbow, Little Spectaclecase, and Lilliput (Table 1). Though there are species-specific requirements, the preferred habitat for these mussel species is shallow areas with sand and gravel along stream banks with flowing, well-oxygenated water. There are three life history factors that may limit population distribution of these species. In the larval stage, glochidia must attached to a host fish for metamorphosis to the juvenile stage and often different mussel species require the presence of specific host fish species. In the juvenile stage, stream flow and substrate composition can affect the ability of juveniles to attach to the stream bottom. In the adult stage, flow alterations, sedimentation, and pollution can impact the ability of the adult to feed and respire. If hydrologic conditions, sediment loading, pollution loading, or habitat change is outside the species' range of tolerance or the host fish species are not present, all three life stages have a reduced chance of survival.

The goal of this project proposal is to identify:

- Has hydrologic change occurred over time?
- If there has been change, how has hydrology changed during base and storm flow?
- What are the relationships between urban land use, annual rates of discharge, and precipitation rates?
- What is the impact of streambank and streambed instability on mussel SGCN's?

Purpose and Objectives

Location

The UIRW occurs primarily in the Ozark Highlands ecoregion and is located across Benton (40%), Washington (60%), and Crawford Counties (1%; see Figure 1). The headwaters of several major tributaries of the watershed are located within the 22nd fastest growing metropolitan area of the country, with more rural lands to the west and along the border with Oklahoma. There are 28 HUC 12 subwatersheds that exhibit a wide range of conditions, from highly urbanized concrete channels and areas of exposed and eroding streambanks to areas with dense riparian forest and high-quality habitat (FTN Associates, 2012).

Designated uses for the watershed, as set forth by the Arkansas Pollution Control and Ecology Commission (APCEC), include fisheries, primary and secondary contact recreation, drinking water supply, and agricultural and industrial water supply, but segments of streams within the watershed are considered impaired for these uses. Additionally, there are several species of conservation concern located within the watershed, including the Ozark cavefish, least darter, Oklahoma salamander, and Neosho mucket. The presence of these species has resulted in several streams within the UIRW being classified as extraordinary resource or ecologically sensitive waters.

Land use in the watershed has changed significantly since the 1990's, with rapid urbanization along the eastern border and within the upper reaches of several major tributaries (Figure 2). In 1999, land use was 6.9% urban, 36.4% forest, and 56% pasture (Arkansas Watershed Information System, 2006). In 2016, the watershed was composed of 13.1% urban, 36.5% forest, and 45% pasture land uses; indicating pasture lands are being converted to high and low density urban areas. The Northwest Arkansas region's average population increase since April 2010 is 27 people per day (Northwest Arkansas Council, 2017). The main concern with this rapid urban development is the increase in impervious surfaces, which increases the quantity and velocity of surface stormwater runoff and decreases infiltration opportunities, which may ultimately impact the downstream subwatersheds via hydrological changes, increasing streambank erosion, and changes to aquatic and riparian ecology.

It is the goal of this study to target aquatic habitat throughout the watershed by quantifying hydrology change and assessing impact to SGCNs in context of current hydrologic conditions.

Approach

This project will be completed in two phases. This grant proposal focuses on implementing Phase 1 of the overall project.

Phase 1- Determining the Impact of Impervious Surfaces on Stream Stability

In order to determine if continued urbanization (i.e., increase of impervious surfaces) of Northwest Arkansas (NWA) is contributing to stream instability in the UIRW the following approach will be utilized. Stream data [i.e., stream base flow, bank full flow, discharge (i.e., daily, monthly, and yearly means), precipitation levels, and annual runoff] will be analyzed from date of establishment to current date of ten USGS gauges (i.e., stream gauge numbers 07195000, 07194933, 07194880, 071948095, 07195500, 07194906, 07195800, 07195400, 07195430, and 07194800; Figure 1) located in the UIRW. Initial analysis will be a characterization study looking only at change in stream data over time, including periods of dramatic urbanization in NWA from the 1990s to present. A second analysis will utilize annual stream discharge data and correlate it with GIS land use data over a set time period (i.e., current GIS Land Use/Land Cover data goes back 10 years) to weigh whether or not an increase in urban land use relates to increases in stream discharge. In addition, similar rainfall/precipitation events through time paired with land use data will be compared to one another to add support to any correlation determination. Lastly, data from a streambank erosion inventory conducted by Natural State Streams, LLC, at the behest of IRWP, will be used as stream instability indicators. Streambank

erosion data will be annually collected at 15 permanent monitoring sites throughout the UIRW to evaluate current stream bed and bank instability; as well as estimate sediment and phosphorus loading using BEHI modeling methods. Data will be statistically analyzed and fitted with a regression lines to determine relationships between urbanization, precipitation, stream discharge, and stream instability. Timeline for this phase will be 2 years.

Phase 2- Community Outreach and Watershed Protection Plan (i.e., if urbanization is concluded to be the reason for stream instability)

In order to generate a consequential watershed protection plan, community outreach will be conducted to municipalities within the watershed to discuss findings in phase 1. Informational pamphlets will be sent out to stakeholders (i.e., government, construction, business, conservation, and education) in the UIRW, and feedback will be requested via a survey to the same stakeholders to weigh concerns and/or interests. Additional work with local governments, construction, and business stakeholders to determine the exact locations within the UIRW that will experience increased urbanization. That information will be used to establish priority areas based on current stream instability and future urban growth potential. Lastly, we will partner with local conservation and restoration organizations to utilize their expertise in developing a watershed protection plan to focus on encouraging green infrastructure, restoring degraded stream reaches, and conserving green spaces in priority urbanizing areas. Timeline for this project will be 1-2 years.

Expected Results and Benefits

Data from this project can be used to develop a watershed protection plan that will improve water quality and promote a stable stream flow within the UIRW; therefore, having a direct impact on SGCNs that are located within the UIRW. Water quality improvement and stable stream flow will result from a reduction of stormwater runoff, therefore reducing the quantity of contaminants and volume of water entering the stream system. Improved water quality will assist in improving the overall biological health of the targeted SGCNs and the fish species they rely on during their larval development (NRCS and WHC, 2017). A stable stream flow will promote stream stability by minimizing streambank erosion caused by a faster discharge. The reduction of streambank erosion will help improve water quality by reducing sediment loading that could alter a streams flow, erode the shells of mussels (NRCS and WHC, 2017), and/or reduce the overall health of any organism present in the stream. A more stable stream flow will also assist SGCNs during their juvenile growth stage, by allowing them to establish themselves into the streambed. To promote a more habitable stream for mussel SGCNs, any restoration or physical alteration will be carried out using federal and/or state funding in partnership with other local organizations.

Table 1: Common and scientific names of species to be included in this project, as well as their priority score and page number from the Arkansas Wildlife Action Plan.

Common Name	Scientific Name	Priority Score	WAP Page Numbers
Rainbow	*Villosa iris*	15	1084 - 1086
Round Pigtoe	*Pleurobema sintoxia*	17	1031 - 1033

Little Spectaclecase	*Villosa sp. cf lienosa*	17	1087 - 1089
Elktoe	*Alasmidonta marginata*	19	959-961
Lilliput	*Toxolasma parvum*	19	1064-1066
Ellipse	*Venustachoncha ellipsiformis*	23	1078 - 1080
Elongate Pigtoe	*Fusconaia sp. cf. flava*	29	989-991
Neosho Mucket	*Lampsilis refinesqueana*	62	1001-1003
Rabbitsfoot	*Quadrula cylindrica cylindrica*	52	1046 - 1049

Budget

Item	**IRWP Match**	**SWG Request**	**Total**
Personnel Expenses			
Executive Director (10% of time for 2 years)		$15,000	$15,000
Program Manager (25% of time for 2 years)		$22,000	$22,000
Salary Subtotal	**$0**	**$37,000**	**$37,000**
Fringe Benefits and Overhead		$9,620	$9,620
Travel (500 miles at $0.54 per mile)	$270		$270
Personnel Total:	**$270**	**$46,620**	**$46,890**
Research Expense			
Streambank Erosion Monitoring Study (funded by Walton Family Foundation)	$42,304		
Research Total:	**$42,304**	**$0**	**$42,304**
Project Totals:	**$42,574**	**$46,620**	**$89,194**
Match:			48%

Qualifications

Casey Rector, Program Manager, Illinois River Watershed Partnership
Casey will serve as the project manager for this grant. Casey has 5+ years' experience in project management including, but not limited to, a greenhouse gas emissions research project in the Arkansas Delta for two years and creating and analyzing performance reports for compliance purposes at a Fortune 500 company. He also has 2+ years' experience in field research and associated statistical analyses measuring greenhouse gas emissions, field runoff for soil amendments, and soil infiltration rates in agricultural settings. He has a B.S. in Environmental, Soil, and Water Science from the University of Arkansas and will be completing a M.S. in Crop, Soil, and Environmental Science in May 2018. He is also in process to become Associate Soil Scientist certified through the Soil Science Society of America.

Nicole Hardiman, Ph.D., Executive Director, Illinois River Watershed Partnership
Nicole will oversee progress of the project and will be responsible for project reporting. She has ten years of experience managing conservation-related programs and projects at non-profit and academic organizations such as The Sustainability Consortium, Northwest Arkansas Land Trust, Northwest Arkansas Council, and Arkansas Water Resources Center. She holds a Ph.D. in conservation biology from the University of Cincinnati and a B.A. in biological sciences from the University of Arkansas.

Lee Moore and Josh Duzan, Principals, Natural State Streams
Natural State Streams will be responsible for implementing the streambank erosion monitoring portion of this project. Lee and Josh have a combined 30 years of experience in natural resource conservation and management fields. Having both graduate at Hendrix College and worked at The Nature Conservancy, their firm specializes in watershed assessment and restoration design and planning.

Erin Scott, Program Manager, Arkansas Water Resources Center
Arkansas Water Resources Center will be assisting with the statistical data analysis portion of this project. Erin has worked for the Arkansas Water Resources Center since the fall of 2013. Having completed her M.S. in Environmental Science at the University of Arkansas studying biochemical cycling in aquatic ecosystems, she is responsible for grants management, personnel management, and communications at AWRC.

Figure 1: Map of the Upper Illinois River Watershed and its 28 HUC 12 subwatersheds, along with locations of ten USGS stream gauges ( ).

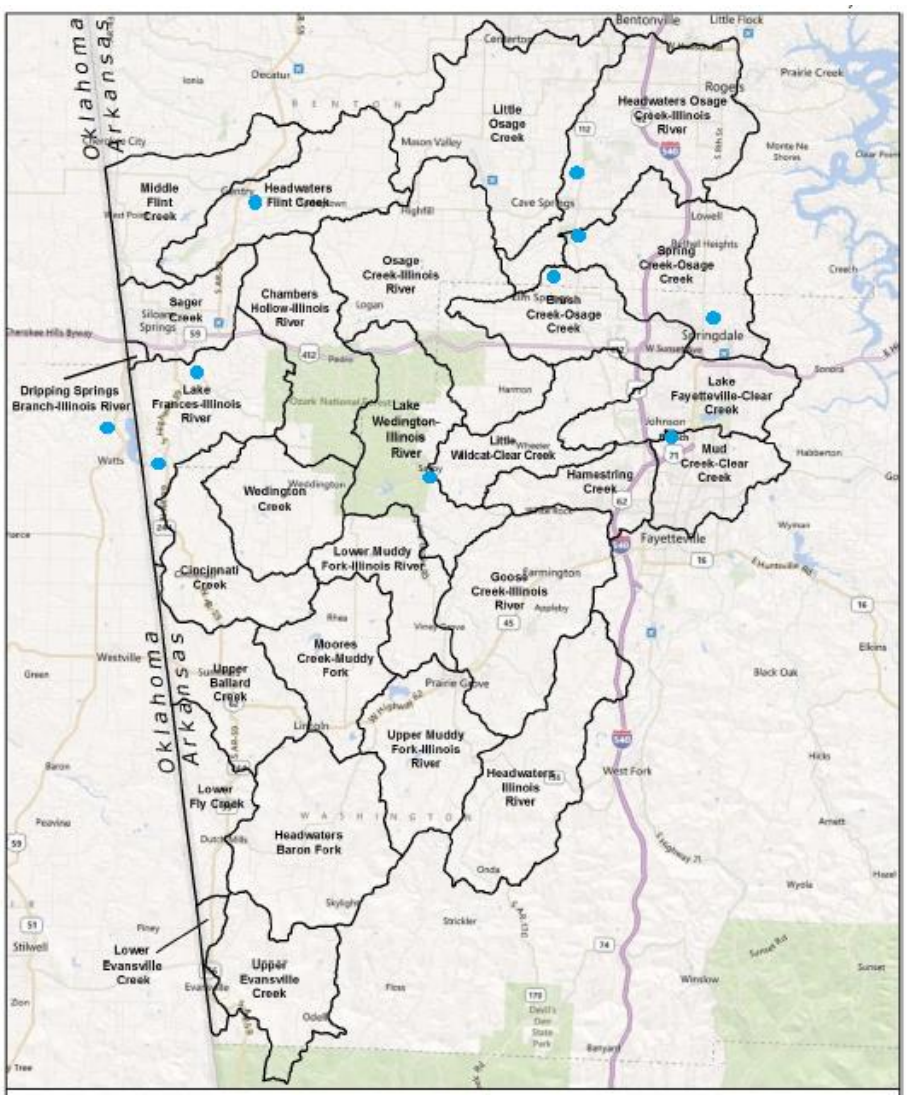
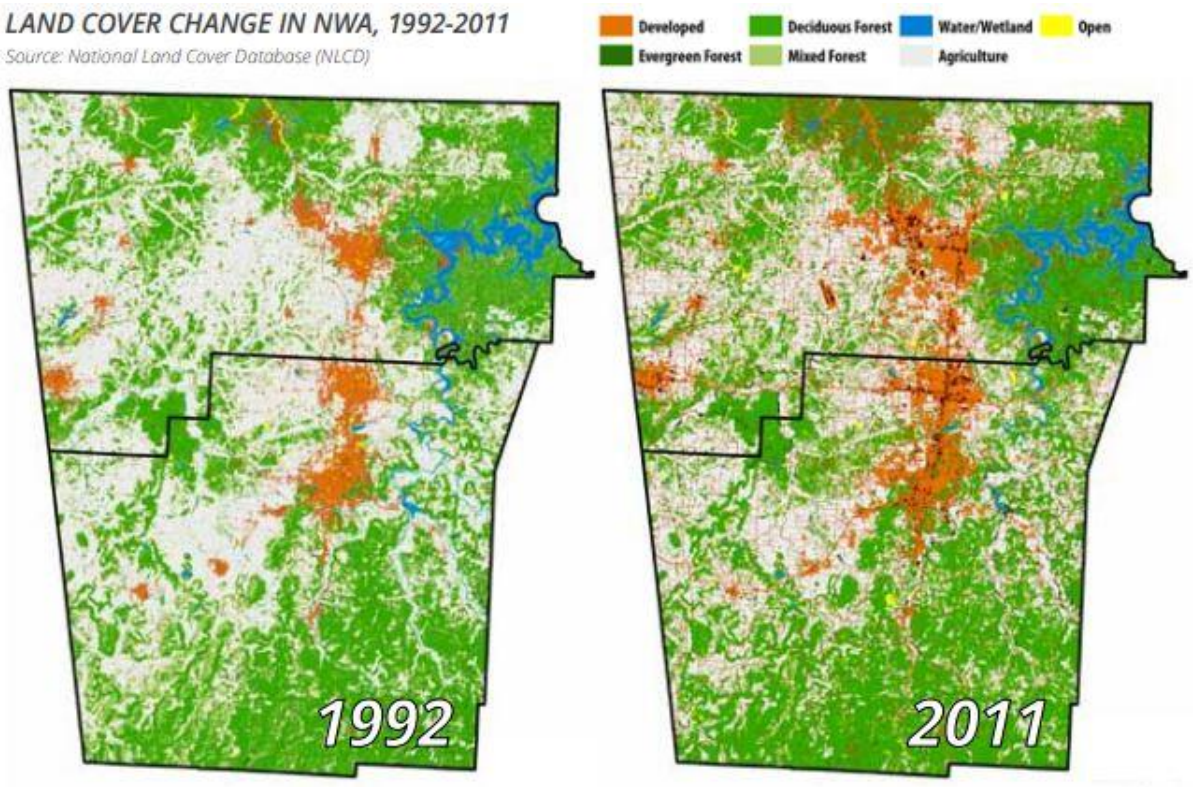


Figure 2: Land cover change in Northwest Arkansas from 1992 to 2011. Maps sourced from Northwest Arkansas Regional Planning Commission's Open Space Plan.



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