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March 15, 2007

Ms. Jane Anderson
Arkansas Wildlife Action Plan
Implementation Coordinator
Arkansas Game and Fish Commission
2 Natural Resources Drive
Little Rock, AR 72205

Dear Ms. Anderson:

Enclosed please find the PDF file for a proposal entitled "Hydroporus sulphurius (Coleoptera: Dytiscidae Occurrence in the Sulphur Springs Headwater System and in Buffalo National River Tributaries (Arkansas, USA): Current Distribution, Habitat Conditions, and Biomonitoring Framework" submitted by the Board of Trustees of the University of Arkansas on behalf of Dr. Brian E. Haggard of the Department of Biological and Agricultural Engineering.

All financial and/or contractual negotiations regarding this project should be conducted with this office. If questions arise concerning the technical aspects of the proposal, please contact Dr. Haggard at (479) 575-2879. The University appreciates the interest and support of the Arkansas Game and Fish Commission.

Sincerely,

Patricia Turner

Patricia Turner
Research Administrator
Pre-Award Services

pkt
Enclosure(s)
cc: B. Haggard
S. Longing

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UNIVERSITY of ARKANSAS

Hydroporus sulphurius (Coleoptera: Dytiscidae) Occurrence in the Sulphur Springs Headwater System and in Buffalo National River Tributaries (Arkansas, USA): Current Distribution, Habitat Conditions, and Biomonitoring Framework

A Proposal Submitted to

Arkansas Game and Fish Commission State Wildlife Grant Program

Prepared by

Crop, Soil and Environmental Science

College of Agircultural, Food and Life Sciences

Period of Performance: 07/01/2007 - 06/30/2009

Amount Requested: $39,370

Submitted by
Board of Trustees

Brian E Haggard

Scott D. Longing

Rosemary Ruff, Director
Research Support and Sponsored Programs

Hydroporus sulphurius (Coleoptera: Dytiscidae) Occurrence in the Sulphur Springs Headwater System and in Buffalo National River Tributaries (Arkansas, USA): Current Distribution, Habitat Conditions, and Biomonitoring Framework

Historic locations for the critically imperiled beetle, *Hydroporus sulphurius* (*H. sulphurius*), will be reexamined and their habitat extensively characterized. Sampling will be conducted using aquatic nets and bottle traps. Environmental descriptors at the habitat and system scale will be investigated to increase the accuracy of subsequent biosurveys at potential sites and to provide a framework for long-term biomonitoring of *H. sulphurius*. Findings will show the current distribution of *H. sulphurius* and will provide an important ecological dataset regarding this species and its aquatic environment.

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State Wildlife Grant Request: $39,370

Matching Funds and In-Kind Services: $39,988

Contents

1.0. Proposal abstract

Stream invertebrate populations will be sampled to fill data gaps and determine conservation status of the critically imperiled water beetle, *H. sulphurius*[1]. A performance comparison of three sampling devices and two sampling methods will aid the development of standardized and repeatable strategies for long-term biomonitoring. An important goal of the proposed study is to develop environmental descriptors for determining sites that may contain *H. sulphurius*. Therefore, physical stream characteristics will be determined for each sampling location and used to increase the precision (involving four performance measures) of subsequent biosurveys. Precise sampling associated with defined habitat types will provide a framework for biomonitoring, while focusing on the specific habitat of *H. sulphurius* and co-occurring species. The overall goals are to (1) fill the data gap regarding *H. sulphurius* occurrence and distribution among historical sites, and (2) determine if a specific environment is related to discrete taxonomic assemblages containing *H. sulphurius*, and (3) provide a framework for a conservation monitoring strategy for *H. sulphurius* and other imperiled aquatic invertebrates in Arkansas.

2.0. Conservation priority addressed

H. sulphurius is a small water beetle in the family Dytiscidae. Members of this family are commonly known as predaceous diving beetles, although some are considered scavengers. There are over 500 described species in North America (Merritt and Cummins 2002). The Dytiscidae are one of the most highly specialized coleopteran families in aquatic systems, and their populations are typically comprised of high densities of individuals among defined environmental settings (Larson 1985, Eyre 2006). Because of their ubiquitous distribution and the discrete species complexes that may form in small lentic and lotic water bodies (Larson 1985), the Dytiscidae show potential as bio-indicators for monitoring water and habitat quality in freshwater systems.

H. Sulphurius was first collected from Sulphur Springs in 1955 by Dr. Paul Spangler and deposited in the National Museum of Natural History. Matta and Wolfe (1979) later described *H. sulphurius* from that collection along with two additional new species of *Hydroporus*. Preceding the new species description, efforts to collect *H. Sulphurius* at Sulphur Springs by Dr. Spangler again in 1978 were unsuccessful. Wolfe and Harp (2003) described a small Dytiscid beetle, *Heterosternuta phoebeae*, collected from second, third, and fourth order tributaries of the Buffalo National River. In that study, nine additional dytiscid species were found to co-occur with *H. phoebeae* among those sites, including *H. sulphurius*. However, *H. sulphurius* occurred in very low numbers; only three out of approximately 900 individuals (Dr. George Harp, personal communication). The Sulphur Springs Hydroporus Diving Beetle populations have been listed as critically imperiled both globally (G1) and in Arkansas (S1), having a priority score of 80 out of 100.

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[1] Wolfe (2000) elevated the subgenus *Heterosternuta* of genus *Hydroporus* to the generic level. This resulted in *Hydroporus* (*Heterosternuta*) *sulphurius* henceforth being referred to as *Heterosternuta sulphurius* (George Harp, personal communication). The scientific name contained in this report maintains this water beetle as *Hydroporus sulphurius* to avoid confusion with SGCN lists. However, subsequent reports will list this species as *Heterosternuta sulphurius*.

3.0. Proposed study outcomes

The proposed study of *H. Sulphurius* occurrence in the Sulphur Springs headwater system and in Buffalo National River tributaries will fill data gaps and advance the information for monitoring this Species of Greatest Conservation Need (SGCN). Data collected on *H. sulphurius* will be provided to the Arkansas Game and Fish Commission (AGFC) in the form of an interim and final report. Locations of *H. sulphurius* occurrence will be mapped along with GPS coordinates. Numbers of *H. sulphurius* specimens collected, as well as preferred habitat conditions across historic sites will be documented to improve future sampling efforts and to develop a standardized monitoring procedure for *H. sulphurius*.

4.0. Geographic area of study

The study will be conducted at sites where *H. sulphurius* and other dytiscids have been collected in northern Arkansas. We will focus on those sites and work to gain information on additional sites and water bodies that may contain *H. sulphurius*. Historic locations where *H. sulphurius* was collected are provided by Wolfe and Harp (2003) and supporting documents containing exact locations, species occurrences, and pictures of habitats where *H. sulphurius* was collected (Dr. George Harp, Arkansas State University).

5.0. Goals of study

By 2009, we propose to have filled some of the data gaps regarding the distribution of *H. sulphurius* within northern Arkansas. At that time, we will be able to provide the AGFC a report on the distribution and status of *H. sulphurius* from historical collection sites and other potential sites. Our findings will assist the Comprehensive Wildlife Conservation Strategy (CWCS) development and future monitoring of this aquatic insect. In addition, we hope that information from this project can be applied to an overall conservation monitoring framework for other aquatic invertebrates in Arkansas.

Primary objectives for reaching these goals are: (1) determine the occurrence of *H. sulphurius* at the type locality, Sulphur Springs, AR, and in Buffalo National River tributaries, (2) compare the biological efficacy and performance of three different types of sampling devices and two sampling methods, (3) develop environmental descriptors that relate to the occurrence of *H. sulphurius* and the Dytiscidae fauna, and (4) develop a conservation biomonitoring framework for detecting long-term trends in *H. sulphurius* status and distribution.

6.0. Monitoring methodology and performance measures

6.1. Sampling method

At historic sampling locations, specific sites and invertebrate sampling will be stratified to include known potential habitats of *H. sulphurius* (Larson 1985, G. Harp personal communication). Initial habitat stratification will select for habitats comprised of clean gravel and cobble near vegetated banks with partially open tree canopies. Additionally, other factors that will be considered upon initial habitat stratification include channel position (e.g., stream margins, mineral substrate lacking heavy detritus, and streambeds with structural complexity). Factors suggested to present environmental difficulties for dytiscid beetles include low productivity, instability of water levels, and structural simplicity (Eyre 2006); therefore, these environmental descriptors will be used to exclude some habitats.

We propose to sample in a variety of habitat types at all historical sites; at least 9 tributaries of the Buffalo National River (Table 1, Fig. 1, Wolfe and Harp 2003) and five streams including the large pool of the type locality in the Sulphur Springs headwater system (Fig. 2). An adaptive sampling design will be used during the initial biosurveys. Sampling adaptation will consist of modifying the type of selected habitat based on performance measures for the three sampling devices. For example, initial sampling will focus on habitat conditions known to contain *H. sulphurius* including clean large gravel and cobble stream margins with open canopies (Fig. 3); however, if no *H. sulphurius* are found in those habitats (with indication of low performance across sampling devices), a sequence of sampling events will focus on different habitats until we successfully collect *H. sulphurius*. In the event that a majority of the defined habitat types are visited with unsuccessful collection of *H. sulphurius*, we will delineate candidate reaches (containing similar general environmental characteristics of historic sites) and employ a systematic, random sampling method. Such a design will allow us to sample from a variety of habitat types, with the focus away from habitat-specific environmental descriptors until *H. sulphurius* is collected. If *H. sulphurius* is collected using the systematic sampling method, the development of environmental descriptors will focus on the habitat from which *H. sulphurius* was collected using that method. Unsuccessful collection of *H. sulphurius* at all historical sites using both the stratified and systematic sampling method will initiate reconnaissance biosurveys at waterbodies with similar environmental characteristics of historic sites. Those biosurveys would consist of sampling at easily accessed locations in order to visit a large number of sites in the Ozark Mountains.

Table 1. Buffalo River tributaries where *H. sulphurius* was found to co-occur with other Dytiscidae

Sampling location	Date
Bear Creek at US Hwy 65 30/V/88	1-Jul-92
Beech Creek at St. Hwy. 74, 0.8 miles south of Boxley	1-Jul-92
Little Buffalo River, 4 mi. upstream from Parthenon	30-Jun-92
Smith Creek at St. Hwy 21, 2 mi. south of Boxley	1-Jul-92
Calf Creek, 4 mi. southwest of Gilbert (NC quarter of Section 10)	29-Jun-92
Bear Creek at St. Hwy 74, 3 mi. west of Marshall	29-June-92, 22-Jul-89
Big Creek at St. Hwy 14, 10.5 mi northeast of Marshall	28-Jun-92
Long Creek at St. Hwy 74, 11 mi. east of Marshall	28-Jun-92
Long Creek 10 mi. east of Marshall, south of Hwy 74	28-Jun-92

Species collected: *Heterosternuta phoebeae, Heterosternuta pulchar, Hydroporus sulphurius, Hydroporus wickami, Hydroporus signattis, Hydroporus ouachitas, Neoporus clypealis, Neoporus striatopunctatus*

6.2. Sampling devices and habitat

It is important that sampling for a species with an unknown, and potentially limited distribution involves a variety of sampling techniques that are assessed individually for performance and biological efficacy. Sampling will be conducted in aquatic habitats using three sampling devices: (1) bottle traps (Aiken and Roughly 1985, Hilsenhoff and Tracy 1985), (2) D-frame net, and (3) a new net developed for collecting aquatic invertebrates along vegetated banks. The new net will consist of two wooden poles (length = 2 m.) attached to a 0.5 x 1.5 m sheet of Nitex® mesh (500μm mesh size, area = 2.25 m^2). The Nitex will be recessed to form a concave shape, with 5 cm of heavy nylon forming the recessed skirt. The net is designed for collecting invertebrates from bank habitats and from mineral substrate located near bank habitats. The sampling net is placed near the streambed and is moved steadily towards the bank, with the long edge of the net parallel to the bank. The net contacts the bank vegetation, and moves upward through the vegetation and out of the water. This method will allow a larger portion of stream habitats to be sampled at one time, and reduces the chance that *H. sulphurius* may escape due to their strong swimming ability. The D-frame net (area = .09m^2) is designed to sweep or jab, or by kicking the substrate and letting organisms flow into the net, and has been a typical method for collected benthic macroinvertebrates as part of freshwater biological assessments (Barbour et al. 1999).

The Dytiscidae are typically collected from lentic waters using bottle traps, with sampling most effective when supplemented with aquatic nets (Aiken and Roughly 1985, Hilsenhoff and Tracy 1985). Nets may be more effective for sampling small dytiscids that are known to prefer vegetation for refuge, while large-size dytiscids readily swim in the water column. Moreover, while bottle traps collected more dytiscids in the spring, nets and bottle traps had similar numbers captured in the fall (Hilsenhoff 1987), which the authors attributed to these univoltine beetles slowing down compared to the more active spring season. The efficacy of bottle traps in lotic waters in unknown, and challenges may exist due to flow velocities in our systems. However, bottle traps should prove effective in lotic habitats that maintain low flow velocities (e.g., backwaters, side pools, stream margins).

An objective is to assess the performance of each sampling device within similar habitats. Therefore, at each sampling location, we will attempt to select at least three similar habitats (see *6.1*) and use one sampling device per habitat. Each sampling device will be used at various locations of the selected, defined habitat type within each reach. In the event that a historic collecting site does not contain enough of the selected habitat type, bottle traps will be deployed following a brief biosurvey using nets. At sites possessing adequate area of the initially defined habitat type, bottles traps will be fixed to the streambed at one habitat, and nets will be used separately within two or more of the similar habitat. Net samples will be collected and preserved with 70% ethanol. Bottle traps will be recovered in 2 – 3 days. Immediately following the removal of the bottle traps, the closest bank habitats will be sampled with nets. Net sampling at those locations during the initial placement of the traps would possibly affect bottle trap catches (and alter performance) due to disturbances caused by net sampling. General conditions of invertebrates in bottle traps (e.g., dead, decomposed) will be noted, and such conditions would indicate that the duration of bottle sampling should be shortened. In addition, control bottles (containing a known number of water beetles or other aquatic insects) will be placed at some sites to determine if unknown factors (e.g., escape, predation, or mortality) may affect bottle trap performance. Aquatic invertebrates will be preserved, identified to species level, and deposited in the Department of Entomology Arthropod Museum at the University of Arkansas. All invertebrates may not be sacrificed, and selection of invertebrates for taxonomic identifications will be determined following initial reconnaissance biosurveys. We will preserve all invertebrate samplings that are collected if an invertebrate sampling event coincides with habitat and water quality measurements (i.e., some reconnaissance biosurveys may just involve invertebrate sampling with no habitat or water quality measures). We suspect that the fauna in our samples will include sparse total numbers of individuals, not high total abundances that are typically found in habitats such as stream riffles. Furthermore, total numbers and species richness will be low compared to typical benthic invertebrate samples, because we will primarily be focusing on the successful collection of *H. sulphurius*. However, in so doing we will inherently collect several invertebrate taxa using our three sampling devices.

The aquatic environment at the location of sampling will be recorded through quantitative habitat and water quality parameters and visual estimates of habitat conditions. Ultimately, a suite of environmental descriptors will be produced that are found to influence the occurrence of *H. sulphurius*. Environmental descriptors will be developed for the habitat scale and the system scale (Table 2). If *H. sulphurius* and its potential, associated assemblage form discrete species complexes among a specific environment, then environmental descriptors operating at the system scale will be evaluated to determine if habitat scale descriptors can be predicted based on those large scale, system features.

Table 2. Environmental descriptors at the habitat and system scale.

habitat descriptors	*system descriptors*
stream width	watershed area
water depth	valley confinement
flow velocity	valley slope
percent vegetated bank	channel gradient
percent exposed bank	dominant geology
width of riparian corridor	watershed vegetation
riparian vegetation	elevation
submerged macrophytes	land–cover
submerged bank vegetation	land–use
bank height	climate-rainfall
area of dominant substrate	stream size
algae presence	
water permanence	
dominant substrate type	
subdominant substrate type	
presence of fine sediment	
deposition	
habitat position in channel	
canopy conditions	
distance from source	
adjacent land-use	
percent occurrence of habitat (within 100m)	
dissolved oxygen, pH, conductivity	
water quality (nitrogen, phosphorus, carbon, chloride, and other soluble trace elements)	

6.3. Biomonitoring for H. sulphurius

Biomonitoring techniques developed for *H. sulphurius* will depend on our ability to link specific dytiscid assemblages to habitats based on our selected environmental descriptors. Freshwater systems (lentic and lotic) can contain discrete assemblages of water beetles that are related to environmental conditions including productivity, habitat structure including vegetation, water permanence, substrate type, and water temperature (Larson 1985, Eyre 2006). The species rich Dytiscidae fauna of temperate North America and preference for specific habitat conditions can lead to significant co-occurrences and dense "species packing" in aquatic habitats (Larson 1985), thus potentially providing important habitat templates and expected species occurrences that facilitate standardization of long-term biomonitoring programs (Thomas 2005). Biotope classifications (e.g., marshes, temporary ponds, fast-flowing streams) using water beetles have recently been determined in Britain for developing standardized and reproducible survey methods and to monitor climate change using beetle distributions (Coope 1994, Eyre 2006).

Biomonitoring activities will include utilizing sampling devices and methods that are determined to be most effective (high performance) for collecting *H. sulphurius*. In the event that *H. sulphurius* occurs with very low frequency among our sites, we will focus biomonitoring activities on habitats that contain other small dytiscids. Furthermore, unsuccessful collection of *H. sulphurius* using the developed monitoring framework will provide the impetus for modification of the conservation status for *H. sulphurius*. Performance measures for long-term monitoring will be similar to those used in the initial biosurvey. However, the initial biosurvey will probably see an increase in performance over the two-year study period, while performance associated with long-term biomonitoring will consist of maintaining a performance measure over time (determined from the initial biosurveys). Therefore, our performance measures for long-term monitoring will have to fall within an acceptable range determined by the performance of initial biosurveys.

6.4. Performance measures

Technical guidance provided by the U.S. Environmental Protection Agency will be used to develop performance measures for the initial biosurveys and for long-term biomonitoring (Barbour et al. 1999, Ch. 4: Performance-Based Methods System). Performance measures will be developed for (1) the three different sampling devices for collecting small dytiscids (2) two sampling methods (i.e., stratified and systematic), and (3) long-term monitoring aimed at most effectively sampling *H. sulphurius* (i.e., monitoring temporal patterns and modifying sampling methods when performance measures fall below a determined criterion). Our performance measures range from coarse scale (Per1), to fine scale (Per3, see below). In addition, we will develop a performance measure related to our adaptive sampling design and the ability to determine discrete biota-environment relationships. When associated with long-term biomonitoring, a strong decrease in a coarse-scale performance measure could indicate a natural, temporally-dynamic system, or system stress. Low performance across time for Per3 would be due to unsuccessful collection of *H. sulphurius*, with implications regarding the modification of sampling methods and possibly the re-evaluation of *H. sulphurius* conservation status.

Performance measures will be used to determine the precision and bias associated with three sampling devices and at least one sampling method. Precision will be assessed using invertebrate abundance coefficients of variation (CVs) for three performance measures. Sampling device bias will determined by the number of invertebrate taxa unique to a particular sampling method. A final performance measure will assess the effectiveness of sampling method and will represent method ability to determine (1) the presence of *H. sulphurius*, and (2) significant environmental descriptors. Performance using (1) and (2) above will be assessed for the random, systematic sampling only if *H. sulphurius* is not collected with the stratified sampling method (see *6.1*).

Performance Measure 1 (Per1): Aquatic invertebrate abundance and coefficient of variation of abundances across invertebrate samples for each sampling device and sampling method.

Performance Measure 2 (Per2): Dytiscidae abundance and coefficient of variation of abundances across invertebrate samples for each sampling device and sampling method.

Performance Measure 3 (Per3): *H. sulphurius* abundance and coefficient of variation of abundances across invertebrate samples for each sampling device and sampling method.

Performance Measure 4 (Per4): Number of influential environmental descriptors for *H. Sulphurius* and an associated assemblage. High performance will be indicated by an environment that is explained with the strongest and fewest environmental descriptors, and yields consistent high performance with Per2 and Per3.

7.0. Associated species under SGCN status and others

Species that may be collected and are under SGCN status include *Heterosternuta phoebeae* (priority score 19, G?, S2) and *Hydroporus ouachitus* (priority score 19, G?, S2). In addition, all taxa comprising the assemblage associated with *H. sulphurius* occurrence will be identified and documented. Although focus will be on collecting *H. sulphurius*, environment-biota relationships, abundances, and frequencies will be determined for all additional taxa.

8.0. Related biomonitoring research benefiting from proposed study

8.1. A framework for conservation monitoring: expected species and environmental descriptors

> *In a recent paper discussing insect monitoring to assess global changes in invertebrate biodiversity, Thomas (2005) states: "I strongly recommend that those authorities responsible for the supply and quality of water in all nations apply the same methods (to conservation and biodiversity studies) of using invertebrate diversity to measure water quality that are currently employed across Europe, North America, and Australia. I recommend that conservation organizations capitalize on this infrastructure to use existing schemes to monitor change in invertebrate biodiversity per se."*

Effective freshwater biomonitoring depends on the ability to link aquatic biota to their habitats. Determining the environmental factors influencing biotic assemblages allows field sampling to be conducted with a known precision, therefore enhancing the overall accuracy of site evaluations. Reference conditions (i.e., those exposed to minimal watershed stress) provide the basis for biological comparisons, yet are variously defined in terms of the site-specific environment. Geographic delineations (e.g., ecoregions) assist in defining reference biocriteria by providing a spatial framework to partition natural variability among sites considered to be reference. Thus, biological information from a suspect test site can be compared to reference conditions within the same region.

The accuracy of bioassessments essentially depends on the ability to develop sites classification based on some aspect of the environment. Typically, large scale watershed factors (e.g., ecoregion or stream size) are typically used to classify reference sites based on environmental features. Although benthic invertebrates are strongly associated with environmental features at local scales (e.g., substrate and flow velocity), reference site classification has mostly been a top-down approach regarding influential environmental features.

When associated with evaluations to determine if a waterbody fails to display reference conditions, statistical errors may occur that compromise the accuracy of a bioassessment (type II statistical errors, indicating sites are different when they are not). Therefore, biomonitoring programs should benefit from the increasing ability to precisely predict the occurrence of species under a specific type of environmental conditions, with the idea to ultimate relate environmental conditions at all spatial scales (from habitat to watershed) to a predictable species composition.

An approach for determining reference conditions that has been developed and tested within the last 10 years is based on predictive modeling and expected species occurrence in reference conditions. Based on the predictive modeling approach, a major recent advancement in freshwater bioassessment is Reference Condition Approach (RCA, Bailey et al. 2004). Similar to its predecessor, the RCA seeks to sample a very large number of sites, record environmental descriptors, select subgroups of reference sites based on those descriptors, and then places a test site nearest the reference group with the most similar environment. Then, the biological comparison among test and reference is the ratio of observed number of species/expected number of species within that environment. Determining the number of species expected to occur under a specific set of environmental descriptors essentially involves large scale, qualitative biosurveys among a large number of sites and environmental conditions (in order to determine reference condition variability). However, such observed/expected ratios should be most accurate in the instance that a species list could be predicted to occur under any definable set of environmental conditions.

Determining biota-environment relationships for establishing reference biocriteria greatly facilitates conservation studies and provides a framework for developing long-term biomonitoring for Species of Greatest Conservation Need, due to the fact that, if collected, such organisms should be associated with a specific set of environmental conditions and co-occurrence of additional taxa (the assemblage). Through our biosurveys for *H. sulphurius*, we propose a framework that will support the development of such a reference condition database. Although our sites may not be in reference condition (as pristine as possible), our goal is to link biota to specific habitats based on environmental descriptors, thus providing site standardization and repeatability of methods. Therefore, establishing relationships for our species of concern could be a prototype for developing a long-term, reference condition database for biomonitoring. A framework will be developed from our studies of *H. sulphurius* and includes (1) successful collection of the organism of concern, (2) determination of the preferred environment, (3) development of the sampling universe (e.g., vegetated banks with clean cobble substrate), and (4) biological and physical monitoring of the sampling universe over time including performance measures that assess sampling method precision.

9.0. Commitment to advance information related to the status of H. sulphurius

9.1. National Resource Monitoring Partnership online

Monitoring methodologies will be provided for uploading to the National Resource Monitoring Partnership at http://nrmp.nbii.gov.

9.2. Commitment to update Comprehensive Wildlife Conservation Strategy (CWCS)

A PI will travel to the AGFC in Little Rock to update the CWCS database at the conclusion of the project.

9.3. Commitment to update the scientific community

Results contained in the interim report and the final report will be presented at state and national meetings by the PIs and the graduate student working on the project. Results contained in the final report can be presented to the scientific community upon conclusion of the project in 2009.

9.4. Public connection

Because of the name and type locality of our species of concern, we plan to provide a description of our work to the local news media in Sulphur Springs, AR and areas in Benton and Washington counties. In so doing, we hope to spark conservation awareness associated with this predaceous water beetle named for the town and citizens of Sulphur Springs.

10.0. Deliverables

10.1. Interim report

An Interim Report will be submitted one year from the initiation of the project: July 1st, 2008. Information contained in the Interim Report will focus on performance measures that will be calculated from two or more sampling events. The most important performance measure in the interim report will be the number of *H. Sulphurius* captured in those sampling events. We consider that Per1 may indicate that insects are being collected, but Per3 will indicate if a year of sampling has resulted in successful capture of *H. sulphurius*. Additionally, if no *H. sulphurius* are found by that time, then modification (and strong re-evaluation of existing habitat types) of environmental features used to focus for sampling design stratification will have been well underway. Our goal by the time of the interim report is to have a strong idea of the typical environment for successful collection of *H. sulphurius* and the taxonomic composition of co-occurring assemblages.

10.2. Final report

Due to sampling events possibly being conducted through late spring 2009, a desired date for submitting the final report to the Arkansas Game and Fish Commission is August 1, 2009.

10.3. Field Sampling Timeline

Below is a tentative schedule of field sampling activities. Specific dates after the initiation of sampling are contingent on sampling performance and successful collection of *H. sulphurius.*

<u>2007 sampling events:</u>

13 and 14 July – Reconnaissance biosurveys - Sulphur Springs (historic sampling locations)
27 and 28 July - Reconnaissance biosurveys - Buffalo River Tributaries (historic sampling locations)

6 through 12 August – Buffalo River Tributaries (sampling historic locations and open-canopied mouths of tributaries along the Buffalo River).

24 and 25 August - Sulphur Springs (historic sampling locations)

21 and 22 September – Buffalo National River tributaries and field recon of potential temporary waters at baseflow
5 and 6 October – Sulphur Springs
19 and 20 October – Buffalo National River tributaries

9 and 10 November – Sulphur Springs
23 and 24 November – Buffalo National River tributaries

<u>2008 Sampling Events:</u>

25 and 26 January – Buffalo National River tributaries
1 and 2 February – Sulphur Springs

1 and 2 March – Buffalo National River tributaries
14 and 15 March – Sulphur Springs

We will be sampling every two weeks in the Buffalo National River tributaries from 4 April until 22 June, 2008 and from 8 August until 18 October, 2008. Those periods include the active spring season and the fall season when habitats may become less connected in our streams, resulting in confined pools. Sampling thereafter will be contingent on our performance measures and ability to locate potential habitats of *H. sulphurius*. The off week between our Buffalo National River tributary sampling events in those seasons will involve sampling in the Sulphur Springs headwater system.

<u>2009 Sampling Events:</u>

Contingent upon 2008 sampling performance.
Sampling in 2009 will at least consist of a spring sampling run (approximately 2 – 3 sampling events) at both locations.

11.0. Budget

UA Lead Investigator:	B.E. Haggard					YEAR 1		YEAR 2		CUMULATIVE	
		Type	PERSON-MONTHS			Grant	U of A	Grant	U of A	Grant	U of A
SALARIES & WAGES	Base Salary	Appoint.	CAL	AY	SMR						
PI, B.E. Haggard		12 mo.	0.82			0	8,465	0	8,719	0	17,184
Postdoctoral Associate	$40,000	12 mo.				10,500	0	10,500	0	21,000	0
Research Associate (staff)		12 mo.				0	0	0	0	0	0
Research Assistant or Tech.		12 mo.				0	0	0	0	0	0
Graduate Assistant (Ph.D.)				mo. @		0	0	0	0	0	0
Graduate Assistant (Masters)				mo. @		0	0	0	0	0	0
Hourly, non-student(s)				hrs @		0	0	0	0	0	0
Hourly, enrolled student				hrs @		0	0	0	0	0	0
Total S&W						*10,500*	8,465	*10,500*	*8,719*	21,000	17,184
FRINGE BENEFITS		Institutional Rate:									
Faculty/staff academic / calendar salary		25.30%				2,730	2,201	2,730	2,267	5,460	4,468
Faculty summer salary		16.80%				0	0	0	0	0	0
GRA(s)		2.40%				0	0	0	0	0	0
Hourly, non-student		7.00%				0	0	0	0	0	0
Hourly, enrolled student		0.10%				0	0	0	0	0	0
Total FB						*2,730*	*2,201*	*2,730*	*2,267*	5,460	4,468
Total Salaries + Benefits						**13,230**	*10,665*	**13,230**	*10,986*	26,460	21,651
TRAVEL - Domestic						2,025		2,750		4,775	0
TRAVEL - Foreign						0		0		0	0
MATERIALS & SUPPLIES						2,100		900		3,000	0
JOURNAL PUBLICATION FEES						0		0		0	0
OTHER DIRECT COSTS											
										0	0
										0	0
Subtotal Other Direct Costs						**0**		**0**		0	0
Modified Total Direct Costs (above subtotal costs subject to F&A Cost)						*17,355*	*10,665*	*16,880*	*10,986*	34,235	21,651
F & A COST (MTDC x RATE):		**42%**	**(Only 15% Grant)**			2,603	9,165	2,532	9,172	5,135	18,337
GRA TUITION (~10% increase/Yr)	# Credit Hours: 0		Rate: $0			0	0	0	0	0	0
TOTAL DIRECT COST						***19,958***	***19,831***	***19,412***	***20,158***	***39,370***	***39,988***
TOTAL PROJECT COST						**$19,958**	**$19,831**	**$19,412**	**$20,158**	**$39,370**	**$39,988**

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13.0. Figures

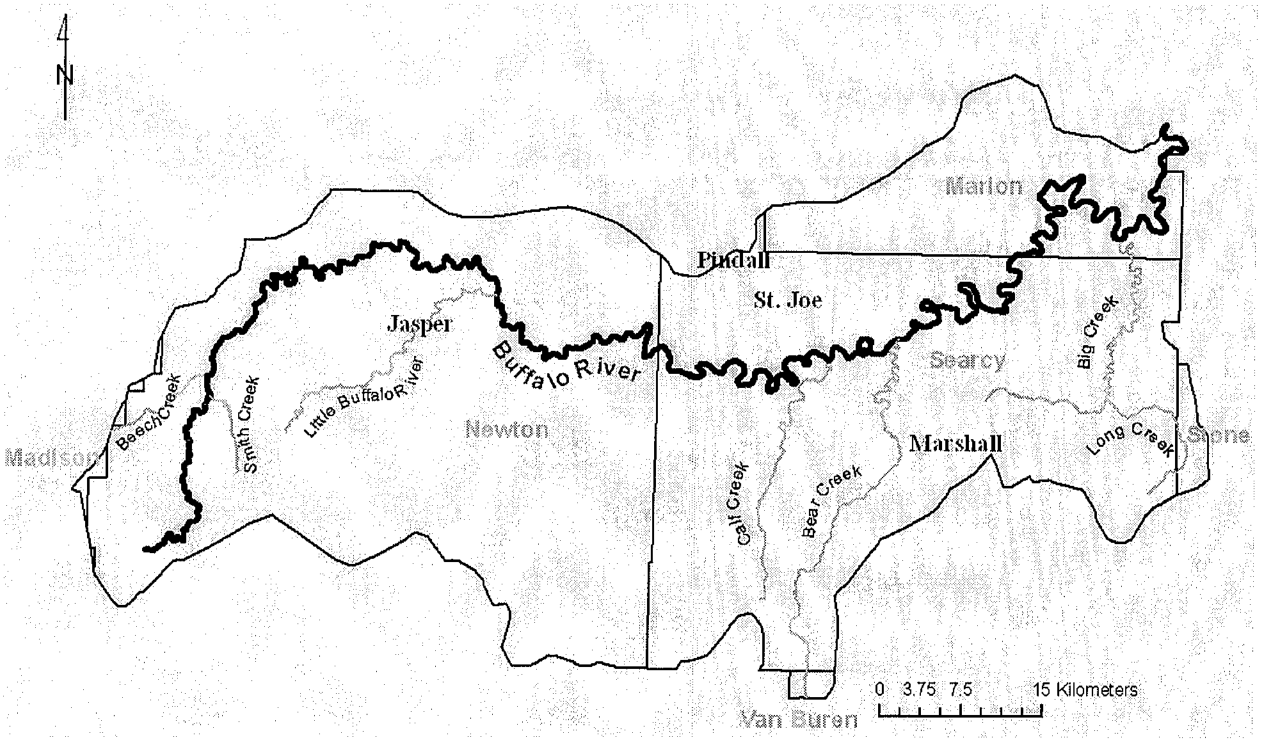

Figure 1. Buffalo National River (dark line) and tributaries where dytiscid populations were sampled in 1992 by Dr. George and Phoebe Harp. Two tributaries were found to contain one individual of *H. sulphurius* (Smith Creek and Beech Creek).

Figure 2. Type locality of *H. sulphurius*, Sulphur Springs.

Figure 3. Stream habitat on Beech Creek where *H. sulphurius* was collected in 1992 by Dr. George and Phoebe Harp.

14.0. Personnel

Scott Longing completed a Ph.D. program in the Department of Entomology at Virginia Tech in 2006. There, his research involved ecological studies of benthic invertebrates in Chattahoochee National Forest headwater mountain streams affected by sedimentation. A Masters Degree program was completed in 2002 in the Department of Entomology, University of Arkansas, where thesis research focused on darkling beetle (Coleoptera: Tenebrionidae) population abundance estimates and spatial distribution in a turkey brooder house. Currently, he is a research scientist working on the baseline bioassessment for the new Watershed Research and Education Center at the University of Arkansas Agricultural Experiment Station. Scott is currently developing and teaching a Freshwater Biomonitoring course at the University of Arkansas. Past aquatic-related work includes assisting the Arkansas Subterranean Biodiversity project with collection and taxonomic identifications of cave arthropods in Ozark karst systems. Prior to Ph.D. studies at Virginia Tech, he was the Apiary Section Head with the Arkansas State Plant Board where he supervised compliance procedures of Arkansas Apiary Laws and Regulations and supervised other regulatory activities involving several important insects in agriculture.

Dr. Haggard's primary area of research is the effect of land use on stream sediment and water chemistry; his sediment and water quality laboratory at the University of Arkansas has the ability to analyze water and sediment samples as required for nitrogen, phosphorus, carbon, chloride and many other soluble trace elements. The equipment available in this laboratory includes a Skalar San Plus Wet Chemistry Autoanalyzer for nitrogen, phosphorus, carbon and chloride, a Spectro Inductively Couple Plasma Optical Emission Spectroscopy (ICP-OES), and a Varian Bio-50 UV-Visible Spectrophotometer. This laboratory has field equipment available to measure physico-chemical parameters on site at stream monitoring stations, including pH, dissolved oxygen, conductivity and temperature.