ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

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Quality Assurance Project Plan (QAPP) for Wetland Program Development Grant No. CD-00E00963-0

Project:

Assessment of Wetland Quality on Illinois Public Lands

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A1. Title Page and QAPP Approval

Quality Assurance Project Plan

for the project:

ASSESSMENT OF WETLAND QUALITY ON ILLINOIS PUBLIC LANDS

US EPA Grant No. CD-00E00963-0
Revision 0

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A2. TABLE OF CONTENTS

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Technical Contact

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U.S. EPA Region 5
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A4. PROJECT/TASKS ORGANIZATION

Grant activities will be administered by personnel from the Illinois Natural History Survey and Lindenwood University Department of Biology. Seasonal technical staff will also be hired to aid in field work and data management activities. Illinois Department of Natural Resources seasonal interns and volunteers from IDNR and local universities and colleges may aid in data collection activities.

Sampling will be conducted by Christopher A. Phillips, John A. Crawford, Andrew R. Kuhns and seasonal staff under their supervision. Personnel listed below are the Primary Investigators for this project and truncated Curriculum vitae of the PI's are provided in Appendix I.

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A5. PROBLEM DEFINITION/ BACKGROUND

The U.S. Clean Water Act mandates protection of the physical, chemical, and biological integrity of wetlands. Despite the attention given to the "no net loss" of wetland acreage (quantity), much less political and management attention has focused on the ecological integrity (quality) of wetlands despite the fact that actual ecological success (as opposed to regulatory success) of a wetland protection program requires measurable ecological performance goals as opposed to measuring acres of wetlands restored (NAS 2001; Mack 2007). The organisms that inhabit a natural ecosystem, both individually and as communities, are indicators of the actual conditions in that system since they are subject to the physical and chemical properties of the system as well as natural and human caused variation (Ohio EPA 1988; Ohio EPA 1989). Thus, a primary response to the Clean Water Act has been the development of numerous indices of biotic integrity (IBIs) using various taxonomic groups (e.g., Micacchion 2004; Hartzell et al. 2007; Mack 2007; Shulse et al. 2009) to assess the condition of water bodies in the United States. The IBI is a frequently used approach for assessing the ecological integrity of streams (typically with fish and macroinvertebrates); however it is much less commonly applied to wetland systems, despite the scientific and policy needs to assess wetland condition and develop ecological performance goals for wetland monitoring, creation, and restoration. Further, while a few IBI's are sophisticated approaches with statewide application that have undergone multiple testing iterations, most published IBI's are the result of a single data set using a single aquatic resource with limited geographic sampling (Mack 2007).

Approximately 220 million acres of wetlands are estimated to have existed in the continental U.S. prior to 1700 (U.S. EPA 2003). Since that time, over half of the original wetlands have been drained and converted to other uses. This form of habitat loss has no doubt played a large role in the current biodiversity crisis that has received a great deal of attention over the past two decades. Extinction rates for plants and animals are estimated to be 1,000 times higher than background rates from the fossil record (Baillie et al. 2004). Of the vertebrate groups that have been completely evaluated (birds, mammals, and amphibians), the IUCN found that 12% of all bird species, 21% of all mammal species, and 30% of all amphibian species were at risk of extinction (IUCN 2009). Further, while the reptile assessment has only recently begun, it is believed that an even greater percentage of this taxon is at risk of extinction (Gibbons et al. 2000; IUCN 2009). While there are a number of factors that have contributed to these declines, it is widely accepted that the primary threat facing wildlife is habitat loss and degradation (Cushman 2006).

Amphibian and semi-aquatic reptile (i.e., turtles and snakes that are wetland dependent) assemblages make up critical ecological components of many wetland ecosystems. Amphibians play a large role in food webs as both predators of invertebrates and prey of larger vertebrates (Davic and Welsh 2004), and they often exceed the combined biomass of other terrestrial vertebrates within the system (Burton and Likens 1975; Peterman et. al 2008). Due to their unique life history cycle, amphibians can potentially supply a large proportion of the energy transfer between aquatic and terrestrial habitats (Gibbons et al. 2006). Within wetland ecosystems, many semi-aquatic reptiles are top predators and therefore a decline in their numbers can have serious consequences on ecosystem function (Reading et al. 2010). Additionally, amphibians and semi-aquatic reptiles can serve as useful bioindicators of environmental change because they are sensitive to various forms of environmental and habitat alteration (Storfer 2003; Gardner et al. 2007). Due to their importance in wetland ecosystems and their status as indicator taxa, amphibians and semi-aquatic reptiles can serve as models for understanding the roles that seasonal and semi-permanent wetlands play in ecosystem function.

Seasonal and semi-permanent wetlands are shallow, depressional wetlands that occur throughout the Midwestern and Eastern United States. Distribution and abundance of seasonal wetlands are regarded as an indicator of overall ecosystem health and are especially important to numerous species of plants and wildlife. In addition to their biological importance, these wetlands play critical roles in hydrology (surface water storage and groundwater exchange), biogeochemical cycling, and energy exchange (via amphibian production and dispersal) to adjacent terrestrial habitat. Despite their ecological significance within the landscape, seasonal and semi-permanent wetlands typically receive minimal regulatory protection at both the federal and state levels because they are often small and hydrologically isolated (Lichko and Calhoun 2003).

Animals such as amphibians, semi-aquatic reptiles, and macroinvertebrates depend on wetlands for all or part of their life cycle, which means that their survival is directly linked to the presence and ecological health of wetlands. In Illinois, 32 of the 41 amphibians and 47 of the 61 reptiles are wetland dependent species (Phillips et al. 1999; U.S. EPA 2003), in addition to the numerous macroinvertebrate taxa found across the state. While the US loses approximately 60,000 acres of wetlands each year (U.S. EPA 2004), wetland conversion and drainage in Illinois has been especially extensive where an estimated 90% of original wetland area has been lost (Suloway and Hubbell 1994); therefore assessment and protection of wetlands is a high priority within the state (IDNR 2005). Further, Action Item 3 of the Wetlands Campaign in the Illinois Wildlife Action Plan is to fill information gaps and develop conservation actions to address remaining wetlands in Illinois (IDNR 2005). Specifically, the action item calls for: 1) Updated inventory of wetland habitat in Illinois; 2) Research on the ecological aspects of high-quality wetland sites; and 3) Assessment of the status and distribution of wetland-dependent amphibians and reptiles.

A6: PROJECT/ TASK DESCRIPTION

A.6.1 Task Description

While a great deal of attention has been given to wetland acreage due to the “no net loss” policy over the past two decades, much less attention has been given to the ecological integrity of these same wetlands (Mack 2007). In order to accurately assess wetland health, it is important to examine how they function ecologically (Shulse et al. 2009). To accomplish this assessment, regulatory agencies and land managers need clear performance standards that are based on the ecology of wetland organisms.

In order to evaluate overall ecological health and function of seasonal and semi-permanent wetlands in Illinois, we will sample 240 wetlands distributed across 60 state managed lands over three field seasons (2012-2014; see attached map for preliminary site locations). During each field season, we will conduct sampling on 20 state managed properties and 4 wetlands will be sampled at each site (n = 80 wetlands per season). At each wetland surveys will be conducted during four time periods over a five month span (February-June) to increase the probability of species detection. Additionally, due to fluctuations in population sizes, variability in breeding phenologies, and suspected detection rates between taxonomic groups (i.e. rare species have lower detection rates than common species), wetlands will be sampled for three nights per period (n =12 total samples in a season). By repeatedly sampling wetlands during the field season, we can estimate occupancy and detection rates using program PRESENCE 3.1. Each state managed property (and associated wetlands) will be sampled during only one field season to increase the number of overall sites sampled during the study and all wetlands will be located on Illinois Department of Natural Resources (IDNR) managed properties to ensure accessibility. Wetland health and function will be assessed by examining three critical components of wetlands ecosystems: 1) Amphibian diversity and abundance; 2) Reptile diversity and abundance; and 3) Macroinvertebrate diversity and abundance. Each of these primary components will

be incorporated into an index of biological integrity (IBI) to determine how well the wetland is functioning within the ecosystem.

A.6.2 Products

A.6.2.1. Outputs

Completion of this proposed project will result in the following outputs: 1) Development of a rapid assessment methodology to assess wetland condition; 2) Establishment of reference (baseline) wetland conditions for each part of the state of Illinois; 3) Collect data at seasonal and semi-permanent wetlands for analysis of wetland health/function; 4) Analyze data to identify high-quality wetland sites; 5) Analyze data to identify areas of the state where wetlands are deficient in ecological function; 6) Report on the overall health of wetland on public lands in Illinois and provide recommendations to IDNR for areas in need of protection and restoration; and 7) Contribute information to the management plans of imperiled wetland-dependent species.

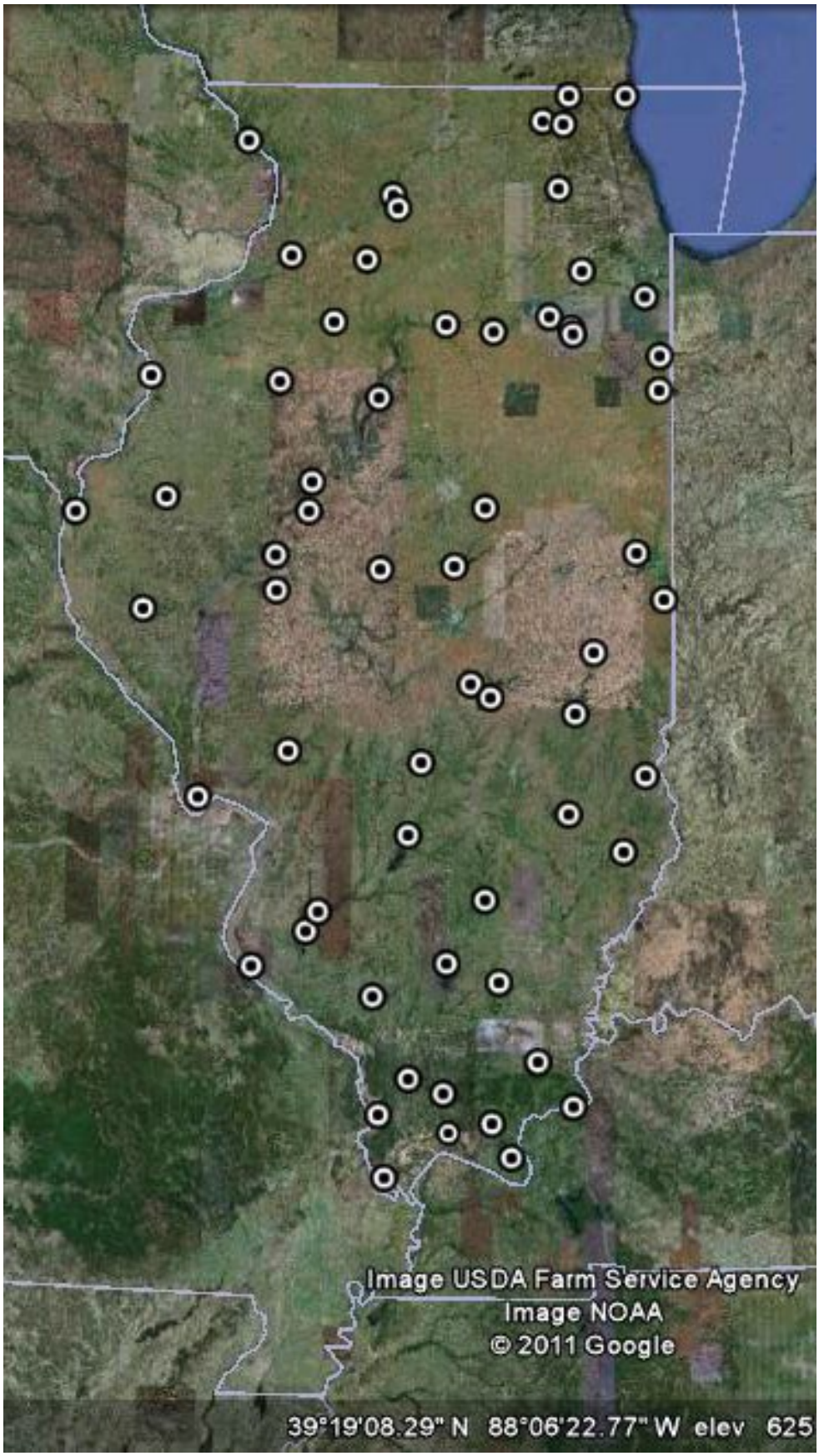
A.6.2.2. Outcomes

Completion of this proposed project will result in the following outcomes: 1) Increased understanding of wetland conditions across the state of Illinois; 2) Increased understanding of the status and distribution of threatened and endangered amphibians, reptiles, and macroinvertebrates in Illinois; 3) Increased understanding of the location of high-quality wetland sites in Illinois; and 4) Improved methodologies for evaluating seasonal and semi-permanent wetland condition.

A6.3. Project implementation schedule

Milestones			**Year 1**			**Year 2**			**Year 3**			**Deliverables**
Project Tasks	***Start***	***Finish***	***Feb***	***Apr***	***June***	***Feb***	***Apr***	***June***	***Feb***	***Apr***	***June***	
Site visits to select study ponds	1/1/2012	2/15/2014										None
Amphibian sampling (4 times per year)	2/15/2012	7/1/2014										None
Reptile sampling (4 times per year)	2/15/2012	7/1/2014										None
Macroinvert sampling (4 times per year)	2/15/2012	7/1/2014										None
Analysis of amphibian data (yearly)	8/1/2012	10/1/14										Manuscript
Analysis of reptile data (yearly)	8/1/2012	10/1/14										Manuscript
Analysis of macroinvert data (yearly)	8/1/2012	10/1/14										Manuscript
IBI development and analysis (yearly)	8/1/2012	10/1/14										Manuscript
Presentation of results at conferences	6/1/13	12/31/14										Presentations
Preparation of final report	10/1/14	12/31/14										Final Report
Dissemination of final report to agencies		12/31/14										Final Report

A.6.4 Potential project site locations.



A7. QUALITY OBJECTIVES AND CRITERIA

A7.1 Statement of the Problem

The primary purpose of our study is to develop and implement an assessment methodology that can be completed in one field season that evaluates the ecological health and function of seasonal semi-permanent wetlands on public managed state properties thoroughout Illinois.

A7.2 Identify the Decisions to be Made

There are no regulatory decisions to be made by this study. The goals of this study are to generate a rapid assessment method for evaluating wetland health, and identify high quality wetlands and areas where restoration might be beneficial.

A7.3 Identify Data Requirements Needed to Answer the Study Problem

This will be a new dataset that will be generated by repeated sampling of ponds within years as described in section B of this document. IBI's will be based on an occupancy-detectability sampling system. The purpose of using an occupancy-detectability sampling regime is to account for imperfect detection (ie. including the probability that a given species does occupy the site even though sampling fails to detect it). This will be a new dataset that will be generated by sampling four wetlands at 20 properties per year. Each focal group (amphibians, reptiles, and macroinvertebrates) will be sampled by two methods. Amphibians will be sampled by minnow trap and drift fence, reptiles will be sampled by hoop trap and drift fence, and macroinvertebrates will be sampled by minnow trap and dip net. Each of the 80 wetlands will be sampled over four sampling periods per year. Each of these sampling periods will occur over four days, resulting in three samples, one from each night of sampling. This will result in a twelve digit binary capture history of 1's (detected) and 0's (not detected) for each species at each wetland. This will be repeated in the subsequent two years so that 240 wetlands from 60 sites across Illinois will be sampled 12 times each.

A7.4 Specific Boundaries of Study Area and Time

Spatial boundaries of the project occur within the state of Illinois with potential sites shown in A6.4. Temporal boundaries are anticipated to occur from 2012 through October of 2014.

A7.5 Specify How Data will be Summarized and Used to Answer the Study Problems

To determine the health and function of seasonal and semi-permanent wetlands, an integrated index of biological integrity (IBI) will be developed and used for assessment of all wetlands sampled. While the use of IBI's is becoming more common in wetland systems, key indicators are typically focused on only one component of the wetland ecosystem. For our proposed study, we will develop an IBI that incorporates information from three major biotic components (amphibians, reptiles, and macroinvertebrates) of seasonal and semi-permanent wetlands. Development of individual IBIs for amphibians, reptiles, and macroinvertebrates will use prior templates (e.g., Micacchion 2004; Hartzell et al. 2007; Shulse et al. 2009) and scientific literature. For a given wetland, we will report both individual IBI's for amphibians, reptiles, and macroinvertebrates and an overall IBI = (Amphibian IBI + Reptile IBI + Macroinvertebrate IBI)/3. This will allow us to draw conclusions about any "camouflaging" effects and determine if independent indicators score wetland quality differently than our integrated IBI.

In addition to the biotic data that is collected at each wetland, we will also record data on the following environmental metrics: site coordinates, wetland size, wetland slope, fish presence/absence, and canopy cover. Water at each wetland will be sampled for water temperature (± 0.15 ºC), dissolved oxygen (± 2% of reading), hydrogen ion concentration (as pH; ± 0.2 units), and specific conductivity (± 0.5% of reading) with a handheld YSI 556MPS water meter. This data will be used to develop habitat models by employing regression analyses using an information-theoretic approach (AIC).

Lastly, overall IBI's will be calculated for each wetland that is sampled during this study. Following the protocol of Shulse et al. (2009), each amphibian and reptile species as well as each macroinvertebrate family/order will be assigned a numerical conservation coefficient. To obtain these coefficients, the three project PI's (C.A. Phillips, J.A. Crawford, and A.R. Kuhns) will independently assess the ecology of each species or taxa and assign a score between 1 and 10 for three ecological criteria – sensitivity to disturbance, rarity of the species within Illinois, and range of the species within Illinois. The three scores for each category will then be averaged to obtain the conservation coefficient (CC). The three CC's developed for each species or taxa from each PI are then averaged. Higher scores indicate higher conservation priority. An individual wetland will then be given an overall score by summing the total value of CC's from each species or taxa encountered during field sampling. These generated IBI's will serve as our dependent variable and differences in wetland performance will be assessed using the environmental covariates that will be collected (described above).

A7.6 Error Rates and Consequences of Answering the Study Problems Incorrectly

An integrated IBI can only be produced from data collected in a statistically defensible manner, which serves to reduce error rates and, subsequently, answering a study problem incorrectly. Specifically, any basic ecological study must replicate, randomize, and use statistical analyses to investigate a question/problem to address issues of sampling and experimental error (Cain et al. 2011). The need for replication – as the number of replicates increases, it becomes less likely that the results are due to a variable that was not measured or controlled for in the study. The need for randomization – randomization limits the effects of unmeasured variables by assigning treatments in a random fashion. The need for statistical analyses – statistical analyses (and models that are generated) are used to determine whether a result is "significant" or not. Additionally, a degree a confidence in the result can be inferred from the analyses (and error rates can be estimated). IDNR manages and maintains 324 properties to choose from (IDNR 2011), which will allow us to randomize our site selections, while repeatedly sampling ponds (12x). Further to reduce experimental error (error which is introduced through the fault of the researcher), data that is collected, will be checked for abnormal outliers before data analysis proceeds. No scientific study can ever totally eliminate bias. However, bias can be minimized through proper experimental design and statistical analyses. Considering that this is a landscape level project, we have both randomized and replicated extensively to address issues of bias. While uncertainty could bias others using this study's results, following the scientific method is meant to minimize this possibility. Accurately documenting materials, methods, and results in deliverables will allow potential end users to assess its merits independently and, if deemed necessary, conduct pilot surveys to ensure the IBI's applicability to their given situation..

A8. SPECIAL TRAINING/CERTIFICATION

Seasonal technicians will be trained in amphibian and reptile identification, and how to properly calibrate and use the YSI556 multi-meter prior to working in the absence of the primary researchers (CAP, JAC, ARK). Additionally, all researchers and technicians that conduct amphibian and reptile sampling will be required to complete Institutional Animal Care and Use Committee (IACUC) training modules including Basic Training Program for Animal Users and Occupational Health and Safety

(OHS) Training, complete a Health Screening Questionnaire, read and abide by the University of Illinois IACUC Protocol # 11203 which was prepared and approved for this project. The training modules and questionnaire are available at
http://iacuc.research.illinois.edu/content/TrainingWelcome.aspx

A9. DOCUMENTS AND RECORDS

All data sheets, field notes, database files, spreadsheets, and analyses will be held for at least the duration of the grant. Electronic files will be stored indefinitely on the external SAN server maintained by INHS. Amphibian and reptile specimens will be vouchered into the INHS Amphibians and Reptiles Collection. Macroinvertebrate samples will be stored in 70% Ethanol for the duration of the project and subsamples may be accessioned into the INHS insect collection.

Copies of the QA Project Plan will be saved in PDF form on each data collection device, so that technicians will have access to the most recent revision. Only the latest copy will be available on the field data entry devices to avoid confusion. Revision number and date will be noted in the header of each page of the QAPP to further ensure the latest iteration is being followed.

Reports will be produced annually and submitted in the form of INHS Technical Reports which will remain on file at the Prairie Research Institute Library (part of the University of Illinois Library System). Electronic forms of these reports will be indexed in the IDEALS (Illinois Digital Environment for Access to Learning and Scholarship) Institutional Repository and also be distributed to EPA personnel identified in A3 of this document. In addition, we anticipate publication in peer-refereed journals from data collected for this project.

B. DATA GENERATION AND ACQUISITION

B1. SAMPLING PROCESS DESIGN (EXPERIMENTAL DESIGN)

In order to evaluate overall ecological health and function of seasonal and semi-permanent wetlands in Illinois, we will sample 240 wetlands distributed across 60 state managed lands over three field seasons (2012-2014; see attached map for preliminary site locations). During each field season, we will conduct sampling on 20 state managed properties and 4 wetlands will be sampled at each site (n = 80 wetlands per season). At each wetland surveys will be conducted during four time periods over a five month span (February-June) to increase the probability of species detection. Additionally, due to fluctuations in population sizes, variability in breeding phenologies, and suspected detection rates between taxonomic groups (i.e. rare species have lower detection rates than common species), wetlands will be sampled for three nights per period (n =12 total samples in a season). By repeatedly sampling wetlands during the field season, we can estimate occupancy and detection rates using program PRESENCE 3.1. Each state managed property (and associated wetlands) will be sampled during only one field season to increase the number of overall sites sampled during the study and all wetlands will be located on Illinois Department of Natural Resources (IDNR) managed properties to ensure accessibility. Wetland health and function will be assessed by examining three critical components of wetlands ecosystems: 1) Amphibian diversity and abundance; 2) Reptile diversity and abundance; and 3) Macroinvertebrate diversity and abundance. Each of these primary components will be incorporated into an index of biological integrity (IBI) to determine how well the wetland is functioning within the ecosystem. At each wetland we will record: site coordinates, wetland size, maximum wetland depth, fish presence/absence, and canopy cover.

There are several foreseeable reasons why sampling might not be possible due to the protocols established in this design. First, sites may be temporarily inaccessible due to acts of nature, such as flooding. In this case, sampling of those sites will be tabled until conditions improve to allow access, it the mean time we will move other sites up in the rotation and sample them a week earlier. Second, some wetlands may not fill or hold water long enough to complete all samples in a year. This will not affect drift- fence sampling, but it would preclude aquatic trapping and dip net sweeps. However, this will remain as useful data as absence of larval amphibians and macroinvertebrates in these ponds will still aid in determining conservation coefficients for the overall project. We would be unable to sample water quality at that time, so we would resume sampling of water once ponds re-filled later in the year. Finally, some wetlands might be destroyed by dam blow-out or cutting into a tile making ponds lost for the remainder of the study. Because most of the state managed properties we are examining in this study have multiple ponds, so we could select a substitute pond in subsequent sampling while maintaining overall sample sizes.

B2. SAMPLING METHODS

B2.1 Amphibian Sampling

We will sample for adult and larval amphibians using two techniques: minnow traps and terrestrial drift fences. We will use Promar TR-501 collapsible traps that are 18" X 10" with dual 2.5" funnel throat openings. Number of traps deployed will be scaled to the size of the wetland (1 trap per 25 m^2; minimum of 4 traps and maximum of 15 traps per wetland). Two partial terrestrial drift fences will be installed on opposite sides of the wetland and located approximately 25 m from the wetland's edge. Each fence will be constructed as a Y-array (Jones 1981) with each arm approximately 10 m in length. A 5-gallon bucket will be placed in the center of the array as a pitfall trap and vinyl-coated minnow traps will be placed at the end of each arm on both sides of the fence (Corn 1994). All amphibians will be identified to species, assigned an age-class (adult, juvenile, larva, etc.) and non-larval individuals will receive a single mark (toe-clip or tail-clip depending on size and species). This mark will ensure no single individual is counted again in a subsequent survey and allow for estimates of relative abundance. We will record number of unique individuals (and recaptures) per species captured in each sampling event. Results will be used to calculate diversity and abundance values for the amphibian assemblage at each wetland.

B2.2 Reptile Sampling

We will sample for adult aquatic and semi-aquatic reptiles using two techniques: baited hoop traps and terrestrial drift fences. Hoop trap size (1m D x 1.5m L; 0.5m D x 1m L; or 0.3m D x 0.5m L) will be scaled to the depth of the wetland so that throats remain below the water surface, while at least 5 cm of the trap remains above the surface to ensure individuals have access to air. Number of hoop traps deployed will be scaled to the size of the wetland (1 trap per 25 m^2; minimum of 4 traps and maximum of 15 traps per wetland). Two terrestrial drift fences will be installed on opposite sides of the wetland and located approximately 25 m from the wetland's edge. Each fence will be constructed as a Y-array with each arm approximately 10 m in length. A 5-gallon bucket will be placed in the center of the array as a pitfall trap and vinyl-coated minnow traps will be placed at the end of each arm on both sides of the fence (Corn 1994). All reptiles will be identified to species, assigned an age-class (adult, juvenile, etc.) and will receive a single mark (ventral scale clip for snakes, shell notch for turtles). This mark will ensure no single individual is counted again in a subsequent survey and allow for estimates of relative abundance. We will record number of unique individuals (and recaptures) per species captured in each sampling event. Results will be used to calculate diversity and abundance values for the reptile assemblage at each wetland.

B2.3 Macroinvertebrate Sampling

We will sample for aquatic macroinvertebrates using two techniques: minnow traps (Promar 501) and dipnet sweeps. Number of minnow traps deployed will be scaled to the size of the wetland (1 trap per 25 m^2; minimum of 4 traps and maximum of 15 traps per wetland). A 250 µm mesh D-frame dipnet will be used to conduct dipnet sampling and number of sweeps will be scaled to the size of the wetland (1 sweep per 25 m^2; minimum of 4 sweeps and maximum of 40 sweeps per wetland). All samples will be preserved with 70% ethanol in 1 L polyethylene jars. Storage and identification procedures for macroinvertebrates will follow those described by Moulton et al. (2000).

B2.4 Water Quality Sampling

Field parameters will be measured with a handheld YSI 556MPS immediately prior to each scheduled survey (4 X year). Values from field water quality parameters include water and ambient temperatures (± 0.15 ^{0}C), dissolved oxygen (±2% of reading), saturation of dissolved oxygen (±2%of reading), hydrogen ion concentration (as *p*H; ±0.2 units), specific conductivity (±0.5% of reading), salinity (± 1% of reading), and total dissolved solids.

B3. SAMPLE HANDLING AND CUSTODY

The majority of amphibians and reptiles will be released back at the site of capture after identification and marking. Occasionally, amphibian and reptile specimens may be collected from the field. In these instances, they will be euthanized with buffered MS-222, fixed in 10% formalin, and accessioned into the Illinois Natural History Survey Amphibian and Reptile collection. Macroinvertebrates will be preserved in 70% ETOH and labeled by pond/date and a unique sample number associated with that pond and date. This number will also be recorded in the database entry taken for that pond sample.

B4. ANALYTICAL METHODS

To determine the health and function of seasonal and semi-permanent wetlands, an integrated index of biological integrity (IBI) will be developed and used for assessment of all wetlands sampled. While the use of IBI's is becoming more common in wetland systems, key indicators are typically focused on only one component of the wetland ecosystem. For our proposed study, we will develop an IBI that incorporates information from three major biotic components (amphibians, reptiles, and macroinvertebrates) of seasonal and semi-permanent wetlands. Development of individual IBIs for amphibians, reptiles, and macroinvertebrates will use prior templates (e.g., Micacchion 2004; Hartzell et al. 2007; Shulse et al. 2009) and scientific literature. For a given wetland, the overall IBI = (Amphibian IBI + Reptile IBI + Macroinvertebrate IBI)/3.

In addition to the biotic data that is collected at each wetland we will also record data on the following environmental metrics: site coordinates, wetland size, wetland slope, fish presence/absence, and canopy cover. Water at each wetland will be sampled for water temperature (± 0.15 ºC), dissolved oxygen (± 2% of reading), hydrogen ion concentration (as pH; ± 0.2 units), and specific conductivity (± 0.5% of reading) with a handheld YSI 556MPS water meter. This data will be used to develop habitat models by employing regression analyses using an information-theoretic approach (AIC).

Lastly, overall IBI's will be calculated for each wetland that is sampled during this study. Following the protocol of Shulse et al. (2009), each amphibian and reptile species as well as each macroinvertebrate family/order will be assigned a numerical conservation coefficient. To obtain these coefficients, the three project PI's (C.A. Phillips, J.A. Crawford, and A.R. Kuhns) will independently assess the ecology of each species or taxa and assign a score between 1 and 10 for three ecological criteria – sensitivity to disturbance, rarity of the species within Illinois, and range of the species within Illinois.

The three scores for each category will then be averaged to obtain the conservation coefficient (CC). The three CC's developed for each species or taxa from each PI are then averaged. Higher scores indicate higher conservation priority. An individual wetland will then be given an overall score by summing the total value of CC's from each species or taxa encountered during field sampling. These generated IBI's will serve as our dependent variable and differences in wetland performance will be assessed using the environmental covariates that will be collected (described above).

B5. QUALITY CONTROL

Quality control of amphibian, reptile and macroinvertebrate sampling will be primarily ensured by providing clear easily replicable sampling procedures and providing clear easy to use data forms that allow users to record the data accurately and completely. Sampling for all three organism types can be highly variable due to season, climatic conditions, and micro-habitat types. To combat this we will conduct repeated samples over multiple wetlands within each site. Further, detectability rates will be calculated for amphibian and reptiles species to allow us to estimate the likelihood of presence despite non-detection.

B6. INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

The manufacturer's equipment manual will be followed for field equipment maintenance for the YSI 556 multimeter and probe.

B7. INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Calibration procedures for the YSI 556 probe will follow the guidelines provided by the operator's manual. Since data collected from the field will likely occur over one or two days per week, we will calibrate the equipment within 24 hours of data collection.

B8. INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Calibration standards for the YSI 556 probes will be inspected to ensure that they have not expired and the date of opening will be recorded on the vessel. Unused calibration standards will be discarded upon expiration date.

B9. NON-DIRECT MEASURES

The only non-direct measures that will be utilized for this project are climatic variables. All climate data will be obtained from the National Climatic Data Center (http://www.ncdc.noaa.gov/oa/ncdc.html). The NCDC implements numerous quality control measures to verify the data. Information on data verification and error rates can be obtained at (http://www.ncdc.noaa.gov/oa/climate/ghcn-daily/index.php?name=quality).

B10. DATA MANAGEMENT

Data from amphibian and reptile sampling will be recorded directly into iPads using Filemaker Go software. At the completion of each field sampling the database will be cloned and copied to a laptop computer and emailed to A.R. Kuhns. The database will reside on the INHS SAN which is backed up every 24 hours. Additional copies will be stored on the personal computer of A.R. Kuhns and backed up to an external hard drive every 24 hours. Macroinvertebrate data will be entered directly into a database upon identification and stored on the INHS SAN server. Water quality data collected in the field will be stored on the YSI 556 and be backed up to a laptop and the SAN server upon weekly completion of data collection.

C. ASSESSMENT AND OVERSIGHT

C1. Assessments and Response Actions

Because this project will be conducted with only a small team, assessments such as surveillance, management systems review, readiness review, technical systems audits, audits of data quality are not necessary. Databases will be proofed at the completion of the field season prior to any analyses.

C2. Reports to Management

Reports will be submitted annually to the EPA detailing progress made and preliminary results obtained over the past year. Annual Reports will be submitted by 31 December of each calendar year for the project's duration.

D. DATA VALIDATION AND USABLILITY

D1. Data Review, Validation, and Verification

Internal data review, verification, and validation will be performed using self-assessment and review by the research team.

D2. Validation and Verification Methods

Data will initially be validated by the researchers in field during data entry. Subsequent validation and verification will occur by sorting and searching databases for outliers and aberrant values. If there is no reason to exclude or qualify the data it will be accepted. Any detected errors will be corrected by editing databases, or excluded. Since each site will be visited three times per sampling period (four sampling periods total; n=12), there will be multiple opportunities for verification of species occurrence. Additionally, secondary validation and verification of biological samples is conducted by Illinois Natural History Survey taxonomic specialists for any specimens accessioned into the collections.

D3. RECONCILIATION WITH USER REQUIREMENTS

Collected data will be continuously reviewed for accuracy, precision and completeness. Questionable data will be examined by the research team and excluded from analysis if it does not meet QA/QC requirements. An outlier is defined as an observation point that is numerically distant from the rest of the data. Outliers can occur by chance in any distribution, but they are often the result of some type of experimental error (measurement, data entry, etc.). Unfortunately there is no standard definition of what constitutes an outlier, so determining whether a data point is an outlier is a somewhat subjective exercise. However, there are four statistical tests that can be used to identify potential outliers: 1) Rosner Test; 2) Dixon Test; 3) Grubbs' Test; and 4) the Boxplot Rule. In this study, we will identify potential outliers using Grubbs' Test, which is recommended by the EPA as a statistical test for outliers (US EPA, 1992). The EPA suggests taking the logarithms of environmental data, which are often log-normally distributed. The data are ranked in ascending order and the mean and standard deviation are calculated. The lowest and highest data points can then be tested as outliers. A tau statistic is calculated for both the smallest and largest values and compared with a critical tau value for the sample size and selected alpha ($\alpha = 0.05$). If the tau statistic is greater than the tau critical, the null hypothesis is rejected and the conclusion is that the data point under consideration is an outlier (Taylor, 1987). Further, if a data point is statistically determined to be an outlier, the EPA suggests an

explanation for this outlier should be found before it can be excluded from further analyses (US EPA, 1992). If we cannot find a valid explanation for the presence of an outlier it will be treated as a valid measurement and included in all analyses (US EPA, 1992).Because, repeat visits to sites will occur within years, resampling will be possible.

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APPENDIX I. Truncated Curricula Vitae of the Principal Investigators.

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PROFESSIONAL EXPERIENCE
2008–present Ecologist, University of Illinois, Prairie Research Institute, Illinois Natural History Survey
2005–2008 Assistant Technical Scientist, Illinois Department of Natural Resources, Illinois Natural History Survey.

PUBLICATIONS
McAllister, C.T., C.R. Bursey, J.A. Crawford, **A.R. Kuhns**, C. Shaffer, and S.E. Trauth. 2010. Metacercariae of *Clinostomum* (Trematoda: Digenea) from three species of *Ambystoma* (Caudata: Ambystomatidae) from Arkansas and Illinois, U.S.A. Comparative Parasitology 77:25–30.

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GRANTS AND FELLOWSHIPS

Awarded:

2011 U.S. Environmental Protection Agency (Region 5 Wetlands Protection Development Grant). Assessment of ecological function of created wetlands. PI's: **A.R. Kuhns**, J.A. Crawford, and P. Mettler-Cherry. **$317,205.00**

2009 Illinois Department of Natural Resources, Illinois Endangered Species Protection Fund. Conservation genetics of Jefferson Salamanders in Illinois: Implications for conservation and recovery. P.I.'s: **A.R. Kuhns** & J.Crawford. **$5,995.**

2008 Illinois Wildlife Preservation Fund. Distribution, abundance, and habitat use of Jefferson Salamander; a threatened species with a restricted range in Illinois. P.I.'s: **A.R. Kuhns** & J.Crawford. **$7,354**.

2007 Illinois Wildlife Preservation Fund. Identifying the distribution and habitat of Jefferson's Salamander, *Ambystoma jeffersonianum*, in Illinois. P.I.'s: **A.R. Kuhns** & J.Crawford. **$1,982**.

2007 Lake County Forest Preserve District. Status of Blanding's Turtles in Lake County Forest Preserve District and feasibility of initiating a head-starting program: Years 4-6. P.I.'s **A.R. Kuhns** & C.A. Phillips. **$90,000**

2006 Lake County Forest Preserve District. Status of Blanding's Turtles in Lake County Forest Preserve District and feasibility of initiating a head-starting program: Year 3. P.I.'s **A.R. Kuhns**, C.A. Phillips and C.D. Benda. **$48,822**

2005 Chicago Wilderness. Ecology of the threatened Blanding's Turtle, *Emydoidea blandingii*, in the Chicago Wilderness Area. PI's **A.R. Kuhns**, C.A. Phillips & M.J. Dreslik. **$14,982**

2003 Illinois Wildlife Preservation Fund. Status of the state listed Illinois Chorus Frog, *Pseudacris streckeri illinoensis*, in Mason and Cass counties, IL. P.I.'s J.Crawford & **A.R. Kuhns. $1,000.**

2002 Illinois Wildlife Preservation Fund. Survey for amphibians and reptiles inhabiting Pulaski Co., IL. P.I.: **A.R. Kuhns. $997**.

2001 Illinois State University: Phi Sigma Honors Society Research Grant. Breeding behavior of Fowler's Toad, *Bufo fowleri.* P.I.: **A.R. Kuhns.** . **$760.**

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Illinois State University M.S., Biological Sciences, December 2000
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2009–present Assistant Professor of Biology, Lindenwood University, Department of Biology.
2009–present Affiliate Research Scientist, University of Illinois, Illinois Natural History Survey.
2007–2009 Postdoctoral Research Associate, Indiana University, School of Medicine – TH. Dual appointment with position below.
2007–2009 Postdoctoral Research Fellow, Lakehead University, Faculty of Forestry and the Forest Environment. Dual appointment with position above.
2008 Visiting Instructor, University of Iowa, Lakeside Field Station.

PUBLICATIONS
McAllister, C.T., C.R. Bursey, **J.A. Crawford**, A.R. Kuhns, C. Shaffer, and S.E. Trauth. 2010. Metacercariae of *Clinostomum* (Trematoda: Digenea) from three species of *Ambystoma* (Caudata: Ambystomatidae) from Arkansas and Illinois, U.S.A. Comparative Parasitology 77:25–30.

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1993-present: Adjunct Associate Professor--Department of Animal Biology, Department of Animal Sciences, Department of Natural Resources and Environmental Sciences, University of Illinois, Urbana-Champaign
2003-2007: Assistant Professional Scientist-- Illinois Natural History Survey, Champaign, Illinois.
2001 2002: Research Scientist--Illinois Natural History Survey, Champaign, Illinois.
1997-2001: Associate Research Scientist--Illinois Natural History Survey, Champaign, Illinois.
1993-1997: Assistant Research Scientist--Illinois Natural History Survey, Champaign, Illinois.
1992-1993: Lecturer and Research Associate--Department of Biology, Washington University, St. Louis, Missouri.
1989-1991: Postdoctoral Research Associate--Department of Ecology, Ethology and Evolution, University of Illinois, Urbana-Champaign.

SELECTED PUBLICATIONS (Last 5 Years)
Cosentino, B. J., R. L. Schooley, and **C. A. Phillips**. 2010. Connectivity of agroecosystems: dispersal costs can vary among crops. Landscape Ecology 26(3): 371-9.
Cosentino, B., R. Schooley, and **C.A. Phillips**. 2010. Wetland hydrology, area, and isolation influence occupancy and spatial turnover of the painted turtle, *Chrysemys picta*. Landscape Ecology 25:1589-1600.
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Shepard, D.B., A.R. Kuhns, M.J. Dreslik, and **C.A. Phillips**. 2008. Roads as barriers to animal movement in fragmented landscapes. Animal Conservation 11: (2008) 288–296.
J. Jakubanis, M.J. Dreslik, and **C.A. Phillips**. 2008. Nest Ecology of the Southern Two-lined Salamander in Illinois. Northeastern Naturalist 15 (1):131-140.
Readel, A.M., **C.A. Phillips**, and M.J. Wetzel. 2008. Leech parasitism in a turtle assemblage: effects of host and environmental characteristics. Copeia 2008 (1): 227-233.
Hedtke, S.M., K.R. Zamudio, **C.A. Phillips**, J. Losos, and P. Brylski. 2007. Conservation genetics of the endangered Coachella Valley Fringe-Toed Lizard (*Uma inornata)* Herpetologica 63(4): 411-420.

GRANTS AND FELLOWSHIPS (Last 5 Years)
2010-15 Biological Surveys and Monitoring Associated with Illinois Toll Highway Construction Activities. Illinois Toll Highway Authority. $1,110,000.

2009-2011 Modeling Occupancy Rates, Detection Probability and Niche for *Batrachochytrium dendrobatidis* in the Midwest. US Army Construction and Engineering Research Lab. $170,000. With J. Crawford, W. Peterman, and Mike Lannoo.

2008-2009 Statewide biological survey and assessment program. Illinois Department of Transportation, Springfield. $1,600,000. With J. Taft and J. Hofmann.

2007-2008 Ecology of the Eastern Massasauga Rattlesnake in Piatt County. Illinois Department of Natural Resources. $23,250.

2007-2008 Wetland Occupancy and Connectivity Patters of Blanding's and Western Painted Turtles in the Green River Valley. Illinois Department of Natural Resources, Wildlife Preservation Fund. $5,000.

2007-2010: Strategies for recovery of an amphibian and a reptile inhabiting sand areas in Mason and Tazewell Counties. Illinois Department of Natural Resources. State Wildlife Grant Program. $136,000.

2007: Response to habitat management by the eastern massasauga rattlesnake at Carlyle Lake Illinois. Illinois Department of Natural Resources, U.S. Fish & Wildlife Service- Section 6 Funds. $34,673. With M. Dreslik & S. Baker.

2005-2009 Biological Surveys and Monitoring Associated with Illinois Toll Highway Construction Activities. Illinois Toll Highway Authority. $2,500,00.

2004-2009 Status of Blanding's turtles in Lake County Forest Preserve District and feasibility of initiating a head-starting program at Rollins Savanna; Lake County Forest Preserve District. $212,568. With A. Kuhns.