Project Title: Constructing a distributional map for winter stonefly species of greatest conservation need in Arkansas

Project Summary: The *overall project goal* is to address the need to obtain baseline information on the current distribution, abundance, and habitat requirements of winter stonefly (*Allocapnia* spp.) species of greatest conservation need (SGCN) in Arkansas. *Objective 1* aims to collect aquatic stonefly nymphs from sites in river basins with previous records of *Allocapnia* species (Ozark Highlands, Boston Mountain and Arkansas Valley Regions of the Arkansas and White River Basins). We will then incubate a subsample of *Allocapnia* nymphs from each collection site and rear them to the terrestrial adult stage where they can be identified to species. *Objective 2* aims to measure sample reach habitat characteristics (substrate composition, vegetation type, flow characteristics, water temperature, water quality) and watershed characteristics (size, slope, land use, and flow regime) to examine relationships between landscape and local environmental conditions and stonefly nymph abundance and community structure. Distributional models using landscape- and local-scale variables and stream assessments of confirmed SGCN sites will result; both can guide conservation action recommendations.

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Project Partner: Daniel D. Magoulick, Professor, University of Arkansas, Department of Biological Sciences, 601 Science Engineering, Fayetteville, AR 72701. Phone 479-575-5449. Email: danmag@uark.edu

Project Partner: John Chapman, Watershed Restoration Program Director, The Nature Conservancy, Fayetteville, Arkansas 72701.

Project Budget:
SWG amount requested: $85,365
Match amount provided (47.5%): $40,522 [$12,588 in faculty salary; $27,934 unrecovered indirect costs]
Total amount of project: $125,887

Project Statement

Need: The proposed project addresses the Arkansas Wildlife Action Plan (AWAP) and 2017 SWG funding priority *need* to obtain a baseline distribution, population status, and habitat requirements for winter stoneflies species that can lead to conservation action recommendations. The last major census of stonefly (Order: Plecoptera) species distributions to the best of our knowledge occurred in the 1980's (Poulton and Stewart 1991). Aquatic nymphs are frequently collected using traditional aquatic bioassessment sampling techniques; these techniques are not targeted to sample the terrestrial adult form that is often required for species-level identification (Fig. 1; Poulton and Stewart 1991; Stewart and Stark 2008). Specifically, we will sample nymphs and rear adults for species-level identification from focal regions and locations of previous records for Capniidae genera and species of greatest conservation need [SGCN(AWAP priority score; river basin)] [(*Allocapnia jaenae* (50; Arkansas and White River), *Allocapnia malverna* (11; Ouachita River), *Allocapnia oribata* (80; Little Red River in Searcy Co.), *Allocapnia ozarkana* (50; Cannon Creek in Madison Co), and *Allocapnia warreni* (80; Clear Creek near Fayetteville) based on the last census (Poulton and Stewart 1991). *A. warreni* is possibly extinct due to waste water treatment inputs to Clear Creek.

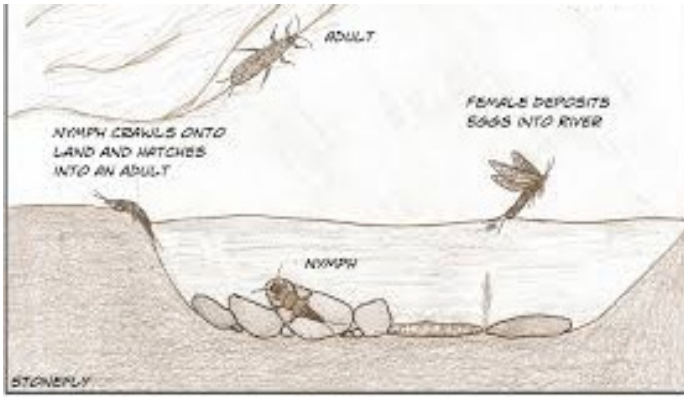

Figure 1. North American stonefly eggs and nymphs (i.e., larvae) are aquatic; exterior reproductive parts are only visible in the adults of many genera and adults are primarily terrestrial. Adults emerge in winter (Nov-Mar) and live approximately 1-4 weeks. They occur in riparian vegetation or among rocks and detrital debris where they mate (Stewart and Stark 2008). Gravid females deposit eggs over the water surface or directly in the water where they attach to benthic substrata.

Purpose and Objectives: The *overall project goals* are to construct maps of actual and potential distributions for stoneflies with an emphasis on *Allocapnia* SGCN and to complete site-specific habitat assessments; both can inform conservation action recommendations. We have two main objectives that will address the project goals. *Objective 1* aims to provide stonefly occurrence, abundance, and community structure data for river basins in regions with previous records of *Allocapnia* nymphs and SGCN (Arkansas and White Rivers). *Objective 2* aims to measure sample reach habitat characteristics (substrate composition, flow characteristics, water temperature, water quality) and watershed characteristics (size, slope, land use, and flow regime) to examine relationships between landscape and local environmental conditions and stonefly nymph abundance and community structure.

Location: We will focus on the Boston Mountains, Ozark Highlands, and Arkansas Valley regions of the Arkansas and White River basins. These regions and river basins have high aquatic habitat priority scores in the AWAP (Anderson 2006) and contain locations of previous *Allocapnia* SGCN sampled by Poulton and Stewart (1991; Fig. 2). Sampling sites will be chosen based on proximity to historical records and will include a range in landscape-level land-use (Entrekin et al. 2015) and hydrologic metrics (Leasure et al. 2014; Leasure et al. 2016). Historical records include sites with confirmed historical records of *A. jaenae, A. oribata, A. malverna, A. ozarkana*, and *A. warreni* (Figure 2; Poulton and Stewart 1991) as well as additional stream macroinvertebrate sites that have been sampled by our research group (Leasure et al. 2014, Austin et al. 2015, Entrekin et al. 2016) and other groups [Ozarks Water Watch Upper (formerly White River Basin Foundation) and Arkansas Department of Environmental Quality] in the White and Arkansas River basins. *Allocapnia* spp. nymphs are frequently found in these samples but species designation of these records is impossible without adult specimens. Sampling will focus on the time surrounding *Allocapnia* adult emergence (November to March) so that collected nymphs will be in their final instar stages.

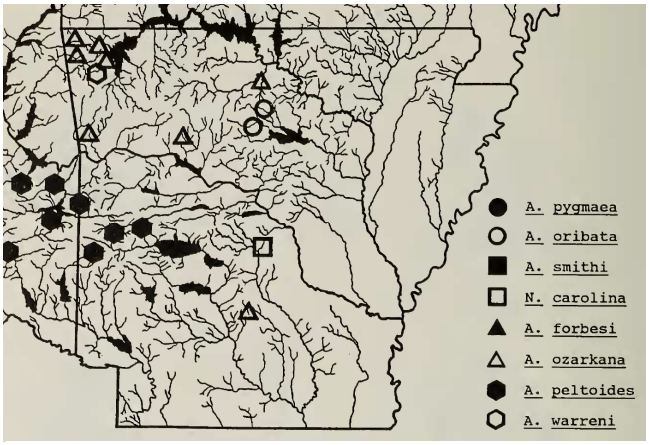

Figure 2 Distributional map of *Allocapnia* spp. modified from Poulton and Stewart 1991.

Approach: Our approach mirrors that of Poulton and Stewart (1991) who collected and cultured nymphs to the adult stage. Nymphs will be quantitatively assessed and collected from each study reach using a modified Hess sample of stream substrates, leaf litter deposits, and debris dams during the winters of 2017 and 2018 (Table 1). Individuals will be picked from debris, placed in clean stream water and transported back to the laboratory for counting and identification. A subset of each genera from each site will be preserved and a subset will be cultured in UA and UCA environmental chambers where adults will be collected, counted, and identified to species (Figure 3). Local water quality (i.e., conductivity, dissolved oxygen) and leaf litter food resource biomass will be measured and habitat will be assessed (Bowles et al. 2007) to examine relationships between the local habitat template and the stonefly community. HOBO temperature loggers will be placed at study sites with historic and confirmed SCGN records for the duration of the stonefly life cycle to determine temperature dynamics that may be required for development; these temperature requirements can allow for predictions about future distributions given climate change. In addition, the physical integrity of these SCGN study reaches will be estimated using a channel stability index (Pfankuch 1975). Sample basin will be delineated upstream of every sample location with ArcHydro toolset in

Spatial analyst. Then, land use, soil type, slope, and dominant flow regime will be quantified for each basin using methods described in Entrekin et al. 2015. Local habitat characteristics that predict *Allocapnia* spp presence will then be related to landscape characteristics. Distributional models for *Allocapnia* spp will be developed based on relationships between species abundance and community structure with landscape factors (Rottenberry et al. 2006; Sheldon and Grubbs 2013). Maps of actual and potential distributions will be developed at the Hydrologic Unit Code 12 spatial scale.

Table 1. A timeline of events for the active period of 10/1/17 to 09/30/19. We will have difficulty completing all the stonefly sampling the first winter due to the consecutive timing of stonefly emergence with the active period of the grant. Sampling will be completed by winter 2019.

Year	2017		2018				2019	
Season	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer
Activity								
Hiring and sample site selection and permission	********							
Stream sampling	****	********	***		***	*****		
Rearing activities	****	********	********		***	*****		
Sample processing		********	********	********	********	********	********	
Data Analysis					********	********	********	****
Final Report								********

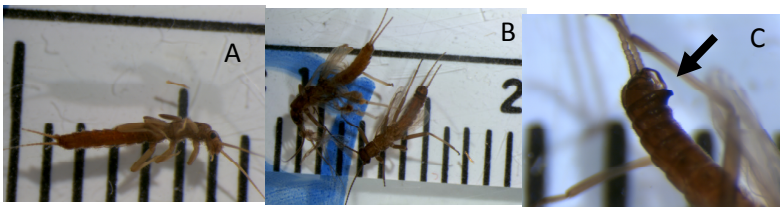

Figure 3. An *Allocapnia* nymph collected from the King's River (A) and cultured in the laboratory to produce adults (B). This male has reproductive parts that are used to key out species (C).

Expected Results and Benefits: The proposed project addresses the need to obtain baseline distribution, population status, and habitat requirements for winter stonefly SGCN. The proposed project will build distributional models using landscape variables and conduct stream assessments that can guide conservation action recommendations.

Budget:

Budget Category	Year 1	Year 2	Total
Salaries & Benefits*	$54,247.00	$8,284.00	$62,531.00
Materials & Supplies	$8,000.00	$0.00	$8,000.00
Travel	$5,516.00	$2,008.00	$7,524.00
Tuition	$5,160.00	$0.00	$5,160.00
Indirect Funds	$2,150.00	$0.00	$2,150.00
Total	$75,073.00	$10,292.00	**$85,365.00**
*Includes support for 2 GRAs			

SWG amount requested: $85,365
Match amount provided (47.5%): $40,522 [$12,588 in faculty salary; $27,934 unrecovered indirect costs]
Total amount of project: $125,887

Qualifications

Michelle Evans-White has degrees in Fisheries Biology and Biology from Kansas State University and the University of Notre Dame. She is an Associate Professor at the University of Arkansas where her research focuses on microbial (fungi, bacteria, and algae) and macroinvertebrate population and community responses to anthropogenic change. She has 25 years of experience collecting and identifying benthic macroinvertebrate and algal species. She successfully cultures stonefly nymphs in the laboratory where the nymphs grow and emerge into adults. She will lead sampling efforts and provide distribution models.

Sally Entrekin has degrees in Entomology and Biology from the University of Georgia and the University of Notre Dame. She is an Associate Professor at the University of Central Arkansas where her research focuses on changes in community structure and production of aquatic insects and organic matter processing across altered landscapes. She also has experience developing landscape-level models in Arkansas watersheds. She has 25 years of experience collecting and identifying larval and adult insect forms and has expertise culturing nymphs in the laboratory and the field. She will aid sampling efforts and develop a landscape vulnerability metric for stoneflies.

Dan Magoulick has degrees in Fisheries and Biology from Michigan State University, Eastern Michigan University and University of Pittsburgh. He is a Professor at the University of Arkansas and Assistant Unit Leader of the Arkansas Cooperative Fish and Wildlife Research Unit. His research focuses on factors affecting population and community dynamics of freshwater fish and invertebrates, especially the role of disturbance in community dynamics, impacts of introduced species in aquatic ecosystems and conservation of aquatic ecosystems. He has 37 years of experience in macroinvertebrate ecology and modeling population dynamics. He will develop species distribution models and aid in data analysis.

John Chapman is a graduate of the University of Arkansas at Monticello with a B.S. in Spatial Information Systems. He is the Watershed Restoration Program Director for The Nature Conservancy, Arkansas Chapter, where he specializes in watershed and geomorphic assessments and design and implementation of stream restoration projects using natural channel design techniques. He has completed four intensive courses in “Applied Fluvial Geomorphology” and “Natural Channel Design” led by instructor Dave Rosgen, Ph.D., conducted numerous geomorphic surveys, and worked to implement stream restoration projects on the West Fork of the White River, Kings River, and Little Osage Creek. He also has 15 years of experience in the Geographic Information Systems (GIS) field.

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