Title – **Ranges of the Sulphur Springs Diving Beetle, *Heterosternuta sulphuria,* and *Heterosternuta phoebeae*, endemic SGCN in Ozark streams**

Project summary – Geographical ranges of two endemic water beetle species of concern will be determined. The realized extent of *H. sulphuria* will further support important conservation research involving population structures and environmental limiting factors (including environmental flows) across the Ozark region. Determining the range of *H. phoebeae* will provide insight into its dispersal ecology within the watershed of the Buffalo National River and adjacent watersheds. Research and conservation actions focused on small Ozark streams could broadly impact additional species in connected freshwater systems including cave streams, rivers and reservoirs.

Project leader – Scott D. Longing, Postdoctoral Fellow, Arkansas Cooperative Fish and Wildlife Research Unit, Department of Biological Sciences, University of Arkansas, SCEN 632, Fayetteville, AR 72701, slonging@uark.edu, 479.575.2031.

Project partners – The project will be conducted by a graduate student, a student research technician and the project leader.

Budget
SWG amount requested: $71,736
Match amount: $46,318
Total amount of project: $118,054

Project Statement

Need – The *Heterosternuta* are comprised of 14 species distributed across the eastern U.S. and extreme southeastern Canada with the center of diversity being the Appalachian and Ozark Mountains. Six regionally endemic species are found in parts of Arkansas, Tennessee, and Alabama. Three endemic *Heterosternuta* in Arkansas include the Sulphur Springs Diving Beetle, *Heterosternuta sulphuria* (SGCN priority score of 80), *H. ouachita* (19) and *H. phoebeae* (19). However, geographic range extents for these species are unknown and therefore strategies for population-level conservation across their ranges cannot be developed.

Recent survey and watershed data show that *H. sulphuria* (Fig. 1A-B) occupies upper headwater reaches (median watershed area of occurrences = 1.75 km^2, n = 42) with many of these locations known to maintain water permanence over the period of record or observation. Co-occurring with *H. sulphuria*, an undescribed species has been collected from these small headwater habitats and this (morpho) species appears to be relatively rare (*Sanfilippodytes* cf. *vilis*, Fig. 1D, median watershed area = 0.56 km^2, n = 17). A potential factor leading to the occurrence and potential isolation of *H. sulphuria* and *Sanfilippodytes* populations in these small freshwater habitats might involve the degree of flow variability and permanence, yet investigations of the importance of such environmental flows requires information on the population conditions of these species across their ranges.

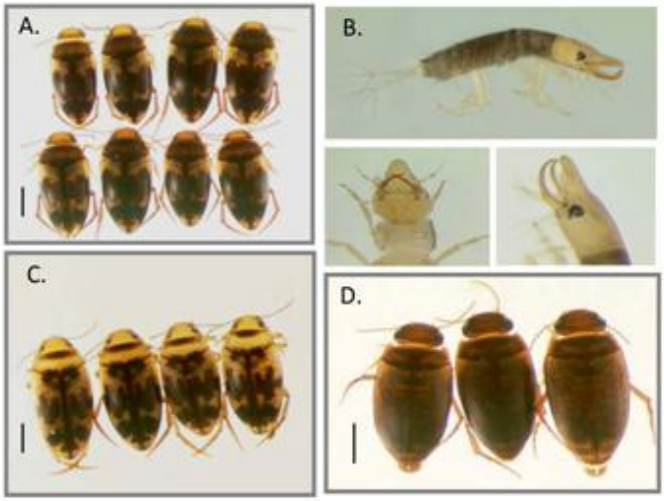

Figure 1. Focal species of current research: A. endemic *Heterosternuta sulphuria*, B. *H. sulphuria* larvae, previously unknown, C. endemic *H. phoebeae*, D. *Sanfilippodytes cf. vilis.* Bar represents 1 mm.

Heterosternuta phoebeae (Fig. 1C) is known only from the watershed of the Buffalo National River (BNR), yet with a new record in 2011 being the first outside the BNR (Madison County, AR). In contrast to small habitats and watersheds occupied by *H. sulphuria* and *Sanfilippodytes* sp., *H. phoebeae* has been observed in high densities and collected from drying pools and margins of larger tributaries of the BNR (median watershed area = 13.84 km^2, n = 13).

A major concern for headwater/groundwater seep populations involves dispersal capacity and genetic population structures across dynamic and changing freshwater systems. Genetic and flight studies for *H. sulphuria* and *H. phoebeae* are currently underway. To date, no *H. sulphuria* individuals have flown from dry containers, instead dying within 24 hours (n = 67 individuals) while 18 of 76 individuals of *H. phoebeae* were observed to fly from dry containers. Supportive laboratory experiments are currently addressing species responses to levels of microhabitat drying. Furthermore, few beetle species have been collected from small perennial urban streams in northwestern Arkansas; to date a total of only four *H. sulphuria* populations have been found in or near the perimeter of urban areas. However, populations have been recorded from several agriculturally dominated headwater streams on the periphery of urban

areas in Washington and Benton Counties. Overall findings suggest that *H. sulphuria* populations could be experiencing localized extirpations attributed to land-use change and weak dispersal capacity.

A previous SWG (T26-R-2, 2007 – 2009) established new distributional records for *H. sulphuria* across 10 contiguous counties in northwestern Arkansas. However, an updated conservation ranking (a downgrade) requires more information on their range, population conditions and freshwater habitats. Moreover, a downgrade in conservation status could put numerous potentially isolated populations at risk. For conservation, developing further information on the distributions/ranges and population structures of *H. sulphuria* and related species across contemporary landscapes remains an urgent need.

The objective of the proposed study is to determine the range extents of *Heterosternuta sulphuria* and *H. phoebeae*. Information developed from this study will further support broad investigations of environmental factors affecting genetic population structures and ultimately the viability of populations across the Ozarks. Some questions that can be addressed with improved knowledge of range extents include: How did *H. sulphuria* colonize broad headwater systems if it is a weak disperser? Data suggests that *H. phoebeae* is a stronger flier, so why does it have a relatively narrower current range? Did *H. sulphuria* lose capacity for flight in isolated, groundwater-influenced aquatic habitats? Do simply the flow dynamics of these habitats determine the spatial arrangement of *H. sulphuria* populations? Does human alteration of landscapes eliminate satellite populations that have otherwise been successful across the ebb and flow of freshwater habitats over millennia? In addition to unique occupancy-abundance and phylogeographic investigations, these species could provide effective model organisms for improving our understanding of the natural history of freshwater habitats and environmental flows on the Ozark Plateau, thus aiding management strategies for our immensely important freshwater ecosystems.

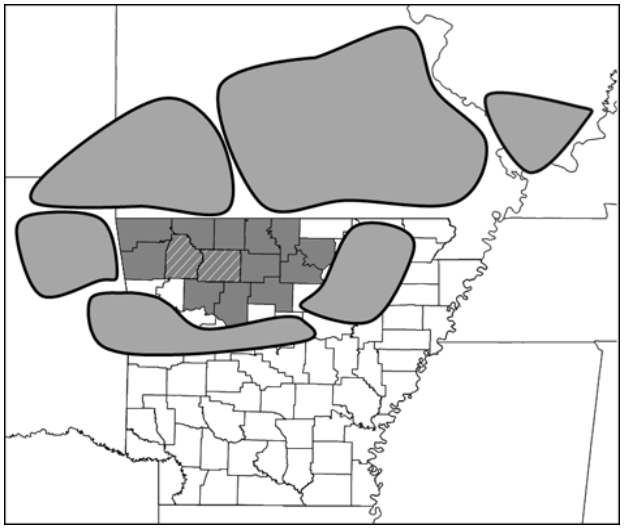

Figure 2. Arkansas's counties where *H. sulphuria* and *H. phoebeae* (hatched) have been collected. Six regions surrounding this area is the focus of range extents for *H. sulphuria*, while distributional surveys for *H. phobeae* will focus on tributaries of the Buffalo National River and adjacent watersheds.

Location - Ozark Highlands and Boston Mountain ecoregions, including major watersheds in Arkansas, Oklahoma, Missouri, extreme southeastern Kansas and southern Illinois. Habitats targeted include stream margins among first through fourth order stream reaches.

Objective – The objective is to determine geographic range extents of *H. sulphuria* and *H. phoebeae* and to report additional element occurrences for *Sanfilippodytes*, a candidate SGCN (Fig 1D). The overall goal is to provide baseline information on the realized extent of these

endemic species to support future research on the ecology, evolution and conservation of these species and their freshwater habitats.

Approach – Surveys of stream reaches will be conducted across six Ozark regions (Fig. 2) and range extents will be estimated for *H. sulphuria*, *H. phoebeae* and *Sanfilippodytes* sp. Extents will be initially assessed using the extent of occurrence approach and further research will be aimed at determining the internal structures of distribution and dispersion within their ranges, therefore extents could be further modified according to refined areas of occupancy. Sampling during summer months (preferably at base flow) will provide an initial assessment of water permanence at surveyed reaches. GIS will be used to select headwater reaches across watersheds. Surveys for *H. phobeae* at BNR and adjacent watersheds will involve both headwater tributaries and main stem reaches, while surveys for *H. sulphuria* will involve randomly selecting primarily-forested reaches across small watersheds.

Expected results and benefits – The proposed project will build information to further address environmental flow needs for aquatic SGCN. Surveys will provide key additional element occurrence data and range extent maps for these species. Addressing the proposed research directly achieves broad biodiversity conservation for additional freshwater species and their habitats, such as numerous SGCN species in connected subterranean karst systems and SGCN invertebrate and fish species occupying small Ozark streams. A major goal is to build support across states regarding aquatic insect conservation in the Ozark region. A graduate student will gain valuable experience in conservation research while contributing directly to regional freshwater biodiversity conservation.

Budget – Requested funding from AGFC will be used primarily to support a graduate student research project. Field surveys will be conducted for approximately 40 days per summer and it is estimated that 4000 miles per summer will be logged.

Budget.

	Year 1		Year 2		Totals		
	SWG	UA-Coop	SWG	UA-Coop	SWG	UA-Coop	Project
PI salary and fringe	6,445		6,683		13,128		13,128
Graduate Assistant (incl. fringe)	17,338		17,858		35,196		35,196
Tuition		7,035		7,739		14,774	14,774
Field Technician (enrolled student)	2,883		2,969		5,852		5,852
Travel							
Vehicle	2,380		2,380		4,760		4,760
Room (30 days/year)	2,100		2,100		4,200		4,200
Food (40 days/year)	3,000		3,000		6,000		6,000
Materials and supplies	850				850		850
Journal publication fees/meetings			1,750		1,750		1,750
F&A cost (unrecovered, 44%)		15,398		16,146		31,544	31,544
	34,996	22,433	36,740	23,885	$71,736	$46,318	$118,054

Qualifications – Project leader Scott Longing is an aquatic entomologist with a focus on applied ecology and conservation in Ozark Plateau streams. His published research includes freshwater studies involving environmental stressors of aquatic ecosystems and species conservation. Scott is currently investigating long-term flow variation in Arkansas's streams and rivers, which will provide the foundation to support ecohydrological studies of Arkansas's important freshwater ecosystems. Scott is currently a postdoctoral fellow in the Arkansas Cooperative Fish and Wildlife Research Unit and is the 2012 president of the Arkansas Entomological Society.