

# **BIODIVERSITY IN SELECTED NATURAL COMMUNITIES RELATED TO GLOBAL CLIMATE CHANGE**

A proposal submitted to:

## **Wisconsin Focus on Energy Research Grants: Environmental Research Program**

To address:

II. Carbon sequestration/greenhouse gas emissions  
A. Biotic model for global warming in Wisconsin

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**Note:** In the previous proposal our primary focus was on coniferous wetlands (black spruce swamp, tamarack poor and rich swamp, and white cedar swamp) and poor fen communities. After further discussion regarding the project design, it was determined that the "peatland complex" (a more inclusive level) would be more appropriate given the objectives of the climate change study. Segregated research on one or two components of a system would not provide the degree of insight we believe is necessary to address this study. A number of the Natural Heritage Inventory program's "Natural Communities" fall within the definitions of a peatland, and these are described in greater detail in Sections B and C.

### **A. Abstract:**

Environmental changes associated with global warming are likely to cause significant ecological changes and could cause major shifts in natural communities. Plants and animals are expected to respond through changes in range, abundance, phenology, productivity, physiology, community composition, biotic interactions, activity patterns, behavior or dispersal. At present, it is unclear how such changes might impact Wisconsin's biodiversity, but impacts could be highly significant. One way to assess impacts is to conduct baseline inventories in areas that are most likely to change as a result of global warming, and then to monitor those same areas over time to see if changes are occurring. The proposed study will focus on peatland complexes. Peatland complexes occur primarily in northern Wisconsin, becoming progressively rarer to the south. NHI Natural Communities that are considered peatlands include black spruce swamps, bog relicts, boreal rich fens, muskegs, open bogs, poor fens (including central poor fens), tamarack poor swamps, tamarack rich swamps, northern wet-mesic forests (white cedar swamps), southern sedge meadows, and northern sedge meadows. The composition of these communities includes many specialized plants and animals that are not typically found in other habitats, including many rare species. As these habitats contain so many species south of their normal range limits, some type of response to a warming climate might be expected. Biologists from the Natural Heritage Inventory (NHI) program and the Ecological Inventory and Monitoring (EIM) program of the WDNR will survey multiple taxa groups and collect associated ancillary abiotic data in Wisconsin's peatlands.

The primary goals of this project are 1) to provide baseline data on the presence/absence, abundance, and distribution of multiple taxa groups associated with peatland communities in Wisconsin, and 2) to document biotic (e.g. structure and composition of habitat) and abiotic (e.g. hydrology, weather, and peatland size) variables that could potentially influence the organisms being studied. Taxa to be surveyed include bryophytes, rare vascular plants, lichens, rare terrestrial invertebrates, rare aquatic invertebrates, small mammals, birds, rare reptiles and amphibians. In order to model the effects of climate change on these taxa groups, surveys will be conducted at two levels: intensive and extensive. By conducting surveys at two levels of intensity we will obtain 1) fine scale temporal resolution, important in identifying frequencies of biological changes and establishing relationships between those changes and associated physiological events, 2) broad scale spatial resolution, important in establishing whether changes are occurring throughout a species' range or are simply due to smaller scale local perturbations, and 3) wide taxonomic resolution, important in ruling out alternate hypotheses. Changes across several taxonomic groups or life history strategies are more likely to be general biological responses to climatic changes. Surveys from this study will directly support NHI, whose data are an integral part of both master planning for WDNR and other agencies and the environmental review process. Data from this study will also contribute to the development of the EIM program's statewide sampling framework for terrestrial resources. Finally, multi-taxa biotic inventories will improve our understanding of distributions, populations, and ecological processes in Wisconsin's peatlands and how these unique communities might be impacted by global climate change.

### **B. Program Interest Area to be Addressed:**

Biologists from the Natural Heritage Inventory (NHI) program and the Ecological Inventory and Monitoring (EIM) program of the WDNR Bureaus of Endangered Resources and Integrated Science Services will team up to survey multiple taxa groups in Wisconsin peatlands. NHI Natural Communities that are considered peatlands include black spruce swamps, bog relicts, boreal rich fens, muskegs, open bogs, poor fens (including central poor fens), tamarack poor swamps, tamarack rich swamps, northern wet-mesic forests (white cedar swamps), southern sedge meadows, and northern sedge meadows.

Peatland complexes occur primarily in northern Wisconsin, becoming progressively rarer to the south. The composition of these communities includes many specialized plants and animals that are not typically found in other habitats, including many rare species. As these habitats contain many species south of their normal range limits, one might expect to detect a response due to a changing climate. For example, species might be expected to shift their ranges to maintain their viability. In fact, using meta-analyses, Root et al (2003) and Parmesan & Yohe (2003) have shown that many species of plants and

animals have shifted their ranges in the directions expected by climate change models. Because communities consist of many different species with widely varying abilities to disperse, communities as we know them now may become unrecognizable and species might be extirpated from the state. Within peatland complexes, there is most likely some resilience or “relicts” in southern Wisconsin that would no longer exist. However, many stands, especially in the tension zone and southern Wisconsin, appear to be in marginal condition at present, having already been hit especially hard by hydrological alterations, recent colonization by invasive plants, and insect infestations (e.g. larch sawfly in coniferous wetlands). These stands may not recover if subjected to yet another perturbation.

In order to help determine the effects of climate change, systematically gathered baseline data are needed. Properly gathered baseline information on multiple taxa will provide future inventories a better opportunity to detect changes in biotic communities in future inventories. Animals are expected to respond to climate change through changes in range (compression, extension, shifting), abundance, phenology, productivity, community composition, biotic interactions, activity patterns, and behavior. Similarly, plants are expected to respond to climate change through changes in range (compression, extension, shifting), abundance, phenology, productivity, physiology (photosynthetic rate, net primary production, water-use efficiency), community composition, biotic interactions, and dispersal. Prior to European settlement species range shifts that resulted from climate change were not especially constrained by physical barriers such as roadways, cities, reservoirs, and altered, discontinuous habitats. Thus it would be reasonable to hypothesize that negative patterns in population trends and even species extinction could be more severe with the present landscape and trend in the climate.

Baseline data collected during the life of this study (3 to 6 years) will allow comparisons with data that are collected in future inventories that take place at 10 to 20 year intervals. Baseline data should be obtained in a way that is replicable in future inventories. Comprehensive inventories, rare species status surveys, and documentation of abiotic and biotic ancillary data within the suite of peatland communities can provide a basis for future inventory and monitoring activities. If funding is not provided by the WFOE's Environmental Research Program through the current grant proposal, NHI and EIM will seek alternative funding sources to complete the objectives outlined below. However, the level of funding requested here will allow the collection of the data that are the core of this study.

### **C. Usefulness and Value of Project Results:**

The primary goals of this project are 1) to provide baseline data on the presence/absence, abundance, and distribution of rare species in multiple taxa groups associated with peatland communities in Wisconsin, and 2) to document selected biotic and abiotic variables that could potentially influence the organisms being studied. Taxa to be surveyed by the NHI and EIM teams include bryophytes, rare vascular plants, lichens, rare terrestrial and aquatic invertebrates, small mammals (covers rare small mammals), birds (covers rare birds), and rare reptiles and amphibians (covers rare amphibians). In order to determine the effects of climate change on these taxa groups, baseline data need to include information on biotic and abiotic influences, and need to be obtained in a way that is replicable in future inventories. Using two levels of survey intensity (Tables 1 and 2), we will attempt to identify "normal" variation of the taxa surveyed. This approach will allow future inventory and monitoring efforts to eliminate alternative hypotheses regarding causation mechanisms behind observed differences between baseline and future surveys. That is to say, it will be easier to relate detected differences in biotic communities to global climate change by dismissing confounding variables.

Surveys from this study will directly support rare species status determinations for Natural Heritage Inventory Program. NHI data are an integral part of rarity status determinations, legal listing as Endangered or Threatened, and master planning for the DNR and other agencies. These data are also used as part of the environmental review process for development undertaken by the state, business, and industry. <http://www.dnr.state.wi.us/org/land/er/nhi/nhimain.htm#Environmental%20Review>. Some NHI records date back over a century, and can provide insight to status trends of rare species in Wisconsin. Unfortunately, many of the records have not been gathered in manner that is replicable, plus many of the older records have poor location and population data associated with them, and many others species have

not been systematically surveyed across the state. This project will allow NHI to meet the following objectives: 1) to develop tools and protocols and apply all available data including remote sensing tools to determine random representative potential peatland sites to survey; 2) to obtain baseline information about selected groups of rare species by conducting status surveys in selected sites using standard Natural Heritage Inventory methodology.

Data collected from this project will also complement and benefit from the ongoing Coniferous Wetland Forest Bird Inventory (CWFBI) being conducted by the EIM team. The CWFBI is a survey of birds and plants associated with coniferous wetlands and will directly support conservation planning, forest management and land-use planning statewide. The objectives of the CWFBI are (1) to produce information on the presence, local and regional distribution, and habitat associations of coniferous wetland birds, rare vascular plants, and invasive plant species, (2) to build models that predict bird and plant species distributions, and (3) to produce a manual with information on the identification, distribution, and composition of bird and plant communities in coniferous wetland forests throughout the state. Bird data collected to meet the goals of this climate change study will be used for the CWFBI and vice versa. The plant data will be collected in plots centered on bird survey points.

Baseline surveys conducted during this project will also benefit EIM's ongoing statewide mammal inventory. Jackson's 1961 "Mammals of Wisconsin" provides the most comprehensive and current information on mammal distributions and populations in Wisconsin, even though it is based on field data collected from 1898-1952. Fifty years have passed since this initial inventory without significant additional knowledge being acquired on how mammal distributions have changed along with land cover, land management, invasive species distributions, and climate change. Numerous partners are helping design and conduct a new statewide mammal inventory. EIM is developing species predicted distribution maps to identify priority locations for survey work over the next five years and this effort is being directly linked to research on vegetation, invertebrates, birds, and natural communities. The objectives of EIM's mammal inventory are to provide information on: 1) local and regional distribution, 2) relative abundance, 3) habitat association, 4) population trends, 5) population status, and 6) the influence of land use and management practices on 40 smaller, primarily nongame species, 11 of which are currently designated "Species of Special Concern" in Wisconsin.

Wisconsin currently has several long-term monitoring efforts for amphibians, including the Wisconsin Frog and Toad Survey (WFTS) and the Wisconsin Herpetological Atlas. These efforts provide information on population trends and distribution of amphibians in the state. However, there remain gaps in both datasets for specific habitat types and for quantitative data for most of the state. The objective of the amphibian study is to obtain information on the presence, species composition and richness, local and regional distribution, and habitat associations of amphibians living in or at the boundaries of peatlands where amphibians have been little studied in Wisconsin. The framework for this study may be used as a model for future amphibian inventory and monitoring projects at the statewide level. Information obtained through this study will also fill gaps in species accounts for the Wisconsin Frog and Toad Survey and the Wisconsin Herpetological Atlas.

Overall, this climate change project will provide a replicable, representative survey of occurrences of rare species tied to peatland habitats as well as building on existing rare species and high quality natural community information that is housed in the NHI database, past inventory reports (e.g., biotic inventories for the Northern Highland-American Legion State Forest, Black River State Forest, tamarack swamp bird surveys), and other efforts like county surveys that have been used to identify potential state natural areas. Likewise, data collected from this project will directly complement and benefit from closely related efforts of the EIM program like the CWFBI and the Small Mammal Inventory. In addition, the EIM program is in the process of developing a sampling framework for all terrestrial resources which is modeled after the concept of the EPA's Long Term Ecological Research Stations. This project will help set a common framework with fixed sampling stations that can be re-surveyed through time. Multi-taxa biotic inventories will improve our understanding of distributions, populations, and ecological processes in Wisconsin's peatlands, and provide a baseline for future efforts documenting climate change in biotic communities.

#### **D. Soundness of Project Methods:**

Peatland dominated wetlands as such are typically discreet features on the landscape, but the component natural communities are rarely distinct entities, but rather more typically gradients of a large system interconnected and influenced by similar biotic and abiotic factors. The scope of this project might most easily be visualized by examining the two major physiognomic groups: the coniferous wetland forests and the open peatlands. Coniferous wetland forests and open peatlands often form a complex continuum between the dense, closed canopy swamp that grades into muskeg and a variety of different types of open peatlands. Coniferous wetland forests are dominated by black spruce, tamarack, or white cedar, and are most common in the northern and central part of the state with the distribution getting progressively less common in southern Wisconsin. Open peatlands include northern and southern sedge meadows, and fens (boreal rich, poor, and central poor). Northern sedge meadows, boreal rich fens, and poor fens are mainly found in the north and in the tension zone. Southern sedge meadows occur mostly in and south of the tension zone. Central poor fens are confined to central Wisconsin. More northerly species in these peatland communities are often at the southern edge of their ranges in the tension zone and southern Wisconsin.

Wisconsin peatlands provide a good opportunity to detect change in a natural system that results from global climate change. The rate of natural vegetation growth and change in closed (forested) peatlands is very slow. Black spruce, tamarack, and white cedar have minimal growth rates in peatland habitats, adding perhaps only fractions of an inch in diameter and perhaps several feet in height over years, even decades. Many closed peatlands contain unmerchantable timber and harvest on some public lands (e.g., National Forests) has been restricted through moratoriums (e.g., the US Forest Service). In addition, the peatland complex provides an enclosed system within a basin and has easily identifiable boundaries, unlike upland systems that have much more subtle gradients between habitat types. These peatland characteristics become advantageous when determining the trends in wildlife distribution and abundance since a large subset of variables, namely vegetation structure and composition, are essentially constant in comparison to other terrestrial habitats which could be proposed for study.

Sagarin (2002) identified the following three important components for studies related to global climate change: 1) fine scale temporal resolution, 2) broad scale spatial resolution, and 3) wide taxonomic resolution. Fine scale temporal resolution is important to identify the frequencies of biological changes and to establish the relationship between those biological changes and any associated physiological events. Broad scale spatial resolution helps establish whether changes are occurring throughout the range of a species or are simply due to smaller scale local perturbations. Wide taxonomic resolution helps to rule out alternate hypotheses. If a change is seen across several or many taxonomic groups or life history strategies it is more likely to be a general biological response to climactic changes.

The basic challenge of this study is to provide sufficient temporal, spatial, and taxonomic coverage to gain an adequate understanding of "normal" variation and interactions in both the abiotic and biotic components of Wisconsin's peatland complexes. Information on these "normal" or expected variations will be critical in understanding the larger picture and will help eliminate alternate hypotheses regarding causes behind any observed changes over time. In order to overcome this challenge, taxa surveys and ancillary data collection for this study will be carried out at two different levels: intensive and extensive. The number and type of metrics will vary to some extent based on the taxa group and intensity level, but will be appropriate for obtaining the desired information at a given location and for a particular species. The number and type of ancillary variables, including, among others, elevation, plant association, disturbance, and water basin size, measured will vary along with the type of survey and will be used for correlation analyses within the two survey levels (intensive and extensive).

Varying levels of surveys will provide a broad range of information and quantification that will allow rare species status surveys and comprehensive species inventories to be conducted simultaneously. Intensive surveys are important because of the volume of data and repetition over time that we will obtain. Intensive surveys will be conducted at 10 to 20 non-randomly selected peatlands distributed along a north-south gradient in the state (Table 1). Surveys for each taxa group will be comprehensive and

metrics may include presence/absence, relative abundance, diversity indices, density, and others as determined appropriate by the principal investigators. Expected products from the intensive surveys include baseline measures of each metric with a short-term variance estimate, and associations among taxa groups, habitat types, and biotic and abiotic characteristics of sites. Extensive surveys will be conducted at an additional 200 to 400 randomly selected peatlands stratified by ecological unit and distributed throughout state (Table 2). Surveys at the extensive sites will be for rare species, and the metrics and products will be limited by the survey methods used to document each rare species. A subset of extensive survey sites will be sampled more comprehensively for small mammals, passerine birds, and amphibians (Table 2).

Site selection will vary depending on the level of survey. Intensive survey sites will be subjectively chosen based on NHI records of Natural Communities, State Natural Areas, and other sources that identify peatlands having minimal disturbance history and with a future that is projected to be relatively stable (i.e., not subject to direct anthropogenic influences). Every effort will be made to find communities with natural patterns and processes for the intensive sites. In contrast, the extensive survey sites will be stratified and chosen randomly using methods developed and tested by EIM's CWFBI project, as well as methods being developed by WDNR's Bureau of Enterprise Information Technology and Applications (BEITA) for NHI's Moss Dependent Species Status Surveys Project. EIM mapped the distribution of coniferous wetland forests with WISCLAND Land Cover data, and used the National Hierarchical Framework of Ecological Units (NHFEU) to name individual sites and define ecologically meaningful boundaries for a stratified random sampling scheme. The CWFBI sampling unit is an individual coniferous wetland forest stand located within a cluster that was identified by Level 3 WISCLAND Land Cover Data. While this method worked well for identifying and locating forested coniferous peatlands in Wisconsin's landscape, additional methods are necessary to identify and locate open peatlands. A GIS tool, similar to the one used by EIM's CWFBI, is being developed by BEITA to identify open peatlands. The tool will be field checked to verify its accuracy and will then be used to identify potential survey sites. Like the tool used for EIM's CWFBI, BEITA's tool will use the NHFEU to name individual open peatland sites and to define ecologically meaningful boundaries for a stratified random sampling scheme. Using a combination of the two GIS tools, we will select stratified random samples for extensive peatland sites throughout the state.

Taxa groups, survey type, survey replication, and responsible team (NHI or EIM) are summarized in Tables 1 and 2. NHI will focus on rare species surveys at all sites, whereas EIM will conduct comprehensive surveys for small mammals, breeding passerine birds, and amphibians at intensive sites and at a subset of the extensive survey sites. All surveys regardless of taxa, responsible team, or site intensity are standard and use proven techniques. NHI will conduct rare species surveys for selected rare amphibians and reptiles, vascular plants, aquatic and terrestrial invertebrates, and all bryophytes. NHI's surveys will be conducted based on seasonal timing that should maximize the probability of finding rare species and provide the greatest amount of useful plot data. Rare species status surveys will be conducted using standardized NHI methodology as promulgated by NatureServe, an international organization that coordinates Natural Heritage Inventory and Conservation Data Centre programs. EIM will conduct small mammal surveys through a variety of means designed to ensure all species are represented and adequate data can be collected for distribution modeling. This includes direct live and kill trapping, observational surveys, and sign collection throughout various stages of the life cycle and year. For breeding passerine birds, EIM will use standard point count methods adapted from Howe et al. (1995) and Ralph et al. (1995), which are the same methods used for the CWFBI. Vegetation structure and composition will be measured at bird point count stations at each site based on methods adapted from the California Native Plant Society (1998). Amphibian survey methods will be appropriate for the species or group of species being surveyed and will follow standard methods or modifications of standard methods (as appropriate) as described by Heyer et al. in *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians* (1994). Certain amphibian species are not easily detected using standard methods and for these species we will use "species specific" methods. Amphibian survey methods may include calling surveys, time-constrained searches, egg mass searches, or visual encounter surveys.

## Literature Cited:

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## E. Statement of Work and Schedule:

### 1. Objectives, Methods, Deliverables

1. Identify and select peatland study sites (NHI - EIM)
  - (a) Use GIS tools and other resources to select, proof, and map peatland study sites throughout Wisconsin including representatives of the following plant communities: black spruce swamps, bog relicts, boreal rich fens, muskegs, open bogs, poor fens (including central poor fens), tamarack poor swamps, tamarack rich swamps, northern wet-mesic forests (white cedar swamps), southern sedge meadows, and northern sedge meadows.
  - (b) Attain sufficient spatial coverage to document normal variation in the abiotic and biotic components of select peatland complexes.
  - (c) Select 10 to 20 intensive study sites along a north-south gradient based on NHI records of natural communities, State Natural Areas, and other sources that identify peatlands having minimal known or anticipated anthropogenic disturbance(s).
  - (d) Select 200-400 extensive study sites stratified by ecological unit and distributed throughout state using methodology developed by the CWFBI project, in-house GIS analysis, contract work with DNR's Bureau of Enterprise Information Technology, and / or via UW expertise.
  - (e) Produce study site maps, tabular attribute data for select sites, and obtain land owner permission for future survey work.
2. Conduct comprehensive biotic inventories at intensive and selected extensive survey sites (EIM).
  - (a) Funded taxa groups (currently proposed for breeding passerine birds, small mammals, and amphibians) will be surveyed using broad-based, standardized, and repeatable methods following the best available and scientifically accepted techniques. Passerine bird surveys will use standard methods adapted from Howe et al. (1995) and Ralph et al. (1995).

- Vegetation sampling methods at passerine bird point count stations are adapted from the California Native Plant Society (1998). Amphibian surveys will follow Heyer et al. (1994). Small mammal surveys will follow Wilson et al. (1996). Standardized new methodology will be developed and implemented as necessary.
- (b) The metrics of dependent data will provide the maximum numeric resolution reasonable within existing budgets and may include binary presence / absence, species distribution (spatial representation of presence / absence), relative abundance, density, and / or population size for individual species or guilds at select life stages (e.g., egg mass, juveniles, breeding adults).
  - (c) Unfunded taxa groups will NOT be inventoried, monitored, or researched until supplemental and supporting funding is obtained. This currently includes aquatic and terrestrial invertebrates, reptiles, vascular plants, bryophytes, lichens, and natural communities.
3. Conduct NHI rare species inventories at intensive and extensive survey sites (NHI).
    - (a) Funded taxa groups (currently proposed for rare aquatic and terrestrial invertebrates, terrestrial vertebrates, vascular plants, and all bryophytes in open peatlands) will be surveyed based on seasonal timing that should maximize the probability of finding rare species and provide the greatest amount of useful plot data. Rare species status surveys will be conducted using standardized NHI methodology as promulgated by NatureServe, an international organization that coordinates Natural Heritage Inventory and Conservation Data Centre programs.
  4. Collect data on ancillary variables at intensive and selected extensive survey sites (EIM)
    - (a) Ancillary variables will be measured through the course of the study and will be used for correlational analyses with observed trends in species data. Ancillary variable collection will vary between intensive and selected extensive sites in accordance to budget limitations. These variables may include: location (spatial coordinates), elevation, survey timing (time of day, date, season), peatland complex size, plant association / habitat size, disturbance to peatland complex (wind, hail, ice damage, flooding, fire, infestation, ditching, drainage, forestry, other management), watershed basin size, adjacent land use patterns, adjacent land cover patterns, hydrology, limited water chemistry and quality, water depth,), vegetation composition and structure, aquatic substrate, and aquatic vegetation.
  5. Enter comprehensive inventory and rare species survey data into appropriate databases (NHI - EIM)
    - (a) Enter EIM comprehensive inventory data into a relational database. Submit metadata to the Aquatic and Terrestrial Resources Inventory (ATRI) database. Make all data available to cooperating researchers.
    - (b) Enter rare species survey data into Natural Heritage Inventory database.
  6. Submit annual summary reports for each taxa group by February 28 each year (NHI and EIM).
    - (a) Document species detected at intensive and extensive survey sites.
    - (b) Map species distributions, report abundance measures, and describe community composition.
    - (c) Document ancillary variables collected at intensive and extensive survey sites.
    - (d) Identify and show preliminary influences of ancillary variables on species metrics.
  7. Report writing and information transfer to be completed by September 30, 2008 (NHI and EIM).
    - (a) Synthesize annual reports into taxa summaries that highlight usefulness of findings.
    - (b) Write final technical report incorporating taxa summaries and all levels of site intensity.
    - (c) Identify spatial and temporal variations, interactions, and relationships of covered taxa to other biotic and abiotic measures.

- (d) Assess study's potential to address competing hypotheses regarding causal mechanisms behind observed spatial and temporal trends and projected spatial and temporal trends.
- (e) Provide electronic access to project data through the Aquatic and Terrestrial Resources Inventory and Natural Heritage Inventory Database, subject to the exemption of Natural Heritage Inventory data from Wisconsin's Open Record Law.
- (f) Outline future inventory objectives and protocols, and present to the Environmental Research Forum.

## 2. Reporting Plan

*NHI biotic inventory:* Preliminary reports will be written and submitted by February 28 each year. Occurrences of rare species will be entered and available for analysis and interpretation each calendar year. A final report summarizing all findings from the biotic inventory and rare species found during the CWFBI and small mammals surveys in open peatlands and coniferous wetlands will be written and distributed by September 30, 2008.

*CWFBI:* Preliminary reports will be written and submitted by February 28 of years 1-2. Predictive models of bird occurrence will be shared with land managers for validation and to test functionality. A final management reference manual with an atlas of coniferous wetlands statewide, information on the structure and composition of coniferous wetland natural communities, and models that predict the probability of bird occurrence based on habitat conditions and bird distributions will be written and distributed by the end of the 3rd calendar year.

*Small mammal surveys:* Preliminary reports will be written and submitted at the end of each calendar year. Predictive models of mammal occurrence will be shared with land managers for validation and to test functionality as developed. We will compile a management reference manual, atlas, and models to predict mammal distribution based on habitat condition for the final report by September 30, 2008.

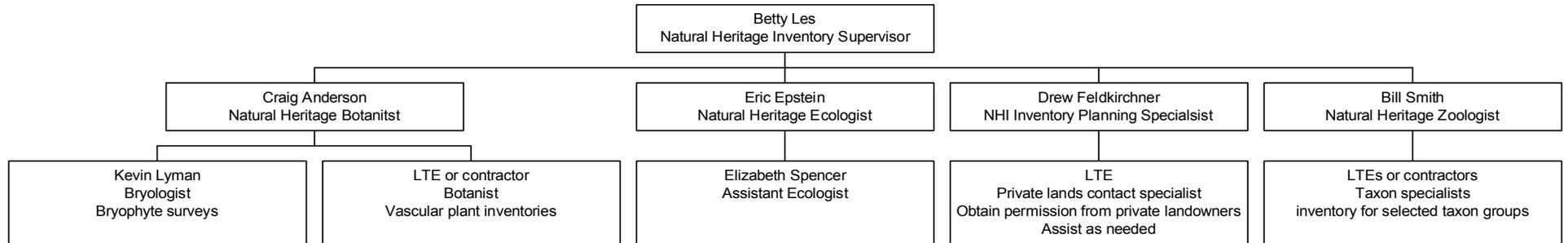
## 3. Master Schedule (based on calendar year with an assumed start of May 1, 2003, although the schedule would actually run through the fiscal year ending September 30, 2008)

1. Identify and select peatland study sites - **May 1, 2003 through April 2004**
  - (f) Identify and field check intensive sites - October 2003
  - (g) Compile background information on intensive sites - December 2003
  - (h) Complete GIS selection and field check of extensive survey sites - April 2004
  - (i) Produce study site maps, tabular attribute data for select sites, obtain access permissions - April 2004
2. Conduct comprehensive biotic inventories at intensive and selected extensive survey sites - **April through September, 2004-2006**
  - (a) Breeding passerine bird surveys - May 20 through July 3, 2004, annually thereafter for a total of 3 field seasons.
  - (b) Small mammal surveys - July 1 through September 30, 2004, annually thereafter for a total of 3 field seasons.
  - (c) Amphibians surveys - April 1, 2004 through September 30, 2004, annually thereafter for a total of 3 field seasons.

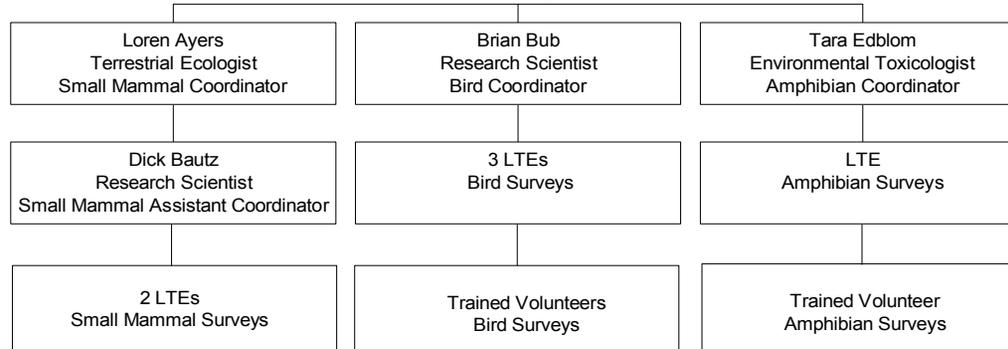
- (d) Unfunded taxa groups - As needed to address taxa group, annually thereafter, contingent on obtaining funding. This is planned to include aquatic and terrestrial invertebrates, reptiles, vascular plants, bryophytes, lichens, and natural community mapping.
3. Conduct NHI rare species inventories at intensive and extensive survey sites - **April through September, 2004-2007**
    - (a) Aquatic and terrestrial invertebrates – April-September
    - (b) terrestrial vertebrates - April-September
    - (c) vascular plants - April-September
    - (d) All bryophytes - April-September
  4. Ancillary data collection at intensive and extensive survey sites - **July 2003 through Sept. 2006**
    - (a) GIS land attribute data - April 2004
    - (b) Survey specific ancillary data
    - (c) Cooperator specific ancillary data - to be determined
  5. Enter survey data into appropriate databases - **May through December, 2004-2008**
    - (a) EIM comprehensive inventory data to relational database - annually following field data collection
    - (b) Metadata to ATRI - annually following field data entry into relational database
    - (c) Rare species data into Natural Heritage Inventory database - annually following field data collection and verification / screening.
  6. Submit annual summary reports for each taxon group, information transfer - **February 28, 2005-2008 and as warranted.**
  7. Final report and information transfer – **September 30, 2008**
    - (a) Synthesize annual reports into taxa summaries.
    - (b) Write final technical report for all levels of survey intensity.
    - (c) Outline future inventory objectives and protocols
    - (d) Present written and verbal reports to the Environmental Research Forum.

**F. Management Plan and Qualifications**  
**1. Organizational Chart**

Bureau of Endangered Resources  
 NHI Biotic Inventory



Bureau of Integrated Science Services  
 Ecological Inventory and Monitoring  
 Erin Crain, Supervisor



## 2. Resumes (Previously Submitted)

## 3. Related Projects

- (a) "Biotic Inventory and Analysis of the Northern Highland American Legion State Forest," WDNr report PUBL-ER-093 99. This was a multi-year (1992-1996) effort supported by the WDNr Division of Forestry to inventory and analyze selected biotic resources of the Northern Highland State Forest (BRSF) and the surrounding landscape. The project provided some of the necessary baseline ecological information relevant to the development of a new property Master Plan for the Forest. The objectives were to identify and evaluate animals, plants and natural communities of the forest, as well as aquatic features. In addition, we identified sites that were appropriate for restoration of lost or declining communities or habitats and highlighted important protection, management and restoration opportunities for the Northern Highlands landscape. The project was supported through funding from the Division of Forestry (\$300,000) as well as the Endangered Resources Fund. Contact: Bob Mather, WDNr Division of Forestry 266-1727.
- (b) "Biotic Inventory and Analysis of the Black River / Meadow Valley Landscape," WDNr report in preparation. This was a multi-year (1997-1999) effort supported by the WDNr Division of Forestry to inventory and analyze selected biotic resources of the Black River State Forest (BRSF) and the surrounding landscape, including three State Wildlife Areas. The project provided some of the necessary baseline ecological information relevant to the development of a new property Master Plan for the Forest. The objectives were to identify and evaluate animals, plants and natural communities of the study area, as well as aquatic features. In addition, we identified sites that were appropriate for restoration of lost or declining communities or habitats and highlighted important protection, management and restoration opportunities for the Black River / Meadow Valley landscape. The project was supported through funding from the Division of Forestry (\$200,000) as well as the Endangered Resources Fund. Contact: Bob Mather, WDNr Division of Forestry 266-1727.
- (c) "The Fox River Headwaters Ecosystem: An Ecological Assessment for Conservation Planning," WDNr report PUB-ER-804 2002. This project was a one-year assessment of the significant ecological resources of the Fox River Headwaters Ecosystem. It synthesized what was known about the most significant ecological resources in this area to help guide future conservation strategies by public, nonprofit, and private land managers and landowners. The project included a limited field survey, a survey from a group of experts on various places in the area (locations were mapped and described in detail), and an interdisciplinary workshop to discuss information gathered on over 192 locations within the study area. In addition, further analysis and review was performed by the Endangered Resources Program. The information from all of these efforts was synthesized in a report that was distributed to various field managers, researchers, and conservation groups and will be used to support future master planning in this area. The project was supported through a Great Lakes Protection Fund Grant (\$30,000) as well as the Endangered Resources Fund. Contact: Charles Ledin, WDNr Bureau of Watershed Management 266-1956.
- (d) Statewide Small Mammal Inventory: WDNr ongoing project. This multi-year project began in 2001 and will last approximately 10 years. Distributions and population for most mammals in Wisconsin has not been adequately determined since publication of Jackson's *Mammals of Wisconsin* in 1961, which is based on field data collected from 1898-1952. The project is developing species predicted distribution maps to identify priority locations for survey work over the next five years and is training staff biologists

to assist in this work. The objectives are to provide information on: 1) local and regional distribution, 2) relative abundance, 3) habitat association, 4) population trends, 5) population status, and 6) the influence of land use and management practices on 40 smaller, primarily nongame species. Support for the project is through the federal Wildlife Conservation and Restoration Program (\$80,000) and federal State Wildlife Grants Program (\$160,000). Contact: Loren Ayers, 608-261-6449, WDNR Bureau of Integrated Science Services.

- (e) Coniferous Wetland Forest Bird Inventory: WDNR ongoing project. This multi-year project began in 2001 and is scheduled to be complete in 2004. This project is a survey of birds and plants that are associated with tamarack and northern white-cedar swamps, and black spruce bogs. The goal is to predict the probabilities of bird occurrence and map bird distribution patterns based on forest structure and composition, forest patch size, and adjacent habitat types. This project will directly support the conservation planning and forest management guidelines for coniferous wetland forests in Wisconsin. Support for the project is through the federal Wildlife Conservation and Restoration Program (\$40,000) and federal State Wildlife Grants Program (\$80,000). Contact: Brian Bub, 608-267-8450, WDNR Bureau of Integrated Science Services.

### **G. Project Budget**

### **H. Letters of Commitment or Support (Previously Submitted)**

**Table 1. Intensive Surveys****10-20 Peatlands**

Intensive Surveys will be conducted at 10-20 peatlands that are selected non-randomly and are distributed along a north-south gradient in the state. Surveys for each taxa group will be comprehensive and metrics will include presence/absence, relative abundance, diversity indices, density, cover classes, and other measures to be determined by principal investigators. Expected products from the Intensive Surveys include baseline measures of each metric with a short-term estimate of variance, and associations among taxa groups, habitat types, and biotic/abiotic characteristics of sites.

Taxa	Bureau <sup>1</sup>	Survey Type	Metrics	Products	Funding <sup>2</sup>	Visits/yr <sup>3</sup>	Years	Anc. Variables
Aquatic Invertebrates	EIM	Comprehensive	many	many	--	--	3	many
Terrestrial Invertebrates	EIM	Comprehensive	many	many	--	--	3	many
Reptiles	EIM	Comprehensive	many	many	--	--	3	many
Vascular Plants	EIM	Comprehensive	many	many	--	--	3	many
Bryophytes	EIM	Comprehensive	many	many	--	--	3	many
Small Mammals	EIM	Comprehensive	many	many	WFOE	1-2	3	many
Breeding Passerine Birds	EIM	Comprehensive	many	many	WFOE	3	3	many
Amphibians	EIM	Comprehensive	many	many	WFOE	2-3	3	many
Lichens	AM	Comprehensive	many	many	--	--	3	many
Natural Communities	NHI	Comprehensive	many	many	--	1	1	many

**Table 2. Extensive Surveys****200-400 Peatlands**

Extensive surveys will be conducted at an additional 200-400 peatlands that will be randomly selected, distributed throughout the state, and stratified by ecological units. Surveys at all sites will be for selected rare taxa. Additionally, a subset of sites will be surveyed more comprehensively for small mammals, breeding passerine birds, and amphibians to fill important information gaps that exist for more common species in these groups. Metrics will vary, as will expected products.

Taxa	Section <sup>1</sup>	Survey Type	Metrics	Products	Funding <sup>2</sup>	Visits/yr <sup>3</sup>	Years	Anc. Variables
Aquatic Invertebrates	NHI	Rare Species	few	few	WFOE	1	1	some
Terrestrial Invertebrates	NHI	Rare Species	few	few	WFOE	1	1	some
Open Wetland Vertebrates	NHI	Rare Species	few	few	WFOE	1	1	some
Vascular Plants	NHI	Rare Species	few	few	WFOE	1	1	some
Bryophytes	NHI	Rare Species	few	few	WFOE	1	1	some
Small Mammals	EIM	Comprehensive	some	some	WFOE	1-2	1	some
Breeding Passerine Birds	EIM	Comprehensive	some	some	WFOE	3	1	some
Amphibians	EIM	Comprehensive	some	some	WFOE	--	1	some
Lichens	AM	Comprehensive	some	some	WFOE	--	1	some
Natural Communities	NHI	n/a	n/a	n/a	n/a	n/a	n/a	n/a

<sup>1</sup> Wisconsin DNR Sections participating include Natural Heritage Inventory (NHI), Ecological Inventory and Monitoring (EIM), and Air Management (AM)

<sup>2</sup> Funding cells that have blanks represent funds that are to be acquired by WDNR beyond the WFOE grant. WDNR is not responsible for delivering these products if additional funds are not acquired.

<sup>3</sup> Visits/year cells that have blanks are to be determined by the principal investigators.

