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# Table of Contents

**Preface: 75th Anniversary** ................................................................................................. i-ii

**Personnel and Cooperators** ............................................................................................. 1
- Unit Coordinating Committee .................................................................................................. 2
- Unit Staff .................................................................................................................................. 2
- Graduate Students .................................................................................................................. 2
- Unit-affiliated Research Staff .................................................................................................. 3
- Laboratory and Field Technicians .......................................................................................... 3
- University Cooperators .......................................................................................................... 3
- Iowa Department of Natural Resources Cooperators .............................................................. 4
- Other Cooperators .................................................................................................................. 5

**Current Fisheries/Aquatic Projects** ............................................................... 7
- Effects ofIntroduced Common Carp and Invading Zebra Mussels on Water Quality and the Native Biological Community of Clear Lake, Iowa ........................................................................ 9
- Fish Assemblages in Iowa’s Non-wadeable Rivers: Relationships with Habitat and Sampling Methods ......................................................................................................................... 10
- Effects of Managed Riparian Buffers on Fish Communities in Central Iowa Streams .......... 11
- Effects of Commercial Harvest on Shovelnose Sturgeon in the Upper Mississippi River ........ 12
- Assessment of Interrelationships Between the Fisheries Community and Limnological Characteristics of Iowa Lakes ............................................................................................................. 13
- Relationships of Fish Communities and Availability of Deep-water Habitat ...................... 14

**Completed Fisheries/Aquatic Projects** ............................................................... 15
- Radio-telemetry Investigation of Common Carp in Clear Lake, Iowa .................................. 16
- Physical Habitat Component of the Iowa REMAP Program ................................................. 17
- An Integrated Immunological-GIS Approach for Bio-monitoring of Ecological Impacts of Swine Manure Pollutants in Streams .................................................................................. 18

**Current Wildlife/Terrestrial Projects** ............................................................... 21
- Assessment of Environmental Services of CREP Wetlands in Iowa and the Midwestern Corn Belt 22
- Statistical Support of the Iowa DNR Wildlife Bureau Research ........................................ 23
- Development of Harvest Strategies for Mourning Doves ...................................................... 24
- Bird Response to Enhanced Vegetation Diversity in the Spring Run Complex of Northwestern Iowa ........................................................................................................................................... 25
- Development and Evaluation of Methods for Regional Monitoring of Mourning Dove Recruitment ........................................................................................................................................ 26
- Amphibian Malformation and Disease in Midwestern Landscapes ....................................... 27

**Completed Wildlife/Terrestrial Projects** ............................................................... 29
- Effects of Prairie Restoration Using Fire and Grazing Regimes on the Butterfly Community of Iowa’s Loess Hills ............................................................................................................. 30
COOPERATING FACULTY PROJECTS ................................................................. 31
Develop a User-friendly Interface for Iowa’s Lake Databases - Watershed, Water Quality and Fisheries ................................................................. 32
A Landscape Genetics Approach to Assessing the Risk of CWD-infected White-tailed Deer Dispersing From Wisconsin to Iowa ....................................................... 33
Conservation Genetics of the Freshwater Mussel Margaritifera hembeli (Bivalvia: Margaritiferidae) ................................................................. 34
Insect Survey of Aquatic Habitats in Iowa ......................................................... 35
Diagnostic/Feasibility Restoration Studies - Upper Gar Lake, Minnewashta, and Lower Gar Lake ................................................................. 36
Diagnostic/Feasibility Restoration Studies - Easter Lake ....................................... 37
Iowa NatureMapping: Enhancing Comprehensive Wildlife Management through Internet GIS Mapping Technology ......................................................... 38
Genetic Structure and Intraspecific Phylogeography of the Sheepnose Mussel ................................................................. 40
South Coastal Alaska/Wrangell St. Elias Mountains Moonwort Fern Surveys and Genetic Analysis with an Emphasis on Botrychium tunux .................................................. 41
Diagnostic/Feasibility Restoration Studies - Prairie Rose Lake, Lake Darling, Green Valley Lake and Lizard Lake ................................................................. 42
Best Management Practices for Aquatic Vegetation Management .................................................. 43
Development of an Invertebrate-based Terrestrial Index of Biotic Integrity .................................................. 44
Temporal Shifts in Avian Diversity and Community Structure through Stages of Restoration of a Tallgrass Prairie, Neal Smith National Wildlife Refuge (NSNWR) .................................................. 45
Population Dynamics and Dispersal of Bobcats in Iowa .................................................. 46
Effects of Managed Riparian Buffers on Fish Communities in Central Iowa Streams .................................................. 47
Interactions Between Bison, Elk, and Plant Communities in an Ongoing Tallgrass Prairie Restoration Effort .................................................. 48
Bird Nesting on Rotationally Grazed Pastures that Incorporate Warm-season Grasses .................................................. 49
The Use of Cattle-Grazing and Fire as Management Tools to Maintain Biodiversity on Grassland Reserves in Southern Iowa .................................................. 50
Genetic Variation of Northern and Southern Populations of Quadrula fragosa (Conrad, 1835) Using Microsatellites .................................................. 51
Response of Forest Birds to Changes in Land Use/Land Cover in the Driftless Area of Northeastern Iowa .................................................. 52
Spatial Analysis of Waterfowl-predator Interactions .................................................. 53
Survey of White-tailed Jackrabbit (Lepus townsendii) Populations on ISU Research Farms .................................................. 54
Assessment of the Intertelationships Between Fish Population Dynamics and Limnological Characteristic of Iowa Lakes .................................................. 55
The Effect of Preserve and Conservation Site Clustering on Local Amphibian Densities and Species Richness .................................................. 56
PUBLICATIONS AND REPORTS ................................................................. 59
Peer-reviewed Publications .................................................. 59
Theses and Dissertations .................................................. 59
Technical and Semi-Technical Reports .................................................. 60
Presentations at Professional Meetings .................................................. 60
SERVICE ................................................................. 61
NEWS ................................................................. 62
In early 1932, Iowa conservationist and cartoonist Jay ‘Ding’ Darling convinced the Iowa Fish and Game Commission and Iowa State College to match his personal contribution to fund a 3-year cooperative program that would conduct wildlife research and train future professionals in the new field of wildlife management. That summer, Dr. Paul Errington joined the staff of Iowa State College as the leader of this new enterprise. This innovative approach and its success led to the creation of a Federal Cooperative Unit Program in 1935, which has continued to expand into its current status of 39 fish and wildlife units in 37 states.

On October 5-6, 2007, we celebrated the 75th anniversary of the Iowa Cooperative Fish and Wildlife Research Unit by holding an alumni reception, open house, and banquet in Ames, Iowa. More than 60 former and current Unit staff and graduate students, faculty cooperators, and university and agency administrators attended. The event was highlighted by a distinguished agenda of speakers who described the significant research accomplishments and mentoring of future fisheries and wildlife professionals by Iowa Unit scientists and collaborators during its history. For additional information on the celebration, we invite you to visit our website http://www.cfwru.iastate.edu/75th.html.
Former staff and students on field trip during 75th Anniversary Celebration.

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CURRENT FISHERIES PROJECTS

Effects of Introduced Common Carp and Invading Zebra Mussels on Water Quality and the Native Biological Community of Clear Lake, Iowa

Principal Investigators: Clay L. Pierce and Timothy W. Stewart
Student Investigators: Michael E. Colvin (Ph.D.), Eric D. Katzenmeyer (M.S.)
Collaborators: Joe Larscheid and Jim Wahl, Iowa Department of Natural Resources
Duration: May 2007 to June 2011
Funding Source(s): Iowa Department of Natural Resources

Goals and Objectives:
- Quantify major ecosystem components, including common carp, zebra mussels, and the native fish and macroinvertebrate communities.
- Compile and organize existing data.
- Assemble empirical relationships from the literature and compiled data.
- Construct several component models describing portions of the ecosystem.
- Combine component models into a single ecosystem-level simulation model.

Introduction:
This study is attempting to understand the interactions and effects of introduced common carp, invading zebra mussels, and the native biological community on water quality in Clear Lake, and to organize this knowledge into a simulation model for predicting future changes and the outcomes of management actions. The resulting model will enable prediction of the effects of both biotic and abiotic factors on water quality in Clear Lake, and facilitate evaluation of a variety of scenarios and management alternatives for future water quality. How much of the existing carp biomass must be removed before a water quality improvement is seen? Will reduction of carp biomass through targeted commercial harvesting improve water quality, or will other benthic species such as black bullheads rapidly increase in response to reduced carp and impede water quality improvement? As invading zebra mussels increase in abundance, how will water quality respond? Without a model to simulate all these interrelated components, we have no answers to these and many more important questions. Our simulation model will provide a tool for scientists, managers and other decision makers to evaluate effects of potential ecosystem changes and alternative management actions in Clear Lake and other similar systems.

Progress:
A mark-recapture population estimate for adult common carp and sampling to estimate inshore and offshore densities and biomass of all fish species were completed. Benthic invertebrates, including zebra mussels, were sampled to estimate densities and biomass. Water column sampling to characterize water quality and abundance of zebra mussel veligers was completed. Age structures were obtained from common carp. Age and growth analyses were performed on data from common carp. A master database was created and available data to date were populated. Preliminary models were created and tested. Several presentations were made at various meetings.

Future Plans:
This is a multi-year study, so many of the 2007 activities will be repeated in 2008. Model development and refinement will continue as the empirical database grows. Many more presentations of preliminary findings are planned.
Fish Assemblages in Iowa’s Non-wadeable Rivers: Relationships with Habitat and Sampling Methods

Principal Investigators: Michael C. Quist and Clay L. Pierce
Student Investigator: Travis Neebling (M.S.)
Collaborators: Tom Wilton, Greg Gelwicks, and Greg Simmons, Iowa Department of Natural Resources
Duration: June 2007 to June 2009
Funding Source(s): Iowa Department of Natural Resources

Goals and Objectives:
- Describe the presence and abundance of fishes in Iowa’s non-wadeable rivers, and
- Determine appropriate sampling designs and gears for effectively sampling fishes in Iowa’s non-wadeable rivers.

Introduction:
Large rivers are unique and dynamic ecosystems which not only serve commercial and recreational purposes, but also support a diversity of aquatic and semi-aquatic species. Because large rivers are a product of smaller streams and rivers in a watershed, they are highly susceptible to pollution and degradation. Iowa has over 115,000 km of streams and rivers within its borders and approximately 5,470 km of those are non-wadeable. Much of the research conducted on large rivers in Iowa has focused on sport fishes. As such, little is known about the ecology, distribution, and abundance of native, nongame fishes in Iowa’s non-wadeable river systems. Similarly, little is known about the best methods for sampling fish and habitat in these rivers. This project was developed to provide information on the ecology of fishes and to provide guidance on sampling fish and habitat in Iowa rivers. Non-wadeable rivers are those that cannot be safely sampled using wadeable stream protocols, and are generally 5th order or greater. Thirty-five potential sampling sites have been identified, with sampling reach lengths of 3 of 5 km depending on stream order. Reaches are divided up into 100 m long sections, separated by a habitat transect. Half of the sections in a reach are being sampled with boat-mounted electrofishing equipment, the other half are being sampled with both a modified Missouri trawl and a bag seine. At each of the transects, habitat is being measured using a protocol based on the Iowa Department of Natural Resources’ wadeable streams physical habitat assessment and the United States Environmental Protection Agency’s non-wadeable river protocols.

Progress:
During the first field season (2007) ten sites were sampled on nine different rivers. A total of 12,021 fish representing 66 species and 13 families were sampled. Thirteen species of greatest conservation need were collected, as well as one state threatened species (western sand darter). There were three noteworthy collections: the first spotted gar documented in an interior Iowa river, the first skipjack herring documented in an interior Iowa river, and the first western sand darter recorded from an interior Iowa river since 1958. Preliminary analysis shows that all three gear types collected relatively the same number of species and individuals at current effort levels.

Future Plans:
Future plans for this project include sampling 15 new sites and resampling one or two of the 2007 sites in 2008.
Effects of Managed Riparian Buffers on Fish Communities in Central Iowa Streams

Principal Investigators: Michael C. Quist, Timothy W. Stewart, Thomas M. Isenhart
Student Investigator: Jonathan Lore (B.S.), Skyler Wigen (B.S.)
Duration: May 2007 to June 2008
Funding Source(s): Iowa Water Center, Iowa Department of Natural Resources
Goals and Objectives:
- Evaluate fish communities in streams with and without managed riparian buffers.

Progress:
During the summer of 2007, fish and habitat were sampled from 40 stream reaches in Bear, Long Dick, and Keigley Branch creeks of central Iowa. Fish were sampled using backpack electrofishing. All sampled fish were identified to species and measured. Ten creek chubs and ten central stonerollers per centimeter length group were sacrificed for age and growth analysis. All other fishes were returned to the stream. Instream habitat was also measured from each reach using standard methods. Nearly all of the sampling data have been entered into the database and are ready for detailed analysis. Otoliths are currently being mounted onto glass slides in preparation for aging.

Future Plans:
Analysis of fish assemblage structure will begin this winter, as will assessment of age and growth of creek chubs and central stonerollers. Final analyses will be conducted after all data becomes available (by early spring 2008).
CURRENT FISHERIES PROJECTS

Effects of Commercial Harvest on Shovelnose Sturgeon in the Upper Mississippi River

Principal Investigators: Michael C. Quist and Clay L. Pierce
Student Investigator: Jeff Koch (M.S.)
Collaborators: Michael Steuck and Kirk Hansen, Iowa Department of Natural Resources
Patrick Short, Wisconsin Department of Natural Resources
Duration: May 2006 to June 2008
Funding Source(s): Iowa Department of Natural Resources
U.S. Fish and Wildlife Service

Goals and Objectives:
- Describe population parameters of shovelnose sturgeon in the upper Mississippi River (UMR).
- Assess current and future harvest scenarios and accompanying actions that might be used to sustain commercial harvest of shovelnose sturgeon in the UMR.

Progress:
In two field seasons (2006 and 2007), approximately 1,700 shovelnose sturgeon have been collected from eight study pools (i.e., Pools 4, 7, 9, 11, 13, 14, 16, and 18) of the upper Mississippi River. Analyses show that shovelnose sturgeon from upstream reaches are generally larger and older than shovelnose sturgeon from downstream study pools; however, growth appears to be similar across pools. Total annual mortality estimates for shovelnose sturgeon populations varied from approximately 20% in areas with low exploitation to 35% in areas with high harvest of shovelnose sturgeon. Sex ratios were estimated by sacrificing a subsample of shovelnose sturgeon in all pools except for Pools 4 and 7. Females outnumbered males in all pools except Pool 14. This possibly represents a mechanism to balance the numbers of each sex’s spawning fish, since females spawn every three years and males every one to two years. Since shovelnose sturgeon are the target of commercial harvest, managers are concerned about recruitment overfishing. Recruitment overfishing occurs when individuals are harvested before they are able to replace themselves in the population, thus leading to the possibility of a stock collapse. Initial population simulations suggest a 27-inch minimum length limit for commercial harvest of shovelnose sturgeon may be needed to avoid recruitment overfishing.

Future Plans:
Population simulations will be conducted using additional data from the most recent field season. Additionally, analyses will be conducted to incorporate variation in population parameters to better evaluate the effects of harvest on shovelnose sturgeon populations.
Assessment of the Interrelationships Between Fish Population Dynamics and Limnological Characteristics of Iowa Lakes

Principal Investigator: Michael C. Quist
Student Investigator: Zachary J. Jackson (M.S.)
Collaborators: Joe Larscheid and Michael Hawkins, Iowa Department of Natural Resources
Duration: August 2005 to June 2008
Funding Source(s): Iowa Department of Natural Resources

Goals and Objectives:
- Evaluate patterns in fish assemblage structure among Iowa lakes using extant fisheries data,
- Describe and assess age and growth of indicator fish species,
- Examine relationships among fish assemblage structure, limnological conditions, lake basin morphology, and watershed characteristics.

Progress:
Databases containing length, weight, catch, and growth information were developed. A total of 113,103 fish were sampled the 2001-2006 study period representing 10 families and 44 species, of which 27,702 were aged. Multiple-linear-regression analysis was used to describe patterns among the study lakes and provide guidance for management activities. Specifically, multiple regression was used to model relations between fish population characteristics and physicochemical habitat and watershed characteristics. Fish population characteristics were further examined using nonmetric multidimensional scaling and showed similar patterns as the regression models. The final report was delivered in November.

Conclusions and Recommendations:
Lakes are important ecological and recreational resources and understanding relationships between fish, humans, and environmental conditions is critical for guiding and evaluating management activities. We examined fish populations, limnological conditions, lake basin morphology, and watershed characteristics over a large spatial area to evaluate patterns in population characteristics of important fish species in relation to environmental conditions. Fish populations and environmental characteristics were sampled from 129 Iowa lakes using standard techniques from 2001-2006. High water transparency resulted in high relative abundance, good condition, and fast growth of sport fishes in Iowa’s highly productive lakes. Catch rates of bluegill, black crappie, and largemouth bass were generally low when omnivores (e.g., black bullhead, common carp) were present. Body condition of the study species was highest in highly productive lakes (i.e., high nutrient or chlorophyll a concentrations) with clear water. We also found evidence that reductions of the abundance of black bullhead and common carp may benefit sport fishes in many systems and that activities resulting in increased densities of bluegill, largemouth bass, and black crappie will negatively influence condition and growth of these species. Although fish population dynamics were more closely related to biotic and limnological conditions compared to measures of lake basin morphology and watershed characteristics, many of the observed patterns are likely mediated by land use activities.
CURRENT FISHERIES PROJECTS

Relationships of Fish Communities and Availability of Deep-water Habitat

Principal Investigator: Clay L. Pierce
Collaborators: Gregory T. Gelwicks
Duration: May 2003 to August 2007
Funding Source(s): Iowa Department of Natural Resources

Goals and Objectives:
- The purpose of this study is to examine relationships of fish communities and populations of channel catfish and smallmouth bass with availability of deep-water habitat. The specific objectives are:
  - To quantify the existence of quality deep-water gamefish habitat in stream sections of interest.
  - To quantify fish community characteristics in the stream sections of interest.
  - To quantify channel catfish and smallmouth bass population size and growth rates in the stream sections of interest.
  - To explore relationships of fish communities and gamefish characteristics with availability of deep-water habitat.

Progress:
Twelve study reaches on 3 eastern Iowa rivers were surveyed for depth profile using a GPS/depth sonar. The collected data was entered into ArcGIS for analysis. Depths were categorized into four categories: shallow (0 to 1 meter), intermediate (1 to 2 meters), moderately deep (2 to 3 meters), and deep (greater than 3 meters). Depth variables were calculated for each category and analyzed. Preliminary depth zone maps have been created. Fish community data from new collections and existing databases were compiled for all study reaches. Fish community data have been entered into a database and used in summary statistics calculations (i.e. fish IBI scores, species abundances, etc.) for each stream reach. Smallmouth bass and channel catfish aging structures were collected from all study reaches. Structures have been cataloged and aged. Relationships between depth variables and fish variables were analyzed using correlation analysis and linear regression.

Future Plans:
Errors were found in the depth data and QA/QC checks are underway to correct them. New depth maps will be generated with corrected data, and analyses with fish community data will be completed.
Completed Fisheries/Aquatic Projects
Radio-telemetry Investigation of Common Carp in Clear Lake, Iowa

Principal Investigator: Clay L. Pierce
Student Investigator: Christopher R. Penne (M.S.)
Duration: June 2004 to August 2007
Funding Source(s): Iowa Department of Natural Resources

Goals and Objectives:
- The purpose of this study is to document seasonal locations, movements and tendency to aggregate of common carp in Clear Lake, Iowa. This information is necessary to evaluate potential future carp reduction strategies, such as targeted netting or poisoning. The specific objectives are to:
  - Capture, radio-tag and track sub-adult and adult carp over a period of two years.
  - Describe and quantify the seasonal locations, movements and tendency to aggregate of sub-adult and adult carp.
  - Interpret the results in light of the desire to reduce carp biomass through potential future carp reduction strategies, such as targeted netting or poisoning.

Progress:
Investigators began tracking in November 2004 and completed tracking in August 2006, totaling 22 months of year-round tracking and collecting over 2,100 study fish relocations. These data were used to construct maps detailing the seasonal distribution, habitat preferences, and aggregation areas of common carp in Clear Lake. A report was submitted to Iowa DNR and the results are being published in the Transactions of the American Fisheries Society.

Conclusions and Recommendations:
The common carp *Cyprinus carpio* is widely distributed and frequently considered a nuisance species outside its native range. Common carp are abundant in Clear Lake, Iowa, where they are both a symptom of degradation and an impediment to improving the water quality and fishery. We used radio telemetry to quantify seasonal distribution, aggregation, and habitat selection of adult and subadult common carp in Clear Lake in an effort to guide future control strategies. Over a 22-month period we recorded locations from 54 adults and 60 subadults implanted with radio-transmitters. Adults demonstrated a clear tendency to aggregate in an offshore area during the late fall and winter and in shallow vegetated areas prior to and during spring spawning. Late fall and winter aggregations were estimated to include a larger percentage of the adult population than in spring. Subadults aggregated in shallow vegetated areas during the spring and early summer. Our study, when considered with previous research, suggests repeatable patterns of distribution, aggregation, and habitat selection that should facilitate common carp reduction programs in Clear Lake and similar systems.
Physical Habitat Component of the Iowa REMAP Program

<table>
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<tr>
<td>Funding Source(s):</td>
<td>Iowa Department of Natural Resources</td>
</tr>
</tbody>
</table>

Goals and Objectives:
- Quantify stream habitat conditions in 45 sites per year throughout Iowa, representing 2nd-through 5th-order streams and all ecological subregions.
- Determine and describe relationships of stream habitat with fish communities, stream reach characteristics, land use and ecological subregions.
- Identify ecoregion, stream reach and land use characteristics associated with healthy stream habitat conditions.
- Identify stream habitat characteristics associated with fish assemblages.
- Evaluate and recommend habitat mitigation and rehabilitation alternatives.

Progress:
A completion report was delivered and results have been submitted for publication in Transactions of the American Fisheries Society.

Conclusions and Recommendations:
Fish assemblages play a crucial role in the assessment of stream health. Physical habitat is an important determinant of the integrity of stream fish assemblages. Streams in Iowa and other Midwestern states have been profoundly altered due to pervasive agricultural land use. We analyzed fish and physical habitat data from 93 randomly selected sites on wadeable Iowa streams to explore fish assemblage relationships with reach scale physical habitat. Sites were sampled using DC electrofishing and the USEPA EMAP wadeable streams physical habitat protocol. Non-metric multidimensional scaling ordination and stepwise multiple regression were used to explore, identify and quantify relationships. Ordination of sites by species abundance showed significant gradients related to stream size and stream health. Thirty variables were identified as significantly correlated to the ordination of fish assemblage and significantly differed between healthy and impaired sites. Eighteen physical habitat variables were identified as predictors of fish assemblage metrics. Variables described channel morphology, channel cross section and bank morphology, residual pool volume, relative bed stability, large woody debris, riparian vegetation, fish cover, proximity of human disturbance and substrate composition. Fish assemblages in wadeable Iowa streams are associated with the quality of the instream physical conditions that constitute an important part of their habitat. We discuss these results and likely causes of physical habitat conditions in an agriculturally dominated landscape.

Physical habitat is a key component of stream ecosystems and plays a major role in determining biotic assemblages and stream integrity. There is increasing recognition of the role landscape-level factors play in determining biotic assemblages and stream integrity. Landscapes in Iowa and other Midwestern states have been profoundly altered by conversion of native prairies to agriculture. We analyzed fish, physical habitat and landscape characteristics at multiple spatial scales from 93 randomly selected sites on wadeable Iowa streams to explore relationships between fish assemblage, reach scale physical habitat and landscape characteristics. Non-metric multidimensional scaling ordination and stepwise multiple regression were used to explore, identify and quantify relationships. Ordination of sites by physical habitat showed significant gradients of channel shape and habitat complexity, substrate composition and stream size. Land cover variables were strongly correlated with channel shape and habitat complexity, and catchment land area and gradient were correlated with stream size. Fish assemblage was associated with gradients of land cover and stream size. We describe a spatial gradient of stream impairment from northeastern Iowa to southwestern Iowa as the interaction of an East-West gradient of increasing row crop land cover in local riparian buffers and a North-South gradient of decreasing coarse substrate availability. Our results support hierarchical stream system theory and support the view that landscape-level factors strongly influence mainly physical habitat characteristics in streams, and that, in turn, these physical habitat characteristics strongly influence stream fish assemblages. We discuss these findings and recommend scale-appropriate management strategies to protect and improve streams in Iowa’s agriculturally dominated landscape.
COMPLETED FISHERIES PROJECTS

An Integrated Immunological-GIS Approach for Bio-monitoring of Ecological Impacts of Swine Manure Pollutants in Streams

Principal Investigators: James A. Roth, Bruce W. Menzel, Clay L. Pierce, Dusan Palic
Duration: September 2002 to September 2006
Funding Source(s): U.S. Geological Survey, National Institute for Water Resources

Goals and Objectives:
- Evaluate hypothesis through a series of laboratory immunological assays applied to the test organism, the fathead minnow (*Pimephales promelas*)
- Identify one or more assays for use as a bio-monitoring technique to detect ecological impact of manure pollution in nature. A subsequent task involves use of digital environmental databases that are maintained and managed by the USGS BRD Iowa Cooperative Fish and Wildlife Research Unit at Iowa State University.
- Characterize a number of Iowa watersheds and stream systems according to their potential susceptibility to hog manure pollution and to use this information to design a water quality and fish sampling regime.
- Quantitatively measure ecological impact of manure pollution on the streams.
- Evaluate the utility of this approach as a biomonitoring tool for environmental protection agencies.

Progress:
A completion report was delivered and results have been submitted for publication.

Conclusions and Recommendations:
2003 - Fathead minnow colony was successfully established. We have developed and constructed the computer controlled flow through system, but water heating problems caused unexpected delays in project timeline. We have developed the isolation technique for extracting leukocytes from fathead minnow kidney. We finished morphological and cytochemical characterization of prepared leukocytes. We have developed and optimized assay for measuring production of reactive oxygen species in isolated neutrophils by cytochrom C reduction method.

2004 - We have developed and optimized assay for degranulation of primary granules. The assay is capable of detecting handling and crowding stress as well as differences in various stress causing treatments (anesthesia procedures). We established baseline values for FHM neutrophil oxidative burst, myeloperoxidase content and degranulation. We have tested developed assays on several fish species (Catfish, Bluegill, Largemouth bass). We have started production of GIS maps in order to determine possible manure/chemical loads within designated watersheds. We have tested electrofishing equipment and assayed fish samples with our developed techniques.

2005 - We expanded the battery of assays with NETs (neutrophil extracellular traps) release assay, and tested existing battery of assays with different immunomodulators. We calibrated the assays to be used in fathead minnows and optimized assays for use on bluegills, largemouth bass, common carp and catfish. We have compiled GIS map of surfaces likely exposed to manure loading and currently are preparing maps for use in flow path analysis. We continued sampling in order to optimize sample collection and laboratory procedures for rapid and efficient analysis of neutrophil function from field samples. USGS approved extension of the project to 09/2006.

2006 - Flow path analysis for the State of Iowa has been partially completed and the analysis is ongoing. Data on fish kills and Iowa Department of Natural Resources fish community sampling was requested form IA DNR and is included in the GIS analysis of the flow path. Laboratory testing of manure effects on neutrophil function is ongoing.

2007 - To analyze the flow path and relations of the field application of manure to stream network, TauDEM extension for ArcGIS was used. Also, two functions, Decaying Accumulation Function and Upslope Dependence Function, were applied to resolve the manure flow. Using this approach, we estimated spatial distribution of manure loads and concentrations that reach receiving waters and determined stream sections with high potential for critical manure exposure. Described procedure has the potential to provide the basis for a field sampling regime to determine the actual conditions of water quality and fish communities at stream sites selected to represent a range of calculated manure pollutant loadings. Furthermore, changes in landscape features can be utilized in the model to assist management decisions. The presented model has significant potential for use in the determination of critical points in streams exposed to manure contamination and investigating effects of land cover changes on runoff from fields.
EXAMPLE AERIAL VIEWS OF AGRICULTURAL LANDSCAPE WITH A STREAM ILLUSTRATING CAPABILITY OF PROPOSED ANIMAL WASTE FLOW MODELING. VIEWS OF FIELDS RECEIVING ANIMAL WASTE AND LOCATIONS OF WASTE DISPOSAL FACILITIES, HYPOTHETICAL ANIMAL WASTE APPLICATIONS AND PREDICTED FLOWS, AND RESULTING STREAM ENTRY POINTS.
CURRENT WILDLIFE/TERRRESTRIAL PROJECTS
**CURRENT WILDLIFE PROJECTS**

**Assessment of Environmental Services of CREP Wetlands in Iowa and the Midwestern Corn Belt**

**Principal Investigators:** David L. Otis
William G. Crumpton
Rex Johnson, U.S. Fish and Wildlife Service
Mark VanDever, U.S. Geological Survey, Ft. Collins Science Center

**Collaborators:** Kevin Kane, Robin McNeeley, and Anna Loan-Wilsey

**Duration:** September 2007 to December 2008

**Funding Source(s):** USDA Farm Services Agency

**Goals and Objectives:**

- Conduct assessment of nitrogen removal, hydrological storage, carbon sequestration, and wildlife habitat enhancement services in existing and potential Iowa CREP wetland sites.
- Model predictions for simulated populations of wetland sites that would result in a 30% reduction in nitrogen load to the Mississippi River.
- Design similar assessment of various scenarios for the Midwestern Corn Belt region.

**Introduction:**

The Conservation Reserve Enhancement Program (CREP) is intended to protect environmentally sensitive land, decrease erosion, restore wildlife habitat, and safeguard ground and surface water. CREP combines an existing USDA Conservation Reserve Program administered by the Farm Services Agency (FSA) with state programs to provide a framework for partnerships to meet specific State and National environmental objectives. The Iowa CREP specifically involves 37 counties in the tile-drained north central region of Iowa, and its primary goal is to restore wetlands that intercept tile drainage from agricultural watersheds that function as nitrogen sinks to reduce downstream nitrogen loads.

In recognition of the need for science-based information of the potential of Iowa CREP program performance in reducing nitrogen loads and in providing additional environmental services, FSA has requested a assessment of these multiple services; specifically: nutrient and sediment reduction, hydrological storage, carbon sequestration, and wildlife population enhancement. The assessment will be accomplished primarily by use of currently available predictive models that relate landscape context and wetland/buffer attributes to physical/biological responses. Additionally, we will investigate tradeoffs in these services as a function of site attributes and spatial distribution in Iowa, with the goal of informing future CREP program implementation throughout the Midwestern corn belt region.

Co-PIs will be responsible for modeling potential nitrogen reduction, hydrological storage, and wildlife response of resident and migratory bird species. We will also establish a monitoring program for vegetation communities in existing CREP projects.

**Progress:**

We have begun to assemble the necessary GIS data for modeling the wildlife habitat and nitrogen removal functions of the set of constructed CREP wetlands and a set of representative potential additional wetland projects.
Statistical Support of the Iowa DNR Wildlife Bureau Research Program

Principal Investigator: David L. Otis  
Student Investigator: Brad Heller (M.S.)  
Duration: August 2007 to August 2009  
Funding Source(s): Iowa Department of Natural Resources  
Goals and Objectives:  
- Provide statistical design and analysis support for Wildlife Bureau research projects.

Introduction:  
The goal of this project is to provide statistical design and analysis support for DNR wildlife research projects, and a training opportunity for a graduate student with a career interest in wildlife biometrics. Specific objectives described below represent a combination of specific statistical project tasks to be accomplished, and opportunities for additional statistical consulting and relevant field experience.

Landscape Features Associated with the Bobwhite Quail Decline in Iowa. During the past 2 decades, the DNR has been increasingly concerned about the decline in Iowa’s bobwhite quail populations. Iowa agricultural statistics show the number of farms has decreased 53% since 1940, while farm size has increased 106% (Sands and Holden 1995). Although agricultural statistics report changes in the number and size of farms in Iowa, they provide insufficient information about habitat availability and spatial pattern that are relevant to bobwhite management. Our objective is to quantify, at several points in time, landscape habitat metrics across southern Iowa’s bobwhite range, and then relate these metrics to corresponding bobwhite population status. Aerial photography for a random sample of 72 public land survey sections in Iowa’s southern bobwhite range was obtained from local or national USDA-NRCS offices for each selected section. Aerial photos for three time periods, the 1940s, 1960s, and 1980s, were collected for each section. Land use classifications were defined using categories most often reported in the literature as being meaningful to bobwhite. Aerial photos were digitized and basic summary statistics of land use categories were calculated for each time period. We will continue the analysis beyond the present status by i. obtaining recent aerial photography for the 72 sections and create digital GIS coverage for this recent time period following the same procedures as above, ii. calculate relevant spatial and compositional landscape metrics for each section and time period, iii. statistically evaluate changes in these metrics among the four time periods, and iv. explore correlations between southern Iowa landscape attributes during the 4 time periods and the corresponding bobwhite population/harvest indices.

Canada Goose Harvest and Survival in Iowa. The DNR bands and releases 4,000-5,000 Canada geese annually in Iowa. Some are banded in areas closed to Canada goose hunting, some in urban areas, which are by default closed to hunting, and some in areas that are hunted every year. The hunting seasons have varied from 55 days to 90 days in the past 10 years and a special early September hunting opportunity has been added in some years. Band recovery information will be analyzed to answer questions about the effects of changes in hunting seasons and closed zone sizes on harvest and survival rates of Canada geese in Iowa. These analyses will help inform the DNR about the relationship between a 90-day season in Iowa and resident goose population abundance in Iowa. We will collaborate with DNR staff to develop appropriate goose band recovery datasets. We will use program MARK to construct and evaluate alternative hypotheses about the effects of harvest regulation attributes on survival and harvest rates.

Additional Assistance As Requested. We anticipate that additional statistical assistance and student training opportunities will arise during the period of performance of this agreement. These situations will be dealt with on an ad hoc basis, based on current workload and relative priorities. At the completion of the first year of the project, specific project objectives will be revisited and modified as necessary.

Progress:  
A student was recruited and began his graduate program in August. The student has been reviewing scientific literature and DNR reports relevant to the bobwhite and goose projects, and has been introduced to statistical analysis techniques for band recovery data.
Current Wildlife Projects

Development of Harvest Strategies for Mourning Doves

Principal Investigators:  David L. Otis  
Philip M. Dixon  
John Sauer, U.S. Geological Survey, Patuxent Wildlife Research Center

Duration:  July 2006 to July 2008

Funding Source(s):  U.S. Fish and Wildlife Service

Goals and Objectives:

- Develop statistical techniques for combining CCS and population growth rate estimates derived from banding and harvest data to produce reliable predictions of population status and trend.
- Develop a detailed harvest management framework that continuously integrates monitoring data, population models, and harvest and population objectives into a harvest management system.
- Develop a Banding Needs Document driven by information required for accomplishment of objectives above.

Progress:

Based on a renewed emphasis on more informed harvest management for mourning doves, the Mourning Dove National Strategic Harvest Management Plan (National Plan) was approved in 2003 by the Flyway Councils. The foundation of this strategy is a set of population models that predict population growth and harvest as a function of survival and recruitment rates. In 2004, the USFWS became concerned about the need for a more formalized harvest strategy during the time period required for implementation of the National Plan. In 2006, the USFWS requested interim strategies that would rely more heavily for the next few years on CCS trends and more rigorously derived regulation change thresholds. Subsequent discussions within the dove management and research community led to the concept of development of interim strategies that utilize CCS and BBS survey databases and the time series of population growth rates that will result from an operational banding program and continuing harvest survey. These strategies and associated statistical technique development must be constructed within the context of continuous progress toward implementation of the National Plan, and thus this project is also intended to serve as a catalyst for development of a more specific stepwise plan for transition to the National Plan.

In consultation with state and federal dove harvest management biologists, it was decided that a composite estimator of annual trend derived from application of Bayesian hierarchical modeling techniques would be used as the basic metric for making harvest regulation decisions in a new interim strategy. Population indices at the state level from the CCS (both number heard and number seen) and BBS surveys (1966 - 2006), as well as population estimates derived from harvest data (2003 - 2006), constitute input into the statistical model. Estimates of retrospective trends and their posterior probability distributions for several alternative time periods were derived from this composite model, and initial simulated results of the performance of alternative harvest management strategies based on these estimates were provided to the management unit technical committees in fall 2007. Finalized harvest strategies based on these results will be presented for approval by the flyway technical committees in 2008, with expected implementation in the 2009 dove harvest regulation cycle.

Future Plans:

Finalized harvest strategies based on these results will be presented for approval by the flyway technical committees in 2008, with expected implementation in the 2009 dove harvest regulation cycle. We will explore ideas for integration of our hierarchical modeling technique with mechanistic population and harvest models to produce more informed, theoretically derived harvest strategies as envisioned in the National Plan. A draft Banding Needs Document will be provided to USFWS staff for review.
Bird Response to Enhanced Vegetation Diversity in the Spring Run Complex of Northwestern Iowa

Principal Investigators: Rolf R. Koford  
David L. Otis  

Student Investigator: Jennifer Vogel (Ph.D.)  

Collaborators: Todd R. Bogenschutz, Iowa Department of Natural Resources  

Duration: June 2006 to August 2010  

Funding Source(s): Iowa Department of Natural Resources  
U.S. Fish and Wildlife Service  

Goals and Objectives:
- Quantify bird use of four habitat types that have been or might be established on managed land in the Spring Run Complex.
- Monitor vegetation composition and structure in each habitat and map land cover classes around each study field.
- Estimate nest success, nestling growth rate, and brood survival of common bird species using each habitat type.
- Measure invertebrate populations in the three habitat types.

Progress:
The Spring Run Wetland Complex of northwest Iowa is one of the largest grassland units in the state, and it has been recognized as an official site in the National Audubon Society’s Important Bird Areas program. Previous research indicated that increased vegetation diversity could enhance the reproductive success of grassland birds.

During the spring of 2007, we selected and mapped an additional 15 study fields in the Spring Run Complex. Two of the 15 fields were located on private lands. We now have a total of 24 study fields arranged in a complete block design: 6 blocks each with 4 field types. The four field types are (1) Cool Season - introduced grasses (e.g. smooth brome, reed canary grass, Kentucky bluegrass, timothy) with scattered legumes such as alfalfa, sweet clover, and Canada thistle, (2) New CP-2, a mix of native tall-grass species (e.g. big bluestem, little bluestem, switchgrass, side-oats grama, Indian grass) planted since 2000, (3) Old CP-2, a mix of native tall-grass species (e.g. big bluestem, little bluestem, switchgrass, side-oats grama, Indian grass) planted before 2000, and (4) Primo, a diverse mixture over 40 species of forbs and native grasses. In each of the 15 fields, we laid out transects for estimating bird densities and vegetation structure/composition.

In the summer of 2007, we conducted 6 line transect bird surveys, 2 vegetation surveys, and 3 invertebrate sweep net surveys on all fields. We conducted nest searches for grassland songbirds on all fields using systematic searches and behavioral observations. Data on nest success were recorded for each nest encountered. Dickcissel nestlings were banded with numbered aluminum bands and a unique combination of colored leg bands, and were weighed and measured (tarsus and wing) in the nest from day 3 until fledging. At 6-7 days (just prior to fledging), Dickcissel nestlings were fitted with radio transmitters attached with a combination of glue and backpack harnesses. Dickcissel fledglings were tracked twice daily post-fledge until they either died or left the study area.

We detected 3,280 individuals of 38 different species during our 2007 bird transect surveys. The most common species encountered in the study area were Red-winged Blackbirds, Common Yellowthroats, Bobolinks, and Sedge Wrens. We are formatting data from bird transect surveys for analysis with program DISTANCE to estimate species densities in the four field types. We have started the process of sorting invertebrate samples (to Order) for later drying and weighing to get estimates of food resource availability for each field. Vegetation, nest, and telemetry data have been entered into a computer database and are being verified for accuracy.

Future Plans:
Data collected during the 2007 field season will continue to be analyzed during the spring of 2008. Bird transect surveys, vegetation surveys, and invertebrate surveys will continue during the summer of 2008. Preliminary analyses of nest and telemetry data will guide our decisions about how to proceed with these techniques during the summer of 2008.
Development and Evaluation of Methods for Regional Monitoring of Mourning Dove Recruitment

Principal Investigator: David L. Otis
Student Investigator: David Miller (Ph.D.)
Collaborators: John Schulz, Missouri Department of Conservation
Paul Padding, U.S. Fish and Wildlife Service

Duration: August 2005 to August 2009
Funding Source(s): U.S. Fish and Wildlife Service
Multiple State Wildlife Agencies

Goals and Objectives:
- Calibrate juvenile to adult ratios of harvested doves in order to produce an unbiased estimate of annual recruitment of juveniles into the fall population based on wing collection surveys.
- Evaluate potential sampling designs and logistical constraints for a national harvest wing survey for monitoring recruitment.
- Determine the potential for employing recaptures from an intensive banding program to generate independent estimates of age ratios that can be used to validate wing survey estimates.
- Improve understanding of intra-annual variation in reproductive output of breeding doves.

Progress:
A national mourning dove national strategic harvest management plan was adopted in 2003 by state and federal migratory game bird managers. The plan identifies a need for monitoring annual recruitment of juveniles into the fall population. Harvest age ratios derived from harvested wing collections are a traditional method for estimating fall age-ratios for game bird species. However, before a reliable operational wing survey can be implemented, a number of issues must be addressed. These include the need to calibrate harvest wing age ratios to produce an estimate of true age ratios, to evaluate the efficiency of different sampling protocols to meet the information needs for doves, and to validate the accuracy of age ratio estimates using independent data. There is also a need to increase our understanding of the basic breeding biology of the species, which will in turn assist with interpretation of recruitment estimates.

During the 2005-2007 hunting seasons, 22 states collected >90,000 wings from 58 unique degree blocks. Age and molt score data were recorded from 2005-2006 wings in national wing bees. A matched sample of age and molt scores was collected from birds captured and released during summer banding operations in the same study sites. These 2 datasets have been used to develop and evaluate statistical models for calibration of harvest age ratios into estimates of fall recruitment. Classification of unknown age wings has focused on projecting primary molt scores hatch year and after hatch year birds caught during late summer when almost all can be aged to the time of harvest. The best non-linear least squares fit between the two distributions is used to estimate molt rates and corrected harvest age ratios. Initial simulation results using 2005-2006 data suggested we can successfully correct estimates to account for unknown age wings.

A field study on dove reproductive biology has been conducted in central Iowa during the 2005-2007 breeding seasons. We have monitored >200 nests in each year. More than 100 adults have been trapped on nests, measured, and marked, and a blood sample taken. In addition, blood samples were taken from ~700 squabs in order to determine their sex using PCR techniques. This information will help to determine whether there are sex specific patterns in growth and recruitment for the population. Additional field work was focused on measuring growth rates of squabs and focused on understanding factors that affect growth and development during the nestling stage. We are analyzing data to examine the relationship of hormone levels to reproductive investment in doves, the role of development on future flight ability, and the role of egg size and hatching asynchrony on development and growth. A captive bird experiment was conducted to evaluate the effects of early stress on growth, adult size, and flight ability.

Future Plans:
A third annual wingbee will occur in January, 2008 to collect the third and final year of age ratio data. We are continuing to improve our statistical estimation technique to correct harvest age ratios for unknown age birds and to generate variance estimates for the corrected age ratios. We also plan to conduct Monte Carlo simulation experiments to evaluate the statistical performance of these methods.
Amphibian Malformation and Disease in Midwestern Landscapes

Principal Investigator: David L. Otis
Student Investigator: Jenny Loda (M.S.)
Vince Evelsizer, Iowa Department of Natural Resources
Duration: October 2002 to December 2007
Funding Source(s): USGS National Wildlife Health Center
Iowa Department of Natural Resources

Goals and Objectives:
- Estimate the strength of relationships between amphibian species abundance and richness and a suite of land use and physical/chemical water quality parameters in semi-permanent Iowa wetlands.
- Estimate the prevalence of chytrid fungus in the sample wetlands.

Progress:
In 2005, collaborators in the Iowa DNR initiated a survey of water quality and land use parameters in a random sample of 29 semi-permanent wetlands in the Winnebago watershed in northern Iowa. In the summer of 2005, we collected amphibian community data on a subsample of these wetlands to develop amphibian field sampling techniques to be used in 2006. We also discussed with NWHC collaborators the field and laboratory techniques that would be used to collect and process chytrid fungus samples from juvenile frogs. In the spring and summer of 2006, we used a combination of call surveys, visual encounter surveys, and funnel traps to survey amphibians in all wetlands on 3 occasions; in 2007, we conducted 3 call surveys at each wetland. Northern leopard frogs, western chorus frogs, and American toads were detected at all sites at least once during 2006-7, gray treefrogs were detected at 21 wetlands, and tiger salamanders were detected at 9 wetlands. The percentage of wetlands with evidence of successful reproduction was high for American toads (86%) and leopard frogs (72%), and much lower for chorus frogs (34%), tiger salamanders (31%), and gray treefrogs (13%). There was consistent evidence of a negative association between anuran reproductive success and wetland concentrations of the herbicide alachlor and its degradates, and weaker evidence of a negative association with phosphorus concentrations. There was no evidence of an effect of atrazine on reproductive success. Species richness was greater in wetlands without fish species and no tiger salamander reproduction was recorded in wetlands with fish. Neither percent of crop or wetland density within the surrounding landscape was associated with presence of amphibian species or reproductive success in a wetland.

Chytrid samples were collected in 2006 using a swab technique from 720 leopard frog tadpoles, 25 metamorphs, and 10 adults in 22 wetlands. We utilized a real-time Taqman PCR assay to test for infections of *Batrachochytrium dendrobatidis* (*Bd*). *Bd* was detected on swabs from 5 adults, in 5 of 8 sampled wetlands (62% prevalence), but no tadpoles or metamorphs were positive for *Bd*.

Future Plans:
Additional *Bd* samples from adult leopard frogs were collected in 2007 from several wetlands, and these samples will be analyzed in 2008. We may try to extend the study by surveying wetlands again in 2008. Emphasis will be on further investigation of the potential negative effects of alachlor and phosphorus on anurans, and on additional documentation of the prevalence and spatial distribution of *Bd* in both early and late life stages of leopard frogs.
COMPLETED
WILDLIFE/TERRESTRIAL
PROJECTS
Effects of Prairie Restoration Using Fire and Grazing Regimes on the Butterfly Community of Iowa’s Loess Hills

Principal Investigators: Diane M. Debinski, Rolf R. Koford, James R. Miller
Student Investigator: Jennifer Vogel (M.S.)
Duration: May 2004 to April 2007
Funding Source(s): Iowa Department of Natural Resources

Goals and Objectives:
- Evaluate how grazing and burning management regimes affect butterfly species richness and abundance.
- Determine whether butterfly eggs or early instar larvae can survive a burn.
- Assess whether Regal Fritillary (Speyeria idalia) butterfly populations within a 0.5-5 km² area management unit within the Loess Hills prairie can recover within one or two years after a prescribed burn.
- Provide recommendations on best management practices for prairie restoration based on the results of this study combined with relevant information from the literature.

Progress:
A Master’s thesis was filed in 2006 (abstract below), and two manuscripts from this work have been submitted for publication in peer-reviewed journals.

Conclusions and Recommendations:
Fire and grazing are common methods used for prairie restoration and conservation. However, effects of restoration on grassland invertebrates have been evaluated with mixed results. We examined the effects of prairie restoration through fire and grazing and the relative contributions of the direct and indirect effects of time since fire on the grassland butterfly community of the Loess Hills of Iowa. Both total and habitat-specialist (prairie-dependent) butterfly abundance were highest on prairies that were managed with grazing and burning, and lowest on those that were only burned. Butterfly species richness did not differ among any of the management types. Responses of individual butterfly species to management practices were variable. In the best predictive models, both habitat-specialist and total butterfly abundance were negatively associated with the percent cover of bare ground, total butterfly abundance was positively associated with the percent cover of forbs, and habitat-generalist butterfly abundance was positively associated with floral resource availability. Areas managed with fire, grazing, or a fire/grazing combination all maintained equally species rich, yet compositionally different, butterfly communities. Butterfly abundance increased as time since burn increased. The percent cover of warm season grasses increased with time since burn. We used path analysis to examine direct and indirect effects of burning. For habitat-specialist species abundance path models, the total indirect effects of time since burn through floral resources, warm season grass cover, or bare ground were stronger relative to the direct effect of time since burn. The indirect pathway through bare ground had higher relative strength than other indirect paths in the models for habitat-specialist species. For the habitat-generalist species path models, the direct effect of time since burn was stronger relative to the indirect effects. Because of this variation in butterfly species responses to different management practices, we do not recommend a single type of management that would benefit all species or even all species within habitat-specialist or habitat-generalist habitat guilds. Our data illustrate the profound effects, both direct and indirect, of fire on grassland butterfly abundance.
COOPERATING FACULTY PROJECTS
**Cooperating Faculty Projects**

**Develop a User-Friendly Interface for Iowa’s Lake Databases – Watershed, Water Quality and Fisheries**

**Principal Investigator:** John A. Downing  
**Duration:** January 2008 to April 2008  
**Funding Source(s):** Iowa Department of Natural Resources

<table>
<thead>
<tr>
<th>Goals and Objectives:</th>
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<td>To provide the Iowa Department of Natural Resources with improved custom reporting of DNR Fisheries data along with relevant information from the Iowa Lakes Information System and Iowa Water Database. Improved reporting will involve expanding the capability to upload data from these data sources for the creation of printable summary lake reports (“Mini-reports”) specific to DNR Fisheries needs. The purpose is to enhance printable lake mini-reports geared toward local management needs and public use. Included is the ability to choose from a select group of report components, then download and print the desired information.</td>
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**Introduction:**
Starting in June 2001, the ISU Limnology Lab, assisted by the DNR, worked to create a computerized data system of Iowa lake data and information and to analyze these integrated data into a lakes classification system toward the prioritization of Iowa lakes for restoration and conservation (Downing, 2005). At completion of the Lakes Information System, in May of 2005, the DNR had expressed a desire to integrate past lake fisheries data and develop an on-line reporting function.

The ISU Limnology Lab Integrated past DNR Fisheries data, specifically Age Growth data, Fyke Net / Shocking data, Macrophyte Surveys, and Management History with the Lakes Information System. There were two main components to the integration of past data. The database migration and redesign phase, which included researching past database information and definitions. In addition, integration involved consolidating all database components into the Iowa Lakes Information System. The second component was data transformation into SQL Server and data cleaning phase, which included uploading data to the SQL database and verifying data integrity with source material.

On-line reporting involved integrating DNR Fisheries data within the Lakes Information System web site. Following preparation of data files into the correct format and incorporation of data into the Lakes Information System, work was initiated to present the information online. Web pages were designed to access fisheries data online as a component of the overall Lakes Information System.

The DNR also expressed the desire to create user-friendly tools to retrieve and present water quality and fisheries information. Under the work plan a printable mini-lake report function, geared toward public use and local management needs, was developed. Report generation included the ability to choose from a select group of report components, then download and print the desired information in PDF format.

The benefit of providing fisheries data along with water quality information is to help deal with the diverse nature of resource improvement projects and to create a broader understanding of water quality management in the context of the fisheries resources of the State of Iowa. Customized mini-reports will meet the anticipated needs of the public and resource managers for a more interpretive product. The goal is for the user to be able to choose various components of individual lake reporting and have a computer compiled PDF report generated in a printable format. ISU limnology will work in conjunction with DNR staff members to insure that reporting style meets the needs of both public and resource manager needs.

**Progress:**
We have completed phase 1 of the work and have begun the second phase. This phase will improve the format of the reports and make them more widely available.

**Future Plans:**
Complete the second phase of the work.
A Landscape Genetics Approach to Assessing the Risk of CWD-infected White-tailed Deer Dispersing From Wisconsin to Iowa

Principal Investigator: Julie A. Blanchong
Student Investigator: Krista Eucken (M.S.)
Duration: January 2008 to December 2009
Funding Source(s): Iowa Department of Natural Resources

Goals and Objectives:
- Characterize population genetic structure (i.e., relative rates of dispersal) among deer harvested from counties in Iowa and Wisconsin that border the Mississippi River.
- Characterize the influence of features of the Mississippi River on genetic connectivity between Iowa and Wisconsin deer populations (i.e., the permeability/resistance to deer movement).
- Use results from objectives 1+2 to identify regions of Iowa where deer are at highest risk of CWD infection based on rates of genetic exchange with Wisconsin deer.

Introduction:
The potential for introduction and spread of chronic wasting disease to Iowa’s free-ranging deer population is of great concern. The increasing spatial area over which CWD-infected free-ranging white-tailed deer are being found in Wisconsin and Illinois is of particular concern because of their proximity to the Iowa border. While CWD appears to spread geographically at a slow rate, it is difficult to detect disease in a population when it is rare and often multiple years of monitoring and the testing of large numbers of animals are needed requiring substantial resources in terms of time, personnel, and finances. Identifying factors influencing the spatial spread of disease, however, is critical to determining which populations are at highest risk of outbreaks, targeting surveillance efforts, and designing effective disease control and containment programs.

Although considerable uncertainty exists about the mechanism for CWD spread across the midwestern landscape, dispersing deer are likely an important avenue of disease spread. In Wisconsin, based on harvest data, infected males appear to be more broadly distributed across south-central Wisconsin than females, reinforcing the hypothesis that male dispersal plays an important role in the spread of CWD. Studies of deer dispersal indicate that dispersal distance and direction in white-tailed deer are influenced by landscape features such as habitat type and degree of fragmentation. A landscape genetic analysis (an analysis that aims to identify how landscape features influence genetic discontinuities within or among populations) in Wisconsin demonstrated that the spatial distribution of CWD was strongly correlated with features of the landscape that influence deer dispersal (as measured by gene flow). Such results suggest that a landscape genetics approach can be used to predict risks of disease spread into areas not yet infected with CWD.

The goal of the proposed project is to integrate genetic tools (measurement of gene flow (i.e., deer dispersal)) with landscape ecology (identification of habitat permeability and landscape features that influence deer movement) to characterize the risk of disease spread from Wisconsin to Iowa via the dispersal of infected free-ranging deer. This project will be coincident with and build on a similar project being conducted in Wisconsin aimed at predicting the spread of CWD throughout Wisconsin. Results will help Iowa identify and focus disease surveillance and control activities on regions of Iowa where deer are at greatest risk of infection.

Progress:
Funding from the Iowa Department of Natural Resources has been secured, and a graduate student, Krista Eucken has been recruited to begin work in January, 2008.

Future Plans:
In January 2008, Krista Eucken will begin work towards achieving the objectives listed above. Initial activities will concentrate on selecting appropriate deer samples and selecting and optimizing molecular markers for characterization of population genetic structure.
Conservation Genetics of the Freshwater Mussel *Margaritifera hembeli* (Bivalvia: Margaritiferidae)

**Principal Investigator:** Kevin J. Roe  
**Duration:** September 2007 to March 2009  
**Funding Source(s):** U. S. Geological Survey, U.S. Fish and Wildlife Service

**Goals and Objectives:**
- The objective of the project is to document population genetic structure, the extent of gene flow, and historical connections between populations of the Louisiana Pearlshell (*Margaritifera hembeli* Conrad, 1838). This information could be used in identifying unique or genetically distinct populations of this threatened species and serve as guidelines for future conservation related actions such as hatchery propagation and reintroduction or population augmentation aimed at reversing declines and preventing extinction of this species throughout its range.

**Introduction:**
*Margaritifera hembeli* is one of five members of the freshwater mussel family Margaritiferidae in North America and one of three species found in the southeastern U.S. *Margaritifera hembeli* occupies a restricted range and has been found in only the Red River and Bayou Boeuf drainages in the state of Louisiana. Population distribution of *M. hembeli* has been described as patchy, typically large beds of mussels are found in shallow areas in small streams with stable substrate that are separated from other such beds by areas of less stable substrate inhabited by few or no individuals.

This type of distribution implies that isolated mussel beds of *M. hembeli* may show some degree of genetic differentiation. In addition, because these populations are spread across two separate watersheds, there is a strong likelihood that populations from these drainages will exhibit significant genetic differentiation from each other. In the absence of gene flow there is the possibility that these populations are currently exhibiting the effects of sustained population size restrictions such as loss of genetic diversity and reduced fitness. Loss of genetic diversity is associated with reduction in population size and extinction of populations (e.g. Bouzat et al. 1998). Prior examination of population variation in *M. hembeli* using allozymes (Curole et al. 2004) found little variation but the authors recommended further investigations using hyper-variable loci such as microsatellites. DNA sequences and microsatellites typically reveal greater variation than allozymes. Information on genetic diversity and degree of genetic connectivity between extant populations is a critical part of developing an effective conservation plan including developing parameters and priorities for population augmentation or species re-introduction. In addition, population genetic information in conjunction with incomplete or partial natural history data can also be used in a predictive manner to aid in the determination of likely host fishes, habitat requirements and other life-history parameters.

Knowledge of the population genetic structure of this species is critical to guiding the propagation and reintroduction of individuals. Such information is necessary to avoid problems of further reductions in fitness associated with inbreeding depression as well as the disruption of co-adapted gene complexes via outbreeding depression. Additionally, any propagation work should attempt to replicate natural recruitment levels within healthy populations of *M. hembeli*. Use of hyper-variable genetic markers can provide information on parentage and thereby allow the estimation of reproductive success of individual mussels as well as the construction of pedigrees that can be used to develop and monitor captive breeding programs.

**Progress:**
As stipulated in the proposal, the project will be conducted in three phases described below:
- **Phase I** – Generate species-specific microsatellites for *M. hembeli*. Obtain specimens from across the species’ range.
- **Phase II** – Screen potential microsatellites.
- **Phase III** – Determine genetic diversity of *M. hembeli*.

**Future Plans:**
Following extraction of DNA samples and identification of microsatellite markers, individual screening and construction of the dataset will begin.
Insect Survey of Aquatic Habitats in Iowa

Principal Investigator: Gregory W. Courtney  
Student Investigator: Jessica Davis (Ph.D.)  
Duration: July 2007 to July 2008  
Funding Source(s): Iowa Department of Natural Resources  

Goals and Objectives:
- The short-term goals of this research that are to: 1. identify as many taxa to species level as possible by soliciting help from specialists, 2. identify the remaining specimens to family, 3. correlate taxon richness with environmental/habitat variables and identify potential indicator taxa, and 4. make the lists of taxa available as an interactive web-based learning program.

Introduction:
Little is known about the distribution and identity of the insects of Iowa. Data on the insects of Iowa will be gathered via Malaise trap sampling, a form of passive flight intercept sampling. Volunteer school groups, individuals and conservation organizations will be contacted to help with different aspects of the project such as collecting and identifying specimens.

Progress:
In 2007 we set Malaise traps at six locations in Iowa (Bixby State Preserve, Cedar Bluffs State Preserve, Rock Island State Preserve, Behren's Pond State Preserve, Hanging Bog State Preserve, and Snyder Bend). Traps were out from approximately May through August, 2007, as a preliminary assessment of the project feasibility, volunteer activities, and sorting.

Volunteers were a tremendous asset to this project. All volunteers said they enjoyed the project and were satisfied knowing that they were benefiting science even though most were non-scientists. We have since kept in touch with most volunteers regarding the sorting and any interesting findings. We will continue to build these relationships in hopes of keeping the same volunteers for 2008, in addition to looking for more volunteers where necessary.

Two students, one from Briar Cliff College and the other from Cornell College, have taken full responsibility for one trap each. Both students report that they are making good progress in their sorting of samples. Entomology classes at Briar Cliff have been involved with a great deal of the sorting. Entomology classes at ISU have also assisted with sorting the samples. One student in particular has been quite involved in sorting and plans to conduct an independent study project to help develop the webpage on Iowa insect species.

We have sorted Bixby, Behren's Pond, Cedar Bluffs and Hanging Bog samples to order. We have also sorted out specific families (Meropeidae, Bittacidae, Panorpidae, Tipulidae, Psychodidae, Formicidae, Culicidae, Cercopidae, Asilidae) where we have known collaborators to identify these families to lower taxonomic levels. Aquatic groups (Plecoptera, Trichoptera and Ephemeroptera) also are separated and ready to ship to collaborators at the Iowa Hygenic Lab for species identification. Coleoptera are being sorted to family by a volunteer citizen scientist in eastern Iowa. Certain families of Coleoptera will be sent to specialists (Scarabidae, Carabidae, Cercopidae, Coccinellidae). Hymenoptera will be sent from specialist to specialist with each individual sorting to their specific specialty.

As stated in our proposal, Malaise trap sampling increases the possibility that we will discover rare and interesting species. Among such discoveries are new records of both female and male specimens of Merope tuber at three locations (Bixby, Behren's Pond and Cedar Bluffs).

Future Plans:
We will continue to sort throughout the winter months. We plan to reset the Malaise traps in April 2008. To the extent that volunteers are still available, the same sites that were sampled in 2007 will be sampled in 2008.
COOPERATING FACULTY PROJECTS

Diagnostic and Feasibility Restoration Studies – Upper Gar Lake, Minnewashta, and Lower Gar Lake

Principal Investigator: John A. Downing
Student Investigator: Adam Heathcote (Ph.D.)
Collaborators: Mimi Wagner
Duration: September 2007 to October 2009
Funding Source(s): Iowa Department of Natural Resources

Goals and Objectives:
- To provide the Iowa Department of Natural Resources (referred to below as DNR) with a diagnostic and feasibility study of Upper Gar, Minnewashta, and Lower Gar Lakes (referred to in this document as the Lower Chain), Dickinson County, Iowa for planning a lake restoration program on the lake and its watershed.

Introduction:
The Lower Gar Chain is an important recreational resource that has experienced water quality problems over the past several years. There is substantial public demand for a plan to restore quality in these water bodies. This study is an essential first step toward this goal.

Progress:
We have begun sampling this set of water bodies and have embarked upon the process of diagnosis.

Future Plans:
We will complete the diagnosis, hold public meetings, and forge a feasibility study to propose a restoration plan.
**Diagnostic/Feasibility Restoration Studies – Easter Lake**

**Principal Investigator:** John A. Downing  
**Collaborators:** Mimi Wagner  
**Duration:** September 2007 to October 2009  
**Funding Source(s):** Iowa Department of Natural Resources and Polk County, Iowa

**Goals and Objectives:**
- To provide the Iowa Department of Natural Resources (referred to below as DNR) and the Polk County Conservation Board with a diagnostic and feasibility study of Easter Lake, Polk County, Iowa for planning a lake restoration program on the lake and its watershed.

**Introduction:**
Easter Lake is an important recreational resource that has experienced water quality problems over the past several years. There is substantial public demand for a plan to restore quality in these water bodies. This study is an essential first step toward this goal.

**Progress:**
We have begun sampling this body and have embarked upon the process of diagnosis.

**Future Plans:**
We will complete the diagnosis, hold public meetings, and forge a feasibility study to propose a restoration plan.
Iowa NatureMapping: Enhancing Comprehensive Wildlife Management through Internet GIS Mapping Technology

Principal Investigator: James L. Pease
Research Associate: Jason P. O’Brien
Collaborators: ISU Brenton Center and ISU GIS Facility
Duration: April 2006 to September 2007
Funding Source(s): Iowa Department of Natural Resources

Goals and Objectives:
- Develop a comprehensive Geographic Information System (GIS) online wildlife mapping tool, to allow access to NatureMapping and other wildlife and natural resource data in formats useful to wildlife professionals.
- Work with various local and state wildlife and natural resource management agencies and organizations to develop a protocol for reviewing and confirming data submitted through the Iowa NatureMapping Program, using the GIS mapping tool, and adhering to the Iowa Wildlife Action Plan (IWAP).

Introduction:
Since 1999, NatureMapping, a wildlife monitoring program, has been collecting bird, mammal, reptile, and amphibian data from trained volunteers. To date, over 68,000 unique observations have been submitted, yet very little of the data has been utilized by wildlife researchers, managers and others who use such data to accomplish their goals. This project designed data entry and retrieval tools in line with Iowa’s 2005 Wildlife Action Plan (IWAP), which implements monitoring and management projects for priority species.

Progress:
Phase one of this project included work on the existing electronic database. Minor mistakes in the data were fixed and design changes improved performance. Also, improvements in front-end web forms for those entering and retrieving data (volunteers, scientists, managers, general public) were addressed in three parts: new and updated interactive web forms and queries for the User, Administrator, and Reviewer. User pages for current and future NatureMapping volunteers improve the overall efficiency and detail of data entry and retrieval. Administrator pages improve efficiency of data queries and look ups for the NatureMapping Coordinator, improving volunteer management. Reviewer pages, still in design stages, are new to the NatureMapping database, and allow full access to the data by wildlife experts to review and comment on all NatureMapping data and maintain personal contact with volunteers throughout the process. Phase two of this project is the NatureMapping GIS Mapping Tool; a seamless element fully integrated into most data entry and retrieval pages where relevant data is enhanced by mapping technology. The GIS tool is designed to be simple, intuitive, and user friendly. It is considerably less sophisticated than desktop GIS software, but provides ample flexibility for multiple user groups, from the novice to the expert, without the need for such software.

Conclusions and Recommendations:
The initial database and web programmer hired for the database and web pages left abruptly leaving many items incomplete and causing two no-cost extensions. Additional non-SWG money was secured to hire another programmer and good progress and improvements have been made. The Reviewer pages are still in development, however, no mechanism has ever been developed in Iowa for the purpose of reviewing volunteer data and providing such interaction between volunteer and professional. For all intents and purposes, this project is finished, with the exception of the aforementioned programming. Final testing is underway for all elements of this project, and will include all intended users, from volunteers to resource professionals and researchers. Initial reaction is positive, but more information is needed to conclude whether or not this project will serve its intended audiences and address the priorities in the IWAP. Despite the setbacks and hiring a new programmer over the life of this project, the amount of money spent within and outside of the SWG has been relatively small, considering the technology that has been developed. Consideration should be given to hiring a professional programmer for future work. Despite being much more expensive, it would add much needed efficiencies to the overall project.

On the following page, the GIS Mapping Tool zoomed into sub-county level with bald eagle locations overlaid with aerial, river and public land layers.
### Detailed Observation Report

**Eagle, Bald (Haliaeetus leucocephalus)**

Total Observed: 466

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**Detailed Observation Report**

**Mammals**

Total Observed: 8127

#### Observations by Species

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#### Observations by Year

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**Cooperating Faculty Projects**

**Genetic Structure and Intraspecific Phylogeography of the Sheepnose Mussel**

**Principal Investigator:** Kevin J. Roe  
**Duration:** June 2007 to June 2010  
**Funding Source(s):** Iowa Department of Natural Resources

**Goals and Objectives:**
- The objective of the project is to document genetic diversity, population structure, the extent of gene flow, and historical connections between populations of the sheepnose (*Plethobasus cyphus*). This information would be used in identifying unique or genetically distinct populations of the sheepnose and serve as guidelines for reintroduction population augmentation aimed at reversing declines in population size and number of populations of this species throughout the U.S.

**Introduction:**

The sheepnose (*Plethobasus cyphus*) is a medium-sized freshwater mussel in the family Unionidae. The shell is described as elongate ovate, and is moderately inflated, with thick and solid valves. The anterior end of the shell is rounded, and the posterior end is somewhat bluntly pointed, but the most striking feature is a row of large, broad tubercular swellings on the center of the shell extending from the beak to the ventral margin. The periostracum is generally smooth, and light yellow to a dull yellowish brown in color. The sheepnose appears to inhabit larger-streams, and it occurs primarily in shallow shoal habitats with moderate to swift currents over coarse sand and gravel. The sheepnose may also be found in habitats that include mud, cobble, and boulders. Specimens in larger rivers may be found in deep runs. Like most unionids the larvae of the sheepnose are obligate parasites on a vertebrate host. To date the only known host of the sheepnose is the Sauger (*Stizostedion canadense*), although it is strongly suspected that other natural hosts remain unidentified. The central stoneroller (*Campostoma anomalum*) successfully transformed sheepnose larvae when infected in lab experiments.

Historically, the sheepnose occurred throughout much of the Mississippi River system with the exception of the upper Missouri River system and most lowland tributaries in the lower Mississippi River system. Major drainages where the sheepnose was known to occur include: Mississippi, Ohio, Cumberland, Tennessee, and Ohio Rivers. Other studies indicate that the sheepnose was historically known from 77 streams (including 1 canal) in 15 states. The sheepnose has been extirpated throughout much of its former range or reduced to isolated populations, and the last extant records for other streams are from decades ago. The sheepnose has been eliminated from two-thirds of the total number of streams from which it was historically known (26 streams currently compared to 77 streams historically). This species also appears to have been eliminated from former habitat in hundreds of miles of the Illinois, Cumberland, and other rivers, and from portions of the Mississippi and Tennessee Rivers. In addition, the species is no longer known from the state of Arkansas. Twenty-six extant sheepnose populations occur in the following streams in 14 states: Alabama (Tennessee River), Illinois (Mississippi, Kankakee, Ohio, Wabash Rivers), Indiana (Ohio, Wabash, Tippecanoe, Eel Rivers), Iowa (Mississippi River), Kentucky (Ohio, Licking, Kentucky, Green, Cumberland Rivers), Minnesota (Mississippi, St. Croix Rivers), Mississippi (Big Sunflower River), Missouri (Mississippi, Meramec, Bourbeuse, Osage Fork Gasconade Rivers), Ohio (Ohio, Muskingum Rivers), Pennsylvania (Allegheny River), Tennessee (Tennessee, Holston, Clinch, Powell Rivers), Virginia (Clinch, Powell Rivers), West Virginia (Ohio, Kanawha Rivers), and Wisconsin (Mississippi, St. Croix, Chippewa, Flambeau, Wisconsin Rivers). In Iowa, the sheepnose was known from the main channel of the Mississippi River, and the Iowa, Des Moines, and Little Sioux Rivers. Currently, populations of the sheepnose in Iowa are known from the Mississippi River.

**Progress:**

As stipulated in the proposal, the project will be conducted in three phases described below:
- Phase I – Generate species-specific microsatellites/ Mt DNA sequences for the sheepnose. Obtain specimens from across the range of the species.
- Phase II – Screen potential microsatellites
- Phase III – Determine genetic diversity of the sheepnose

**Future Plans:**

Constitute to collect/obtain specimens. Screen samples on hand using microsatellites and Mt DNA as they are obtained.
South Coastal Alaska/Wrangell St. Elias Mountains Moonwort Fern Surveys and Genetic Analysis with an Emphasis on *Botrychium tunux*

**Principal Investigator:** Donald R. Farrar  
**Student Investigator:** Mary Stensvold (Ph.D.)  
**Collaborators:** USDA Forest Service, Alaska Region; National Park Service, Wrangell St. Elias National Park; Parks Canada, Kluane National Park; Yukon Territory; Kluane Lake Research Station  
**Duration:** June 2007 to November 2007  
**Funding Source(s):** U.S. Fish and Wildlife Service, U.S. Forest Service

Goals and Objectives:

- The purpose of this project is to help determine the abundance and distribution of *Botrychium tunux* and *Botrychium lineare* in the Wrangell-St. Elias Mountains of Alaska and the Yukon Territory.
- The field work and genetic analysis concentrate on *B. lineare* and *B. tunux* because there are conservation concerns for these moonworts on account of their apparent rarity and because some plants were found in areas of potential human disturbance in Alaska and the Yukon.

Introduction:

Moonwort ferns (genus Botrychium) are interesting, strange-looking, yet often overlooked little plants. These ferns consist of a single deciduous leaf that is divided into two segments, a leaf-like sterile segment divided into several pairs of linear to fan-shaped pinnae, and a fertile segment bearing clusters of spherical sporangia. Depending on the species, moonworts can range in height from ½ inch to ten inches. There are about 30 species of moonworts worldwide, with most growing in cool temperate and boreal areas of the Northern Hemisphere.

About 13 species are known from and adjacent to the Wrangell-St. Elias Mountains of Canada and Alaska (a moonwort hotspot). In recent years there has been increasing interest in moonworts, consequently more people have been looking for and finding them. As moonworts are studied more intensely, new species are being identified, such as *B. tunux* and *B. lineare* (both of which are of conservation concern). Genetic analysis has shown moonwort taxa to be genetically distinct from each other. However, they can be variable morphologically and therefore not always morphologically distinct. This morphological variability often makes identifying them difficult. The use of starch-gel enzyme electrophoresis to verify the identities of moonworts genetically is a critical aspect of this study.

Progress:

Field surveys were conducted between June 23 and June 29, 2007 in and adjacent to the Wrangell-St. Elias Mountains by Donald R. Farrar of Iowa State University, Department of Ecology, Evolution and Organismal Biology, and Mary Stensvold of the USDA Forest Service, Alaska Region. Surveys were conducted in the vicinity of the Haines Road and Alaska Highway between Haines and Tok Alaska. Moonworts were found at 28 sites. Helicopter was used to reach three sites near Haines Junction, Yukon; and fixed-wing aircraft was used to access nine sites in Wrangell St. Elias National Park, Alaska. Genetic analysis was conducted at ISU from September through November of 2007.

*B. lineare* was found at two sites in the Yukon and at no sites in Alaska. *B. tunux* was found at seven sites in the Yukon and five sites in Alaska. Including these taxa, eleven species of Botrychium were documented as a result of the surveys and subsequent genetic analysis.

Nearly all moonworts found during these surveys were growing in areas of human disturbance. These disturbances include brush clearing, roadside mowing, airstrip maintenance, low density grazing by horses and old abandoned roads that are maintained as travel routes or trails. These disturbances have two things in common: vegetation that would choke out moonworts has been removed and ongoing disturbance does not churn or damage soil. These kinds of human disturbance appear to maintain the populations of moonworts.

Future Plans:

Genetic and morphological data resulting from these field surveys will be valuable for comparison purposes in future analysis of moonwort distribution and abundance from Alaska and the Yukon as well as in other parts of the world.
Diagnostic and Feasibility Restoration Studies - Prairie Rose Lake, Lake Darling, Green Valley Lake and Lizard Lake

Principal Investigator: John A. Downing
Student Investigator: Adam Heathcote (Ph.D.)
Collaborators: Mimi Wagner
Duration: September 2006 to March 2008
Funding Source(s): Iowa Department of Natural Resources

Goals and Objectives:
- To provide the Iowa Department of Natural Resources with a diagnostic and feasibility studies of Lake Darling, Prairie Rose Lake, Lizard Lake, and Green Valley Lake, for planning lake restoration programs on these lakes and their watersheds.

Introduction:
These lakes are important recreational resources that have experienced water quality problems over the past several years. There is substantial public demand for a plan to restore quality in these water bodies. This study is an essential first step toward this goal.

Progress:
We have completed the data collection phase of these projects and are now compiling reports and meeting with the public to discuss the results.

Future Plans:
This work will be completed this spring and these projects will then give rise to restoration programs for these lakes and their watersheds.
Best Management Practices for Aquatic Vegetation Management

Principal Investigator: Joseph E. Morris  
Student Investigator: Megan A. Ernst (M.S.)  
Duration: July 2006 to June 2009  
Funding Source(s): Iowa Department of Natural Resources

Goals and Objectives:
- The goal is to develop a strategy to address concerns related to aquatic vegetation management with the ultimate goal of producing a best management practices protocol their management in Iowa’s ponds and lakes. This information will be used to guide future aquatic vegetation management options in newly reclaimed bodies of water. Specific objectives are:
  - Perform literature search on quantifiable plant census techniques.
  - Identify best management practices for managing aquatic vegetation in Iowa lakes and ponds.
  - Develop educational materials related to aquatic plant identification and their specific management options.
  - Compile, analyze, and publish in federal aid documents and appropriate journals the best management practices for managing aquatic vegetation in Iowa lakes and ponds.

Introduction:
Many different aquatic plants can be found in lakes and ponds. These plants range from microscopic organisms, known as plankton algae that drift suspended in the water, to larger plants rooted in the pond bottom. Moderate plant growth is essential to water bodies because plants produce oxygen, food, and cover for fish and other aquatic organisms. Nutrients and fish feeds introduced into the water (often from the surrounding watershed) can create an ideal habitat for aquatic weed growth. In ponds that have too many weeds, it may be difficult to harvest fish using seines and/or fishing tackle.

The ideal aquatic plant control is a management plan that incorporates preventive methods (proper pond construction and maintenance), biological methods (grass carp \(Ctenopharyngodon idella\)), mechanical (physical removal), cultural methods, and the use of labeled aquatic herbicides. Developing an aquatic weed management plan depends on correctly identifying the problem weed(s) and selecting control methods that are compatible with efficient pond usage, e.g., sport fishing, aquaculture, animal watering, or swimming.

Measurements of aquatic plant communities include both qualitative and quantitative surveys. Qualitative measurements note the presence or absence of specific taxa as well as estimated percentage cover. Although qualitative surveys can be accomplished using limited labor and associated costs, they are limited by their utility in statistical analyses. Quantitative measurements include measurements of biomass, density as well as relative abundance.

Progress:
Field collections were initiated July 2006 and have continued through the present. A total of 13 lakes across the state of Iowa have been sampled; selection was based on similarity in physical attributes e.g., mean depth, watershed area and volume development, and past management decisions, e.g., presence of grass carp. Physical attributes being collected include nutrient composition, pH as well as biological parameters (zooplankton and phytoplankton samples, and young of year sportfish). Aquatic vegetation samples were collected monthly using a 2-sided rake along a set number of transects depending on lake area.

Analyses done to date indicate the dynamic nature of the aquatic vegetation populations in Iowa’s lakes. The increase in primary production subsequently influences associated zooplankton populations as well as age-0 fish.

Future Plans:
Sampling will continue through summer 2008 with final analyses being completed Spring 2009. Refinement of 2008 field procedures will include initial sampling dates to best reflect aquatic vegetation abundance while making best use of field time.
Development of an Invertebrate-based Terrestrial Index of Biotic Integrity

Principal Investigator: Diane M. Debinski
Student Investigator: Jessica Orlofske (M.S.)
Duration: June 2006 to June 2008
Funding Source(s): Iowa Department of Natural Resources
Iowa Science Foundation
Prairie Biotic Research, Inc.
The Nature Conservancy

Goals and Objectives:
- Design an effective, non-technical sampling protocol for a diverse set of prairie invertebrates.
- Broaden the number of invertebrate groups that can be used in biotic integrity indices.
- Develop an efficient method of analyzing the data to determine site quality.

Introduction:
Biotic integrity, the capacity of an area to support and maintain the appropriate diversity of organisms that allow for a functional, adaptive system comparable to natural habitat of the same type, is difficult to measure directly. Invertebrate assessment as part of an index of biotic integrity, a measurement of the quality of the system based on resident organisms, has been used extensively and productively in aquatic ecosystems. Yet, terrestrial invertebrates used as bioindicators may be just as useful as their aquatic counterparts. Terrestrial invertebrates possess many of the same character traits that enabled scientists to develop the indices for aquatic systems. Invertebrates compose a significant proportion of all terrestrial life and perform critical ecosystem services: pollination and decomposition which contributes to soil fertility and plant productivity. Invertebrates possess sensitivity to environmental alterations and can respond in abundance and distribution because of short generation times and high fecundity. The scientific and professional communities have demonstrated a need for a non-technical, inexpensive, and effective tool for environmental monitoring and assessment. In Iowa the greatest need for the development of such an index is for prairies and prairie restorations. However, such methodology for community indices remains underdeveloped, and that which has been proposed remains untested.

The purpose of this research is to overcome the sampling and taxonomic obstacles and make critical progress toward a terrestrial index of biotic integrity for Iowa’s vital and disappearing tall grass prairie ecosystem. The results will include effective sampling protocols, identification of important invertebrate bioindicators, a standardized method of analysis and a preliminary tool for private and public landowners and managers.

Progress:
The second season of field work occurred June to August 2007. Sweep net surveys for invertebrates were collected at all 30 prairies in central Iowa. All sweep net samples from both field years have been processed with insects identified to the family level. Statistical analysis is ongoing.

Future Plans:
The final step for this project is to complete the statistical analysis and prepare manuscripts for publication.
Temporal Shifts in Avian Diversity and Community Structure through Stages of Restoration of a Tallgrass Prairie, Neal Smith National Wildlife Refuge (NSNWR)

**Principal Investigator:** Diane M. Debinski  
**Student Investigator:** Brian F.M. Olechnowski (Ph.D.)  
**Collaborators:** Pauline Drobney, U.S. Fish and Wildlife Service, NSNWR  
Karen Viste-Sparkman, U.S. Fish and Wildlife Service, NSNWR  
**Duration:** May 2007 to May 2009  
**Funding Source(s):** Iowa Department of Natural Resources, Iowa Academy of Sciences, Iowa Prairie Network

**Goals and Objectives:**
- Inventory, survey and monitor avian diversity at about 120 restored grassland and savannah areas at NSNWR.
- Examine how individual grassland bird species respond to the amount of time a prairie restoration has been out of crop rotation, and study how avian community composition shifts through these succession stages on a large-scale restoration of a tallgrass prairie.
- Measure differences in vegetation structure through the stages of restoration and examine how this may influence avian community composition.
- Correlate the abundance of sensitive avian grassland and savannah species to habitat variables and determine which variables are most important in predicting the presence of these species in restored areas; propose management implications and suggestions to the U.S. Fish and Wildlife Service.
- Educate the public on the importance of avian diversity in our restored grassland and savannah habitats in the state of Iowa.

**Progress:**
During May and June 2007, both vegetation surveys and bird surveys were performed at study locations at NSNWR. Preliminary analyses of bird response to length of time since removal from crop rotation and restoration to tallgrass prairie began in Fall 2007. Certain species become less abundant as the restored prairies age (Red-Winged Blackbirds, Horned Larks, Killdeers, Vesper Sparrows). Other species tend to peak in abundance 2-3 years after site restoration (Dickcissels and Common Yellowthroats). Henslow’s Sparrows, a grassland specialist species and a species of conservation concern in Iowa, only appear in sites that have been out of rotation for 6+ years. A number of generalist species show no trend, including American Goldfinches, Song Sparrows, and American Robins. Overall species richness tends to increase at sites that have been out of crop rotation for 3-6+ years. Abundance of individual birds at our study sites is greatest in areas that are at least 2 years out of crop rotation. The community composition of avian species tends to shift dramatically as grassland succession proceeds. According to a multi-random permutation procedure (MRPP), study sites that are out of rotation for 1 year are significantly different in avian community composition than sites that are out of rotation for 2 years ($p=.0007$), 3 years ($p<.0001$), 4-6 years ($p<.0001$), and 6+ years ($p<.0001$). Study sites that are 1 year out of crop rotation and 6+ years out of crop rotation display the least degree of similarity in community composition. In addition, sites that are 4-6 years out of crop rotation have significantly different community composition than sites that are 6+ years out of crop rotation ($p=.03$). This is likely due to the fact that we only see Henslow’s Sparrows at study sites that are 6+ years out of crop rotation.

**Future Plans:**
In summer 2008, vegetation and bird surveys will continue. We will conduct analyses to determine which habitat variables are most critical in determining avian species richness and abundance in restored tall-grass prairies in central Iowa. Analyses will also show how the vegetation structure changes in restored prairies through time. We will compare avian community composition, species richness, and abundance in restored tall-grass prairies to remnant tall-grass prairies in the refuge. Study sites found in riparian and savannah woodland areas will be further refined and analyzed. The Ph.D. student on this project, Brian Olechnowski, anticipates completion of a dissertation in May 2009. Adaptive management recommendations for restored prairies at NSNWR will be made to the US Fish and Wildlife Service, and we are currently developing a brochure for Neal Smith that will educate the public on succession in our prairies and the importance of habitat structure to grassland and savannah avian species.
Population Dynamics and Dispersal of Bobcats in Iowa

Principal Investigator: William R. Clark
Student Investigator: Dawn M. Reding (Ph.D.)
Collaborators: Todd Gosselink & Ron Andrews, Iowa Department of Natural Resources
Anne M. Bronikowski, Department of Ecology, Evolution and Organismal Biology, Iowa State University
Duration: July 2006 to June 2009
Funding Source(s): Iowa Department of Natural Resources

Goals and Objectives:
- Determine local habitat selection by bobcats, including home range characteristics and dispersal patterns in relation to forest, grassland, and agricultural land and the configuration of these habitats.
- Evaluate population monitoring techniques that can be reliably and efficiently used to survey bobcats both at the local scale and also across Iowa.
- Determine demographic rates of bobcats in Iowa, including recruitment and survival.
- Evaluate genetic similarity of the Iowa population in relation to potential dispersal linkages with other populations.

Introduction:
In 2003 the Iowa Department of Natural Resources, in cooperation with Iowa State University, initiated a study of the conservation biology of the bobcat (Lynx rufus), a species which has become increasingly common in the corn belt of the Midwest. Although we began studying bobcats in southern Iowa 3 years ago, we still have many unanswered questions related to the landscape ecology and population dynamics of bobcats in Iowa. Desires expressed by the public range from complete protection of bobcats to limited harvest, so we must be prepared to define management options based on scientific data. Data collection for Phase I objectives, emphasizing habitat relationships and demography, is essentially completed although final publication is in progress. This project, which is referred to as Phase II, emphasizes estimating statewide distribution, dispersal in relation to landscape features, and population genetics.

Progress:
We have largely completed the data collection to determine habitat selection at the local scale (Objective 1) but we are reanalyzing data collected during the first 3 years before submitting the final publications. We have only recorded detailed dispersal tracks of 3 female and 9 male bobcats. We are redesigning the telemetry tracking scheme to focus less on local habitat selection and more specifically on dispersing individuals. Dispersal movements often last from 1 to 5 months and we have observed one dispersal >150 km into Missouri. Interestingly, we have not observed a single dispersal northward into Iowa and we wish to investigate the landscape configurations that might pose barriers to dispersal along river systems in Iowa. Results from Phase I suggest that the bow hunter survey will be our most successful design for assessing statewide distribution (Objective 2) and we have now collected data for 3 years. But the statistical reliability is such that we can distinguish abundance at the level of 9 climate regions within Iowa but that county-level inference will require new statistical methods. During Phase I we also focused on demography (Objective 3) but we must resolve questions about survival estimates and the rate of increase. Telemetry data indicate very high (82%) survival of adults suggesting mean life span as an adult of >5 years, but age structure based on carcasses reveals only 2% of the population reach that age. In Phase II we are focusing on the role of regional and local population genetics in the recovery of the species (Objective 4). Using a combination of genetic and demographic methods we are investigating whether bobcats in Iowa represent the periphery of the current range into which the regional population is expanding, or alternatively whether the Iowa population at the periphery of the geographic range is self-sustaining and largely isolated. In cooperation with the laboratory of Dr. Anne Bronikowski at Iowa State University we have established procedures and have now extracted DNA from tissue samples of 362 bobcats. With the collaboration of Dr. Warren Johnson at the Laboratory of Genomic Diversity we will next investigate genetic diversity using established microsatellite markers.

Future Plans:
Dawn Reding will begin her Ph.D. courses in January 2007. We will continue to monitor bobcats using the bow survey in 2007, and to mark and track another sample of 25 bobcats in 2007-2008. Genetic sequencing and associated analyses will commence in 2007.
Effects of Managed Riparian Buffers on Fish Communities in Central Iowa Streams

Principal Investigators: Michael C. Quist, Timothy W. Stewart, Thomas M. Isenhart
Student Investigator: Jonathan Lore (B.S.), Skyler Wigen (B.S.)
Duration: May 2007 to June 2008
Funding Source(s): Iowa Water Center, Iowa Department of Natural Resources

Goals and Objectives:
- Evaluate fish communities in streams with and without managed riparian buffers.

Progress:
During the summer of 2007, fish and habitat were sampled from 40 stream reaches in Bear, Long Dick, and Keigley Branch creeks of central Iowa. Fish were sampled using backpack electrofishing. All sampled fish were identified to species and measured. Ten creek chubs and ten central stonerollers per centimeter length group were sacrificed for age and growth analysis. All other fishes were returned to the stream. Instream habitat was also measured from each reach using standard methods. Nearly all of the sampling data have been entered into the database and are ready for detailed analysis. Otoliths are currently being mounted onto glass slides in preparation for aging.

Future Plans:
Analysis of fish assemblage structure will begin this winter, as will assessment of age and growth of creek chubs and central stonerollers. Final analyses will be conducted after all data becomes available (by early spring 2008).
Interactions Between Bison, Elk, and Plant Communities in an Ongoing Tallgrass Prairie Restoration Effort

Principal Investigator: W. Sue Fairbanks
Student Investigator: Barbara Kagima (M.S.) and Josh Divan (B.S.)
Collaborators: Neal Smith, National Wildlife Refuge
Duration: January 2007 to September 2007
Funding Source(s): U.S. Geological Survey

Goals and Objectives:
- Determine habitat selection by the Neal Smith NWR elk and bison during the growing season with respect to plant communities, reconstruction activities (burning, seeding, mowing), topographic features (aspect, slope, distance to water and to roads), and plant nutritional quality.
- Determine the relative importance of plant community composition and quality versus other factors, such as topography, on habitat use.
- Determine seasonal diet selection by bison and elk at Neal Smith NWR with respect to forage class (forbs, browse, sedges, C3 grasses, and C4 grasses).
- Determine the proportion of native tallgrass prairie plants versus exotic plant species in bison and elk diets in different seasons.
- Assess spatial, temporal, and diet overlap among elk and bison.
- Develop a brochure or display for the general public regarding native herbivore interactions with tallgrass prairie ecosystems.

Progress:
Fieldwork was conducted 9 May to 8 August 2007. Complete censuses of bison and elk were randomly initiated once a day, 5 days a week during this period. Elk censuses and observations took place for 2-3 h immediately after sunrise (0600 h) or for 2-3 h before sunset (1800 to 1900 h). Bison censuses and observation times were randomly generated between 0600 and 1900 h. We recorded group size, group composition with respect to sex and age, UTM location, and activity of individuals within the group, i.e. foraging, resting, standing, walking, running, and nursing. To determine native ungulate use of tree patches, we used 15 infrared trail cameras to calculate sightings per day for bison, elk, and deer. Elk fecal pellet groups were opportunistically collected from across the plant community patches used. About 15 g of fecal material from individual bison patties were collected from across plant community patches and stored in a -20°C refrigerator, along with the elk fecal samples. Thirty fecal samples from May 2006 to August 2007 were shipped to the Wildlife Habitat Nutrition Laboratory at Washington State University for microhistological fecal analysis which will determine diet selection to plant genus and species, when possible. Plant community compositions of patches within the enclosure were sampled in the first week of August. Plant composition was determined by visually estimating percent cover of plant species within randomly placed 50cm x 50cm quadrats. Selected species were clipped in each patch, air dried, and will be ground and analyzed for crude protein and ADF and NDF as indices of digestibility.

White-tailed deer sightings were mostly in the northern half of the enclosure and both deer and elk primarily used the tree patches. A majority of the core areas of use by the bison bachelor groups were located in the exotic brome patches in the enclosure. The bison bachelor groups were randomly distributed across the landscape (P = 0.26). The mixed sex/age bison group was not randomly distributed (P = 0.03) and spent most of the growing season in the spring 2007 burn area of the enclosure. Based on univariate analyses, the mixed sex/age bison group selected for plant community patches that contained a higher proportion of native plants (P = 0.03), grasses (P = 0.04), and forbs (P =0.03). The bison bachelor groups and elk did not appear to select for plant communities on the basis of forage class composition.

Future Plans:
Future analysis will assess habitat selection models for bison and elk with respect to physical characteristics of the landscape (slope, aspect, and distance to fence) and plant community characteristics (proportion of native species, grass to forb ratio, burned and mowed patches). Plant species selection in the diet will be determined through microhistological fecal analysis. Forage quality among the plant communities will be determined by examining nitrogen content and digestibility.
Bird Nesting on Rotationally Grazed Pastures that Incorporate Warm-season Grasses

Principal Investigator: James L. Pease
Student Investigator: Ryan Marquardt (M.S.)
Collaborators: Southern Iowa Forage and Livestock Committee
Duration: December 2006 to May 2008
Funding Source(s): U.S. Fish and Wildlife Service
Iowa State University
Southern Iowa Forage & Livestock Committee

Goals and Objectives:

- The primary objective of this research is to evaluate a short-duration rotational grazing system. This grazing system had one-quarter of its grazing area in warm-season grass paddocks. These warm-season grass paddocks are undisturbed between May and June, during the prime nesting season, and then grazed in July and August, while the traditional cool-season grass paddocks were rested. A comparison between bird use, nesting, nest survival, and nest fate (success, trampled, deserted, predated) on warm-season and cool-season grass rotationally grazed paddocks and ungrazed cool-season and warm-season grass CRP fields was conducted. Plant composition and structure were also assessed to determine if they have a significant effect on whether birds are attracted to the pasture to nest and how successful nesting is.

Progress:
The field season began on May 14th, 2007 with data collection commencing on May 25th and concluding on July 27th. Data collected included point count observational data, nesting information, and vegetation variables. Point-counts were conducted weekly over all twenty-two points on all sites. Nests were located using a combination of observation cues and three spaced nest searches that utilized a drag method. Vegetation variables include maximum height of live and dead vegetation, litter depth, and Robel pole concealment. Percent grass, forb, standing dead vegetation, litter, and bare ground characterize vegetation stand composition.

Drought conditions persisted in 2007, and grazed cool-season grass paddocks were heavily depleted by the time they were rested in July, while the warm-season grasses continued to provide forage growth for grazing in July.

Field season data was entered by October and analysis and data manipulation have progressed from there. Analysis of variance using regression analysis and logistic regression was attempted to assess the relationship between bird use and vegetation. Very few vegetation variables proved to be significant in determining which species utilize specific fields. Principal component analysis was also attempted to see how the fields overlapped. The two grazed systems did not differentiate themselves, but the two ungrazed systems did sort out based on measured vegetation variables.

Bird use and nesting indicates distinctive preferences for specific field type by specific species. Populations for 2007 trend downward from factors outside of the research. A likely contributing factor to this trend is the cold weather experienced in late spring. This weather may have resulted in early season mortality of migratory birds. The number of nests found in 2007 was lower than 2006 for most species, but 2007 was the first year that Common Yellow-throat nests were found. The Northern Harriers returned to nest on-site again and successfully raised two young. The list of observed nesting species includes Red-winged Blackbird, Grasshopper Sparrow, Dickcissel, and Sedge Wren. None of these species had enough nests in 2007 to be statistically analyzed. Apparent nesting success outside of the grazing system exceeded 30%, but nesting success within the grazing system was below 10%.

Future Plans:
Data analysis continues with utilization of program Distance to assess bird density in fields and paddocks. Utilization of a bird diversity index is planned to see if the diversity differs between the time paddocks are grazed and the time when fields are resting. Present plans aim for the student investigator to graduate in May and write his thesis based on this research. An additional extension publication directed at land managers is due out by the end of June 2007.
The Use of Cattle-Grazing and Fire as Management Tools to Maintain Biodiversity on Grassland Reserves in Southern Iowa

Principal Investigators: James R. Miller, David M. Engle, Diane M. Debinski
Student Investigators: Finn Pillsbury (Ph.D.), Devan McGranahan (M.S.), Sheri Svehla (Ph.D.)
Duration: October 2006 to September 2010
Funding Source(s): Iowa Department of Natural Resources, Leopold Center for Sustainable Agriculture, U.S. Forest Service, Joint Fire Sciences

Goals and Objectives:
- Collect pre-treatment data on all sites for soil carbon, plants, invertebrates, and birds.
- Conduct controlled experiments to test the effects of the fire-grazing model on species distribution patterns of both plant and animal taxa in Southern Iowa.
- Quantify the response of invertebrates and prairie-obligate butterflies to changes in vegetation structure and composition.
- Quantify the response of grassland birds to changes in vegetation structure and composition, and to changes in invertebrate prey base.
- Quantify the relationship between nesting success of grassland bird species and habitat conditions.
- Identify other potential sites under public and private ownership in the Grand River Grasslands and surrounding region for possible inclusion in a follow-up regional study.

Progress:
In March 2007, one patch in each of four patch-burn pastures was burned, and sample plots for vegetation and transects for butterfly and bird surveys were established in each pasture. Aerial photos were used to characterize land cover in areas surrounding the pastures at two spatial scales: (1) within 300 m of each pasture, and (2) 300-1000 m from each pasture. The 300-m scale will allow examination of landscape structure at pasture edges, which has been shown to influence habitat use by grassland birds, whereas landscape composition within 1000 m of each pasture will provide a measure of landscape fragmentation and broad-scale habitat availability. The landscape matrix within 300 m of our study pastures was dominated by harvested grassland, with somewhat lesser amounts of non-harvested grassland and deciduous trees. Coniferous trees (primarily Eastern Red cedar) accounted for a relatively small percentage of land cover at this scale. These same general proportions described the surrounding landscape at the 1-km scale. Data on vegetation composition collected in 2006 and compiled in 2007 reflect the presence of dominant prairie grasses and forbs, but also conservative prairie forbs and legumes, some of which are sensitive to grazing. Plants included native herbaceous species (n=132), exotic herbaceous species (n=57), and woody species (n=14). Vegetation structure and composition on bird survey transects in 2007 were highly variable, likely a function of fire and grazing history and restoration-reconstruction history. Grasses dominated all sites, but meaningful differences in forb and woody cover were observed. We detected 26 butterfly species in 2007. The most abundant species included a combination of those that are relatively common, such as Eastern tailed-blue and clouded sulphur, as well as specialists such as the regal and meadow fritillary. Butterfly species abundance was not significantly greater in the burned patches when compared to the non-burned patches within the patch-burn treatments. Similarly, richness showed no significant differences between treatments. Species-by-species comparisons also showed no major differences among treatments. We observed 2,822 individual birds representing 53 species during the 2007 breeding season. These comprised 9 grassland obligate bird species and 13 grassland facultative species, and included 7 Species of Greatest Conservation Need. We also monitored 46 nests of 6 species. The most commonly encountered species were the Grasshopper Sparrow, Red-winged Blackbird, Bobolink, Eastern Meadowlark, and Brown-headed Cowbird. The most widespread species were Dickcissel, Eastern Kingbird, Eastern Meadowlark, Grasshopper Sparrow, and Red-winged Blackbird, which were seen on all 13 study pastures. Two species (Brown-headed Cowbird and Common Yellowthroat) were observed on 12 pastures and 3 species (Bobolink, Henslow’s Sparrow, and Sedge Wren) were observed on 11 pastures.

Future Plans:
Data will again be collected using the methods described above in 2008-2009. Data analyses will be conducted to gauge changes in response variables from the pre-treatment year through 2007 sampling that can be attributed to patch-burning and grazing. Finally, a framework for conducting a regional scale study of this sort focused on the Grand River Grasslands will be identified.
Genetic Variation of Northern and Southern Populations of *Quadrula fragosa* (Conrad, 1835) Using Microsatellites

**Principal Investigator:** Jeanne M. Serb  
**Student Investigator:** Amanda Hemningsen (M.S.)  
**Duration:** August 2005 to December 2007  
**Funding Source(s):** U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service

**Goals and Objectives:**
- How diverse are the northern and the southern populations of *Q. fragosa*?  
- What is the degree of genetic difference between northern and southern populations?  
- What are the population dynamics between northern and southern locations?  
- How many females will be needed to generate the same level of genetic diversity in a founder population?

**Progress:**
The winged mapleleaf, *Quadrula fragosa*, historically occurred in the Mississippi, Tennessee, Ohio, and Cumberland river drainages, but has suffered severe population and range reductions. At the time that the species was federally listed as endangered, its range was thought to have been reduced to a stretch of the St. Croix River between northwestern Wisconsin and east-central Minnesota. Recently, morphologically “*Q. fragosa*-like” specimens were discovered at sites in Arkansas (Ouachita River) and Missouri (Bourbeuse River). These specimens were genetically determined to be *Q. fragosa* with mitochondrial DNA sequence, suggesting that two new populations of *Q. fragosa* exist outside the St. Croix River. Because these new southern populations may have a significant impact in the development of conservation management plans for the northern population of *Q. fragosa*, specific information about population structure and genetic diversity of *Q. fragosa* is needed.

Since the fall of 2005, specimens that will be used in the population genetic study have been collected from three southern populations. These populations include a new location (Little Red River, Oklahoma), which contain individuals genetically identified as *Q. fragosa* during this study. Subsequently, we have expanded our research scope to include this population. U.S. Fish and Wildlife Service provided fresh tissue from the St. Croix population (Minnesota) for genomic DNA library development. Two enriched microsatellite libraries were generated for di- (CA) and tetra- (TACA, TCTA, TATG) nucleotide repeats and these libraries were cloned into E. coli bacteria. We screened clones that contain the repeat inserts of interest using chemoluminescence methods.

Twelve variable microsatellite markers have been developed for this species. Forty-four individuals from both northern and southern populations were genotyped. Currently, we are analyzing these data to address our objectives and goals.

**Future Plans:**
Additional population genetic analyses are ongoing and are targeted for completion by March 2008.
Response of Forest Birds to Changes in Land Use/Land Cover in the Driftless Area of Northeastern Iowa

Principal Investigators: James R. Miller and Lisa Schulte
Student Investigator: Jaymi LeBrun (M.S.)
Duration: August 2005 to September 2008
Funding Source(s): Iowa Department of Natural Resources

Goals and Objectives:

- Establish a suite of study sites on public lands using a stratified approach based on local habitat conditions (i.e., forest structure/composition) and landscape position (e.g., cross-boundary land uses, proximity to other forested habitat, reserve size).
- Quantify the relationship between habitat use by forest birds (as measured by species occurrence/density) and forest structure/composition.
- Quantify the influence of the surrounding landscape matrix on habitat use by forest birds once variation due to local habitat conditions has been explained.
- Measure changes over time regarding shifts in the avian community and in forest structure/composition since the surveys of 1996/1997 (Norris 1999).

Progress:
In addition to the 12 sites surveyed in 2006, we added three new sites on private land in 2007. These properties will enable us to test a wider range of predictions generated for species of concern in the Driftless Area using a hierarchical statistical model (Thogmartin et al. 2004, 2006). In our field surveys, we detected a total of 585 birds and 42 bird species on survey plots in 2007. The Brown-headed Cowbird (*Molothrus ater*) was ranked as the most abundant and most frequently encountered species, accounting for 11% of the total occurrences and present at 15 of the 16 sites. The next two most abundant and most frequently detected species were the Red-eyed Vireo (*Vireo olivaceus*) and Blue-gray Gnatcatcher (*Polioptila caerulea*), both accounting for 9% of the total occurrences. These two species were followed by the American Redstart (*Setophaga ruticilla*), which accounted for 6% of total occurrences, the Eastern Wood-Pewee (*Contopus virens*) and the White-breasted Nuthatch (*Sitta carolinensis*), which accounted for 5% of the total occurrences. The Red-eyed Vireo was the only one of the six most abundant species detected at all of the sites. A total of seven species of concern were detected in the Driftless Area sites in 2007. These included the Acadian Flycatcher (*Empidonax virescens*), Blue-winged Warbler (*Vermivora pinus*), Cerulean Warbler (*Dendroica cerulean*), Eastern Towhee (*Pipilo erythrophthalmus*), Veery (*Catharus fuscens*), Wood Thrush (*Hylocichla mustelina*) and Yellow-billed Cuckoo (*Coccyzus americanus*). Their percent total occurrence ranged from <1% to 3%.

Future Plans:
Currently, we are conducting comparative analyses with our data and those collected by Norris in 1995-96. Vegetation data will be analyzed using a combination of univariate and multivariate techniques. Analyses of avian survey data will comprise both single-species approaches as well as community-based methods, again utilizing univariate and multivariate techniques. We will take a multi-stage approach to the analysis of bird data that includes both local habitat variables (including vegetation measures) and landscape variables describing land use/land cover in the surrounding area.
Spatial Analysis of Waterfowl-predator Interactions

**Principal Investigators:** William R. Clark and Philip M. Dixon  
**Student Investigator:** Dale H. Tessin (Ph.D.)  
**Collaborators:** David Howarter, Institute for Wetland and Waterfowl Research  
**Duration:** June 2003 to September 2007  
**Funding Source(s):** Ducks Unlimited, Institute for Wetland and Waterfowl Research  
NSF VIGRE Program

**Goals and Objectives:**
- Review the statistical methods that have previously been used to describe and analyze spatial data, including Ripley’s K and kernel estimation.
- Apply those methods to existing data sets on nesting waterfowl, including DU’s PHJV Assessment data.
- Develop extensions of existing methods better suited to spatial questions relating to waterfowl nest data.
- Explore whether the spatial patterns of waterfowl nests and predation events are related to total density of nests and landscape context.

**Progress:**

We are attempting to understand how habitat fragmentation influences patterns of waterfowl nest initiation, predator movement patterns, and the interaction of predator movements and nest patterns in space and time to determine the nest predation process. Spatial nest initiation point patterns have been investigated using Ripley’s K function and we are using space-time K functions to better understand the true underlying processes in three dimensions. Our use of space-time K functions further generalizes our point pattern analyses through the use of a null model that is robust to habitat heterogeneity. Results show that when time is added to the model, patterns of nest distribution and nest predation can only be distinguished from random patterns at small spatial and/or temporal scales. For n=219 fields of nesting habitat we found that nest initiation patterns tend to be overdispersed at small spatial scales, implying that hens select nest sites farther away from existing nests than would be expected by chance alone and that nests that are located close in both space and time face a much greater risk of predation than would be expected by chance alone. This increased risk of predation extends to ~175m on the same day but only up to ~30m within 3 days. We suggest that predators are not detecting the clusters of nests identified in the space-only model because these clusters don’t exist unless we collapse our data across the temporal dimension. The analyses are consistent with predators displaying Area Restricted Search behaviors which result in the observed pattern of increased destruction risk at small spatial and temporal scales.

We are using kernel density ratios to describe how the risk of nest destruction varies across observed nest point patterns. Predation Risk Surfaces (PRS) are calculated as the ratio of the destroyed nest density surface over the initiated nest density surface and identify the nest destruction process conditional on observed nest locations. Predator Activity Surfaces (PAS) are calculated as the kernel density surface of known predator locations based on radio-collar telemetry data. We calculated PRSs and PASs for eleven fields of waterfowl nesting habitat in North Dakota, then estimated the correlation between them for each field using Spearman’s rank correlation statistic. While some fields showed no correlation, several fields demonstrated significant correlation between the two surfaces, with estimates as high as $r=0.66$ ($P<0.001$). This suggests that we may be able to infer predator activity patterns through the use of prey data alone. Determining whether the variation in the relationship between the two surfaces across fields is due to the nesting and destruction processes or a limitation of the available data is our next question.

**Future Plans:**

We plan to continue our collaboration with Ducks Unlimited exploring the spatial processes that drive waterfowl predation and nest success in the Northern Great Plains, improving our understanding of the nest patterns that predators encounter in both space and time and the risk of predation accompanying those patterns.

We will investigate the interaction of nest point patterns and predator movement behavior by simulating predator trajectories using data collected by Mike Phillips. Nest encounter rates for the observed nest initiation pattern will be compared with encounter rates for random and regularly spaced nest locations. This will help us understand both the predator foraging mechanism that leads to nest destruction and how habitat arrangements lead to areas of high and low nest success through their impacts on nesting spatial patterns. Additionally, Area Restricted Search modeling of predation events in space and time will allow quantification of the strength of this behavior.
Survey of White-tailed Jackrabbit (*Lepus townsendii*) Populations on ISU Research Farms

**Principal Investigator:** W. Sue Fairbanks  
**Student Investigator:** Tyler Bass (B.S.)  
**Duration:** July 2007 to November 2007  
**Funding Source(s):** Iowa Department of Natural Resources

**Goals and Objectives:**
- Estimate population size of jackrabbits on 6 ISU Research Farms, ranging in size from about 40 to 130 ha, in northern and central Iowa.
- Compare population estimates made on individual farms in early summer (middle of jackrabbit reproductive season) to estimates from the end of summer (end of jackrabbit reproductive season).
- Identify percent of observations of jackrabbits in different habitat types.
- Opportunistically collect genetic material for future genetic studies by working with Research Farm personnel to collect road-killed jackrabbits.

**Progress:**
This project was completed in November 2007.

Throughout the Midwest and in Iowa specifically, white-tailed jackrabbits have been experiencing a range reduction since the 1960’s due to the loss of grassland to modern farming practices. In this project, we surveyed ISU Research Farms in northern and central Iowa, which might provide suitable habitat for white-tailed jackrabbit populations as they consist of various-sized test plots with a variety of crops, including small grains and alfalfa, as well as corn and soybeans. Wide grassy lanes surrounding the test plots are mowed, providing open habitat preferred by jackrabbits. Spotlight transect surveys were conducted on the farms in early summer and again in late summer. One of the Research Farms we proposed to survey did not contain features that facilitated our survey method or were hypothesized to benefit jackrabbits (it was one large test plot); another farm was dropped because extensive communication with researchers conducting fieldwork there revealed a lack of jackrabbits; at one site we were unable to coordinate with the farm manager to conduct surveys. The Agronomy and Agricultural Engineering Research Farm west of Ames contained both the largest amount of small grains and alfalfa and the largest number of jackrabbits. Mean number of jackrabbits observed on transects increased from >1/km in early summer to >3/km in the fall. On the Northwestern Research Farm in O’Brien County, jackrabbit numbers decreased over the study period from <0.8/km in summer to 0.1/km in fall. No jackrabbits were spotted in early summer or during harvest in the fall. On the Northwestern Research Farm, 86% of jackrabbits were observed in soybeans with the remainder in grassy lanes in early summer. The only jackrabbit observed in fall was in a grassy lane. Changes in number of jackrabbits and habitat associations over the study period may reflect differences in sightability or differences in use of different habitats by jackrabbits in different seasons.

**Conclusions and Recommendations:**
We established the presence of jackrabbits on only 2 of the ISU Research Farms surveyed. Numbers of jackrabbits per km of transect represent only an index of jackrabbit abundance, but numbers observed were too small to use distance sampling to estimate population size. Increasing the number of survey nights would enable population estimates to be calculated on the Agronomy and Agricultural Engineering Research Farm, but would not help with the low density of jackrabbits on the Northwestern Research Farm. To validate both numbers of jackrabbits and their seasonal habitat use, we recommend use of radiotelemetry on individual animals. Areas with other types of land use, such as airports, should also be surveyed for jackrabbits.

Tyler Bass, an undergraduate student, was supported on this project. He graduated this December and is currently seeking employment.
Assessment of the Interrelationships Between Fish Population Dynamics and Limnological Characteristics of Iowa Lakes

Principal Investigator: Michael C. Quist
Student Investigator: Zachary J. Jackson (M.S.)
Collaborators: Joe Larscheid and Michael Hawkins, Iowa Department of Natural Resources
Duration: August 2005 to June 2008
Funding Source(s): Iowa Department of Natural Resources

Goals and Objectives:
- Evaluate patterns in fish assemblage structure among Iowa lakes using extant fisheries data,
- Describe and assess age and growth of indicator fish species,
- Examine relationships among fish assemblage structure, limnological conditions, lake basin morphology, and watershed characteristics.

Progress:
Databases containing length, weight, catch, and growth information were developed. A total of 113,103 fish were sampled the 2001-2006 study period representing 10 families and 44 species, of which 27,702 were aged. Multiple-linear-regression analysis was used to describe patterns among the study lakes and provide guidance for management activities. Specifically, multiple regression was used to model relations between fish population characteristics and physicochemical habitat and watershed characteristics. Fish population characteristics were further examined using nonmetric multidimensional scaling and showed similar patterns as the regression models. The final report was delivered in November.

Conclusions and Recommendations:
Lakes are important ecological and recreational resources and understanding relationships between fish, humans, and environmental conditions is critical for guiding and evaluating management activities. We examined fish populations, limnological conditions, lake basin morphology, and watershed characteristics over a large spatial area to evaluate patterns in population characteristics of important fish species in relation to environmental conditions. Fish populations and environmental characteristics were sampled from 129 Iowa lakes using standard techniques from 2001-2006. High water transparency resulted in high relative abundance, good condition, and fast growth of sport fishes in Iowa’s highly productive lakes. Catch rates of bluegill, black crappie, and largemouth bass were generally low when omnivores (e.g., black bullhead, common carp) were present. Body condition of the study species was highest in highly productive lakes (i.e., high nutrient or chlorophyll a concentrations) with clear water. We also found evidence that reductions of the abundance of black bullhead and common carp may benefit sport fishes in many systems and that activities resulting in increased densities of bluegill, largemouth bass, and black crappie will negatively influence condition and growth of these species. Although fish population dynamics were more closely related to biotic and limnological conditions compared to measures of lake basin morphology and watershed characteristics, many of the observed patterns are likely mediated by land use activities.
The Effect of Preserve and Conservation Site Clustering on Local Amphibian Densities and Species Richness

Principal Investigator: Brent J. Danielson  
Student Investigator: Anne Johnson (M.S.)  
Duration: October 2004 to June 2007  
Funding Source(s): Iowa Department of Natural Resources (DNR)

Goals and Objectives:
- Determine how the amount and number of conserved areas, including all Iowa DNR properties within a region, affect amphibian species richness and densities.
- Determine the accuracy of Iowa DNR Wildlife Diversity Program volunteer frog and toad call surveys.
- Determine whether restored wetland basins differ in amphibian richness and densities from native wetland basins.

Progress:
This study has been completed, and two papers are currently in review for Applied Herpetology. Master’s student, Anne Johnson, has graduated and is currently working as a GIS habitat and navigatable waters specialist for the Alaska Department of Natural Resources. Her thesis is entitled *An evaluation of anuran monitoring by Iowa Department of Natural Resource volunteers and the spatial scale of habitat use in northwestern Iowa*.

Conclusions and Recommendations:
This study compared anuran presence/absence and categorical abundance data collected by volunteer surveyors to data collected by trained biologists. Volunteers surveyed using auditory survey methods, while the trained biologists used auditory survey methods as well as active searching that involve visual encounter methods at the same sites and during the same time periods as the volunteers. Biologist estimates of species richness for each site/time obtained by both visual encounter and auditory survey methods together were significantly higher than species richness estimates of volunteer surveys. However, volunteers reported higher overall species richness and abundance values when their results were compared to biologist auditory surveys and biologist visual encounter surveys separately. This indicates that a combination of survey techniques provides a more comprehensive picture of anuran species assemblages than one survey method alone.

The ability to conserve species richness is also dependent on understanding the spatial scale of species assemblages. In addition, species richness is limited by the regional context. This study examines the response of anuran richness and abundance to conserved wetlands at various spatial scales. Species richness at a site was dependent on the amount of wetland within only 200 m although analyses extended to 12,000 m.

While our study illustrated how reliable volunteer-collected data are, testing volunteers on auditory and visual identification skills, as well as testing their hearing abilities, would help validate the accuracy of the survey data. Automated recording systems can be used at selected sites to determine if peak calling periods are being missed. This would provide feedback as to the accuracy and precision of volunteer surveys over time. If volunteers are precise and accurate, the sample size needed to determine trends in the data can be reduced. Adding visual encounter surveys is one way of including species that may otherwise be missed by nocturnal calling surveys.

Pickerel frogs are a species of interest in Iowa that may especially benefit by incorporating visual encounter surveys into current volunteer survey protocol. Crouch and Paton (2002) found that pickerel frogs were one of the species most likely to be missed by call surveys due to the infrequent calls of this species.

The small spatial scale at which anurans in northwestern Iowa show correlations with habitat variables imply that usable wetlands should be very closely connected to one another. This indicates that responsible management for wetland species diversity should take into account complexes rather than single, large bodies of water. Wetland complexes should consist of semi-permanent and temporal wetlands that periodically dry in order to reduce or eliminate introduced predators such as fish and bullfrogs. Emergent vegetation marsh is essential to anuran species richness and abundances. Forested marshes should be given special consideration in management decisions for restoration or the purchase of new conservation areas, as this study showed this to be an important habitat type for cricket frogs and treefrogs.
Publications and Reports

Peer-reviewed Publications


Theses and Dissertations


Technical and Semi-Technical Reports


Rowe, D. C., and C. L. Pierce. 2007. Relationships of Fish Assemblages, In-Stream Physical Habitat, and Landscape Characteristics of Wadeable Iowa Streams. Final Report to the Iowa Department of Natural Resources. 136 pages.

Presentations at Professional Meetings


Rowe, D. C., C. L. Pierce, and T. F. Wilton. 2006. Influence of physical habitat and watershed characteristics on stream integrity (invited symposium talk). Midwest Fish and Wildlife Conference, Omaha, NE, December 2006.


Service

Graduate Committee Assignments
- Barbknecht, Andrea, M.S. (Otis)
- Caruthers, Jennet, M.S. (Otis)
- Conover, Ross, Ph.D. (Koford)
- Falcy, Matt, Ph.D. (Otis)
- Henry, Drew, M.S. (Otis)
- Hentjes, Valerie, M.S. (Otis)
- Jovanovich, Boris, Ph.D. (Pierce)
- Koch, Jeff, M.S. (Pierce)
- Neebling, Travis, M.S. (Pierce)
- Olechnowski, Brian, Ph.D. (Koford, Otis)
- Penne, Chris, M.S. (Otis)
- Skrade, Paul, M.S. (Koford)

Courses Taught
- Fisheries Science, AEcl 520 (Pierce - 3 hrs, 12 students, 1/10-5/1/07)
- Stream Ecology, AEcl 518 (Pierce - 3 hrs, 12 students, 8/20-12/18/07)
- Seminar, EEB 698 (Koford - 1 hr, 9 students, 1/15-5/1/07)

University Committees and Workgroups
- Chair, Department Graduate Admissions Committee (Otis)
- Chair, Department Graduate Curriculum Committee (Otis)
- Chair, Errington Lecture Committee (Koford)
- Member, Department Computer Facilities Committee (Van Beek)
- Member, Errington Lecture Committee (Van Beek, ex officio)
- Member, Department Safety and Facilities Committee (Pierce)
- Member, Ecology and Evolutionary Biology Interdepartmental Graduate Program Supervisory Committee (Otis)

Non-society Memberships
- Chair, Environmental Issues Subcommittee, Mississippi Flyway Technical Committee (Otis)
- Member, Research Subcommittee, Mississippi Flyway Technical Committee (Otis)
- U.S. Geological Survey Representative, Mississippi Flyway Technical Committee (Otis)
- Member, National Mourning Dove Task Force (Otis)
- Member, EPA Region 7 Human Stressor Index Oversight Committee (Pierce)

Society Involvement - Memberships
- American Ornithologists’ Union (Koford)
- American Fisheries Society (Pierce)
- American Society of Mammalogists (Koford)
- Biometric Society (Otis)
- Cooper Ornithological Society (Koford)
- Ecological Society of America (Koford, Otis)
- Sigma Xi (Koford)
- Society for Conservation Biology (Koford)
- Society for Ecological Restoration (Koford)
- The Wildlife Society (Koford, Otis)

**Society Involvement - Officer**
- Continuing Education Chairman, Iowa Chapter of the American Fisheries Society (Pierce)
- President, Iowa Chapter of The Wildlife Society (Koford)

**Technical Assistance/Outreach**
- Serving as a member of EPA, Region 7, Synoptic Human Stressor oversight committee. (Pierce)

**Training Provided**
- Pierce, C. L. As Continuing Education Committee Chair of the Iowa Chapter, American Fisheries Society, Clay planned and organized a short course for fisheries professionals titled, “Using the Iowa Rivers Information System (IRIS) for Stream Fisheries Management”, December 19, 2006.
- Pierce, C. L. As Continuing Education Committee Chair of the Iowa Chapter, American Fisheries Society, Clay planned and organized a short course for fisheries professionals titled, “Identification of Iowa Fishes”, July 13, 2007.

**News**

Rob Fletcher (Ph.D. 2003) is now an Assistant Professor in the Department of Wildlife Ecology and Conservation at the University of Florida, Gainesville.

David C. Rowe (M.S.) successfully defended his thesis in May 2007. He is a Fisheries Management Biologist with the Wisconsin Department of Natural Resources in Green Bay.

Christopher R. Penne (M.S.) successfully defended his thesis in May 2007. He is the Community Fisheries Program Leader with the Utah Department of Natural Resources in Salt Lake City.

Mary E. Litvan (M.S. 2006) returned to her hometown of Springfield Missouri in August 2007 to assume the position of Fisheries Management Biologist with the Missouri Department of Conservation.

Nick K. Frohnauer (M.S. 2003) became the Assistant Area Fisheries Supervisor for the Duluth Region of the Minnesota Department of Natural Resources in August 2007.