MISSOURI COOPERATIVE
FISH & WILDLIFE RESEARCH UNIT REPORT

January 2008 – November 2010

Cooperating Agencies:

U. S. Geological Survey
U. S. Fish and Wildlife Service
Missouri Department of Conservation
University of Missouri
Wildlife Management Institute
The Unit Annual Report has been produced for over 30 years. Because our colleagues have graciously allowed us to include their projects and accomplishments, we have a wonderful historical documentation of the activities of the entire Department of Fisheries and Wildlife Sciences. If you desire any additional information, please contact Niki Fuemmeler at our address.
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Dr. Charlie Rabeni retired from the Cooperative Research Unit program after a long tenure as Leader, Acting Leader, and Assistant Leader in his 30 year career. We all congratulate Charlie upon his retirement from the Coop Unit program. In his 30 years with the Missouri Coop Unit, Charlie was a productive and influential researcher who became a leader in warmwater stream ecology. His reputation in stream ecology led to invited seminars and presentations in China, New Zealand, Austria, Poland, Germany, Sweden, and Italy. However, Charlie’s true love was the Ozarks, where he was known to personally ‘sample’ the smallmouth bass populations regularly.

Charlie has published over 100 peer reviewed publications and book chapters, ranging from topics such as the effects of chemical spraying on stream biota, trophic interactions, and ecology of river and stream fishes and invertebrates. However, Charlie is perhaps best known for his research on smallmouth bass and aquatic biota in Ozark streams. In his career, Charlie supervised 48 graduate students with over 20 of these students working on Ozark stream ecology.

Charlie was also very active at the University and professional societies. As an educator, Charlie’s stream ecology course at MU was very well received by faculty and students. In addition, he often served on state to national-level committee for the American Fisheries Society and the North American Benthological Society, as well as serving on the Graduate Affairs Committee for the Fisheries and Wildlife Sciences Department at MU. Charlie’s commitment to MU, MDC, the Unit, and other cooperators sets a high standard and the framework for continued strong collaborations, educational training, and research in Missouri.
THE MISSOURI COOP UNIT

The Cooperative Research Units program is comprised of 40 Units in 38 states. Each Unit is a formal partnership among the U.S. Geological Survey, a State natural resource agency, a host university, the Wildlife Management Institute, and the U.S. Fish and Wildlife Service. The structure of the program provides Federal and State agencies access not only to Unit scientists, but also to facilities and expertise available at the cooperating universities. Because Unit scientists and university faculty members possess diverse areas of expertise, the program collectively embraces a wide variety of disciplines related to fish, wildlife, and natural resource management.

The Missouri Unit is a productive member of the Unit program. Our history began in 1936 when the citizens of Missouri voted to amend the State’s constitution to create a politically independent Conservation Commission. The first official act of the Conservation Commission was to establish a Cooperative Wildlife Research Unit at the University of Missouri. Objectives were settled upon quickly and were “to conduct scientific research on the wildlife of Missouri” and “to educate students, both in technical phases of wildlife management and general aspects of wildlife conservation.” We have grown by adding a Fishery Unit in 1962, consolidated by becoming a single Fish and Wildlife Unit in 1985, and moved from the U.S. Fish and Wildlife Service to the National Biological Survey to the U.S Geological Survey. But through it all we have tried to remain true to these early guiding principles.

Projects conducted by our Unit address the expressed information needs of the Missouri Department of Conservation, the U.S. Geological Survey, and other state and federal agencies. The needs of the University of Missouri, also a primary cooperator, are met by assisting with the education mission of the University at the graduate level. The Unit assists University cooperators in various ways, including sharing Unit resources and by administering USGS and other federal funds through the Research Work Order process.

The diversity of fish and wildlife resources in Missouri requires the Unit to pursue a broad focus for research studies, although waterfowl nutritional ecology, big river ecology and management, and stream fishery resources have long been emphasized. An attempt is made to complement and strengthen existing research thrusts of state and federal agencies. The concern of all cooperators is that Unit research be productive, of high quality, and ultimately useful to the management of fish and wildlife resources of the state and region.
UNIT AND COOPERATOR PERSONNEL ROSTER

A. Permanent Unit Personnel

Craig Paukert, Unit Leader  David L. Galat, Assistant Leader
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Niki Fuemmeler, Administrative Officer
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John Faaborg  Matthew E. Gompper
Robert S. Hayward  John R. Jones
Dylan Kesler  Joshua J. Millspaugh
Charles H. Nilon  Douglas B. Noltie
Robert A. Pierce II  Mark R. Ryan
Frank R. Thompson III  David Diamond
Joanna Whittier

B. Unit Coordinating Committee

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Natural Resources
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PayneT@missouri.edu

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Missouri Department of Conservation  Cooperative Fish and Wildlife Research Units
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Wildlife Management Institute  US Fish & Wildlife Service
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Millersport, OH  43046 Fort Snelling, MN 55111
PatRubleWMI@columbus.rr.com  612-713-5360
## GRADUATE STUDENTS

### 2008 to Present

**Advised by Unit Scientists**

*Student received degree during the report period.*

<table>
<thead>
<tr>
<th>Student and Degree Sought</th>
<th>Thesis Project</th>
<th>Previous Education</th>
<th>Advisor</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Meagan Bradburn, M.S.</em></td>
<td>A study of the abundance, diversity, and recruitment status of freshwater mussels in the Marais des Cygnes River, Kansas.</td>
<td>B.S., University of Pittsburgh</td>
<td>Dr. Rabeni</td>
</tr>
<tr>
<td><em>Shannon Brewer, Ph.D.</em></td>
<td>Landscape and inchannel factors affecting the distribution and abundance of riverine smallmouth bass in Missouri.</td>
<td>B.S., Missouri Western University M.S., University of Missouri</td>
<td>Dr. Rabeni</td>
</tr>
<tr>
<td>Justin Buckler, M.S.</td>
<td>Assessing effects of contaminants on Scaphirhynchus sturgeon.</td>
<td>B.S., University of Missouri-Columbia</td>
<td>Dr. Galat</td>
</tr>
<tr>
<td>Jake Faulkner, M.S.</td>
<td>Seasonal habitat selection of Niangua darters.</td>
<td>B.S., University of Missouri</td>
<td>Dr. Paukert</td>
</tr>
<tr>
<td>Jeffrey D Fore, Ph.D.</td>
<td>Remediating Effects of Human Threats on lotic fish assemblages within the Missouri River Basin: how effective are conservation practices?</td>
<td>B.S., Oklahoma State University M.S., Eastern Illinois University</td>
<td>Dr. Galat</td>
</tr>
<tr>
<td><em>Daniel Garrett, Ph.D.</em></td>
<td>Movement, habitat use, and spawning characteristics of flathead and blue catfish on the Lower Missouri River and tributaries.</td>
<td>B.S., University of Hawaii M.S., University of Washington</td>
<td>Dr. Rabeni</td>
</tr>
<tr>
<td><em>Joshua Lallaman, Ph.D.</em></td>
<td>Ecology of paddlefish in the Osage River.</td>
<td>B.S., University of Wisconsin-Stevens Point M.S., Central Michigan University</td>
<td>Dr. Galat</td>
</tr>
<tr>
<td><em>Doreen Mengel, M.S.</em></td>
<td>Amphibians as wetland restoration indicators on Wetlands Reserve Program sites in Lower Grand River basin, Missouri.</td>
<td>B.S., University of Georgia</td>
<td>Dr. Galat</td>
</tr>
</tbody>
</table>
Meagan Montgomery, M.S.  
Restoring river-floodplain connectivity for fish spawning and nursery in the Lower Missouri River: use of a constructed fish passage facility and an actively managed wetland pool.  
B.S., University of Missouri  
Dr. Galat

Landon Pierce, Ph.D.  
Conservation planning of fishes in the Colorado River basin.  
B.S., University of Nebraska  
M.S., South Dakota State University  
Dr. Paukert

Jonathan Spurgeon, M.S.  
Evaluation of translocations of humpback chub in Grand Canyon.  
B.S., University of Missouri  
Dr. Paukert

*Andy Turner, M.S.  
Watershed-sediment-biotic linkages in small streams of Missouri’s Osage River Basin.  
B.S., University of Missouri  
Dr. Rabeni

Jacob Westhoff, Ph.D.  
Investigating the replacement of imperiled native crayfishes by an introduced crayfish.  
B.S., University of Missouri  
M.S., Tennessee Technological University  
Dr. Rabeni

<table>
<thead>
<tr>
<th>Name</th>
<th>Research Project</th>
<th>Previous Education</th>
<th>Advisor</th>
</tr>
</thead>
</table>
| Dr. Allison Pease         | Population-level effects of climate change on fishes. | B.S., University of Texas  
M.S., University of New Mexico  
Ph.D. Texas AM University    | Dr. Paukert |
| Dr. Karthik Masagounder   | Asian carp invasion potential into the Great Lakes.   | B.S., Tamil Nadu Veterinary and Animal Sciences University, India  
M.S., Central Institute of Fisheries Education, Mumbai, India  
Ph.D. University of Missouri | Dr. Paukert |
| Daniel Whiting            | Evaluation of translocation of humpback chub in Grand Canyon. | B.S., Southern Illinois University  
M.S., Southern Illinois University | Dr. Paukert |
**GRADUATE STUDENTS**

**2008 to Present**

*Advised by Fish & Wildlife Department Cooperator Faculty*

*Student received degree during the report period.*

<table>
<thead>
<tr>
<th>Student and Degree Sought</th>
<th>Thesis Project</th>
<th>Previous Education</th>
<th>Advisor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dylan Allen, Ph.D.</td>
<td>Reproductive ecology of urban opossums.</td>
<td>B.S., Missouri State University M.S., Missouri State University</td>
<td>Dr. Nilon</td>
</tr>
<tr>
<td><em>Aniruddha Belsare, Ph.D.</em></td>
<td>Leopards, dogs, and rabies disease ecology in Maharashtra, India.</td>
<td>B.V.Sc.&amp;A.H. Bombay Veterinary College</td>
<td>Dr. Gompper</td>
</tr>
<tr>
<td><em>Catherine Bodinof, M.S.</em></td>
<td>Translocation and conservation of hellbenders in Missouri.</td>
<td>B.S., Georgetown College</td>
<td>Dr. Millspaugh</td>
</tr>
<tr>
<td><em>Carolyn Broun, M.S.</em></td>
<td>An evaluation of the Missouri Master Naturalist Program and implications for program expansion.</td>
<td>B.S. University of Illinois J.D. St Louis University</td>
<td>Drs. Nilon/Pierce</td>
</tr>
<tr>
<td>Michael Burfield, M.S.</td>
<td>Prairie restoration plan for George Washington Carver National Monument.</td>
<td>B.S., University of Cincinnati</td>
<td>Dr. Nilon</td>
</tr>
<tr>
<td><em>Chandler Denison, M.S</em></td>
<td>Socioeconomic predictors of urban bird abundance.</td>
<td>B.S., Pitzer College</td>
<td>Dr. Nilon</td>
</tr>
<tr>
<td><em>David Eads, M.S.</em></td>
<td>Resource selection of black-footed ferrets.</td>
<td>B.S., Indiana University-Purdue University Indianapolis</td>
<td>Dr. Millspaugh</td>
</tr>
<tr>
<td><em>Mundy Hackett, Ph.D.</em></td>
<td>Occupancy modeling of forest carnivores in Missouri.</td>
<td>B.S., University of Virginia M.S., Virginia Commonwealth University</td>
<td>Dr. Gompper</td>
</tr>
<tr>
<td><em>Christopher Hansen, M.S.</em></td>
<td>Occupancy modeling of ruffed grouse.</td>
<td>B.S., Truman State University</td>
<td>Dr. Millspaugh</td>
</tr>
<tr>
<td>Leslie Hearne, M.S.</td>
<td>Growth/survival of cage-reared Sunfish.</td>
<td>B.S., Lincoln University</td>
<td>Dr. Hayward</td>
</tr>
<tr>
<td>Lianne Hibbert, Ph.D.</td>
<td>Public attitudes toward nature conservation in St. Lucia.</td>
<td>B.S., Grambling State University M.S., University of Missouri</td>
<td>Dr. Nilon</td>
</tr>
<tr>
<td>Jonathan Hogg, M.S.</td>
<td>Ecology of business parks.</td>
<td>B.S., University of Idaho</td>
<td>Dr. Nilon</td>
</tr>
<tr>
<td>Name</td>
<td>Title</td>
<td>Education</td>
<td>Advisor</td>
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<tr>
<td>David Jachowski, Ph.D.</td>
<td>Movements and physiology of translocated elephants.</td>
<td>B.S., University of Montana M.S., University of Missouri</td>
<td>Dr. Millspaugh</td>
</tr>
<tr>
<td>*Hemanta Kafley, Ph.D.</td>
<td>Tiger landscape ecology in Nepal.</td>
<td>B.S., Tribuvan University M.S., Centre for Space Science &amp; Technology Education in Asia and the Pacific</td>
<td>Dr. Gompper</td>
</tr>
<tr>
<td>Barbara Keller, Ph.D.</td>
<td>Forage production and overlap of ungulates.</td>
<td>B.S., Northland College M.S., New Mexico State University</td>
<td>Dr. Millspaugh</td>
</tr>
<tr>
<td>*Jesse Kolar, M.S.</td>
<td>Migration and resource selection of pronghorns.</td>
<td>B.S., University of Montana</td>
<td>Dr. Millspaugh</td>
</tr>
<tr>
<td>Jaymi LeBrun, Ph.D.</td>
<td>Managing wildlife in the face of a changing climate.</td>
<td>B.S., University of Wisconsin (Madison) M.S., Iowa State University</td>
<td>Drs. Millspaugh/. Thompson</td>
</tr>
<tr>
<td>*Karthik Masagounder, Ph.D.</td>
<td>Least-cost diet development for bluegill.</td>
<td>M.S., Central Inst. Fish Mgmt</td>
<td>Dr. Hayward</td>
</tr>
<tr>
<td>Matthew McCloud, Ph.D.</td>
<td>Urban muskrats.</td>
<td>B.S., University of Missouri MBA, Webster University</td>
<td>Dr. Nilon</td>
</tr>
<tr>
<td>*Remington Moll, M.S.</td>
<td>Development of a terrestrial animal-borne video system.</td>
<td>B.S. University of Missouri</td>
<td>Dr. Millspaugh</td>
</tr>
<tr>
<td>*Ryan Monello, Ph.D.</td>
<td>Experimental analyses of the interactions of parasite community structure and host contact rate.</td>
<td>B.S., Benedictine College M.S., University of Idaho</td>
<td>Dr. Gompper</td>
</tr>
<tr>
<td>Rebecca Mowry, M.S.</td>
<td>A genetic approach to determine river otter abundance in Missouri.</td>
<td>B.S., University of Idaho</td>
<td>Dr. Gompper</td>
</tr>
<tr>
<td>*Natalie Olifiers, Ph.D.</td>
<td>Population and disease ecology of the brown-nosed coati (<em>Nasua nasua</em>) and the crab eating-fox (<em>Cerdocyon thous</em>) in the Brazilian Pantanal.</td>
<td>B.A., Federal University of Rio de Janeiro M.S., Federal University of Minas Gerais</td>
<td>Dr. Gompper</td>
</tr>
<tr>
<td>Sarah Pennington, M.S.</td>
<td>Habitat occupancy modeling of forest bats.</td>
<td>B.S., University of Missouri</td>
<td>Dr. Gompper</td>
</tr>
<tr>
<td>Carol Pollard, M.S.</td>
<td>Influence of streambed substrate type and watershed properties on seston algal abundance.</td>
<td>B.S., University of Colorado</td>
<td>Dr. Jones</td>
</tr>
<tr>
<td>Name</td>
<td>Project Description</td>
<td>Degree Details</td>
<td>Advisor(s)</td>
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<tr>
<td>Brandon Pope</td>
<td>Outreach programs for urban youth</td>
<td>B.S., Tuskegee University</td>
<td>Dr. Nilon</td>
</tr>
<tr>
<td>Michael Shane Pruett, M.S.</td>
<td>Avian nest survival and breeding density in cottonwood plantations and native forest fragments in southeast Missouri.</td>
<td></td>
<td>Dr. Thompson, III</td>
</tr>
<tr>
<td>Chadwick Rittenhouse, Ph.D.</td>
<td>Wildlife response to spatial and temporal changes in forest habitat.</td>
<td>B.S. University of Wisconsin (Madison) M.S. University of Missouri</td>
<td>Dr. Millspaugh</td>
</tr>
<tr>
<td>Christopher Rota, Ph.D.</td>
<td>Movements and resource selection of black-backed woodpeckers.</td>
<td>B.S. University of Montana M.S. University of Florida</td>
<td>Drs. Millspaugh/ Kesler</td>
</tr>
<tr>
<td>*Mihai Sun, Ph.D.</td>
<td>Least-cost diet yellow perch/tilapia.</td>
<td>M.S. Pukyong Nat’l. Univ. Korea</td>
<td>Dr. Hayward</td>
</tr>
<tr>
<td>*Abi Vanak, Ph.D.</td>
<td>Intraguild interactions between native and domestic carnivores in central India.</td>
<td>B.S., Madras University M.S., Saurashtra University</td>
<td>Dr. Gompper</td>
</tr>
<tr>
<td>*Nathan Weber, M.S.</td>
<td>Human dimensions of an urban deer hunt.</td>
<td>B.S., Columbia College</td>
<td>Dr. Nilon</td>
</tr>
<tr>
<td>Morgan Wehtje, M.S.</td>
<td>Response of raccoon spatial and social behavior to the presence of an experimentally clumped food resource.</td>
<td>BS California State University, Humboldt</td>
<td>Dr. Gompper</td>
</tr>
<tr>
<td>*Christopher Witte, M.S.</td>
<td>Effects of temperature, photoperiod, and substrate on maturation and reproductive behavior of the topeka shiner.</td>
<td>B.S., University of Missouri</td>
<td>Dr. Noltie</td>
</tr>
<tr>
<td>Stephanie Zimmer, M.S.</td>
<td>Effects of commercial harvest on turtles in the Missouri River.</td>
<td>B.S. Michigan State University</td>
<td>Dr. Millspaugh</td>
</tr>
<tr>
<td>Name</td>
<td>Research Project</td>
<td>Previous Education</td>
<td>Advisor</td>
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<tr>
<td>Prof. Dr. Muhammad Ali</td>
<td>Subsatiation feeding regimes.</td>
<td>Ph.D. Bauhaddin Univ.</td>
<td>Dr. Hayward</td>
</tr>
<tr>
<td>Thomas Bonnot</td>
<td>Evaluating effects of fire and ecosystem restoration on wildlife.</td>
<td>B.S., University of Missouri M.S., University of Missouri</td>
<td>Drs. Millspaugh/Thompson</td>
</tr>
<tr>
<td>Dr. Robert Gitzen</td>
<td>Development of an inventory and monitoring plan for the Northern Great Plains.</td>
<td>B.S., University of Minnesota M.S., University of Washington Ph.D. University of Washington</td>
<td>Dr. Millspaugh</td>
</tr>
<tr>
<td>Christopher Hansen</td>
<td>Sage-grouse and wind energy.</td>
<td>B.S. Truman State University M.S. University of Missouri</td>
<td>Dr. Millspaugh</td>
</tr>
<tr>
<td>Dr. Ryan Monello</td>
<td>Genetics of parasite-host interactions.</td>
<td>B.S., Benedictine College M.S., University of Idaho Ph.D. University of Missouri</td>
<td>Dr. Gompper</td>
</tr>
<tr>
<td>Tony Mong</td>
<td>Doves and agroforestry.</td>
<td>B.S. University of Missouri M.S. Kansas State University</td>
<td>Dr. Millspaugh</td>
</tr>
<tr>
<td>Jennifer Reidy</td>
<td>Bird communities across a savanna-forest gradient; evaluation of bird survey methods.</td>
<td>B.S., Texas A&amp;M M.S., University of Missouri</td>
<td>Dr. Thompson III</td>
</tr>
<tr>
<td>Dr. Maria Ruiz-Lopez</td>
<td>Genetics of parasite-host interactions.</td>
<td>B.S., Universidad Complutense de Madrid M.S., Universidad Complutense de Madrid PhD Universidad Complutense de Madrid</td>
<td>Dr. Gompper</td>
</tr>
<tr>
<td>Rami Woods</td>
<td>Stress physiology of wildlife.</td>
<td>B.S. Illinois State University</td>
<td>Dr. Millspaugh</td>
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</tbody>
</table>
RESEARCH PROJECTS
PROJECTS WITH UNIT SCIENTIST AS PRINCIPAL INVESTIGATOR

DR. DAVID GALAT

AMPHIBIANS AS WETLAND RESTORATION INDICATORS ON WETLANDS RESERVE PROGRAM SITES IN LOWER GRAND RIVER BASIN, MISSOURI

**Investigators**
Doreen Mengel, M.S. 2010
Dr. David L. Galat

**Project Supervisor**
Dr. David L. Galat

**Funding**
MDC
USDA Conservation Effects Assessment Project – Wildlife Component
USGS, Cooperative Fish and Wildlife Research Unit, MU School of Natural Resources, University of Missouri

**Cooperators**
Missouri Department of Conservation
United States Natural Resources Conservation Service

**Objectives**
Evaluate if hydrological wetland characteristics have been restored on WRP properties in the Lower Grand River basin as indicated by amphibian distribution based on proportion of area occupied estimates on walk-away, maximize hydrology, and naturalistic sites.

Evaluate if amphibian detection probability varied

**Status**
Completed

**Progress and Results**
An occupancy and species richness study was conducted to determine if hydrological and biological wetland characteristics had been restored to Wetlands Reserve Program (WRP) sites in the Lower Grand River basin, north-central Missouri. Restoration of hydrological wetland characteristics throughout the Lower Grand River basin was indicated by amphibian distribution whereas restoration of biological wetland characteristics was indicated by amphibian recruitment success. Relative species richness estimates for members of the regional species pool served as indicators of both hydrological and biological wetland characteristics on a site-by-site basis. Three design strategies applied to WRP sites over time were identified: walk-away, maximize hydrology, and naturalistic; the latter emphasizing restoring process as well as structure; and were evaluated to determine if design strategy was a useful covariate for restoration efforts.

Ten amphibian species representing 59% of the regional species pool were encountered. Design strategy was not a predictive site-level covariate as sites within all three design strategies had varying hydrological wetland conditions resulting in greater habitat heterogeneity than anticipated on maximize hydrology and walk-away sites and less than anticipated on naturalistic sites. Amphibian detections occurred across all sites resulting in no difference among design strategy as the degree of heterogeneity in habitat conditions at the within site-scale demonstrated that amphibians were responding to ecological conditions that occur at a finer resolution than site. Results, irrespective of design strategy, indicate seven of the detected species or groups were widely-distributed, two were moderately-distributed, and two were sparsely distributed on WRP sites indicating hydrological wetland characteristics have been restored to sites given the moderate- to wide-distribution of species associated with both seasonal and permanent wetlands. Although species were successfully recruiting young into adult populations, only leopard frogs had high estimates of recruitment success whereas the remaining species had moderately high to moderate to low recruitment estimates indicating biological wetland characteristics are somewhat lacking to lacking for these species. Results from the relative species richness assessment indicate that, whereas 74% of the sites provided some degree of wetland habitat for members of the regional species pool over the course of the field season (7 March – 19 September), 52% of the sites lacked suitable habitat conditions during the peak of amphibian breeding and larval development (May through July). Targeting management actions that result in suitable seasonal wetland habitat conditions (shallow, vegetated wetlands that gradually dry by mid-to late-summer) throughout the time needed for species to complete their life.

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by seasonal response to environmental conditions or sampling method.

Evaluate if biological wetland characteristics have been restored on WRP properties in the Lower Grand River basin as indicated by amphibian recruitment based on estimation of multi-state occupancy probability.

Assess wetland restoration efforts as indicated by the relative species richness metric achieved on WRP properties in the Lower Grand River basin.

Assess whether design strategy serves as a criterion of a functional ecological attribute created by management actions on WRP properties in the Lower Grand River basin through use of a cluster analysis.

**Location**
Wetlands Reserve Program sites in north-central Missouri

**Completion**
December 2010

history requirements is one method to increase the biological wetland value of restored WRP sites.

**Products since 2008**
RESTORING RIVER-FLOODPLAIN CONNECTIVITY FOR FISH SPAWNING AND NURSERY IN THE LOWER MISSOURI RIVER: USE OF A CONSTRUCTED FISH PASSAGE FACILITY

Investigators
Dr. David Galat, MU
Meagan Montgomery, M.S. student

Project Supervisor
Dr. David Galat

Funding
Missouri Department of Conservation

Cooperators
Missouri Department of Conservation
US Geological Survey

Objectives
Predict fish species that potentially access wetland pools based on distribution, habitat-use guilds, spawning temperature ranges, and river water temperature.

Model stage relationship between lower Missouri River (LMOR) and Eagle Bluffs Conservation Area (EBCA) to predict connectivity.

Determine if similar water temperature exist during periods of LMOR-EBCA connectivity and isolation.

Quantify ingress and egress of pooled and selected Missouri River fishes through the fish passage facilities.

Determine how physiochemical variables of the wetland pool compare to optimal ranges for growth and mortality of riverine fishes.

Estimate growth of selected fish species.

Location
Eagle Bluffs Conservation Area

Expected Completion
December 2010

Status
Data analysis is nearing completion; final report is being developed.

Progress and Results
Restoration projects are being undertaken along many large floodplain rivers, including the lower Missouri River (LMOR) to mitigate past channelization and levee construction that severed river-floodplain connectivity and denied riverine fishes access to seasonally-flooded wetlands. Two wetland pools were constructed at Eagle Bluffs Conservation Area (EBCA) as part of the Missouri River Mitigation Project. These pools were built with water-control structures to allow controlled passage of riverine fishes into EBCA for spawning and nursery. This study assessed potential benefits of fish passage structures at EBCA as well as future implementation of similar designs at other river-floodplain mitigation sites.

Thirty-eight species were predicted to access the wetland pools and had a total spawning temperature range of 2.2-35.0°C. Eighty-five percent of these species were estimated to begin spawning between 10.0°C and 21.2°C, which corresponded to the spawning window of April 4 – June 1 (JD 95-153). Stage data from 1993-2006 used to model lateral connectivity between LMOR and EBCA was validated with data from 2007 and 2008. Highest connection frequency occurred from March to August and timing of connectivity event start date also closely matched the spawning window. Duration of connectivity was variable, although usually shorter than 10 days. The amount of water exchanged between LMOR and EBCA during an event varied due to event duration and magnitude of connectivity; mean water exchange at the fish passage structures was 3.05 m³day⁻¹. Environmental circumstances during the two field seasons necessitated selective application of fish sampling data to objectives analyzing lateral fish movement. Preliminary analyses demonstrate that fish access predictions were 68% accurate, based on fish data collected during 2008 ingress events, and comparing predicted and sampled assemblages yielded a Jaccard similarity coefficient of 0.62. The hydrologic model can help resource agencies manage for future flood events by determining optimal dates for enabling river-floodplain connectivity via the fishway. Designed connectivity can be used to improve integrating fish and waterbird use of riverine floodplain wetlands. Predictions of fish use of floodplains enable managers to potentially promote or regulate ingress of targeted species. Data analyses and thesis writing are ongoing.
UPPER MISSISSIPPI NAVIGATION & ECOSYSTEM RESTORATION PROGRAM – INDEPENDENT SCIENCE PANEL

Investigators
John Barko, Barko Environmental, LLC
Steven Bartell, E2 Consulting
Michael Davis, MN DNR
Robert Clevenstine, U.S. Fish & Wildlife Service
David Galat, USGS
Barry Johnson, USGS
Kenneth Lubinski, USGS
John Nestler, U.S. Army COE
Larry Weber, University of Iowa

Project Supervisor
Ken Barr, U.S. Army COE

Funding
U.S. Army Corps of Engineers

Cooperators
U.S. Army Corps of Engineers
Great Rivers Cooperative Ecosystem Studies Unit

Objectives
Provide scientific advice to the USACE for adaptive management and restoration of the UMRS ecosystem.

Facilitate determination of the current state of scientific knowledge, design of projects and actions for effective ecological performance, identification of uncertainties, identification of research needs, and development of monitoring plans and modeling approaches.

Act as a resource to provide data/information and the review of documentation, including project plans as requested by the USACE.

Location
Upper Mississippi River

Completion
December 2010

Status
Completed

Progress and Results
The ecosystem restoration and management component of the U.S. Army Corps of Engineers’ (USACE) Navigation and Ecosystem Sustainability Program (NESP) is a 50-year effort to restore and maintain the environmental health of the Upper Mississippi River System (UMRS). Restoration will occur by implementing a variety of management actions (projects) through integrated, multidisciplinary Project Delivery Teams (PDTs). Project planning will need to range in scale from single, local projects to large programmatic efforts affecting the entire system. The high value of the UMRS ecosystem and the high cost of its management and restoration will require adaptive management and decision-making within a scientific framework. The NESP Science Panel (SP) is charged with providing advice for designing and implementing that framework.

The panel has convened numerous workshops including ecosystem services, modeling, system-levels goals and objectives setting, and water level management. We developed a conceptual model for the UMRS. The SP has worked with the PDTs on reach planning (with attention to goals and objectives), Fish Passage (with attention to long-term effects on fish distribution and abundance), water level management (applied to multiple reaches to develop long-term management strategies), Illinois River coordination, forest/flood plain management, and side-channel restoration.

We prepared a report outlining an approach for learning more about summer water level drawdowns as a management tool, including where and how drawdowns can be applied most effectively within the UMRS.

Products since 2008
COMMITTEE ON MISSOURI RIVER RECOVERY AND ASSOCIATED SEDIMENT MANAGEMENT ISSUES

Investigators
Leonard A. Shabman, Chair, Resources for the Future
Thomas Dunne, Univ. CA, Santa Barbara
Rollin H. Hotchkiss, BYU
W. Carter Johnson, SD State University
Patricia F. McDowell, Univ. of Oregon
Robert H. Meade, USGS (emeritus)
Roger K. Patterson, Metropolitan Water District of Southern CA
Nicholas Pinter, Southern IL Univ.
Sujoy B. Roy, Tetra Tech, Inc.
Donald Scavia, University of Michigan
Sandra B. Zellmer, Univ. of NE

Project Supervisor
Jeffrey Jacobs, National Research Council

Funding
U.S. Army Corps of Engineers

Cooperators
National Research Council, Water Science and Technology Board
Division of Earth and Life Studies, National Academy of Sciences

Objectives
Provide information and recommendations of interest to a broad audience on: 1) the sediment regime of the Missouri River, how it has changed over time, and its roles in river management decisions; 2) the role of sediments in Gulf of Mexico hypoxia; 3) land building in the Gulf; (4) Missouri River water quality; 5) species recovery and bed lowering, and; 6 future management actions.

Location
Missouri and Mississippi rivers

Completion
September 2010

Status
Completed

Progress and Results
To provide independent advice on Missouri River sediment and related resource management, in 2008 the Corps of Engineers requested the National Research Council (NRC) Water Science and Technology Board (WSTB) convened an expert committee to address seven sediment-related questions for the Missouri River system. The committee held five meetings over the course of its project. Public meetings were convened in four Missouri River cities: St. Louis, Omaha, Vermillion, SD, and Kansas City. A final, closed meeting was held in Washington, D.C. in early 2010 at which the committee worked on its draft report.

The Committee’s report addresses the topics of Missouri River sediment, its physical and biological importance, how its dynamics and roles in the river system have changed over time, and its roles in contemporary river management decisions. Specifically, the committee considered: 1. The roles of Missouri River sediment in river ecology and restoration, and its implications for water quality and coastal restoration downstream in the northern Gulf of Mexico; 2. Environmental and economic considerations regarding nutrient and contaminant loadings; 3. Alternatives for reintroducing sediment into the system, and; 4 Current Corps of Engineers restoration actions as they relate to sediment and nutrients, and how they might be improved.

Products since 2008
REMEDIATING EFFECTS OF HUMAN THREATS ON LOTIC FISH ASSEMBLAGES WITHIN THE MISSOURI RIVER BASIN: HOW EFFECTIVE ARE CONSERVATION PRACTICES?

Investigators
Jeffrey Fore, MU
Scott Sowa, The Nature Conservancy
David Diamond, MO Resource Assessment Partnership
David Galat, MU

Project Supervisor
David Galat
David Diamond

Funding
Natural Resources Conservation Service, Conservation Effects Assessment Project

Cooperators
USDA Natural Resource Conservation Service

Objectives
The goal of this project is to assess the effectiveness of NRCS conservation practices at conserving lotic fish assemblages throughout the Missouri River basin.

To develop spatially explicit models to predict the response of fish species abundance within trophic and reproductive guild to human threats and agricultural conservation practice implementation for every stream segment within the Missouri River basin.

Location
Missouri River basin

Expected Completion
June 2012

Status
In progress

Progress and Results
Threats to freshwater biodiversity are primarily driven by large-scale, private agriculture production and human modification of the landscape. As private land holdings account for approximately 70% of land ownership in the United States (US), management of these lands is integral to the success of freshwater biodiversity conservation. The US Department of Agriculture’s Natural Resource Conservation Service is largely responsible for interacting with private land managers in agricultural settings and through Farm Bill legislation and funding has the ability to encourage the implementation of large-scale conservation measures on private lands. Until recently, it has not been possible to evaluate the Natural Resource Conservation Services’ conservation practices to determine their success at conserving aquatic biota. Our goal is to assess effectiveness of the U.S. Department of Agriculture’s Natural Resource Conservation Service (NRCS) conservation practices at conserving flowing-water (lotic) fish assemblages throughout the Missouri River basin. To date, we have developed threat indices that represent the cumulative effects of multiple agriculture, urbanization, point-source pollution, and infrastructural threats for every stream segment in the Missouri River basin. Threat indices can be used to target conservation areas for stream fishes by identifying areas where conservation entities have the potential to remediate existing threats. Models have been developed in two ecoregions within the basin that predict the response of an ecological indicator fish guild (lithophilous spawners) in wadeable streams to multiple human threats and the implementation of agricultural conservation practices. Results indicate that substantial agricultural conservation will be needed to improve ecological condition of wadeable streams in the Missouri River basin. Future work will assess the effectiveness of currently implemented NRCS conservation practices to lotic fishes.
Investigators
Dr. David Galat, MU
Del Lob, MDC

Project Supervisor
Dr. David Galat

Cooperators
Missouri Department of Conservation
US Geological Survey, Columbia
Environmental Research Center
US Fish and Wildlife Service, Columbia
Fisheries Resource Office

Objectives
Evaluate the use of plasma sex steroids to determine spawning status and identify potential spawning dates

Develop a predictive model to determine flow and temperature conditions needed for paddlefish passage past a low-head lock and dam

Determine availability and use of spawning habitat below a major hydroelectric impoundment

Identify spawning locations and evaluate paddlefish reproductive success by capturing eggs and larvae

Location
Osage River, MO

Expected Completion
December 2010

Status
In progress

Progress and Results
Paddlefish are threatened in 11 of the 22 the states within their native range, as a result of overfishing, habitat degradation, and restriction of spawning movements. Populations of paddlefish in Missouri are large enough to support recreational and commercial fisheries and provide a valuable opportunity to study this species where it is abundant. The Osage River supports the largest population of paddlefish in the State of Missouri, but also has several major impoundments that effect paddlefish movement and reproduction. The lower most dam, Osage River Lock and Dam #1, is a low-head structure that potentially restricts upstream access to spawning habitat under low-flow conditions. The upper dam, Bagnell Dam, is a large hydroelectric facility that operates on a daily peaking flow, which may disrupt paddlefish spawning cues. Our objectives were to 1) collect sex and reproductive information using plasma sex steroids, 2) model physical factors needed to facilitate upstream passage of paddlefish at the lock and dam, 3) model available spawning habitat upstream of the lock and dam, and 4) assess reproductive success in the lower Osage River. Paddlefish were captured, assessed for reproductive condition, and had a combined acoustic radio transmitter inserted into the body cavity for daily monitoring. Steroid analysis allowed us to effectively identify reproductive condition and physiological timing of spawning. Daily movement of transmittered paddlefish provided us detailed information on passage conditions at Lock and Dam #1. Upstream habitat analysis indicated the presence of suitable spawning habitat under most flows, but attempts to document reproductive success by capturing eggs or larvae were unsuccessful. Future modification of Lock and Dam #1 to facilitate upstream fish passage may be inconsequential for paddlefish if appropriate spawning conditions are absent upstream.
In 2009, six scientists, including David L. Galat, were appointed to the Independent Science Advisory Committee (ISAC) for the Platte River Recovery Implementation Program (PRRIP). The ISAC provides independent scientific input to the program. The committee's tasks include reviewing scientific information collected and providing opinions on results in response to management interventions. The ISAC also responds to specific scientific questions from the Governance Committee and Executive Director.

The ISAC has reviewed written documentation, viewed sections of the river, and deepened their understanding of the Platte River ecosystem, past decisions, and future plans through extensive dialogue with Program participants. Although informed by consultations, the ISAC has developed its recommendations independently.

The ISAC's 2009 annual report provided written documentation of findings organized around six major topics. These topics include Conceptual Ecological Models (CEMs) and Priority Hypotheses, Experimental Design, Modeling, Data Analysis, Synthesis, and Reporting, Invasive Species, and AMP Management Objectives.

ASSESSING EFFECTS OF CONTAMINANTS ON SCAPHIRHYNCHUS STURGEON

Investigators
Justin Buckler, MU
Dr. David Galat, MU
Dr. Diana Papoulias, USGS-CERC
Dr. Mike McKee, MDC

Project Supervisor
Dr. David Galat

Funding
Missouri Department of Conservation
University of Missouri School of Natural Resources
US Geological Survey Cooperative Research Unit

Cooperators

Objectives
Determine current concentrations of contaminants in feral shovelnose sturgeon eggs and the potential toxicity of chemical extracts from those eggs.

Evaluate developmental and reproductive effects of contaminants on Scaphirhynchus sturgeon.

Assess suitability of shovelnose sturgeon as a surrogate species to the pallid sturgeon in toxicity testing.

Location
Upper Mississippi River, Missouri

Expected Completion
May 2011

Status
In progress

Progress and Results
Contaminants in shovelnose sturgeon (Scaphirhynchus platorynchus) continue to be found at concentrations above thresholds for adverse effects on reproduction and development in other fish species. Thus, contaminants may be contributing to the current decline of both the shovelnose sturgeon and the federally endangered pallid sturgeon (S. albus). Concentrations of polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs), and polybrominated diphenyl ethers (PBDEs) in feral Upper Mississippi River shovelnose sturgeon eggs from two sites (Saverton, Missouri and Cape Girardeau, Missouri) were assessed thorough chemical analysis. Average total PCB, OCP, and PBDE concentrations were higher at Cape Girardeau (910 ng/g egg, 310 ng/g egg, and 150 ng/g egg respectively) than at Saverton (270 ng/g egg, 140 ng/g egg, and 30 ng/g egg respectively). The relationship between contaminant concentration in eggs and the potency of extracts from those eggs is ongoing. Developmental and reproductive effects of PCBs on Scaphirhynchus sturgeon were assessed by exposing eggs to PCB 126, the most potent PCB congener. This study also assessed the suitability of shovelnose sturgeon as a surrogate species to the pallid sturgeon in toxicity testing. Calculated LD50 values were 186 ng/g egg and 224 ng/g egg for shovelnose and pallid sturgeon, respectively. Results indicate that the sensitivity of the two Scaphirhynchus species to PCB 126 are similar to one another and provide evidence for using shovelnose sturgeon as a surrogate species for pallid sturgeon in toxicity testing.
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<thead>
<tr>
<th><strong>Investigators</strong></th>
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<tbody>
<tr>
<td>Dr. Joanna Whittier, MU</td>
<td>In progress.</td>
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<td>Dr. Craig Paukert, MU</td>
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<td>Dr. Julian Olden, Univ. of Washington</td>
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<td>Dr. Angela Strecker, post doc</td>
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<th><strong>Project Supervisors</strong></th>
<th><strong>Progress and Results</strong></th>
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<tr>
<td>Dr. Joanna Whittier</td>
<td>Freshwater ecosystems of the western US deserts are among the most threatened in North America. Our project will develop and validate a suite of threat indicators for desert fishes using the Lower Colorado River Basin (LCRB) as a model system for future regional threat assessments. The analytical framework developed will be readily applicable to other regions and Fish Habitat Partnerships. To do this, we first modeled the distribution of fishes using multivariate adaptive regression splines. This technique allows non-linear responses to environmental variables and can be used in a multivariate context. Using recent advancements in conservation planning methodologies, we generated several landscapes of conservation priorities with differential emphasis on native species endemic to the basin, expansions on existing conservation structures, as well as minimizing threats associated with non-native fishes, climate change and population projections. This research will yield insight into the complexities of conservation planning in multiple stressor environments of the American Southwest. This project will provide an adaptive framework to conduct regional risk assessments that could be utilized by other National Fish Habitat Partnerships through initial development of the threat assessment with stakeholder involvement, and continued refinement of the risk assessment as new information is collected.</td>
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<td>Dr. Craig Paukert</td>
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<th><strong>Funding</strong></th>
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<tr>
<td>US Geological Survey</td>
<td>September 2011</td>
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<th><strong>Cooperators</strong></th>
<th><strong>Location</strong></th>
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<tr>
<td>National Fish Habitat Initiative</td>
<td>Lower Colorado River Basin</td>
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<td>Desert Fish Habitat Partnership</td>
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<th><strong>Objectives</strong></th>
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<tr>
<td>What are the primary threats to freshwater ecosystems in the Lower Colorado River Basin, and how do they vary across spatial scales?</td>
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Which fishes are at greatest risk to anthropogenic and biotic threats? |

What is the association between fish communities and specific threats indices different spatial scales? |
MANAGING THE NATIONS FISH HABITAT AT MULTIPLE SPATIAL SCALES IN A RAPIDLY CHANGING CLIMATE

Investigators
Dr. Craig Paukert, MU
Dr. Joanna Whittier, MU
Dr. Allison Pease, post doc, MU
Mr. Jake Faulkner, MS student, MU
Dr. Jeff Kershner, USGS
Dr. Dana Infante, Michigan St. U.
Dr. Steve Hostetler, USGS
Dr. Lucinda Johnson, U. of MN-Duluth
Dr. Ty Wagner, Penn St. U.
Dr. Paola Ferreri, Penn St. U.
Dr. Lizhu Wang, Michigan DNR
Dr. Julian Olden, U. of Washington
Dr. Don Pereria, Minnesota DNR
Mr. Pete Jacobson, Minnesota DNR
Mr. Gary Whelan, Michigan DNR
Dr. Bryan Pijanowski, Purdue U.

Status
In progress

Project Supervisor
Dr. Craig Paukert

Funding
USGS, National Wildlife Climate Change Science Center

Cooperators
National Fish Habitat Initiative

Objectives
Where are the aquatic habitats in need of conservation as climate and land use changes?

What are the nationwide aquatic habitat alterations from projected climate and land-use changes?

What are the commonalities in the effects of climate and land-use changes across regions and scales?

Location
Nationwide

Expected Completion
September 2011

Progress and Results
Successful conservation and management of aquatic habitat and fisheries will require forecasts of future environmental change to ecosystems as a result of changing climate. To date, climate change impacts have been predicted using Atmosphere-Ocean General Circulation Models (AOGCMs) at large spatial scales; however, management of fish and aquatic habitats mainly occurs at regional and local spatial scales. We are currently using downscaled AOGCM models to identify how climate and land-use change will impact the vulnerability of fish habitat at national, regional, and local scales through 2040, and to determine the biological responses of fishes to these changes. We will use on-going work of the partnership-driven National Fish Habitat Action Plan, to incorporate global climate change models and predicted land-use change to the Nation’s aquatic systems. We will also determine changes in fish habitat from the downscaled climate models at regional and local scales that represent varying climate and land-use patterns, and different aquatic systems. Further, we are currently modeling population-level effects resulting from climate change such as increased water temperature for selected species such as smallmouth bass and Niangua darter. Our research will use empirically-driven models with downscaled AOGCM models to predict aquatic habitat and biological responses to climate change at multiple scales to help resource managers understand the potential effects of various climate change scenarios on fish and habitat. We will provide resource managers with GIS-based maps at national and regional scales of how habitat will change with climate and land-use change, and information on how those changes affect fish populations.
INVASIVE BIGHEAD AND SILVER CARPS AND THE GREAT LAKES: EVALUATION OF ALTERNATIVE NATURAL FOOD SOURCES.

Investigators
Dr. Craig Paukert
Dr. Karthik Masagounder, post doc
Duane Chapman, USGS

Project Supervisor
Dr. Craig Paukert

Funding
US Geological Survey

Cooperators
US Environmental Protection Agency

Objectives
Evaluate adequacy of proposed bioenergetic model for Asian carp.

Evaluate bioenergetic model for juvenile bighead and silver carp in aquaria, using a food of known energetic content consumed by the fish.

Evaluate the Cooke and Hill bioenergetic model using larger adult or subadult fish in mesocosms.

Location
Great Lakes and Columbia, MO

Completion
September 2011

Status
In progress

Progress and Results
Non-native bighead carp and silver carp were imported to the United States in the 1970s. There is tremendous concern that these fishes will invade the Laurentian Great Lakes and have undesirable effects on existing fisheries. If Asian carp are able to establish and achieve high densities in the Lakes, their effect on lake fisheries might be additive because they could take advantage of time periods and limited environments where reasonably high plankton densities persist. However, some believe that large portions of the Great Lakes may not support Asian carp at all because of low plankton densities, and a bioenergetics study partially supports that position. Although observations indicate that bigheaded carps sometimes feed on alternative food sources, we do not know if alternative diets which exist in the Great Lakes are adequate for long term survival and growth of bigheaded carps, or if they provide a sufficient energy source to provide bridges between areas and times when plankton is more abundant. This study is designed, through laboratory and mesocosm experimentation, to shed light on these questions.

Bioenergetic modeling often requires making assumptions regarding unmeasured parameters. For example, the existing bighead carp bioenergetic model uses the temperature dependency coefficient for tilapia because it was the most similar fish for which this datum had been developed. Laboratory experiments have revealed that fish gained about 30-50% body weight in 2 weeks. No differences were detected in fish growth rate for different rates of feeding. Feeding frequency significantly affected feed consumption, with fish fed more often showing more feed consumption. Poor efficiency for all the groups shows that energy was diverted for something else than for growth. Our results indicated growth was lower than expected based on the previous bioenergetic model developed. We will continue these analyses and refine laboratory experiments to further evaluate the accuracy of the existing bioenergetics models developed.
EVALUATION OF HUMBACK CHUB TRANSLOCATIONS IN GRAND CANYON TRIBUTARIES

Investigators
Jon Spurgeon, MS student
Dan Whiting, Research associate
Dr. Craig Paukert
Dr. Joanna Whittier
Dr. Josh Millspaugh
Dr. Bob Gitzen

Project Supervisor
Dr. Craig Paukert

Funding
Grand Canyon National Park
US Bureau of Reclamation
U.S. Geological Survey

Cooperators
National Park Service
US Bureau of Reclamation
US Fish and Wildlife Service
Arizona Game and Fish Dept.

Objectives
How does the fish abundance and community differ in Grand Canyon tributaries?

How many humpback chub remain following translocations?

What is the survival and growth of translocated humpback chub?

Do HBC or other sizes/species of native fish fill a niche vacated by non natives?

Location
Grand Canyon, Arizona

Completion
September 2013

Status
In progress

Progress and Results
This project will aid in developing a comprehensive management strategy to aid in recovery of humpback chub (HBC) in Grand Canyon through the evaluation and analysis of current translocation efforts including nonnative species removal efforts by the US Fish and Wildlife Service and Grand Canyon National Park (GCNP). We will evaluate the response of HBC translocated in Shinumo Creek, and potential interactions including predation and trophic suppression between native and non native fishes in Bright Angel Creek, a site of proposed for HBC relocations in 2012. The installation of a fixed PIT tag antenna and subsequent analyses of these data allow a more precise determination of the fate of the translocated fish. We will use information on HBC locations gathered from the remote antennae installed in June 2009 at the mouth of Shinumo Creek to document the emigration of HBC. In addition, fish community sampling and removal of non native fishes has been ongoing since 2010. In fall 2010, invertebrate sampling in Bright Angel Creek will estimate potential relative abundance of invertebrates available for fish consumption, while diet analysis of nonnative rainbow and brown trout will be used to estimate the proportion of available food that could be potentially available for native fishes post nonnative removal. The analysis and field work began in summer 2009 and will continue through spring 2012. Initial PIT antenna information shows 252 of 602 (41%) introduced HBC have left Shinumo Creek since the beginning of translocations in 2009. Of those, 157 fish were from 2009 and 95 fish were from 2010. The highest emigration periods have occurred immediately following translocation events. Larger fish have tended to emigrate form the system compared to those remaining (P<0.0001). Initial stocking lengths of emigrated fish averaged 130 mm while remaining fish were 118 mm. Initial growth estimates of translocated HBC is 13 mm/month compared to 4 mm/month from mainstem age-2 chub.

Products since 2008
## Conservation Planning for Fishes in the Upper Colorado River Basin

### Investigators
- Dr. Joanna Whittier, MU
- Dr. Craig Paukert, MU
- Landon Pierce, PhD student, MU
- Dr. Julian Olden, Univ. of Washington

### Project Supervisors
- Dr. Joanna Whittier, MU
- Dr. Craig Paukert, MU

### Funding
U.S. Geological Survey, National Gap Analysis Program

### Cooperators
- Colorado Department of Wildlife, Wyoming Game and Fish, Utah Department of Natural Resources, Arizona Game and Fish Department

### Objectives
- Identify landscape-level habitat metrics associated with native and non-native fish presence in the Upper Colorado River Basin.
- Identify areas of high conservation value that captures quality habitat for all native species.
- Provide stakeholders with conservation assessment that they could use to inform conservation and adaptive management decisions.

### Location
Upper Colorado River Basin – AZ, CO, NM, WY, UT.

### Expected Completion
September 2013

### Status
In progress

### Progress and Results
This project builds on previous and on-going research we have been conducting on fish communities in the Lower Colorado River Basin. Aquatic systems across the nation are perhaps the most endangered ecosystems and the Upper Colorado River Basin (UCRB) is no exception. There are only 14 native fish species in the UCRB and most have declined in their range and abundance in the last 100 years. Adverse impacts include modifications to natural flow regimes, physical habitat, stream temperatures and other human-induced agents of environmental change, in addition to the negative effects of invasive species. Therefore, the development of criteria for conservation will aid future considerations to protect aquatic species in the basin. We have compiled a suite of environmental characteristics and threats frequently associated with presence or absence of freshwater fish species. Federal and state agencies from all the states encompassing the UCRB have contributed nearly 800,000 records of fish sampled from the late 1800's to 2010. Future work will include developing community distribution models and threat indices to inform spatially explicit conservation prioritization for the UCRB. This research will provide a seamless integration of both the lower and upper basin to provide a uniform GAP analysis for the entire Colorado River watershed.
Dr. Charles Rabeni

The Influence of Habitat Type on Secondary Production of Three Species of Crayfish (Orconectes spp.) in an Ozark Stream

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<tr>
<th>Investigators</th>
<th>Shannon Brewer, PhD</th>
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<tr>
<th>Project Supervisor</th>
<th>Dr. Charles F. Rabeni</th>
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<th>Robert DiStefano, Missouri Department of Conservation</th>
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<th>Examine habitat-specific production and the individual contributions of biomass and growth rates.</th>
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**Progress and Results**

The contribution of five habitat types to secondary production of three species of stream-dwelling crayfish (Orconectes spp.) was examined at two sites on the Jacks Fork River, Missouri, USA. Nine cohorts were followed over a 10-yr period to examine habitat-specific production and the individual contributions of biomass and growth rates. Habitat-specific production estimates were calculated for riffles, runs, pools, backwaters and emergent vegetation patches. Orconectes luteus was the most productive species with the most similar production across habitats; however, runs and vegetation patches had significantly higher production than other habitats. Production of O. ozarkae and O. punctimanus was significantly greater in vegetation than any other habitat type. There were no species by habitat differences in production between the two sites. Production varied over time for each species; however, O. luteus production was relatively consistent compared to the other species over the 10-yr period. Orconectes punctimanus showed a consistent, nearly linear decrease whereas O. ozarkae variation in production was intermediate between the other species. Differences in production between habitats were largely due to age-class habitat use rather than differences related to growth. Our results suggest a variety of habitats is necessary for maintaining the high secondary production and diversity of crayfish in this system.

**Products since 2008**

**LANDSCAPE INFLUENCES ON RIVERINE SMALLMOUTH BASS POPULATIONS IN MISSOURI**

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<td>Shannon Brewer, PhD</td>
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<td>Dr. Charles F. Rabeni</td>
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<tr>
<td>Mike Roell, MDC</td>
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<td>Sample smallmouth bass at 36 sites so as to relate fish populations to local land use and the interacting effects of natural landscape characteristics.</td>
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Modeling smallmouth-landscape relations data.

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**Progress and Results**

This study examines the status of a freshwater mussel assemblage located on the Marais des Cygnes River at the Marais des Cygnes National Wildlife Refuge in Kansas. Four mussel beds were selected and parameters including density, diversity, area, recruitment status, and habitat selection by mussels were examined at each site. Density within the mussel beds at the four sites ranged from 3.0 mussels/ m2 to 8.9 mussels/ m2. Amblema plicata was the most abundant species at all four sites with densities ranging from 1.3 mussels/ m2 to 4.5 mussels/ m2. The mussel bed at Site 1 had the highest value of species evenness and higher numbers of recent recruits in four aged species. In addition, there was evidence of regular annual recruitment in three tachytictic species at Site 1 in recent years (Amblema plicata, Obliquaria reflexa, and Quadrula pustulosa). In contrast, Ellipsaria lineolata, a bradytictic species experienced higher recruitment success in years where mean monthly discharge in June through August was low. Discriminant models developed at each site based on depth and several substrate variables were accurate (76%-87%) at predicting mussel absence in "unfavorable" habitats (deeper areas with lower ratios of medium and coarse gravel to other particle sizes) but limited in their ability to predict mussel presence in "favorable habitats" (57%-77%). Other factors including stability of the gravel substrate during high flow events, food availability, and temperature may be influencing the micro-scale distribution pattern of mussels at the sites on the Marias des Cygnes River.
THE EFFECTS OF PL-566 HEADWATER IMPOUNDMENTS ON THE ECOLOGICAL INTEGRITY OF MISSOURI STREAM SYSTEMS

Investigators
Kathy E. Doisy, Senior Research Specialist
Greg Wallace, Senior Technician
Scott Sowa, MoRAP
Shannon Brewer, PhD
2008

Project Supervisor
Dr. Charles F. Rabeni

Funding
Missouri Department of Natural Resources and US Environmental Protection Agency

Cooperators
Amanda Sappington, MDNR
Matt Combs, MDC
Del Lobb, MDC

Objectives
Evaluate the localized and cumulative effects of PL-566 impoundments on the ecological integrity of Missouri streams

Location
Missouri

Completion
August 2010

Status
Completed

Progress and Results
The Watershed Protection and Flood Prevention Act (Public Law 83-566) authorized various federal, state and local agencies to plan and carry out works of improvement for soil conservation and other purposes. Missouri’s National Research Conservation Service developed plans for numerous watershed projects on small headwater streams. Due to concerns about the effects of these small impoundments, an interagency committee was formed to evaluate the localized and cumulative effects of PL-566 impoundments on the ecological integrity of Missouri streams. Objectives of this project were: 1) An extensive literature review, synthesis, and annotated bibliography of the existing scientific evidence regarding the influence of small impoundments on stream environments; 2) a research project examining biotic condition (macroinvertebrates) from a set of headwater streams, half with Pl566 structures and half without. Research results indicated significantly different community composition of invertebrates between the two situations, although not necessarily differences in either diversity nor species abundance.

Products since 2008
DEVELOPING A BIOMONITORING PROTOCOL FOR TRIBUTARIES WITHIN THE OZARK NATIONAL SCENIC RIVERWAYS, MISSOURI

Investigators
Kathy E. Doisy, Senior Research Specialist
Greg Wallace, Senior Technician

Project Supervisor
Dr. Charles F. Rabeni

Funding
National Park Service

Cooperators
Victoria Grant, NPS

Objectives
Develop benthic macroinvertebrates metrics needed to monitor the health of the tributaries within the park.

Location
Ozark National Scenic Riverways (OZAR) Park, Missouri

Completion
June 2009

Status
Completed

Progress and Results
The Ozark National Scenic Riverways (OZAR) located within the Ozark Plateau is renowned for its unique, relatively undisturbed streams and springs. The Park anticipates possible regulatory changes that may open up watershed tributaries to previously illegal discharge operations, which may include lead mining, confined animal feeding operations, industrial development and wastewater treatment facilities. Although benthic macroinvertebrates metrics have been developed to monitor the health of these rivers, no such set of metrics has been developed for the tributaries within the park. A thorough literature review of possible aquatic invertebrate communities, the effects of various physical characteristics on these communities, and the most effective methods of assessing these communities was performed and the information synthesized. Seventeen priority park tributaries were sampled for macroinvertebrates multiple times. Results will provide baseline data for future assessment.

Products since 2008
IDENTIFYING LINKAGES BETWEEN WATERSHED ATTRIBUTES, SEDIMENT, AND FISH IN THIRD ORDER STREAMS OF MISSOURI’S OSAGE RIVER BASIN

Investigators
Andy Turner, MS 2008

Project Supervisor
Dr. Charles F. Rabeni

Funding
Missouri Department of Conservation

Cooperators
MDC, US Fish and Wildlife Service

Objectives
Develop a hierarchical model of watershed characteristics, within third-order streams of the Osage River Basin in Missouri

Location
Osage River Basin, Missouri

Completion
June 2010

Status
Completed

Progress and Results
A hierarchical model of watershed characteristics, within third-order streams of the Osage River Basin in Missouri, was developed to better understand the linkages among a stream’s watershed, physical attributes, and biotic composition. A total of 36 Stream sites (N=36) were classified based on soil type and land-use variables previously shown to influence stream sedimentation. Sites were sampled to define sediment and substrate composition. A subset of sites (n=12), encompassing the range of defined sedimentation levels, was sampled to define fish-assemblage composition. Results from these evaluations show that underlying soil classification of a watershed dictates the range of sedimentation and substrate composition of streams. Within these soil classifications both anthropogenic and natural-watershed variables influence the degree of stream sedimentation. Variables associated with increased sedimentation include increased percent cropland within a watershed, watershed area, and the presence of cattle access to the stream. Alternatively, variables associated with decreased sedimentation include increased percent forestland within a watershed, stream gradient, and riparian width. Additionally varying levels of sedimentation are related to various aspects of fish assemblages.
MOVEMENT, HABITAT USE, AND SPAWNING CHRONOLOGY OF FLATHEAD CATFISH AND BLUE CATFISH IN THE MISSOURI RIVER AND TRIBUTARIES

Investigators
Daniel L. Garrett, PhD
2010

Project Supervisor
Dr. Charles F. Rabeni

Funding
Missouri Department of Conservation

Cooperators
Ronald Dent, MDC
Zachary Ford, MDC

Objectives
Determine the use of tributary streams for spawning by flathead catfish and blue catfish resident to the main stem Missouri River.

Determine specific details of blue catfish habitat use and movement over annual, seasonal and daily temporal scales.

Location
Missouri River, Missouri

Completion
June 2010

Status
Completed

Progress and Results
The movement and habitat use patterns of adult flathead and blue catfish were studied via acoustic and radio telemetry in the lower Missouri River and adjacent tributaries including the Grand, Lamine, Chariton, and Little Chariton Rivers. At the largest spatiotemporal scale, annual movement patterns varied greatly from restricted-movement behavior throughout the annual cycle to seasonal migrations commonly tens of kilometers between habitats used for spawning, feeding and growth, and overwintering. Fish moved the least during the overwintering period and the most during the prespawn/spawn period, followed by a third period of restricted movement during the summer and early fall. The diversity in life history strategies suggests that populations of large-river catfish use resources at multiple spatial scales, from the reach to the watershed, to meet life requisites. Diurnal home range and resource selection was investigated during the summer/fall restricted-movement period, an ecologically relevant time frame with respect to feeding and growth. The majority of individuals of both species established small home ranges (<10 km) with fidelity to one, two, or three discrete areas of high use (core areas). Resource selection analysis revealed that both species select deep habitats associated with anthropogenic structures (i.e., dike structures, revetment) that are spatially segregated along the river corridor. The movement behavior of flathead and blue catfish during the summer/fall suggests that diurnal requisites for feeding and growth are primarily exploited in small (< 1 km) sections of river that include deep, low-velocity habitats associated with anthropogenic structures. Telemetry data and field observations indicated that shallow, low-velocity areas downstream of wing- and L-dike structures are used by flathead catfish to complete spawning cycle.
Investigators
Jacob Westhoff, PhD.

Project Supervisor
Dr. Charles F Rabeni

Funding
Missouri Department of Conservation

Cooperators
Robert DiStefano, MDC

Objectives
Determine multi-scale habitat associations of the three species of interest.

Determine potential human induced stressors in the drainage and relate them to the distribution of the introduced and the two endemic species.

Create a monitoring plan for these species that can be used to quantify the spread of the introduced crayfish and decline of the two endemic crayfishes within the drainage.

Location
St. Francis River Drainage, Missouri

Expected Completion
June, 2011

Status
In progress

Progress and Results
The introduction of crayfishes outside of their natural ranges has become an important research topic due to the resulting negative effects on native biota. One such introduction has occurred in the St. Francis River drainage in Missouri where a crayfish from a neighboring drainage, the woodland crayfish (Orconectes hylas), has been documented. Simultaneously, two endemic crayfishes, the Big Creek crayfish (Orconectes peruncus) and the St. Francis River crayfish (Orconectes quadruncus), are disappearing from locations where the introduced O. hylas has become established. Despite the lack of empirical evidence linking the introduced species to the decline of the two endemics, it is believed that O. hylas is at least partly responsible for the decline. The goal of this project is to gather information that facilitates efforts to ensure the persistence of O. peruncus and O. quadruncus. I plan to achieve this goal by addressing three main objectives. The first objective is to determine multi-scale habitat associations of the three species of interest. This information will be used to identify the differences, if any, in habitat associations between the species. If differences are found, that information can be used to determine areas within the drainage that may serve as refugia for the endemic species. The second objective is to determine potential human induced stressors in the drainage and relate them to the distribution of the introduced and the two endemic species. This information will be used to identify the most heavily impacted areas in the drainage and to examine the potential of these impacts as a reason for the decline of the endemic species. The final objective is to create a monitoring plan for these species that can be used to quantify the spread of the introduced crayfish and decline of the two endemic crayfishes within the drainage. Currently, the field work has been completed.
LIFE-HISTORY AND DISEASE ECOLOGY OF THE BROWN-NOSED COATI AND THE CRAB-EATING FOX IN THE BRAZILIAN PANTANAL

Investigators
Natalie Olifiers, Ph.D. 2010
Dr. Matthew Gompper, MU
Dr. Guilherme Moreau.
EMBRAPA
Dr. Paulo S. D’Andrea, Oswaldo Cruz Foundation

Project Supervisor
Dr. Matthew Gompper

Funding
EMBRAPA, Oswaldo Cruz Foundation, MU Graduate School Fellowship

Objectives
Gain knowledge on the natural history of common carnivores from the Brazilian Pantanal

Identify the phenology and predictors of tick parasitism for wildlife

Define the role of coatis and foxes as reservoirs of *Trypanosoma cruzi* and *T. evansi*;

Understand how parasites may influence the health of wildlife hosts.

Location
Mato Grosso do Sol, Brazil

Completion
2010

Status
Completed

Progress and Results
Infectious diseases can be significant threats to public health and wildlife. Yet, there is still a relatively poor understanding of the impact parasites have on the health and demography of wild hosts. Understanding the effects of parasites on hosts requires not only knowledge about the parasites themselves, but also about the ecology of their hosts. We developed a tool for aging coatis (*Nasua nasua*) and crab-eating foxes (*Cerdocyon thous*) and collected basic information on the life-history of these species in the Brazilian Pantanal. We also examined the ectoparasites of coatis and foxes. We investigated how abiotic factors and the host attributes influence tick abundance and prevalence on hosts. This study can be considered a model for investigating the relative importance of biotic and abiotic factors in parasite dynamics. Finally, we examined how hemoparasites and gastrointestinal parasites affect coati health. There are few studies which have investigated the effects of multiple parasites on direct measures of the health parameters of free-ranging hosts. In this sense, this work can also be viewed as a model for future studies focusing in the interplay between parasites and health of wild, free-ranging mammals.

Products since 2008


### INTRAGUILD INTERACTIONS BETWEEN NATIVE AND DOMESTIC CARNIVORES IN CENTRAL INDIA

**Investigators**  
Abi Tamim-Vanak, PhD 2008  
Dr. Matthew Gompper, MU

**Project Supervisor**  
Dr. Matthew Gompper

**Funding**  
MU Research Board, Wildlife Conservation Society, Rufford Foundation

**Objectives**  
Detail the landscape ecology of the Indian fox *Vulpes bengalensis*, a small canid endemic to the Indian subcontinent. We collected home range and habitat selection data on 32 radiocollared Indian foxes in the Great Indian Bustard Wildlife Sanctuary, Nannaj, Maharashtra. Males had consistently larger home-ranges than females across all seasons. Females had smaller home-range sizes during the cool-dry season which is also the denning period, than during any other season. Compositional analysis of Indian fox selection of home-ranges at the landscape level showed heavy influence of the presence of grasslands, plantations and fallow land. Indian foxes avoided human-modified habitat such as agricultural land and human settlements. The presence of grasslands was also the dominant predictor of Indian fox habitat selection across seasons within the home-range as determined by discrete-choice models. Thus, Indian foxes select for natural grasslands and avoid human-modified habitat. To determine if interference competition between dogs and foxes influences the space use patterns of foxes at a landscape level we used a logistic regression analysis in an information theoretic framework, and determined the effects of landcover type, primary prey abundance (rodents) and dog presence on the landscape on the space use of foxes. Indian foxes showed low overlap with dogs based on the volume of intersection index. Top models showed a positive influence of grasslands and a negative influence of agricultural land and dog presence.

**Location**  
Maharashtra, India

**Completion**  
2008

**Status**  
Completed

**Progress and Results**

We determined the factors affecting the resource selection and spatial ecology of the Indian fox *Vulpes bengalensis*, a small canid endemic to the Indian subcontinent. We collected home range and habitat selection data on 32 radiocollared Indian foxes in the Great Indian Bustard Wildlife Sanctuary, Nannaj, Maharashtra. Males had consistently larger home-ranges than females across all seasons. Females had smaller home-range sizes during the cool-dry season which is also the denning period, than during any other season. Compositional analysis of Indian fox selection of home-ranges at the landscape level showed heavy influence of the presence of grasslands, plantations and fallow land. Indian foxes avoided human-modified habitat such as agricultural land and human settlements. The presence of grasslands was also the dominant predictor of Indian fox habitat selection across seasons within the home-range as determined by discrete-choice models. Thus, Indian foxes select for natural grasslands and avoid human-modified habitat. To determine if interference competition between dogs and foxes influences the space use patterns of foxes at a landscape level we used a logistic regression analysis in an information theoretic framework, and determined the effects of landcover type, primary prey abundance (rodents) and dog presence on the landscape on the space use of foxes. Indian foxes showed low overlap with dogs based on the volume of intersection index. Top models showed a positive influence of grasslands and a negative influence of agricultural land and dog presence.

**Products since 2008**

A GENETIC APPROACH TO DETERMINE RIVER OTTER ABUNDANCE IN MISSOURI

Investigators
Rebecca Mowry, M.S.
2010
Dr. Matthew Gompper, MU
Dr. Lori Eggert, MU
Jeff Beringer, Missouri Dept of Conservation

Project Supervisor
Dr. Matthew Gompper

Funding
Missouri Department of Conservation

Cooperators
Missouri Department of Conservation
University of Missouri

Objectives
The specific objectives of this work are: (a) identify the relationships between various measures of otter scat numbers and otter population size; (b) build a model that predicts otter numbers based on field surveys of otter latrines; (c) assess explanations for patterns of genetic diversity of reintroduced otter populations from the Missouri Ozarks.

Location
Missouri Ozarks

Completion
2010

Status
Completed

Progress and Results
Exirpated from Missouri by the 1930s, river otters (Lontra canadensis) were reintroduced by the Missouri Department of Conservation (MDC) from 1982-1992. Since the reintroductions, concerns over the legitimacy of otter trapping and the predator’s effects on sport fish populations have sparked controversy. The MDC responded by increasing efforts to monitor river otter populations, using latrine site counts to measure relative abundance across several rivers in Missouri. However, the actual number of otters represented by these counts was unknown. To address this question, we extracted DNA from scat samples collected along 8 rivers in the winter and spring of 2009, using 10 microsatellite markers plus sexing markers to estimate the number and sex of otters. We then developed models to estimate population size from latrine site index variables, observing that the number of scats per latrine and the density of active latrines across the river best predicted population size. We also used the genotypes to calculate the genetic diversity of otter populations, evaluate the distribution of genotype clusters across the landscape, and track otter movements between latrines. Unexpected genetic similarities indicated that otters translocated to different areas may have come from the same source populations. Overall, this project has demonstrated the utility of genetic methods for estimating otter abundance, provided insight into the genetic diversity of the populations, and presented a model for inexpensive monitoring of river otter populations in the future.

Products since 2008
RESPONSE OF RACCOON SPATIAL AND SOCIAL BEHAVIOR TO THE PRESENCE OF AN EXPERIMENTALLY CLUMPED FOOD RESOURCE

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<td>Dr. Matthew Gompper</td>
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<td>The specific objectives of this work are: (a) to understand how resource availability influences the spatial distribution of raccoons; (b) to understand how resource availability influences the behavioral interactions and likelihood of communal denning distribution of raccoons.</td>
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| Progress and Results| | |
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| The spatial and behavioral ecology of raccoons (Procyon lotor) and many other putatively solitary species can fluctuate based on the availability and location of resources. Hallmarks of a more solitary existence include limited home range overlap and concurrent space use with conspecifics, and lack of social denning behaviors. Conversely raccoons exhibiting greater sociality or a more spatially aggregated local distribution also have greater overlap and conspecific co-occurrence values and higher frequencies of proximal or communal denning. The transition from a solitary to a social or group-living lifestyle can occur when clumped resources patches are available for extended periods, but detailed understanding of how raccoons shift from a solitary to an aggregated distribution is lacking. In this study we used an experimental approach to examine how raccoons respond to the addition of a predictable and abundant food resource. We contrasted raccoons inhabiting two adjacent sites in central Missouri: both received similar food supplements, but one site received the food in a clumped fashion (via the creation of a permanent feeding station) while the other received the food dispersed to multiple sites that varied over time so that the food was neither spatially clumped nor spatio-temporally predictable. Radio telemetry data from adult raccoons were analyzed to assess the influence of the experimentally maintained clumped food source on home range spatial structure and social denning behaviors. Home range size did not differ between treatments sites or genders, but raccoons from the clumped resource site had home range overlap and probability of co-occurrence values were almost twice those of raccoons from the dispersed resource site. Communal denning, proximity of dens, and den reuse behaviors did not differ overall between the two sites, but clumped resource site raccoons moved shorter distances between subsequently used den sites and to utilize dens located within a smaller area. Differences in the patterns of overlap, co-occurrence, communal denning, proximal denning, and den reuse found in this study suggest that raccoons and perhaps other putatively solitary mesocarnivores are not truly solitary, but rather appear so only where resource availability induces territories occupied by just a single individual. |

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EXPERIMENTALLY ASSESSING THE INFLUENCE OF RESOURCE AVAILABILITY AND SOCIAL AGGREGATION ON THE PARASITES OF RACCOONS

Investigators
Ryan Monello, PhD 2009
Dr. Matthew Gompper, MU

Project Supervisor
Dr. Matthew Gompper

Funding
National Science Foundation

Objectives
(a) To measure the relative importance of host characteristics (age, sex, weight) and abiotic variables (site, season, year) on ectoparasite prevalence and abundance and endoparasite species richness; (b) to identify how increases in social aggregation and resource availability affect ectoparasite prevalence and intensity and endoparasite species richness of raccoons; (c) To conduct a parasite-reduction experiment to determine if nematodes and ectoparasites affect baseline levels of fecal glucocorticoid metabolites in free-ranging raccoons.

Location
Missouri

Completion
2009

Status
Completed

Progress and Results
We measured the relative importance of host characteristics (age, sex, weight) and abiotic variables (site, season, year) on ectoparasite prevalence and abundance and endoparasite species richness across 12 unmanipulated sites in mid-Missouri. We developed and tested a priori hypotheses using an information-theoretic framework. Ectoparasites had distinct patterns that were related to their host specificity, mobility, and ability to survive off the host. Tick abundance was dependent on the month of collection, as they are only active in summer and peak in July. However, the abundance of engorged ticks, which need to be present on hosts for 7-10 days prior to obtaining a full blood meal, was primarily related to host age and sex, with older raccoons and males infested by more ticks. Lice prevalence and abundance were best predicted by host age and sex. In particular, male raccoons were infested by 2-3x the number of lice compared to females. Fleas displayed only a weak seasonal pattern of infestation. Among endoparasites, infection patterns diverged according to their life history; directly transmitted parasites declined over the life of the host while indirectly transmitted parasites increased. Collectively, these results highlight the need to consider parasite characteristics and simultaneously assess the relative importance of multiple ecological variables between parasite species when describing general trends and constraints of host-parasite associations.

We also investigated how experimental increases in social aggregation and resource availability affected ectoparasite prevalence and intensity (number of parasites on infested hosts only) and endoparasite species richness of raccoons. Twelve independent raccoon populations were randomly subjected to differential resource provisions for two years; a clumped food distribution to aggregate hosts (n = 5 populations), a dispersed food distribution to control for the effects of food without aggregating hosts (n = 3), and a no food treatment (n = 4). The intensity of ticks was greater in aggregated populations, particularly among male raccoons. Conversely, the intensity of lice on male raccoons declined in aggregated populations due to greater overdispersion of lice and a larger number of male hosts harboring fewer parasites. The intensity of fleas did not differ among treatments and displayed no correlation with host characteristics. Among endoparasites, there was strong evidence that food additions decreased the number of indirectly transmitted parasites, particularly among the oldest age classes at sites with clumped food. Conversely, food and social aggregation had little to no impact on the species richness of directly transmitted parasites. These results suggest that the effects of increased resources and social aggregation of hosts are parasite-specific and can be dependent on parasite mobility and route of transmission, as well as sex-related differences in host behavior or physiology.
We determined sampling constraints of measuring stress hormones (fecal glucocorticoid metabolites, FGM) of raccoons and conducted a parasite-reduction experiment to determine if nematodes and ectoparasites affect baseline levels of FGM in adult free-ranging raccoons. Parasite reduction treatments reduced the prevalence and abundance of the most widespread ectoparasites, the prevalence of most nematodes, and the number of parasite species per individual. No differences in FGM values were observed within individuals or between treatment and control groups following parasite reduction treatments, indicating that the reductions in nematodes and ectoparasites had no effect on stress hormone levels of raccoons during summer.

**Products since 2008**


# EVALUATION OF BAT POPULATION TRENDS: MODELING SITE OCCUPANCY CHANGES OVER TIME

**Investigators**  
Dr. Matthew Gompper, MU  
Dr. Sybill Amelon, USFS  
Sarah Pennington, MS Student, MU

**Project Supervisor**  
Dr. Matthew Gompper

**Funding**  
US Forest Service

## Objectives
The specific objectives of this work are: (a) to use site occupancy models to estimate current (2009/2010) probability of detection and site occupancy (population metric) for a set of sites that were previously estimated between 2001 and 2003 and (b) compare the population metric of site occupancy for eight species of forest bats to determine whether occupancy increased, decreased or remains stable. The information obtained by this project will contribute to the Mark Twain National Forest’s goal of maintaining or improving populations of forest bats by quantifying population metrics to determine population trends.

## Location
Southern Missouri

## Expected Completion
May 2013

## Status
In progress

## Progress
Climate change, human-induced land-use change and introduced disease all threaten bat populations in the Eastern US. The specific goal of this work is to apply the principles of population ecology to maintain or improve diverse and viable populations of forest bat species. The Mark Twain National Forest (MTNF) is in a unique position to determine trends in population status of eight species of forest bats in the Eastern US. Between 2001 and 2003, using ANABAT acoustic monitoring, relationships between habitat covariates and site occupancy of bats were determined through the use of occupancy modeling on lands owned by MTNF. By using site occupancy modeling to estimate detection probability \( p \) and site occupancy \( \psi \), variation in \( p \) in its affects on \( \psi \) and the relationship of \( p \) and \( \psi \) to covariates were determined and a quantitative population metric was estimated for eight forest bat species. We will re-visit a set of the sites sampled between 2001 and 2003, re-sample these sites using the same study design protocol to record echolocation calls of bats using these sites, analyze call data for use in site occupancy models, and model site occupancy and contrast current findings to past findings to determine population trends on the Mark Twain National Forest.
## DOG MASS VACCINATION AND POPULATION GROWTH: ASSESSING MANAGEMENT OUTCOMES

<table>
<thead>
<tr>
<th>Investigators</th>
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<tbody>
<tr>
<td>Dr. Matthew Gompper, MU</td>
<td>In progress</td>
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<tr>
<td>Aniruddha Belsare, PhD</td>
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<tr>
<td>Student, MU</td>
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<tr>
<th>Project Supervisor</th>
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<tr>
<td>Dr. Matthew Gompper</td>
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<tr>
<th>Funding</th>
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<tr>
<td>University of Missouri</td>
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<td>Graduate School Fellowship</td>
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<th>Objectives</th>
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<td>The specific objectives of this work are: (a) to gain field data on the demographics of free-ranging domestic dogs in India; (b) to simultaneously gain field data on the seroprevalence of several important pathogens of domestic dogs; (c) to conduct an experimental vaccination to understand if and how vaccination programs may alter dog demographics.</td>
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<th>Progress</th>
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<td>Many regions of the world have high densities of free-ranging dogs. These dog populations are central concerns for public health, wildlife conservation, and human-wildlife conflict. In rural regions, dog populations act as disease reservoirs for important pathogens of human and wildlife health concern. Dogs also are predators of wildlife, including endangered species, and in some case are the primary causes of wildlife mortality. Furthermore, dog densities are often so high that dogs become a primary component of the diet of large predators, sustaining those predator populations and increasing rates of human-wildlife conflict. Mass vaccination of dogs has been recommended to control disease, and especially to eradicate rabies. However, because disease may be the primary limiting agent for these dog populations, mass vaccination campaigns conducted without fully addressing dog demographics may result in increased survival, reproduction, and population growth.</td>
</tr>
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| An increase in abundance of dogs could then result in increased viral prevalence, increased risk of epidemics, and further negative dog-human and dog-wildlife interactions. Three critical information voids hinder more informed management: field data on dog demographics, measures of the prevalence for important pathogens, and data on how diseases, and disease control, influence dog demographics. We are collecting this data for multiple dog populations in rural India. We are also conducting a mass vaccination campaign for the study populations to monitor the effects of mass vaccination on the dog demographic parameters that underpin population growth rates. This work will provide immediate applied and theoretical insights by identifying limiting factors for dog populations and by identifying outcomes of potential dog vaccination management strategies. |
**INVESTIGATION OF FLEA ECOLOGY AND PLAGUE DYNAMICS IN UTAH PRAIRIE DOG POPULATIONS**

**Investigators**  
Dr. Matthew Gompper, MU  
Dr. Joshua Millspaugh, MU  
David Jachowski, PhD  
Student, MU

**Project Supervisor**  
Dr. Matthew Gompper

**Funding**  
Utah Division of Wildlife Resources,  
U.S. Fish and Wildlife Service

**Objectives**  
The specific objectives of this work are: (a) to identify the species of fleas that occur on Utah prairie dogs; (b) to reveal patterns of flea community structure and patterns in the temporal and spatial dynamics of flea populations on Utah prairie dogs and (c) assess outcome of systemic flea control trials.

**Location**  
Utah, Missouri

**Expected Completion**  
May 2012

**Status**  
In progress

**Progress**  
Sylvatic plague, caused by the bacterium *Yersinia pestis*, is known to be a major threat to Utah prairie dog conservation, but we have a poor understanding of how this disease behaves and which prairie dog populations are at greatest risk. Investigations into flea ecology on black-tailed prairie dogs have provided valuable insight into plague dynamics. Different flea species are more abundant at different times of year and certain species are more likely to carry and transmit the disease, and seasonal variations in flea species have been found to correlate with plague outbreaks. In contrast to black-tailed prairie dogs, little is known about the ecology of fleas on Utah prairie dogs. Basic information on seasonal and elevation variations in flea dynamics could provide insight into plague ecology and provide information to managers about when and where prairie dog populations are most at risk. During tests of systemic flea control, fleas were systematically collected by Utah Division of Wildlife personnel from 30-50 Utah prairie dogs on each of 5 treatment and 5 control sites at monthly intervals in 2009 and 2010. The identification of fleas from these sites is underway and will result in information on the flea community and the temporal and spatial dynamics of flea populations on Utah prairie dogs.
RELATIVE IMPORTANCE OF GENETIC VARIABILITY FOR PREDICTING PARASITISM

Investigators
Dr. Matthew Gompper, MU
Dr. Lori Eggert, MU
Dr. Maria Jose Ruiz-Lopez, MU

Project Supervisor
Dr. Matthew Gompper

Funding
National Science Foundation

Objectives
The specific objectives of this work are: (a) identify the relationships between neutral and MHC genetic variability and the likelihood and extent of parasitism of a host; (b) assess the relative importance of any observed genetic correlations relative to demographic and abiotic factors that are also known to influence extent of parasitism.

Location
Missouri

Expected Completion
May 2012

Status
In progress

Progress
Strong associations exist between an individual’s level of genetic variability and the likelihood and extent of parasitism. These associations are observed for neutral loci (e.g. microsatellites), as well as for regions of the genome such as the major histocompatibility complex (MHC) where selection for genetic variability is strong and particular alleles may influence the likelihood of an individual being parasitized. These observations result in two important questions that are addressed in this project. First, is neutral genetic variability and MHC variability associated with the likelihood of parasitism even in large outcrossing populations and do such patterns persist across diverse parasitic species? Second, if associations between genetic variability or the presence of specific alleles and the likelihood or extent of parasitism exist, what is the relative importance of these genetic predispositions compared to other strong predictors of parasitism? These issues are addressed by examining relationships between genetic variability and parasitism based on data derived from a study of ten free-ranging raccoon populations collectively totaling over 700 known individuals. Preliminary work indicates high levels of microsatellite and MHC variability which is typical of large outcrossing populations, but also broad variance in measures of genetic variability across individuals. Several strong associations between genetic variability and parasitism have been identified, including relationships between genetic variability and ectoparasite abundance, endoparasite species richness, and viral seroconversion.
LANDSCAPE ECOLOGY OF TIGERS IN NEPAL

Investigators
Dr. Matthew Gompper, MU
Hemanta Kafley, PhD Student, MU

Project Supervisor
Dr. Matthew Gompper

Funding
World Wildlife Fund, University of Missouri Graduate School Fellowship, Mizzou Tigers for Tigers

Objectives
To develop habitat suitability models for tigers and other sympatric carnivores in the Terai Arc landscape (TAL) of Nepal.

To identify the trend of the Land use / Land cover change in the TAL and analyze its impact on tiger habitat suitability

To evaluate the ability of the corridors to connect different identified tiger subpopulations in the TAL.

To understand the ecological importance of tiger on the light of spatial and temporal habitat separation / overlap between and among Carnivores and their prey species in the Chitwan National Park, Nepal.

Location
Nepal

Expected Completion
May 2014

Status
In progress

Progress
The chances for a long-term survival of megafauna small and isolated protected areas are slim unless they are linked by intact natural habitat corridors that permit dispersal and provide critical habitat requirements. In Nepal, the tiger now occurs only in small, isolated protected areas (viz. Suklaphanta Wildlife Reserve – 305 sq.km, Bardia National Park- 968 sq.km, Chitwan National Park- 932 sq.km and Parsa Wildlife Reserve- 499 sq.km) connected by different habitat types at varied level of fragmentation and managed for different objectives. In isolation, these protected areas in Nepal are not large enough to support viable tiger population. Therefore, an important step of shifting management from protected areas level to ecosystem or landscape level has been taken in Nepal. The Terai Arc Landscape (TAL) program was designed to restore and maintain the critical forest corridors and bottlenecks with an overall goal to conserve the biodiversity, soils and watersheds of the Terai and Churia Hills to ensure ecological, economic and socio-cultural integrity of the region. However, to date no study has been done to oversee the landscape dynamics of the TAL and its function to serve as a refuge to support tiger and other megacarnivores. This study will identify the critical habitat parameters responsible for the perpetual existence of the tigers and map suitable habitat in the TAL. Impact on tiger habitat suitability due to changes in the land use / land cover along TAL will be analyzed. Simultaneously, remnant viable corridor for the movement of tigers in the TAL will be identified and mapped. This study also aims to understand the response of other carnivores and prey species in Chitwan National Park to the presence of tigers.
RAPID AMINO ACID DETERMINATION IN BLUEGILL, *LEPOMIS MACROCHIRUS*

**Investigators**
Karthik Masagounder, M.S. 2007, PhD 2010
Dr. Jeffry D. Firman

**Project Supervisor**
Dr. Rob Hayward,
Fisheries and Wildlife Sciences, Univ. of Missouri

**Funding**
North Central Regional Aquaculture Center, Michigan State University

**Cooperators**
Division of Animal Sciences; Poultry Nutrition, Univ. of Missouri; Dr. Paul Brown, Purdue University

**Objectives**
Formulate a nutritionally complete, least-cost diet for bluegill

**Location**
Fisheries & Aquaculture Wet Laboratory facility, Univ. of Missouri

**Completion**
September 2009

**Status**
Completed

**Progress and Results**
The aim of this study was to develop a least-cost diet for bluegill. Fish feed costs in aquaculture have increased to the point where they now account for as much as 60% of fish producer’s annual variable costs. Diets formulated to fully meet nutritional requirements of aquaculture species, but at reduced ingredient costs, are now viewed as being critical to the further development of aquaculture. The whole body amino acid profile was determined for juvenile bluegills caught from the wild. Amino acid ratios for 10 essential amino acids were determined. Requirement for dietary lysine was determined by feeding bluegills seven distinct diets containing graded levels of lysine (0.9%-3.0%). Apparent digestibility of dry matter and energy, and availability of amino acids from blood meal, fish meal, meat and bone meal, poultry byproduct meal and other feedstuffs were determined for 57g bluegill. Apparent digestibility of most amino acids exceeded 90% for evaluated protein sources, except for meat and bone meal. High digestibility values determined for soybean meal, poultry byproduct meal and blood meal, indicated good potential for replacing highly expensive fish meal in bluegill diets. The now completed least-cost bluegill diet is scheduled to be evaluated against various industry standard diets in pond trials at universities throughout the North Central Region.

**Products since 2008**
## LEAST-COST DIET STUDIES FOR GROW-OUT STAGE YELLOW PERCH AND NILE TILAPIA

<table>
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<th>Investigators</th>
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<tr>
<td>Dr. Robert Hayward</td>
<td>In progress</td>
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<tr>
<td>Dr. Jeffre Firman</td>
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<tr>
<td>Mr. Mihai Sun</td>
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| Project Supervisor     |              |
| Dr. Robert Hayward     |              |

| Funding                |              |
| North Central Regional Aquaculture Center, Michigan State University |

| Cooperators            |              |
| Division of Animal Sciences, University of Missouri |

| Objectives             |              |
| Develop least-cost, nutritionally complete diets for grow-out-stage yellow perch and Nile tilapia |

| Location               |              |
| Nationwide             |              |

| Expected Completion     |              |
| September 2011         |              |

### Progress and Results

We have completed first stages of projects for Nile tilapia and yellow perch. Literature searches have been conducted on feedstuffs’ amino acid compositions, and amino acid requirements of the two fishes. We have completed digestibility studies for grow-out-stage Nile tilapia. Nine common feedstuffs including fish meal, poultry byproduct meal, meat and bone meal, blood meal, soybean meal, peanut meal, corn glutan meal, as well as wheat and corn have been evaluated. Digestible energy as well as protein and amino acids have been evaluated. These data will be used mainly for the ideal protein diet formulation and least-cost diet formulation.

We have conducted the experiment to determine lysine requirement of grow-out Nile tilapia. This experiment was run for 8 weeks, and will ultimately determine the exact lysine requirement of grow-out Nile tilapia.

In addition, we will evaluate body amino acid compositions of Nile tilapia and yellow perch. The body amino acid profiles will provide a reference for formulating a protein- and amino acid balanced diet for the two focal species.

It is noted that we have experienced difficulty in securing ~250, 6-7” yellow perch. We will continue our efforts to secure suitable-sized yellow perch.
Investigators
Anthony Thorpe
Daniel Obrecht

Project Supervisor
Dr. John R. Jones

Funding
Missouri Department of Natural Resources

Objectives
To determine current water quality of Missouri lakes
To monitor Missouri lakes for changes over time
To educate the public about nonpoint source pollution, water quality issues and lake ecology

Location
Statewide

Expected Completion
Ongoing

Status
In progress

Progress and Results
The Lakes of Missouri Volunteer Program (LMVP) has been monitoring Missouri’s lakes using citizen volunteers since 1992. In 2009, more than 116 lake sites were visited over 800 times by volunteers. In addition to conducting field measurements, volunteers collected samples which were analyzed at the University of Missouri Limnology Laboratory for algal chlorophyll, the nutrients nitrogen and phosphorus, suspended sediments. Citizens who participate in the LMVP develop a deeper understanding of lake ecology and the factors that influence it. They are also better equipped to discuss this information with their peers, making them both stewards of and advocates for their lake. Data produced by the LMVP are submitted to the Missouri Department of Natural Resources for use in lake management decisions, particularly with the newly developed nutrient criteria.

Products since 2008
The Water Line (LMVP Newsletter):
http://lmvp.org/publications.htm

Website: http://lmvp.org/publications.htm

STATEWIDE LAKE ASSESSMENT PROJECT

Investigators
Dr. John R. Jones
Daniel Obrecht

Project Supervisor
Dr. John R. Jones

Funding
Missouri Department of Natural Resources

Objectives
To generate Missouri lake and reservoir water quality data. The data are used to document existing conditions, evaluate trends, model lake processes and assist with management decisions.

Location
Statewide

Expected Completion
Ongoing

Status
In progress

Progress and Results
The Statewide Lake Assessment Project is an inventory of lake resources. Approximately 75 lakes are sampled on 4 occasions per summer to evaluate lake trophic state. This sampling effort dates from 1976 and collectively it is one of the most extensive data sets in the country. The information has been used to establish reservoir nutrient criteria and is currently being used by MDC to assess relationships between trophic state metrics and reservoir fish data.

Products since 2008
SPATIAL ANALYSIS OF SEDIMENT ORGANIC CARBON AND NITROGEN IN FOUR NORTHERN MISSOURI RESERVOIRS

Investigators
Dr. John R. Jones
Mr. Brady Pittman
Dr. Josh Millsbaugh
Dr. Jason Hubbart
Dr. Robert Kremmer
Dr. John Downing

Project Supervisor
Dr. John R. Jones

Funding
Missouri Department of Natural Resources

Cooperators
Missouri Department of Natural Resources
US Department of Agriculture
Iowa State University

Objectives
To quantify the spatial distribution of sediment organic carbon and nitrogen.

To evaluate sampling effort required for estimation of representative sediment organic carbon and nitrogen values.

To determine the relative contributions of autochthonous and allochthonous sources to sediment organic carbon using OC/N ratios.

Location
Jamesport Community Lake (MO)
Peters Lake (Fayette, MO)
Monte Gurwit Lake Dam (MO)
Worth County Community Lake (MO)

Expected Completion
May 2011

Status
In progress

Progress and Results
Global climate change brought about by a disturbance in the global carbon cycle is a growing concern. As carbon dioxide is considered the largest single forcing agent of climate change, a better understanding of its “sources” and “sinks” in the carbon budget would be beneficial in making an estimation of what might influence climate change. While there are many obvious holding places for carbon (the atmosphere, terrestrial vegetation, soil, fossil fuels, the ocean), freshwater reservoirs have not been figured into many determinations of the carbon budget. However, recent research suggests that the carbon storage capacity of small to medium-sized agricultural impoundments may be of the same magnitude as that of the world’s oceans. This estimate, and the fact that reservoirs continue to steadily increase in number, affirm the possibility that the role of such waters in the carbon budget has not received adequate attention. Through the use of ArcGIS’s geostatistical analyst, this research has produced distribution maps for sediment organic carbon (OC), sediment nitrogen (N), and OC/N. The study yielded OC mean and median values that were comparable to previous studies of lake/reservoir sediment carbon. By use of statistical power analysis the study evaluates the sampling effort necessary to produce a given precision for variable values. A determination of the distribution of OC/N in the reservoirs’ sediments suggests that allochthonous (watershed) organic matter inputs make a greater contribution to sediment organic matter at the inflow end than at the dam end. Statistical stratification will potentially be used to aid in the objective of determining optimal sampling location. Through input produced from such a stratification procedure, along with the results of the power analysis, insight will be obtained towards a more efficient and effective sampling strategy.
DR. DYLAN KESLER

NATAL DISPERSAL OF RED-BELLIED WOODPECKERS IN A FRAGMENTED LANDSCAPE

Investigators
Allison Cox, MU
Dr. Dylan Kesler, MU

Project Supervisor
Dr. Dylan Kesler, MU

Funding

Objectives
Identify how landscape composition and configuration affect movements of dispersing resident birds.
Identify how landscape fragmentation affects post-fledging survival of a resident bird.

Location
Central Missouri

Expected Completion
May 2011

Status
In progress

Progress and Results
Identifying the most effective ecological reserves designs has been a challenge to conservation biology for decades. One aspect of prime importance relates to facilitating animal movement between isolated patches of protected areas. Despite repeated calls for empirical assessments of landscape configuration on the movements of dispersing animals, quantitative information is still lacking for avian species. To address this information gap we used radiotelemetry to track the movements of dispersing juvenile Red-bellied Woodpeckers (Melanerpes carolinus). Work was conducted in areas of fragmented and contiguous forest in central Missouri. Movement data are currently being analyzed and results should provide quantitative guidelines for land managers concerned with maintaining intact avian populations. Data will also allow us to model post-fledging survival of Red-bellied Woodpeckers. We will test for effects from intrinsic, social, temporal, and landscape features on post-fledging survival. Results will contribute to an understanding of the impacts of landscape composition and configuration on avian survival.
SURVIVAL AND MOVEMENT OF MISSOURI'S GREATER PRAIRIE-CHICKEN

Investigators
Kaylan Kemink, MU
Dr. Dylan Kesler, MU
Dr. Tom Thompson, Missouri Department of Conservation (MDC)
Max Allegar, MDC
Kevin Sullivan, MDC
Brent Jamison, U.S. Fish and Wildlife Service

Project Supervisor
Dr. Dylan Kesler

Funding
Missouri Department of Conservation, Audubon Society of Missouri, Webster Groves Nature Study Society, Prairie Biotic Research Inc.

Cooperators
Missouri Department of Conservation

Objectives
Examine and compare survival and movements of translocated and resident adult and juvenile Greater Prairie-Chickens.

Identify landscape habitat compositions and configurations that benefit populations of Greater Prairie-Chickens

Location
Wah’Kon-Tah Prairie, Missouri
Taberville Prairie, Missouri

Expected Completion
May 2012

Status
In progress

Progress and Results
The Missouri Department of Conservation has engaged in a range of recovery efforts to address the declining population of Greater Prairie-Chickens (*Tympanuchus cupido*). Despite substantial progress, however, there are remaining gaps in the information needed to ensure success. Specifically, foundational information is needed about Greater Prairie-Chicken adult and juvenile vital rates. The relationship between Greater Prairie-Chicken demography and habitat composition and configuration is also a subject requiring further study. To address these information gaps we designed a radiotelemetry study of resident birds and birds captured in Kansas and released in Missouri. Extensive radio-tracking of both resident and translocated prairie chickens was completed throughout the 2010 spring and summer seasons. Over 4,000 locations were obtained, presenting us with a unique and exciting opportunity to model movement and survival for these birds. We will also be able to answer important management questions about Greater Prairie-Chicken conservation, translocation and reintroduction. A 2011 field season is planned and preliminary data analyses will be initiated in winter 2011. Radio-tagging and tracking efforts will be expanded in upcoming years to include a larger sample size and a more intensive sampling frequency.
CONSERVATION OF INSULAR SEABIRDS IN PACIFIC OCEANIA

Investigators
Lisa Sztukowski, MU
Dr. Dylan Kesler, MU

Project Supervisor
Dr. Dylan Kesler, MU

Funding
Chugach Support Services, Inc.
U.S. Air Force, 15th Airlift Wing
U.S. Department of Defense Legacy Resource Management Project

Cooperators
Chugach Support Services, Inc.
U.S. Air Force, 15th Airlift Wing

Objectives
Assess the likelihood of rodenticide bait consumption by nesting Sooty Terns on Wake Island
Assess the relative influence on hatch-year survival of body condition, rat predation, interspecific aggression, climate conditions, parental attendance, and vegetation.
Identify the developmental stage at which Sooty Tern chicks suffer the highest rate of mortality.

Location
Wake Island, HI

Expected Completion
December 2010

Status
In progress

Progress and Results
Invasive introduced mammals can cause catastrophic effects on delicate island ecosystems. Introduced new world rats (Rattus spp.) have been identified as one of the greatest threats to insular systems of Pacific Oceania and managers have responded with large-scale eradication projects. The US Air Force has scheduled rat eradication on Wake Island to protect and restore the island’s ecosystems and to improve military effectiveness. We initiated work to reduce impacts on non-target species. We are assessing the likelihood of rodenticide bait consumption by nesting seabirds and identifying the factors influencing hatch-year survival. We used color band mark and resight techniques, radiotelemetry, and automated photography to monitor survival and behavior in breeding seabirds on Wake Island during 2008, 2009 and 2010. Data will be analyzed in fall 2010, with the intent of providing guidance for the scheduled 2011 Wake Island rat eradication project.

Products since 2008
| Investigators | Gabrielle Coulombe, MU  
|               | Dr. Dylan Kesler, MU |
| Project Supervisor | Dr. Dylan Kesler |
| Funding | Disney Worldwide Conservation Fund, Pacific Islands Conservation Research Association, Société d’Ornithologie de Polynésie Manu, MU Conservation Biology Program |
| Cooperators | Société d’Ornithologie de Polynésie Manu, Disney’s Animal Kingdom |
| Objectives | Identify key habitats needed for Tuamotu Kingfisher conservation. Identify resource requirements needed at translocation destination. |
| Location | Niau Atoll, Tuamotu Archipelago, French Polynesia |
| Completion | September 2011 |

**Status**
In progress

**Progress and Results**
Our investigation is aimed at identifying the ecological requirements of the critically endangered Tuamotu Kingfisher (*Todiramphus gambieri*) and providing management recommendations that help prevent the bird's extinction. The species is confined to the lowland forests on Niau Atoll in French Polynesia, with a total population of fewer than 250 individuals. A multi-scale resource selection study was based on island-wide surveys and radiotelemetry relocation data from 2006-2010. The birds avoided atoll feo forest vegetation and appeared to rely on agricultural coconut plantations. The plantations were managed with prescribed burning, coconut harvest, and understory clearing. Coconut plantations provided foraging habitat with open understory and visible ground where the kingfishers hunted lizards and other prey items. Such habitat conditions might resemble those of the original lowland forest, which no longer occur on most Tuamotu islands. A subsequent test was made of factors that have the potential to influence space use, and results showed that variation in territory characteristics correlated with the spatial configuration of foraging patches. The Tuamotu Kingfishers appeared to have a maximum territory length limited by their ability to effectively defend territory boundaries, guard nests, and provision nestlings. Thus, regions where habitats occur in very linear or distant patches may be unsuitable for translocations and conservation colonizations. Translocation was identified as a potential conservation strategy for Tuamotu Kingfishers, and additional criteria were provided for island selection to establishing a rescue population.

**Products since 2008**


DEVELOPING RESCUE SCENARIOS FOR THE GUAM MICRONESIAN KINGFISHER

Investigators
Dr. Rebecca Laws, MU
Dr. Dylan Kesler, MU

Project Supervisor
Dr. Dylan Kesler, MU

Funding
U.S. Fish and Wildlife Service, USGS
Missouri Cooperative Fish and Wildlife Research Unit

Cooperators
U.S. Fish and Wildlife Service,
Association of Zoos and Aquariums

Objectives
Model and identify suitable candidate islands to establish the Guam Micronesian Kingfisher in Pacific Oceania

Ground truth candidate islands to determine suitability

Model captive and release population dynamics to identify suitable release individuals and predict post release dynamics

Location
Pacific Oceania, Guam, Federated States of Micronesia, French Polynesia, Marshall Islands, Commonwealth of the Mariana Islands, Republic of Palau

Expected Completion
March 2012

Status
In progress

Progress and Results
A large proportion of historic avian extinctions have been island forms, and many more island species are on the brink of extinction. Species re-introductions and facilitated colonizations have been successfully used as conservation tools. However, the science and methods underlying site selection are often hindered by a lack of information. For this project, information is being gathered from the literature and expert opinions to underpin a Bayesian network model that will serve as a decision support tool to identify potential release sites for the critically endangered Guam Micronesian Kingfisher. The model will be used to help identify candidate islands under multiple release, recovery, and management scenarios. Top candidate islands will then be surveyed to determine suitability, and to establish collaborative research and conservation ties. Population modeling will then be used to test multiple release and translocation approaches, and to help determine which individuals might be selected for re-introductions or translocations, while simultaneously maintaining a robust captive donor population of the critically endangered birds.
DR. JOSHUA MILLSPAUGH

SURVIVAL, MOVEMENTS, AND RESOURCE SELECTION OF CAPTIVE-REARED OZARK HELBENDERS TRANSLOCATED TO THE NORTH FORK OF THE WHITE RIVER, MISSOURI

Investigators
Catherine Bodinof, M.S.
2010
Dr. Joshua Millspaugh
Dr. Jeff Briggler, MDC
Jeff Beringer, MDC

Project Supervisor
Dr. Joshua Millspaugh

Funding
MDC
Saint Louis Zoo

Cooperators
University of Missouri
MDC
Saint Louis Zoo

Objectives
To investigate the use of translocation to improve hellbender populations.

Determine survival rates of translocated hellbenders

Quantify post-release movements and space use of translocated hellbenders

Assess resources selection of translocated hellbenders

Location
Missouri

Completion
July 2010

Status
Completed

Progress and Results
We implanted 36 Ozark hellbenders (C. a.bishopi) that had been reared in captivity at the Saint Louis Zoo for 5.5 years with radio transmitters and translocated them to 2 sites on the North Fork of the White River, Missouri. We collected 3,635 hellbender locations between May 2008 and August 2009. At the end of our study 16 hellbenders were alive, 13 were dead and we were unable to confirm status of 7 animals. Annual survival rates for captive-reared hellbenders were 55 % higher at the lower site (0.7467), though site specific factors driving the difference were not obvious. In addition to exhibiting reduced survival rates, upper site hellbenders tended to gain less weight post release, and a greater proportion carried chytrid fungus, leech parasites and accrued injuries and open sores. We also observed site differences in post-release dispersal. While only 7 of 36 hellbenders dispersed outside of ‘core habitat’, mean distance between release and last observation in the study over twice as long and more variable at the upper site (318.28 m [SE 115.39]), where rock density was lower and the extent of core habitat was smaller than at the lower site (121.95 m [SE 34.13]). At both sites, daily movements of hellbenders were fewer and covered shorter distances, and home range sizes were reduced in the second season of monitoring, suggesting most hellbenders had settled at least semi-permanently in the wild. Hellbender resource selection was positively associated with presence of coarse substrate and bedrock relative to fine substrates; and with decreasing distance to nearest rock in all mesohabitats (i.e., pool, run, riffle). The negative association between increasing distance to rock and selection was intensified as benthic water velocity increased, suggesting the importance of considering substrate arrangement in future release sites. We demonstrated that captive-reared hellbenders were capable of remaining and settling in release sites, while maturing in a wild environment, for over 1 year. However, the site differences we observed in survival and dispersal of captive-reared hellbenders emphasizes the importance of selecting suitable release sites. We suggest selecting future release sites with densely arranged coarse substrate at a fine scale (e.g., within 20 m²) as well as a larger extent.

Products since 2008
Investigators
Mr. Chris Hansen, M.S. 2009
Dr. Joshua Millspaugh
Dr. Mark Rumble, U.S. Forest Service

Project Supervisor
Dr. Joshua Millspaugh

Funding
U.S. Forest Service, Rocky Mountain Research Station and Black Hills Forest
South Dakota Department of Game, Fish, and Parks

Cooperators
U.S. Forest Service, Rocky Mountain Research Station and Black Hills National Forest
South Dakota Department of Game, Fish, and Parks
University of Missouri

Objectives
Evaluate ruffed grouse occupancy and detection probabilities.

Develop a monitoring protocol for ruffed grouse.

Determine the vegetative characteristics that affect ruffed grouse selection of drumming structures.

Location
Black Hills National Forest (SD and WY)

Completion
May 2009

Status
Completed

Progress and Results
Ruffed grouse (Bonasa umbellus) are important game birds and the management indicator species for quaking aspen (Populus tremuloides) in the Black Hills National Forest (BHNF). As a result, a robust monitoring protocol which reflects the status, trends, and habitat associations of ruffed grouse is necessary. To evaluate these processes, we used ruffed grouse drumming counts combined with occupancy modeling. Ruffed grouse occupancy in the BHNF was low (0.12) and positively influenced by the amount of aspen. Detection probability was also low (0.27) and primarily influenced by date, wind speed, and time of the survey. Using occupancy and detection estimates, we evaluated multiple occupancy sampling designs to determine which design required the least effort to achieve occupancy estimates with a desired level of precision. The most efficient sampling design was the standard multi-season design with 3 repeat surveys at each site. However, site requirements using this design were high due to low ruffed grouse occupancy and detection rates in the BHNF. Thus, managers must decide how to allocate and distribute effort towards monitoring. We also addressed ruffed grouse micro-site selection of drumming sites (activity centers) to determine what structure and adjacent vegetative characteristics were correlated with selection of activity centers. Selection was driven by vegetative cover above 1 meter in height, suggesting ruffed grouse selected activity centers that provided protection from predators.

Products since 2008
EVALUATION AND DEVELOPMENT OF BLACK-FOOTED FERRET RESOURCE SELECTION MODELS

Investigators
Mr. David Eads, MU
Mr. David Jachowski, MU
Dr. Joshua Millspaugh, MU
Dr. Dean Biggins, USGS
Mr. Randy Matchett, U.S. Fish and Wildlife Service
Mr. Travis Livieri, Prairie Wildlife Research

Project Supervisor
Dr. Joshua Millspaugh

Funding
National Fish and Wildlife Foundation
South Dakota Department of Game, Fish, and Parks
USGS

Cooperators
USGS, University of Missouri, U.S. Fish and Wildlife Service, Prairie Wildlife Research

Objectives
Evaluate a recently developed ferret resource utilization function generated from observations of ferrets on an adjacent colony

Develop new resource selection functions that consider influences of predators and resource connectivity

Location
Central South Dakota

Completion
May 2009

Status
Completed

Progress and Results
Resource selection (RSF) and utilization function (RUF) models facilitate habitat evaluations and investigation of theorized mechanisms of space use patterns. We monitored post-breeding (2007-2008) resource selection of adult black-footed ferrets (Mustela nigripes) inhabiting a 452-ha black-tailed prairie dog (Cynomys ludovicianus) colony in the Conata Basin, South Dakota, USA. We used the ferret RUF to project the predicted occurrence of ferrets within the South Exclosure, and evaluated model performance via “weighted” compositional analysis and presence count-metrics. Compositional analysis of home range use and colony-level availability, and core area use and home range availability demonstrated ferret selection of the predicted Very High and High occurrence categories. Of all ferret locations, 71.83% (i.e., 329/458) and 72.25% (i.e., 302/418) occurred in areas of Very High or High predicted occurrence in 2007 and 2008, respectively. These results suggested that the RUF was useful in predicting ferret space use. We investigated influences of open black-tailed prairie dog burrows, active burrows, edge effects, resource connectivity and predators (coyotes, Canis latrans, and American badgers, Taxidea taxus) on ferret resource selection. In both years, black-footed ferrets selected areas of increased abundance of active burrows. Ferrets selected areas of increased distance from colony edges in 2007; however, a main-effects interaction suggested that if active burrow density was high in an edge area, ferrets still might select the area. Connectivities of active and open burrow patches also were not retained in our RSFs. Results of this assessment complement previous studies in demonstrating the importance of active burrows in ferret resource selection.

Products since 2008

PRONGHORN MIGRATION AND RESOURCE SELECTION IN SOUTHWESTERN NORTH DAKOTA

Investigators
Mr. Jesse Kolar, MU
Dr. Joshua Millspaugh, MU
Mr. Bruce Stillings, North Dakota Game and Fish Department

Project Supervisor
Dr. Joshua Millspaugh

Funding
North Dakota Game and Fish Department

Cooperators
University of Missouri
North Dakota Game and Fish Department
Bureau of Land Management

Objectives
Determine the timing of migrations, distances and directions moved during migrations, proportion of the population that migrates, and fidelity to seasonal ranges

To determine seasonal resource selection of pronghorn

Location
Southwestern South Dakota

Completion
May 2009

Status
Completed

Progress and Results
Wildlife managers need pronghorn (Antilocapra americana) movement data in North Dakota because harvest quotas are based on a summer aerial survey, which might not represent the distribution of pronghorn during the fall hunting season. Using data from 121 radio-collared pronghorn, we quantified distance, direction and timing of seasonal migrations and site fidelity for pronghorn in North Dakota, 2004-2008. Nearly half (45%) of the pronghorn were migratory, moving > 15 km between winter and summer ranges. Of the migratory pronghorn, 89% moved northeast in the spring, and 97% moved southwest in the fall. Pronghorn showed fidelity to summer ranges, but not to winter ranges. Few fall migrations occurred between the survey and the hunting season; therefore, during our years of study, the survey accurately reflected unit occupancy of pronghorn for the hunting season. Along with migration information, it is important to identify pronghorn habitat to guide land management decisions, inform mitigation processes and identify limited resources for pronghorn. We modeled summer and winter resource selection for 50 GPS-collared, female adult pronghorn in North Dakota, 2005–2008. We used vegetation type, ruggedness and distance to primary, secondary and tertiary roads as predictors. During both seasons, pronghorn selected open vegetation types in non-rugged habitat. Primary roads were avoided in the summer and secondary roads were avoided during both seasons. Reduction of open vegetation or road developments in non-rugged areas where habitat is limited might increase depredation complaints and increase the severity of winter die-offs by decreasing the suitability of habitat.

Products since 2008
DEVELOPMENT AND EVALUATION OF A TERRESTRIAL ANIMAL-BORNE VIDEO SYSTEM FOR ECOLOGICAL RESEARCH

**Investigators**
Mr. Remington Moll, MU
Dr. Joshua Millspaugh, MU
Mr. Jeff Beringer, MDC
Dr. Joel Sartwell, MDC
Dr. Zhihai He, MDC

**Project Supervisor**
Dr. Joshua Millspaugh

**Funding**
National Science Foundation

**Cooperators**
University of Missouri
Missouri Department of Conservation
University of Florida

**Objectives**
To develop a terrestrial animal-borne video system for white-tailed deer
To determine whether attachment of an animal-borne video system results in increased stress to deer
To determine contact among white-tailed deer using an animal-born video system

**Location**
Columbia, Missouri

**Completion**
May 2008

**Status**
Completed

**Progress and Results**
Animal-borne video and environmental data collection systems (AVEDs) are integrated sensor systems that combine video from the animal’s perspective with data from other sensors (e.g., audio, location). By placing sensor data within the context of video, AVEDs provide a unique perspective not offered by other methods and facilitate research into animal behavior, foraging tactics, bioenergetics, wildlife damage issues, and inter- and intra-specific interactions. From 2006 to 2008, we developed the first terrestrial, store-on-board AVED designed for ecological research. To provide ecologists with a framework for evaluating AVED research, we reviewed the historical development, ecological research potential, and future challenges associated with AVEDs. We tested the hypothesis that AVED attachment increases the stress levels (fecal glucocorticoid metabolites [FGMs]) of captive white-tailed deer (*Odocoileus virginianus*). Using a repeated measures analysis of variance, we found no difference in FGMs between control and treatment individuals during a 6 week trial that included a 2 week treatment period. We demonstrated the utility of our AVEDs by describing contacts between white-tailed deer at the Baskett Wildlife Research and Education Area near Ashland, Missouri. Our research shows that our AVEDs are powerful new tools for ecological research that do not elevate stress levels of captive white-tailed deer and enable ecological research opportunities that traditional methods (e.g., radio telemetry) have not provided.

**Products since 2008**
WILDLIFE RESPONSE TO SPATIAL AND TEMPORAL CHANGES IN FOREST HABITAT

Investigators
Dr. Chadwick Rittenhouse, MU
Dr. Joshua Millspaugh, MU
Dr. Frank Thompson, III, U.S. Forest Service
Dr. Steve Shifley, U.S. Forest Service
Mr. William Dijak, U.S. Forest Service

Project Supervisor
Dr. Joshua Millspaugh
Dr. Frank Thompson, III

Funding
U.S. Forest Service

Cooperators
U.S. Forest Service
University of Missouri
Missouri Department of Conservation

Objectives
To develop and assess habitat suitability models for 9 species on the Hoosier National Forest under 5 alternative forest management alternatives
To illustrate HSI model validation using existing demographic data

Location
Nationwide

Completion
May 2008

Status
Completed

Progress and Results
A common goal in land-management planning is to describe the relationship between management actions, vegetation and wildlife habitat conditions for large landscapes. This process can be challenging because ecological processes of disturbance (natural and anthropogenic) and succession affect vegetation composition and structure, which subsequently affects current and future habitat conditions for wildlife. Further, habitat suitability is often used as a surrogate for demographic response to vegetation change yet whether this assumed association is rarely evaluated. We developed habitat suitability models for 10 wildlife species and validated two of those models as predictors of demographic responses (e.g., territory density and nest success). We then simulated future forest conditions and evaluated habitat suitability 10, 50, and 150 years from present as part of the Hoosier National Forest (HNF) plan revision. No single management alternative was best for all wildlife species. Without harvest or prescribed fire, early successional wildlife species will be extirpated from the HNF within 50 years. Harvest benefited early successional species without greatly affecting habitat suitability for late successional species. By incorporating ecological processes of disturbance and succession while retaining the resolution necessary for evaluating wildlife habitat suitability, this modeling approach contributed knowledge to the planning process and was a valuable tool for communicating differences among alternatives to stakeholders.

Products since 2008
EFFECTS OF WIND ENERGY DEVELOPMENT ON GREATER SAGE-GROUSE

**Investigators**
Mr. Christopher Hansen, MU  
Dr. Joshua Millspaugh, MU  
Dr. Mark Rumble, U.S. Forest Service

**Project Supervisor**
Dr. Joshua Millspaugh

**Funding**
Power Company of Wyoming  
U.S. Forest Service, Rocky Mountain Research Station  
Wyoming Game and Fish Department

**Cooperators**
Power Company of Wyoming  
U.S. Forest Service, Rocky Mountain Research Station  
Wyoming Game and Fish Department  
Bureau of Land Management  
University of Missouri  
SWCA Environmental Consultants

**Objectives**
Evaluate the effectiveness of conservation measures for sage-grouse  
Investigate construction and operational effects of the wind energy development to localized sage-grouse populations

**Location**
Rawlins, Wyoming

**Expected Completion**
2020

**Status**
In progress

**Progress and Results**
At regional to global scales, the effects of wind energy on the environment often are considered to be a non-issue or even positive, as the production of renewable energy does not incur many of the negative consequences of carbon-based energy sources such as air pollution, and other greenhouse gas emissions. However, wind-energy facilities have been demonstrated to impact birds and bats and there is evidence that wind-energy development can result in the loss of habitat for some species. Greater sage-grouse (*Centrocercus urophasianus*) are highly dependent on sagebrush dominated ecosystems and threats to the sagebrush ecosystems have been described extensively. While oil- and gas-field development caused measurable effects on sage-grouse, the extent of wind energy development on sage-grouse populations and habitat are unknown. We will use a Before-After-Control-Impact design to evaluate multiple aspects of sage-grouse ecology before, during, and after construction of a wind farm south of Rawlins, Wyoming. We will radio-track and monitor sage-grouse on sites with wind turbines and those without. We have radio-tagged 40 adult hens with satellite transmitters and have collected > 30,000 locations since initiating field work in spring 2010. Using this information, we will evaluate sage-grouse survival, space use, movements, and resource selection at multiple scales.
PHYSIOLOGICAL AND BEHAVIORAL RESPONSE OF AFRICAN ELEPHANTS TO REINTRODUCTION

Investigators
Mr. David S. Jachowski, MU
Dr. Joshua Millspaugh, MU
Dr. Rob Slotow, UKZN

Project Supervisor
Dr. Joshua Millspaugh

Funding
University of Missouri
University of KwaZulu-Natal

Cooperators
University of KwaZulu-Natal
University of Missouri
St. Lucia Wetland Park
Pilanesburg National Park
Phinda Game Reserve

Objectives
How does space use of reintroduced elephant populations develop over time?

What causes certain parks to contain elephants with higher stress hormone levels than others?

How does elephant physiological state influence movement patterns?

Location
Throughout South Africa

Expected Completion
May 2012

Status
In progress

Progress and Results
Reintroduction of elephants is a valuable conservation tool given the ecological and economic importance of maintaining elephant populations. However, translocated elephants can exhibit destructive behavior such as the top-down altering of vegetative structure and ecosystem processes, as well as killing of rhinos and increased aggression toward or killing of humans. Managers need to know what drives elephant behavior in order to limit potential detrimental effects. We are investigating the physiological and behavioral response of elephants to reintroduction in 4 different parks and reserves in South Africa. First, knowledge of how elephant space use patterns change over time could help managers to predict where elephant impacts are likely to be greatest. Second, knowledge of the potential cues of stress in elephants could provide a better understanding of factors that put elephants on edge and how to potentially limit dangerous and destructive behaviors. Therefore, we will assess potential factors environmental (e.g., rainfall and temperature) and biological (e.g., sex ratio, age structure of elephant populations) which explain park to park differences in observed stress hormone levels. Finally, we will combine the monitoring of elephant movements with their stress hormone concentrations to assess the influence of physiological state on movement of elephants. We will use existing databases of stress hormone concentrations and GPS radio-tag data from elephants to address these questions.
FORAGE PRODUCTION, RESOURCE SELECTION, CARRYING CAPACITY AND SPATIAL OVERLAP AMONG AN UNGULATE ASSEMBLAGE IN CUSTER STATE PARK, SOUTH DAKOTA

**Investigators**  
Ms. Barbara J. Keller, MU  
Dr. Joshua Millspaugh, MU  
Dr. Gary Brundige, Custer State Park  
Chris Hansen, MU

**Project Supervisor**  
Dr. Joshua Millspaugh

**Funding**  
South Dakota Department of Game, Fish and Parks  
University of Missouri  
Rocky Mountain Elk Foundation

**Objectives**  
Develop spatially-explicit model to predict forage production.  
Determine seasonal composition and overlap of ungulate diets.  
Determine resource selection of bison and pronghorn.  
Evaluate hypotheses regarding seasonal spatial overlap among ungulate assemblage.  
Integrate forage production, diet selection and resource selection into automated carrying capacity model.

**Location**  
Custer State Park, SD

**Status**  
In progress

**Progress and Results**  
Custer State Park supports populations of bison (*Bison bison*), elk (*Cervus elaphus*), pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), white-tailed deer (*O. virginianus*), and bighorn sheep (*Ovis canadensis*). Park managers currently estimate carrying capacity based on untested assumptions regarding forage production, and space-use, diet composition and competition among ungulate species. We measured biomass in Custer (2005-2008) using the clipping and weighing technique. Our forage production model predicted 28,006,862 kg of palatable forage were produced in a year of average spring precipitation and date of last spring frost. We used microhistological techniques to estimate diet composition of each ungulate species. Overall, dietary overlap was high between bison and elk, pronghorn and mule deer, elk and white-tailed deer, and white-tailed deer and mule deer. In general, the potential for competition among ungulate species was greatest during the summer. We evaluated spatial overlap among 5 ungulate species in CSP and assessed how habitat features modified overlap. In general, spatial overlap was most associated with quality resources (high forage biomass and water) at the edges of habitat patches. We used spatially-explicit information of forage production, diet selection, space-use, and spatial overlap of the ungulate assemblage in Custer, to develop a forage allocation model to predict carrying capacity for ungulates. During summer, our model predicted a carrying capacity of 2826 ungulates, but did not meet the constraints of a minimum population of 500 elk and 50 white-tailed deer. The model predicted a carrying capacity of 2103 ungulates during winter, consisting of 879 bison, 500 elk, and other ungulates. Continued evaluation of the sensitivity of this model to changes in climate, as well as the importance of individual forage species to the linear optimization solution are planned.
NUTRITIONAL CARRYING CAPACITY OF BISON (BISON BISON) AND ELK (CERVUS ELAPHUS) IN WIND CAVE NATIONAL PARK, SOUTH DAKOTA

Investigators
Ms. Barbara J. Keller, MU
Dr. Joshua Millspaugh, MU
Ms. Beth Burkhart, Wind Cave National Park
Mr. Chris Hansen, MU

Project Supervisor
Dr. Joshua Millspaugh

Funding
National Park Service

Objectives
Develop spatially-explicit model to predict forage production.

Determine seasonal composition of bison and elk diets.

Develop carrying capacity model for bison and elk based on biomass and nutritional quality of forage.

Location
Wind Cave National Park, SD

Expected Completion
December 2010

Status
In progress

Progress and Results
This project was developed to provide Wind Cave National Park with a model to predict forage production for rangeland and woodland habitats and to estimate food habits of ungulates, with special emphasis on bison (Bison bison) and elk (Cervus elaphus). Using this information, we aim to estimate carrying capacity based on forage availability and nutritional constraints. We measured forage production and food habits of ungulates in Wind Cave and Custer State Park, SD from 2005–2008. We used the clipping and weighing technique to measure biomass and used this data to build a repeated-measures mixed-effects model to predict forage production in Wind Cave. Our model estimated that Wind Cave produced 14,957,380 kg of biomass in a typical year. We used microhistological techniques to estimate diet composition of each ungulate species. In Wind Cave, bison diets were composed of 52.9% cool season grass, 21.5% warm season grasses, 11.5% sedges, and 8.5% shrubs and forbs. Elk diets in Wind Cave were composed of 41.6% shrubs, 32.9% grasses, and 25.2% forbs. We used Schoener’s (1970) overlap index to estimate diet overlap. Seasonal diet overlap between bison and elk ranged between 0.043 during spring to 0.386 during summer. We will use the carrying capacity algorithm developed by Hanley and Rogers (1989) to estimate nutritional carrying capacity of Wind Cave National Park.
# IMPORTANCE OF MOUNTAIN PINE BEETLE INFESTATIONS AND FIRE AS BLACK-BACKED WOODPECKER HABITAT IN THE BLACK HILLS, SOUTH DAKOTA

**Investigators**  
Mr. Christopher Rota, MU  
Dr. Joshua Millspaugh, MU  
Dr. Dylan Kesler, MU  
Dr. Mark Rumble, U.S. Forest Service  
Dr. Chad Lehman, South Dakota Department of Game, Fish, and Parks  

**Project Supervisor**  
Dr. Joshua Millspaugh, MU  
Dr. Dylan Kesler, MU  

**Funding**  
U.S. Forest Service, South Dakota Department of Game, Fish and Parks  

**Cooperators**  
U.S. Forest Service, South Dakota Department of Game, Fish and Parks, Wind Cave National Park  

**Objectives**  
How is black-backed woodpecker space-use affected by resource distribution within a home range?  

What is the relative value of habitat created by wildfire, mountain pine beetle infestation, and prescribed fire to black-backed woodpeckers?  

What factors affect long-distance movement of black-backed woodpeckers?  

**Location**  
Black Hills, South Dakota  

**Expected Completion**  
May 2013  

**Status**  
In progress  

**Progress and Results**  
Wildfire and beetle infestations historically occurred in most western forests, and these natural disturbances were often considered undesirable. However, recent and ongoing research suggests that disturbed forests provide important habitat for rare species, and prescribed burning is being tested as a management tool. The black-backed woodpecker (*Picoides arcticus*) is a disturbance associated species of conservation concern and an important indicator of the positive and regenerative role that fire and pine beetle epidemics can play in western forests. Effective conservation and management at multiple scales requires detailed knowledge of how the distribution of resources within a home range affects woodpecker space-use, how demographic rates differ between habitat created by wildfire, prescribed fire, and beetle infestations, and how woodpeckers move between habitats at landscape scales.  

We are currently monitoring >40 woodpeckers year-round with VHF radio telemetry. We are collecting home range data on these birds, and will correlate space-use within each home range with vegetation characteristics. We are also collecting habitat-specific demographic data, including data on juvenile and adult survival and reproductive success. Finally, we are monitoring large-scale movements of woodpeckers, and will correlate movement probability with a variety of factors thought to influence decisions to leave a particular area and move to a particular habitat. Our results will provide resource managers in South Dakota and beyond with information necessary for effective conservation of black-backed woodpeckers.
MANAGING WILDLIFE IN THE FACE OF A CHANGING CLIMATE

Investigators
Ms. Jaymi LeBrun, MU
Dr. Joshua Millspaugh, MU
Dr. Frank Thompson III, U.S. Forest Service
Dr. Hong He, MU
Dr. Wayne Thogmartin, USGS
Mr. William Dijak, U.S. Forest Service

Project Supervisor
Dr. Joshua Millspaugh, MU
Dr. Frank Thompson III, U.S. Forest Service

Funding
U.S. Forest Service

Cooperators
U.S. Forest Service
University of Missouri
U.S. Geological Survey

Objectives
What are the impacts of current land cover and climate on the abundance of focal bird species in the Midwestern United States?

What is the response of focal bird species abundance to landscape change under alternative climate and forest management scenarios in the Missouri Ozark Highlands?

What are the economic tradeoffs of managing forests for resilience, adaptation, carbon sequestration, and avian species through timber revenues and carbon credits in the Missouri Ozark Highlands?

Location
Midwestern United States

Expected Completion
May 2013

Status
In progress

Progress and Results
Climate change is becoming a major concern for biological diversity. Already, wildlife populations are experiencing pressures brought on by human-induced changes to the landscape through habitat loss and degradation, introduction of invasive and exotic species, and fire suppression. Compounding these human-induced pressures to wildlife are both direct (e.g. phenology, temperature regulation and range shifts) and indirect (e.g. fire frequency and vegetation changes) effects of climate change. Current work on climate change has dealt primarily with modeling the effects and suggesting potential management implications at both landscape and regional scales. Very few studies have looked at simulating these management strategies for either mitigating or adapting to the effects of climate change with empirically-driven models. Using a Bayesian hierarchical framework, we will determine the impacts of current land cover and climate on the abundance of seven focal bird species in the Midwestern United States. We will then use these models in conjunction with downscaled General Circulation Models and landscapes simulated in LANDIS to predict the response of forest and wildlife species to forest management focused on resilience, adaptation, and carbon sequestration in the Missouri Ozark Highlands through 2080. Final predictions will be conducted under four set time series resulting in 30-m resolution maps of predicted avian abundance. We will also evaluate the economic tradeoffs of managing forests for climate change through timber revenues and carbon credits. Lastly, we will provide resource managers with information regarding the potential impacts to forests and wildlife under climate change along with management and economic implications.
EFFECTS OF COMMERCIAL HARVEST ON TURTLES IN THE MISSOURI RIVER

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<td>Dr. Joshua Millspaugh, MU</td>
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<td>Dr. Jeff Briggler, MDC</td>
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<td>Ms. Stephanie Zimmer, MU</td>
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<td>Dr. Joshua Millspaugh, MU</td>
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<tr>
<td>To determine what level of commercial turtle harvest is sustainable</td>
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<td>To determine the impact of commercial harvesting on the size structure, sex ratio, and fecundity of harvested turtle populations</td>
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<td>To develop a stage-based population model from existing data and information obtained from this study that can assess alternative harvest strategies</td>
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<td>To collect tissue from each species from each of the commercial waters’ rivers and from other non-commercial waters across the state for analyses of microchemistry (isotopes) indicators in order to determine if source of origin for each species can be distinguished</td>
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The effects of commercial turtle harvest practices on turtle populations are poorly understood. The purpose of this project is to determine the sustainable harvest rate for game turtle species in the Missouri River - the common snapping turtle (*Chelydra serpentine*), the spiny softshell turtle (*Apalone spinifera*), and the smooth softshell turtle (*Apalone mutica*). Using data collected during the pilot study season (summer 2010), we have determined the most efficient methods for collecting data in future field seasons to meet our objectives. During summer 2011 and 2012, we will intensively trap three sites in the Missouri River, as well as three sites in each of the following Missouri River tributaries – the Grand, Osage, and Gasconade Rivers. We will also trap at the Missouri-confluences of these three tributaries. Because commercial harvest cannot occur in tributaries and confluence regions, we will compare information from those areas to areas that are open to harvest. In addition to collecting basic age and size structure information, we will conduct a mark-recapture study to estimate abundance. A stage-based population model will be developed using demographic data collected during the field seasons and existing data found in the primary literature. This model will be used for population projections and to assess the impacts of harvest. As turtles are potentially being commercially harvested from legal (Missouri River) and illegal (confluences and tributaries) waters in Missouri, the ability to determine the origin of collected turtles could be a useful tool in regulating the commercial trade. Nail samples will be taken from individuals inhabiting each of the 4 rivers included in this study and analyzed. Ratios of trace elements or isotopes from the nail samples will be compared to those of individuals that are captured in other watersheds to determine if watershed of origin can be distinguished for an individual specimen. Similar studies have been successfully carried out using analysis of otoliths from freshwater fish species to distinguish origin.
DEVELOP, MONITOR, AND EVALUATE MOURNING DOVE HARVEST MANAGEMENT OPPORTUNITIES IN AN AGROFORESTRY COMPLEX

Investigators
Dr. Joshua Millspaugh, MU
Mr. John H. Schulz, MDC
Mr. Thomas Bonnot, MU
Dr. Daniel Dey, U.S. Forest Service
Mr. Tony Mong, MU
Dr. Sherry Gao, MDC

Project Supervisor
Dr. Joshua Millspaugh

Funding
University of Missouri Center for Agroforestry
Missouri Department of Conservation

Cooperators
Missouri Department of Conservation
U.S. Forest Service
University of Missouri

Objectives
This project will determine how doves respond to various management practices (i.e., alternative food sources, mowing) in an agroforestry setting. Specifically, we will: (1) develop techniques for establishing and growing nut bearing and saw log trees in agroforestry plantings; (2) determine how agroforestry plantings affect mourning dove harvest rates.

Location
James A. Reed Memorial Wildlife Area, Lee’s Summit, MO

Expected Completion
September 2011

Status
In progress

Progress and Results
Mourning doves (Zenaida macroura) offer an abundant and economically valuable resource for landowners. With lease hunting (directly with hunters, or indirectly through MDC), landowners could derive annual economic benefits by providing favorable feeding areas within agroforestry plantings. Despite the benefits directly related to managed mourning dove hunting, no experiments have evaluated the efficacy of sunflower plantings to attract and concentrate mourning doves for harvest in an agroforestry setting. At the James A. Reed Memorial Wildlife Area (JARMWA) we are evaluating the best methods for establishing and growing nut bearing and saw log trees that are planted within different cover crops and spacing configurations. We have been attaching leg bands and radio transmitters to mourning doves to assess abundance and field use. We are implanting ~200 doves each year with radio-transmitters. We have recently concluded that dove harvest rates in newly established agroforestry fields (contains both dove crops and tree plantings) did not differ from rates in field managed solely for doves. We used banding data and harvest data across public hunting areas to assess the ability to obtain local and statewide estimates of dove recruitment. We have also used data from an adaptive management program on these areas to identify aspects of crop management as the important drivers (relative to hunt regulations and weather) in the numbers of hunts and doves harvested on the areas each year. We will continue to evaluate the impacts of dove harvest on survival.
## APPLICATION OF WILDLIFE HABITAT SUITABILITY AND VIABILITY MODELS TO EVALUATE EFFECTS OF FIRE AND ECOSYSTEM RESTORATION

### Investigators
- Mr. Thomas Bonnot, MU
- Dr. Frank Thompson, III, U.S Forest Service
- Dr. Joshua Millspaugh, MU

### Project Supervisor
- Dr. Joshua Millspaugh
- Dr. Frank Thompson, III

### Funding
- U.S. Forest Service

### Cooperators
- U.S. Forest Service
- University of Missouri

### Objectives
- Develop new or refine existing wildlife habitat suitability models and apply them to these management scenarios involving fire and ecosystem restoration.
- Develop spatially explicit population models for key wildlife species and link them to the above landscape simulation models.
- Validate key aspects of the above models with existing or newly collected data.

### Location
- Central Hardwoods Bird Conservation Region

### Expected Completion
- September 2011

### Status
- In progress

### Progress and Results
Sustaining wildlife populations in the face of global change and habitat fragmentation and loss requires conservation planning and actions at large scales. Landscape-based population models are potentially valuable tools to help design conservation strategies across large landscapes. By linking habitat suitability models or population viability models with landscape simulation models we are providing a powerful framework for evaluating the effects of ecosystem restoration, disturbance, and succession on wildlife populations. To date, we have successfully developed an approach to extend landscape-based population viability models to ecoregional scales by using ecological subsections. Structuring spatially-explicit habitat and demographic data in subsections allowed replication of population process such as dispersal, density dependence, and source-sink interactions that are important to understanding how regional populations respond to landscape processes such as habitat loss and fragmentation. Our models were within 2% of observed trends over the last 40 years and thus provide a potentially valuable tool to plan and evaluate management.
DEVELOPMENT OF A LONG-TERM MONITORING PLAN FOR NATIONAL PARKS IN THE NORTHERN GREAT PLAINS

Investigators
Dr. Robert Gitzen, MU
Dr. Joshua Millspaugh, MU
Kara Paintner, National Park Service

Project Supervisor
Dr. Joshua Millspaugh

Funding
National Park Service Inventory and Monitoring Program, Northern Great Plains Network (NGPN)

Cooperators
National Park Service NGPN

Objectives
Complete a “Vital Signs” Monitoring Plan outlining monitoring priorities, objectives, sampling designs, protocol-development timelines, and general data-management, reporting, and administrative procedure for the NGPN.

Guide the NGPN and NPS Partners in addressing quantitative issues related to development of sampling designs for monitoring vegetation, water quality, and other attributes.

Develop and publish an edited book with contributions from statistical experts on quantitative design and analysis in long-term monitoring efforts.

Implement additional ecological and adaptive-management investigations for NGPN parks.

Location
Rapid City, South Dakota

Expected Completion
April 2011

Status
In progress

Progress and Results
As one of 32 networks in the National Park Service (NPS) Inventory and Monitoring (I&M) Program, the Northern Great Plains Network (NGPN) is developing a long-term monitoring program for 13 NPS units in North and South Dakota, eastern Wyoming, and northern and western Nebraska. In this project, we have worked with the NGPN I&M staff and park managers to identify, prioritize and develop monitoring objectives for tracking the condition of selected natural-resource attributes and stressors. In collaboration with the NGPN, we successfully completed the NGPN Vital Signs Monitoring Plan, which is currently being implemented. In addition to general scientific guidance, we have provided quantitative guidance to the NGPN related to development of specific monitoring protocols, particularly related to the Network’s top priorities of monitoring vegetation and water quality in its parks. To obtain and disseminate recommendations for top monitoring experts worldwide on these issues, we are developing an edited volume, “Design and Analysis of Long-term Ecological Monitoring Studies”, which will be published by Cambridge University Press. Additional work with the NPGN has involved biological inventories and research related to forest management and ungulate population management.

Products Since 2008

Baltimore Ecosystem Study Bird Monitoring Project

Investigators
Dr. Charles Nilon, MU
Dr. Paige Warren, U. Massachusetts-Amherst
Mr. Chandler Denison, MU

Project Supervisor
Dr. Charles Nilon
Dr. Paige Warren

Funding
Cary Institute for Ecosystem Studies
National Science Foundation

Cooperators
Baltimore Ecosystem Study

Objectives
The BES Bird Monitoring Project is a breeding bird survey designed to find out what birds are found in the breeding season in Baltimore and where. Our monitoring efforts will show associations among block group socioeconomic variables, land cover, land use, and habitat features with breeding bird abundance, to provide information for land managers on possible consequences of land use changes on bird communities.

A distinguishing feature of the bird monitoring at BES LTER, relative to other urban bird work, is the capacity for long-term monitoring of features at multiple scales through links to other parts of the project. Different processes influence habitat for birds at different scales, e.g. ongoing household level human decision-making at lot scale vs. block or neighborhood scale abandonment/re-development. Our project seeks to understand how these processes impact bird occurrence, abundance, and composition differ at

Status
In progress

Progress and Results
We will continue annual monitoring of the breeding bird communities at 82 sites drawn from the 202 UFORE plots in Baltimore City and 50 sites drawn from the more intensive UFORE sampling in WS263. Co-location of bird monitoring with these plots will facilitate use of other BES data on local environmental features and household- and neighborhood-scale management by humans collected from the same sites. Previous BES research has identified at least 4 distinct urban bird communities in Baltimore, including two communities associated with distinct residential landscape types: mature trees and open-but-shrubby neighborhoods. The presence of each community type is significantly correlated with local factors such as urban tree canopy cover, management of decaying wood (e.g. dead tree branches), and horticultural decisions (e.g. amount of shrub versus lawn cover). In BES III, we will expand on this work to address whether neutral processes (extinction & colonization) are also contributing to the distribution of bird species among sites of the same community type. Through spatial analysis of long-term monitoring data, we will test whether community similarity declines with distance (regional factors dominate) versus whether community similarity increases with environmental similarity (local factors dominate). We hypothesize that for the urban bird community associated with mature tree cover, regional factors such as patch size and isolation dominate but that local factors also play a role, such as tree care practices that affect dead and decaying wood. By contrast, the urban bird community associated with shrub-dominated residential areas is expected to be more actively human-facilitated, e.g. effects of gardening, bird feeding, pet ownership. Thus, we hypothesize that for the open-but-shrubby community, environmental similarity rather than distance predicts community similarity. We will use HERCULES to identify patches of mature forest cover around bird sampling locations and street side transects to characterize dead and decaying wood. Questions on bird-related behaviors such as pet ownership, bird feeding, and gardening will be incorporated into the BES telephone survey. Sociodemographic predictors of actions that affect birds will be drawn from US Census and PRIZM datasets. Prior BES research shows that tree canopy cover is
correlated with median income, but that the presence of dead wood in live trees is not. By contrast, poverty status, race, and college education are predictors of abundance of selected bird species. This information is used to develop spatial models for bird species.

**Products Since 2008**


[http://www.urbanhabitats.org/v06n01/baltimore_full.html](http://www.urbanhabitats.org/v06n01/baltimore_full.html)

COMPARATIVE ECOLOGY OF CITIES: WHAT MAKES AN URBAN BIOTA “URBAN”?

Investigators
Dr. M. Cadenasso, UC Davis, USA
Dr. S. Cilliers, NW U., S. Africa
Dr. B. Clarkson, U. Waikato, New Zealand
Mr. M. Goddard, U. Leeds, UK
Dr. I. Kuhn, Helmholtz Centre, Germany
Dr. F. La Sorte, Yale U, USA
Dr. C. Lepzyk, U. Hawaii, USA
Dr. J. Marzluff, U. Washington, USA
Dr. R. McCaffrey, U. Arizona, USA
Dr. U. Mortberg, Royal Institute of Technology, Sweden
Dr. P. Pysek, Acad. Sci., Czech Rep.
Dr. P. Werner, Inst. Housing and Development, Germany
Dr. Nick Williams, U. Melbourne

Project Supervisor / Investigators
Dr. Myla Aronson, Hofstra U.
Dr. Madhu Katti, CA State U-Fresno
Dr. Charles Nilon, MU
Dr. Paige Warren, U. Mass.-Amherst

Funding
National Center for Ecological Analysis and Synthesis (NCEAS)

Objectives
Compile and synthesize large, diverse datasets of the flora and avifauna of cities globally.

Compare the ecological responses of birds and plants in urban habitats.

Understand the social constraints and effects of biodiversity in cities.

Develop recommendations for monitoring biodiversity in urban areas.

Location
Worldwide

Expected Completion
December 2011

Status
In progress

Progress and Results
The rapid urbanization of the world has profound effects on global biodiversity and urbanization has been counted among the processes contributing to the homogenization of the world’s biota. However, there are few generalities of the patterns and drivers of urban biota and even fewer global comparative studies. A comparative approach of urban biota is needed to produce comparable methodologies to understand, preserve, and monitor biodiversity in cities. We propose an NCEAS working group involving researchers from cities worldwide to develop synthesis of urban ecology. We ask the overarching question: “What makes an urban biota ‘urban’?” and with that, “Are the patterns of urban biota and the processes that shape them the same across the world’s cities?” We have identified several factors that may serve as filters determining species distributions. We propose a hierarchical series of filters: 1) regional scale biogeographic context, 2) metropolitan scale urban intensification, and 3) local scale socioeconomic/cultural factors. We will use plants and birds as independent datasets for addressing these broad questions. There is a newly matured wealth of existing urban bird and plant datasets for cities of different sizes, ages, and cultural and development patterns such as Baltimore, Berlin, Jalisco, New York City, Phoenix, Potchefstroom, and Stockholm, among others. We propose to bring datasets together, using commonly available data (e.g. land cover layers, national censuses, life history databases) to synthesize the urban biota. Outcomes from these proposed extensive comparative analyses will not only help to push forward the frontiers of transdisciplinarity in ecology, but will also provide useful information for planners and managers.

We have identified participants for this working group who are leaders in urban biodiversity research. The resources of NCEAS will allow us to bring these experts together to analyze and synthesize diverse datasets at multiple spatial and temporal scales of the biota of cities worldwide. These analyses will lead to an urban global conceptual framework explaining the patterns and processes driving urban biota and methodology for monitoring and preservation of biodiversity in urban regions.
**Investigators**  
Dr. Charles Nilon, MU  
Mr. Mike Burfield, MU

**Project Supervisor**  
Dr. Charles Nilon  
Ms. Lana Henry

**Funding**  
National Park Service / Great Rivers Cooperative Ecosystem Study Unit

**Cooperators**  
George Washington Carver National Monument

**Objectives**  
Research data from this project will be used along with information gathered from the park/partners to form a summary of recommendations to meet integrated management objectives.

This project will integrate interpretive and cultural/natural resource management objectives, and bridge the gap between natural resource science and implementation of practical management practices.

**Location**  
Diamond, Missouri

**Expected Completion**  
May 2011

**Status**  
In progress

**Progress and Results**  
Managers of George Washington Carver National Monument (GWCA) make a number of land management decisions to meet stewardship goals. This project utilizes the products and data provided under Year One “Assessing Prairie Management for GWCA: Control of Invasive Species and Indicator Species on Restored Prairie Units” and builds upon the Vegetation Management Alternatives for GWCA prepared by the Heartland Network Inventory and Monitoring Program (HTLN) in 2009. The project calls for development of an integrated approach for management of the park’s prairie units and woodlands. Prairie restoration efforts came into focus in 1982 at the park, and have received different planning efforts through the years. Efforts have included rotational haying, prescription fire, and chemicals to help control invasive species.

A number of management alternatives for woodlands and prairie units have been provided by the Heartland Network Inventory and Monitoring Program (HTLN), as well as the Cooperator. An analysis of prairie restoration management dating back to 1982, and Prairie Management Recommendations for GWCA were prepared by the Cooperator in 2009. Vegetation Management Alternatives for GWCA were prepared by HTLN in 2009. This project merges these products with an analysis of Habitat Suitability Index data collected from 2009 through 2010 to form Integrated Vegetation Management Recommendations.
PLAYGROUNDS WITHOUT BORDERS: EVALUATING PLAYGROUND ENVIRONMENTAL INTERVENTIONS AMONG LOW-INCOME ELEMENTARY SCHOOLCHILDREN

Investigators
Dr. Stephen Sayers, MU
Dr. Timothy Matisziw, MU
Dr. Sonja Wilhelm Stanis, MU
Dr. Charles Nilon, MU
Dr. Shannon White, MU
Dr. Greg Petroski, MU

Project Supervisor
Dr. Joseph LeMaster, MU

Funding
Robert Wood Johnson Foundation / Active Living Research

Cooperators
Columbia Public Schools

Objectives
Determine the effect of a playground environmental intervention on: a) School recess and lunch-time MVPA% (percent of available time spent engaged in MVPA), b) Total daily MVPA (minutes of available time spent in MVPA in and outside of school), c) Open space MVPA (minutes of MVPA that take place in outdoor open spaces). d) Aggregate proportion of schoolchildren active on playgrounds.

Use cognitive maps and photo-elicitation interviews pre- and post-intervention to assess why children use their school and neighborhood environments.

Use focus group discussions post-intervention to elicit parents’ and children’s perceptions regarding a) intervention planning and construction processes and b) how their school and neighborhood context impacts children’s response to the intervention

Location
Columbia, MO

Expected Completion
January 2013

Status
In progress

Progress and Results
Playground environmental interventions provide a prime opportunity to promote children’s activity as they can reach large populations of children from all racial, ethnic and socioeconomic groups, and provide a safe environment for active play. These interventions may increase the proportion of available playtime at school in which children participate in moderate to vigorous physical activity (MVPA). Some issues remain unclear: how such interventions can be successfully tailored to benefit low-income and ethnic minority U.S. children (since most were conducted in Europe and not among minority students); whether increases in PA at school are matched by increases outside school, both temporally and spatially; whether benefits last beyond the immediate post-intervention period; and to what extent children’s social and physical neighborhood environment influences their response to the intervention. We will investigate these issues by evaluating a school-based, quasi-experiment environmental intervention that seeks to increase PA by modifying school playground environments in Columbia, MO. Our overall goal is to assess when, where and to what extent school playground environmental interventions increase children’s PA, and to use these results to inform local advocacy efforts to prevent obesity in low-income and minority children. We will evaluate 4 schools, 2 of which will receive the environmental intervention early (Fall 2011) and 2 late (Spring 2012). We will measure PA at baseline (Spring 2011), and every 6 months thereafter during the study.
MULTISCALE HABITAT SUITABILITY MODELS FOR PRIORITY LANDBIRDS IN THE CENTRAL HARDWOODS AND WEST GULF COASTAL PLAN BIRD CONSERVATION REGIONS

Investigators
D. Todd Jones-Farrand, MU
John M. Tirpak, MU
Frank R. Thompson, USFS
Daniel J. Twedt, USGS
Jane A. Fitzgerald, ABC
William B. Uihlein, USFWS

Project Supervisor
Frank R. Thompson

Funding
USGS / USFWS

Cooperators
Central Hardwoods Bird Joint Venture
West Gulf Coastal Plain/Ouachitas Bird Joint Venture
USFS Northern Research Station

Objectives
To develop and apply ecoregional scale habitat models for priority birds conservation planning.

Location
Central Hardwoods and West Gulf Coastal Plain/Ouachitas Bird Conservation Regions

Completion
2009

Status
Completed

Progress and Results
Ecoregional conservation planning for priority landbirds requires methods to link populations to habitat conditions at multiple scales. We developed habitat suitability models for 40 priority species for application in the Central Hardwoods and West Gulf Coastal Plain/Ouachitas Bird Conservation Regions. The models use variables from nationally consistent data sets including ecological subsections, national landcover, national hydrography, soils, and USFS Forest Inventory and Analysis data. We verified and validated models using data from the North American Breeding Bird Survey. These models are being used by bird joint ventures as conservation design tools and to assess changes in habitat over time.

Products since 2008


POTENTIAL FOR SPECIES TRANSLOCATION IN RESPONSE TO CLIMATE CHANGE AND HABITAT RESTORATION: BROWN-HEADED NUTHATCH IN THE MISSOURI OZARKS

Investigators
Mr. Richard Stanton Jr., MU
Dr. Dylan Kesler, MU
Dr. Frank Thompson III, USDA Forest Service

Project Supervisor
Dr. Dylan Kesler, MU
Dr. Frank Thompson III, USDA Forest Service

Funding
USDA Forest Service

Cooperators
USDA Forest Service, Northern Research Station

Objectives
Study Brown-headed Nuthatches in northern portions of the range to develop a resource utilization function

User results to identify potential translocation sites in the Missouri Ozarks

Identify landscape factors associated with the dispersal of birds into unoccupied habitat.

Locations
Missouri Ozarks
Arkansas Ouachitas and Ozarks

Expected Completion
May 2013

Status
In progress

Progress and Results
Climate change is predicted to result in the northward advance of pine woodlands from the American southeast. Southern pine systems are home to a fire-adapted endemic avifauna that include the Red-cockaded Woodpecker (Picoides borealis), Bachman’s Sparrow (Aimophila aestivalis), and the Brown-headed Nuthatch (Sitta pusilla). The Brown-headed Nuthatch is a cooperatively breeding resident bird that has been little studied in the shortleaf pine habitats in the northern portions of its range, including the Ouachita and Ozark mountains of Arkansas. Extensive pine woodland restoration efforts in the Missouri Ozarks have created potentially suitable habitat for the nuthatch. This project aims to develop tools that facilitate the northward movement of the birds through conservation colonizations. We will study the Brown-headed Nuthatch in Arkansas with a combination of surveys and mark and resight techniques. Data will be used to develop a resource-selection function and a multiscale model that will subsequently be used to evaluate potential reintroduction sites in Missouri. We hope to identify sites suitable for translocating Brown-headed Nuthatches by accounting for both local habitat and landscape factors.
BIRD COMMUNITIES ACROSS A SAVANNA-WOODLAND GRADIENT

Investigators
Ms. Sarah Wolken, MU
Ms. Jennifer Reidy, MU
Dr. Frank Thompson III, USDA Forest Service
Dr. Dylan Kesler, MU

Project Supervisor
Dr. Frank Thompson III, USDA Forest Service, Northern Research Station

Funding
USDA Forest Service, Northern Research Station

Objectives
Determine how relative or absolute abundance of winter resident birds relates to fire history and habitat structure across savannas, woodlands, and closed canopy forests.

Determine relationships bird abundance and breeding demography (i.e. breeding density, nest success, clutch size, hatching success, fledging rate, and parasitism rate) of focal bird species to management and structure across gradient consisting of savanna, woodland, and closed canopy forest.

Location
Ozark Highlands of Missouri

Expected Completion
May 2011

Status
In progress

Progress and Results
Savanna and woodland habitats historically characterized large proportions of the American Midwest, although they declined throughout the 20th century. Federal and non-government organizations have implemented large-scale restoration programs in Missouri’s Ozark Highlands in an attempt to recover the habitat. Our objective is to study changes in bird communities across a gradient ranging from savannas and woodlands managed by mechanical thinning and fire, to unmanaged closed canopy forests. We are determining breeding and winter bird abundances and nesting success of focal species and relating it to habitat characteristics. Limited information exists for species across this gradient, especially for the winter. Months. Our results will provide land managers with a broad perspective of the effects of restoration on winter and breeding bird communities. To gain better understanding of how species demography varies across this habitat gradient, we are also studying in greater detail the breeding demography of the Eastern Wood-Pewee (Contopus virens). This bird uses a gradient of habitats, from savanna to closed canopy forest, which enables us to evaluate a range of habitat management intensities. Results will aid managers in gauging effects of habitat gradients and disturbances using fire. Two of four field seasons are now complete, and preliminary data analysis will be completed in 2011.
RELATIONSHIP BETWEEN FOREST MANAGEMENT AND SUMMERING INDIANA BATS

Investigators
Ms. Kathryn Womack, MU
Ms. Sarah Pennington, MU
Dr. Frank Thompson III, USFS
Dr. Sybill Amelon, USFS
Dr. Matthew Gompper, MU
Anthony Elliott, MDC

Project Supervisor
Dr. Frank Thompson III, MU
Dr. Sybill Amelon, MU

Funding
U.S. Forest Service
Missouri Department of Conservation

Cooperators
U.S. Forest Service
University of Missouri
Missouri Department of Conservation

Objectives:
What is the probability of patch occupancy and probability of detection for Indiana bats on CHMCA, FVLCA, and Deer Ridge CA (DRCA)?

What environmental factors, vegetative conditions and management factors are associated with increased occupancy?

What are the characteristics of trees used by maternity colonies of Indiana bat?

How are foraging resources selected by female Indiana bats?

Location
Midwestern United States

Expected Completion
May 2013

Status
In progress

Progress and Results
In temperate latitudes, insectivorous bats play key functional roles as predators of insects in terrestrial ecosystems. Declining bat populations are a conservation concern for land-management agencies throughout North America (N. A.). The Indiana bat hibernates in caves and mines during winter and moves to wooded areas in summer to raise young. Loss or modification of roosting and foraging habitat, or their juxtaposition, may affect critical life history parameters, such as birth rate or adult survivorship. Modification from development or management activities has been suggested as a contributing factor to the decline of this species. Until recently, studies of bats rarely included foraging resource selection or effect of landscape modifications. By quantifying resource use over time and space, resource selection models provide insight into how a species meets its life history needs.

Silvicultural and fuel reduction practices have recently incorporated selective harvesting, girdling, and other strategies to create forest patches with different tree densities and potential roosting sites. Bats have extensive mobility allowing them to forage in landscapes far from the maternity roosts. Little is known of the distances traveled or the resources selected for foraging during the maternity period.

Preliminary results from this study indicate pregnant and lactating bats use similar sized resource areas (622-638 ± 240-260 ha); however, there is significant inter-individual variation among lactating bats.

Timing, spatial arrangement, and type of forest management are all important considerations in managing for Indiana bats. The information from this study will be used to guide land managers in determining which management practices are most suitable for Indiana bats.
PEER REVIEWED AND TECHNICAL PUBLICATIONS
PUBLICATIONS BY UNIT SCIENTISTS AND STUDENTS

*Denotes graduate student
** Denotes undergraduate student

Books and Book Chapters


Peer Reviewed Journal Articles


**White, K., *J. Gerken, C. Paukert, and *A. Makinster. 2010. Fish community structure in natural and engineered habitats in the Kansas River. River Research and Applications 26:797-805.**

**Technical and Popular Publications**


Books and Book Chapters


*McGowan, C. P., D. C. Kesler, and M. R. Ryan. In Press. Endangered species management teaching module, comprised of five parts, including: a) lecture slides; b) lecture notes; c) problem case; d) hands-on lab exercise; and e) a synthesis overview. American Museum of Natural History Center for Biodiversity and Conservation.


cover variables for an urban bird monitoring project. Urban Habitats 61
http://www.urbanhabitats.org/v06n01/baltimore_full.html


Technical and Popular Publications


efficient alternative for data collection. USDA Forest Service Research Note RMRS-RN- 38. 3pp.


ORAL AND POSTER PRESENTATIONS
PRESENTATIONS BY UNIT SCIENTISTS AND STUDENTS

*Denotes graduate student
** Denotes undergraduate student


DiStefano, R. J. and *J. T. Westhoff. 2010. Estimating rate of range expansion by an invasive crayfish and subsequent range contraction for two imperiled endemic crayfishes in Missouri (USA) Ozark streams. 18th Symposium of the International Association of Astacology, Columbia, MO.


*Montgomery, M.D and D.L. Galat. 2010. Restoring river-floodplain connectivity for fish spawning and nursery in the lower Missouri River: use of a constructed fish passage facility. 3rd Annual Midwest Student Fisheries Colloquium, Manhattan, KS.


Paukert, C. P. 2009. Alteration of stream and rivers its effects on fishes: can we reverse the trend? Department of Natural Resources Ecology and Management, Iowa State University, Ames, IA. Invited presentation.

Pease, A. Patterns in functional structure of diversity of stream fish assemblages related to environmental factors at multiple scales. Charles W. Schwartz Fisheries and Wildlife Seminar Series, University of Missouri, Columbia, MO.


**PRESENTATIONS BY FISH & WILDLIFE FACULTY AND STUDENTS**


Hicks, C. and R.A. Pierce II. 2008. Cage Culture 101: adding value to your pond through the production of food fish. Missouri Aquaculture Workshop, MU Bradford Research and Extension Center, Columbia, MO.

Cynomys. Utah Chapter of the Wildlife Society annual meeting, Moab, UT.


Kesler, D. C. 2008. Movement analysis techniques for studying migration and home ranging behavior in birds. Hatfield Marine Sciences Center of Oregon State University, Corvallis, OR.

Kesler, D. C. 2008. Using VHF radio telemetry to study movements in small birds. Hatfield Marine Sciences Center of Oregon State University, Corvallis, OR.

Kesler, D. C. 2009. Conservation and management of Wake Island seabirds. Presentation given on Wake Island to describe our ongoing research and describe opportunities for additional work. Wake Islands.


Kesler, D. C., and J. R. Walters. 2010. Territory-scale movements, habitat selection, and a test of a red-cockaded woodpecker habitat suitability model. 128th stated meeting of the American Ornithologists’ Union. San Diego, CA.

Kesler, D. C., and J. R. Walters. 2010. Territory-scale movements, habitat selection, and a test of a red-
cockaded woodpecker habitat suitability model. 128th stated meeting of the American Ornithologists’ Union. San Diego, CA.


Millspaugh, J. J. 2009. Demographics of historical bison populations in the Northern Great Plains. Department of Natural Resources Ecology and Management, Iowa State University, Ames, IA.


Pierce, R. A. II. 2009. Controlling nuisance voles in commercial vegetable production. Missouri Vegetable Growers Association Workshop, California, MO.


Pierce, R. A. II. 2009. Integrating bobwhite quail management with agriculture production FFA field day – MU Bradford Research and Extension Center, Columbia, MO.

Pierce, R. A. II. 2009. Integration of wildlife management projects with agricultural objectives at the MU Bradford Research and Extension Center. MU Bradford Research and Extension Center Advisory Committee Workshop, Columbia, MO.


Pierce, R. A. II. Controlling Nuisance Wildlife from Around the Farm and Home. Missouri Livestock Symposium, Kirksville, MO.


Pierce, R.A. II, M. Seek and M. Morgan. 2008. The Missouri Master Wildlifer Program: a successful educational program that provides science-based information on wildlife management to private landowners in Missouri. Abstract and Poster Presentation, Missouri Natural Resources Conference, Osage Beach, MO.


Pierce, R.A. II. 2008. Integrating bobwhite quail management practices on farms in Missouri. Missouri Livestock Symposium, Kirksville, MO.


Naturalist Program, Lake of the Ozarks Chapter, Camdenton, MO.


Pierce, R.A. II. 2010. Starling nest ecology and controlling nuisance wildlife on the farm. MU Forage Systems Research Center Field Day, Brookfield, MO.


THESIS AND DISSERTATIONS

STUDENTS ADVISED BY UNT SCIENTISTS


STUDENTS ADVISED BY FISH & WILDLIFE FACULTY COOPERATORS


Oliifiers, N. 2010. Population and disease ecology of the brown-nosed coati (Nasua nasua) and the crab


COMMITTEES AND OTHER PROFESSIONAL SERVICE

2008 to Present

UNIT SCIENTISTS AND STUDENTS

David Galat –
- http://www.adaptivemanagement.net/whatis.php
- Faculty Representative, Charles Schwartz Fisheries & Wildlife Graduate Seminar
- Associate Editor, River Research and Applications, 2003 - Present

Craig Paukert –
- Secretary/Treasurer, Education Section of the AFS, 2009 – Present
- Member, AFS Board of Professional Certification, 2007 – 2010
- Member, Science Committee, National Fish Habitat Initiative, 2005-present
- Associate Editor, North American Journal of Fisheries Management, 2003 – Present

Shannon Brewer, Ph.D. Student Advised by Rabeni –
- Member and Chair, Frances Allen Scholarship Committee, American Fisheries Society Equal Opportunity Section. 2006 – Present

Jeff Fore, Ph.D. Student Advised by Galat –
- Charles W. Schwartz Seminar Series – University of Missouri Wildlife and Fisheries Graduate Student Organization Coordinating Committee Member. 2009 – 2010
- American Fisheries Society Continuing Education Committee Member. 2009 – Present

Danny Garrett, Ph.D. Student Advised by Rabeni –
- Fish and Wildlife Graduate Student Seminar Organizing Committee. 2009.

Joshua Lallaman, Ph.D. Student Advised by Galat –

Andy Turner, M.S. Student Advised by Rabeni –
- Fish and Wildlife Graduate Student Seminar Organizing Committee, 2008.
FISH & WILDLIFE FACULTY AND STUDENTS

Matthew Gompper –
- Editor, *Animal Conservation*
- Associate Editor, *Journal of Wildlife Management*, 2009 – Present
- Head of Student Poster Judging, 2008 Annual Meeting of the Society for Conservation Biology. Oversaw team of six judges and awarded prizes at meeting banquet.
- Co-coordinator, Mizzou Tigers for Tigers
- Curator of Mammals and Birds, University of Missouri Museum of Vertebrate Zoology.
- Missouri Natural Heritage Mammal Working Group.
- Panel Member, MU Grantsmanship Training Session – 2008, 2010
- McNair’s Scholar Advisor, Dept. of Fisheries & Wildlife Sciences.
- Chair, School of Natural Resources Promotion and Tenure Committee.
- Departmental Representative, Captive Wild Animal Management minor.

Rob Hayward –
- Elected Chair, Research Technical Committee, North Central Regional Aquaculture Center, Michigan State University; Member, NCRAC Board of Directors. 2008 – Present.

Jack Jones –
- Editorial Board, Aquatic Ecosystem Health and Management, 2008-Present
- Member, Executive Board (elected), International Society of Limnology, 2004-2010
- Editor, (elected), International Journal of Theoretical and Applied Limnology, 2004-2010
- Member, Board of Directors, North Central Regional Aquaculture Center, 2000-Present
- Associate Editor, Journal of Lake and Reservoir Management, 1991-Present
- Field Reviewer, Ecology Program, National Science Foundation, Occasional Panel Member, 1978-Present

Joshua J. Millspaugh –
- Director of Graduate Studies, Department of Fisheries and Wildlife Sciences, 2005 – Present.
- Chair, School of Natural Resources Promotion and Tenure Committee, 2010.
- Director, Baskett Wildlife Research Area, 1999 – 2010.
- Associate Editor for the book Neotropical Cervidology, 2008.
Robert Pierce –
- MU Bradford Research and Extension Center Advisory Committee.
- MU Wurdack Farm Advisory Committee.
- Missouri Aquaculture Coordinating Council.
- Advisor: Novus International Ecological Sustainability Team.
- Board of Directors: Alliance of Natural Resources Outreach and Service Programs.
- USDA NRCS State Technical Committee.
- Missouri Grasslands Coalition.
- Missouri Bobwhite Quail and Grassland Bird Technical Committee.
- Board of Directors: Pinnacles Youth Park.
- Missouri Association of Extension Professionals: Sea Grant/Aquaculture-Natural Resources Committee Chair.
- USDA Southern Regional Aquaculture Center Publication Review Committee.
- National Extension Wildlife Damage Team – CoP.
- State 4-H Wildlife Habitat Evaluation Program Committee.
- Reviewer and co-editor: Covey Headquarters Quarterly Newsletter - cooperatively developed by the Missouri Department of Conservation, USDA NRCS and MU Extension.
- Missouri Master Naturalist Program – a partnership between MU Extension and Missouri Department of Conservation (State Co-Director: MU Extension).

Joanna Whittier –
- President-Elect, Fisheries Information and Technology Section of the American Fisheries Society, 2009 – Present
- Webpage Editor, Arizona/New Mexico Chapter of the American Fisheries Society, 2008 – Present

Catherine Bodinof, M.S. Student Advised by Millspaugh –
- University of Missouri Fisheries and Wildlife Graduate Student Representative for selection of new faculty, 2009 – 2010.

David Jachowski, Ph.D. Student Advised by Millspaugh –
- Served as area science advisor, media liaison, and boat field operations planner for coordinated multi-agency rapid response to Deepwater Horizon oil spill in Gulf of Mexico, Dennis Pass, Louisiana, 2010.
- Served as field supervisor for multi-agency emergency response to sylvatic plague outbreak at the Conata Basin, South Dakota, 2008.

Christopher Rota, Ph.D. Student Advised by Millspaugh, Kesler –
- President, University of Missouri Wildlife and Fisheries Graduate Student Organization, August 2010 – present
AWARDS AND RECOGNITION

2008 to Present

UNIT STAFF AND STUDENTS

David Galat –
- USGS STAR Award for Superior Performance Achievement, 2009.
- University of Missouri Gold Chalk Award for Graduate Student Mentoring, MU Graduate Professional Council, 2010.

Craig Paukert –
- Best Professional Presentation; Kansas Chapter of the AFS, 2008, 2010
- Invited presentation, Iowa State University, 2009

Charles F. Rabeni –
- Dr. Nancy Foster Habitat Conservation Award from NOAA. Presented for “for his extraordinary commitment of more than 30 years to stewardship, research and outreach concerning our nation’s aquatic habitats.” 2010.

Joshua Lallaman, Ph.D. Student Advised by Galat –
- Janice Lee Fenske Memorial Award finalist, 2009.
- Third Place Student Presentation, Midwest Fish and Wildlife Conference, 2008.

Meagan Montgomery, M.S. Student Advised by Galat –
- Best Student Poster Award, Missouri Natural Resources Conference, 2008.

FISH & WILDLIFE FACULTY STAFF AND STUDENTS

Matthew Gompper –
- Invited presentation, Division of Biology, Kansas State University, 2009.
- Invited presentation, Department of Zoology, Southern Illinois University, 2008.
- Invited presentation, Department of Biological Sciences, Virginia Tech University, 2008.
- Invited presentation, Biology Department, Truman State University, 2008.

Jack Jones –
- MU Alumni Association Distinguished Faculty Award, 2009.
- College of Agriculture, Food and Natural Resources Mumford Outstanding Faculty Award, 2009.
- Selected as a Fulbright Senior Specialist – Short course in Nepal, 2008.
Joshua J. Millspaugh –
- Missouri Governor’s Award for Excellence in Teaching, 2009.
- Best Paper at TWS Conference in Monterey, CA (lead author Bob Montgomery, Ph.D. student, Michigan State University), 2009.
- U.S. Department of Agriculture National Teacher of the Year (Excellence in College and University Teaching Award in the Agricultural Sciences, National level), 2008.

Frank R Thompson III –

Catherine Bodinof, M.S. Student Advised by Millspaugh –
- Missouri Chapter of the Wildlife Society Graduate Fellowship, 2010.
- Missouri Chapter of the Wildlife Society, James D. Chambers Memorial Scholarship, 2009.
- American Museum of Natural History Study Collection Grant, 2008.

David Jachowski, Ph.D. Student Advised by Millspaugh –
- Natural Areas Association Student Scholarship, 2010.
- University of Missouri Graduate Student Association Travel Award, 2010.
- American Society of Mammalogists Student Travel Award, 2010.
- University of Missouri Wildlife and Fisheries Graduate Student Organization Travel Award, 2010.
- University of Missouri, Graduate Professional Council Travel Scholarship, 2008.