

MISSOURI COOPERATIVE FISH & WILDLIFE RESEARCH UNIT REPORT

April 2005 – December 2007



Cooperating Agencies:

**U. S. Geological Survey
U. S. Fish and Wildlife Service
Missouri Department of Conservation
University of Missouri
Wildlife Management Institute**

MISSOURI COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

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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.

SANDY CLARK

On May 1, 2006 Sandy Clark retired after 46 years of service to the University of Missouri, the Fisheries and Wildlife Sciences Department, and the Cooperative Unit. It is difficult to convey what she has meant to the success of our operation. Such levels of kindness, dedication, selflessness, and loyalty are unlikely to be matched anytime soon.

In 1965, Cooperative Wildlife Unit Leader Tom Baskett hired Sandy away from the Ag Dean's office to become Special Editorial Assistant for the Journal of Wildlife Management, of which he was editor. In 1968, Tom moved to an assignment as Chief of Wildlife Research for the US Fish and Wildlife Service in Washington D.C. Sandy remained at Stephens Hall as secretary to the fish and wildlife faculty including the Wildlife Research Unit.

In the 1970's the Department was realigned, and Sandy concentrated on secretarial duties of the Fishery and the Wildlife Units. During this time Sandy served on MU's Staff Advisory Council (1978-1982) and was selected as a MU Outstanding Staff member in 1984.

The Fishery and Wildlife Units were combined in 1985 and Sandy became the Unit's Administrative Assistant. She kept up her editorial duties and critically examined every unit publication, and many non unit ones, for grammar, style, and proper setup rules for the particular journal. In 1990 Sandy won the US Fish and Wildlife Service Citizen Award for 25 years of service to the coop unit, and in 1993 was promoted to Administrative Associate.

The Cooperative Units program moved from the US Fish and Wildlife Service in 1994 to the newly created National Biological Survey (soon renamed the National Biological Service), then in 1996 transferred to the US Geological Survey. Such shifting of agencies put a tremendous strain on our administrative operations, but Sandy performed with great skill, diligence and almost always with a smile. As recognition, the Missouri Unit won the outstanding Management Award for the 50 units. Sandy continued her exemplary service through the late 90's until 2006, where in addition to her regular duties she became more involved as the go-to person for grant preparation for Unit and non-unit faculty.

On April 13, 2006, Sandy celebrated her career with co-workers, alumni, students and friends at a gala reception, and was presented with a retirement present of a two week trip to Hawaii (accompanied by her daughter Leslie Sue and escorted for one week by Leigh Fredrickson). From all accounts the trip was a huge success.

RONALD D. DROBNEY

ASSISTANT UNIT LEADER – WILDLIFE

FROM 1986 TO 2004

We all congratulate Ron upon his retirement from the Coop Unit program. In his 18 years with the Missouri Coop Unit, Ron was a productive and influential researcher who contributed to the conservation of wildlife habitat and a variety of flying creatures, ranging from bats to Giant Canada Geese. But Ron truly shined when it came to his dedication to students and educational programs. As an educator, Ron taught classes at three major Universities and served as major professor of 36 graduate students. Ron's students are known for their reputation of publishing in their research, participating in professional groups, and pursuing careers that matter to wildlife. At the University of Missouri, Ron helped lead the development of an interdisciplinary program of spatial analysis, served as member and President of the Faculty Senate, and was Director of Graduate Studies for the Fisheries and Wildlife Department for 13 years. Ron's commitment to the students and educational programs was exemplary within the Unit program at a national scale, and his role as "poster-professor for the advancement of education" will be sorely missed.

THE COOP UNIT

The Cooperative Research Units program is comprised of 39 Units in 37 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 are presently being 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.

**MISSOURI COOPERATIVE FISH & WILDLIFE
RESEARCH UNIT REPORT
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RESEARCH PROJECTS

LEIGH H. FREDERICKSON

NESTING ECOLOGY OF LEAST BITTERNs AT MINGO NATIONAL WILDLIFE REFUGE

Karen Arnold (Research Technician)

FWS Region 3, Gaylord

Complete

Least Bitterns (*Ixobrychus exilis*) are secretive birds that have been federally listed as a Species of Special Concern by the FWS. Currently, most of the information available on this species is limited to site specific studies conducted during the breeding season. As a result, information is lacking that quantifies variation in least bittern breeding ecology across geographically different sites. The objective of this study is to quantify variation in nesting ecology of least bitterns across broad geographic areas where geomorphic, climatic, and hydrologic conditions differ. Least bitterns have been monitored during the breeding season at Mingo NWR in southeast Missouri since 1995. Information gathered from nests included the following: nest success, egg and clutch measurements, hatchling developmental rates, and habitat measurements. The primary results from the projects resulted from comparisons of Least Bittern Nesting Ecology across a large scale from Southern Missouri to Northern Minnesota and addressed the annual variation in bittern response to habitat conditions at three refuges (Mingo, Squaw Creek, and Agassiz). The timing, number of nests, and success of nests were closely linked with habitat conditions at each site and varied greatly among years. Nest densities were much greater at Squaw Creek and Mingo where the area of suitable habitat was minimal compared to Agassiz where thousands of acres of suitable nesting habitat was available. Based on nesting chronology and clutch size, Least Bitterns appear to have somewhat different nesting strategies in Missouri vs Minnesota.

Two theses resulted from the effort, one by Frank Nelson in Missouri and one at South Dakota by Arnold. The primary results from the projects resulted from comparisons of Least Bittern Nesting Ecology across a large scale from Southern Missouri to Northern Minnesota and addressed the annual variation in bittern response to habitat conditions at three refuges (Mingo, Squaw Creek, and Agassiz). The timing, number of nests, and success of nests were closely linked with habitat conditions at each site and varied greatly among years. Nest densities were much greater at Squaw Creek and Mingo where the area of suitable habitat was minimal compared to Agassiz where thousands of acres of suitable habitat was available. Based on nesting chronology and clutch size Least Bitterns appear to have somewhat different nesting strategies in Missouri vs Minnesota.

EFFECTS OF LAND MANAGEMENT PRACTICES ON THE SEASONAL PATTERNS OF WATERBIRD HABITAT USE WITHIN THE SAN LUIS VALLEY OF COLORADO

Michael D'Errico (MS)

RWO # 61 - FWS Region 6

Complete

Within the San Luis Valley of Colorado, anthropogenic activities have resulted in modification of the historic hydrology and vegetation communities. Patterns of land-use have resulted in a landscape dominated by agriculture and rangeland. Federal, state, and private agencies protect a significant amount of wetland habitat, but privately owned lands are no less important in providing resources to residential and migratory waterbirds. Research was conducted on the Alamosa and Monte Vista NWRs and within adjacent privately owned land. Special emphasis was placed on land management practices involving hydrology, grazing, and hay production. Data were collected on 32, 2-ha temporary and seasonal wetlands equally distributed among public and private management. Wetland characteristics, such as vegetation structure, hydrology, and the timing, type, and extent of waterbird use throughout spring, summer, and early fall, were recorded. The project identified the high degree of variability in seasonal and temporary wetland habitats in a high montane valley on public and private lands with different land use. The duration of flooding was highly variable within and among seasons and years. The hydrologic condition was the driving factor for the production and availability of plant and invertebrate food resources and influenced the extent, timing, and duration of avian use. These findings were instrumental in changing the thinking about wetland management strategies in the San Luis Valley where water resources are a scarce commodity and historic management dogma promoted the capture and stabilization of water on managed sites.

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TRANSITIONAL WETLAND HABITATS IN SOUTHERN FORESTED ECOSYSTEMS: DYNAMICS AND USE BY WILDLIFE IN THE UPPER MAV

Belinda Ederington (MS)

EPA, Tennessee Wildlife Resources Agency, FWS, Wildlife Management Institute, and a private landowner

Complete

Although transitional wetland habitat is widespread within the MAV, there is limited knowledge about wildlife use of this system. Preliminary observations indicate that bird species richness and diversity are low. Observations of transitional wetlands use by local and migratory wildlife

populations will provide baseline information for landowners and managers to consider when designing restoration and management projects. Transitional wetland habitats are defined as former forested wetlands, which have converted to emergent wetlands because of anthropogenic effects, beaver activity or a combination. The main anthropogenic processes which impact wetlands in western Tennessee are channelization and land use changes, which have altered geomorphic and hydrologic processes in the region. Channelization implemented to minimize flood impacts and to claim the floodplain primarily for agriculture resulted in isolation of the floodplain from the channel. In addition, land clearing in upland sites, where unstable loess soils are common, resulted in high soil loss rates. Remaining bottomland forests were severely impacted by siltation and development of an extended hydroperiod. The project identified the insidious effects of anthropomorphic perturbations to floodplain systems on rivers of moderate size in the loess area of West Tennessee. The pattern of sedimentation and its effects on the function and value of floodplain wetlands indicated that the historic distribution and abundance of floodplain fauna was changed. The historic structure and composition of flora changed dramatically and a new composition and structure of flora were driven by changes in the sedimentation throughout the floodplain that was studied. Biodiversity dropped precipitously on all study sites because of these changes in fauna and flora. The findings have important implications for the implementation of restoration activities in many southern river systems.

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SHOREBIRD DISTRIBUTION, TIMING, AND USE WITHIN AND SURROUNDING SWAN LAKE NWR

Christina Lienard (Research Technician)

RWO # 80 – USGS/FWS Initiative, Science Support Partnership Program

Complete

Study objectives included 1) determining shorebird migration chronology (arrival, peak, termination) throughout spring and fall at Swan Lake NWR and on surrounding private lands; 2) determining shorebird density and species composition across 3 wetland types (temporarily, seasonally, and semi-permanently flooded) reflecting various hydro-period characteristics within and among migration seasons, years, and management treatments; 3) determining wetland dynamics across wetland types within and among seasons and years. A total of 34 sites were chosen to quantify shorebird use, 18 within the refuge boundary, and 16 on lands surrounding the refuge. Shorebird use was recorded at each site from April until mid-May, and from mid-July until October. In addition to recording bird use, the habitat at each site was mapped out during

each visit. Vegetation density and height and water depths were also recorded weekly along transects within all on-refuge sites. The project documented the high variability of the value of refuge and off-refuge wetlands for waterbirds and especially shorebirds. Managed habitats on Swan Lake National Wildlife Refuge were much more consistent in providing suitable habitat to attract waterbirds compared to wetlands in the surrounding agricultural setting. The off-refuge habitats provided sites for shorebird use during wet periods when refuge wetlands were deeply flooded, but the water levels on private lands were not carefully managed to optimize benefits for waterbirds. There was high variability in the distribution and extent of habitat use on refuge wetlands by waterbirds in relation to the timing and type of hydrologic conditions that were influenced by the constraints of refuge water management infrastructure.

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ECOLOGY AND MANAGEMENT OF AMERICAN BITTERNS (*BOTAURUS LENTIGINOSUS*) IN MARSH AND GRASSLAND HABITATS OF MINNESOTA

Soch Lor (PhD)

National Fish and Wildlife Foundation, FWS Region 3

Complete

Little is known about the behaviors and habitat requirements of the American Bittern (*Botaurus lentiginosus*). It is critical for biologists to have accurate information on the home range size and habitat requirements to properly conserve and manage both grassland and wetland habitats for this threatened species. Objects of this study are to: 1) determine an effective and statistically sound monitoring program for secretive marshbirds, including bitterns, grebes, and rails; 2) examine responses of breeding activities of American bitterns to marsh and grassland management activities; 3) compare nesting activities and productivity of bitterns that use a large, managed wetland complex to those using prairie pothole grassland and marsh habitats; 4) develop and validate models to predict habitat characteristics for nesting, foraging, and molting sites for American Bitterns. The study areas are located at Agassiz National Wildlife Refuge and at Red Lake Farm Indian Reservation in northwestern Minnesota.

A dissertation was produced. The project identified problems with and ways to improve standardized marsh bird surveys and how the value of results varied for Sora, Virginia Rail, American Bittern, Least Bittern, and Pied-billed Grebe. Information collected in this study on home range size was compared to previous studies on American Bitterns at Agassiz National Wildlife Refuge with new analytic techniques that account for a more realistic home range shape

and size. These new techniques proved valuable in identifying more specific habitat conditions not solely related to size of the home range. Habitat models for nesting American Bitterns were tested at Agassiz National Wildlife Refuge but the spatial distribution of the marked birds and their limited number compromised use of analytical approaches. Nevertheless, some variables related to vegetation proved to be valuable in assessing habitat conditions for breeding birds.

DAVID L. GALAT

POPULATION STRUCTURE AND HABITAT USE OF BENTHIC FISHES ALONG THE MISSOURI RIVER

Doug Dieterman (PhD), Eric Roberts (Research Assistant)

COE and USGS RWO #s 48, 51, 55, 58, and 66 in cooperation with Idaho, Iowa, Kansas, Montana, and South Dakota Cooperative Fish and Wildlife Research Units; Montana Fish, Wildlife, and Parks; and USGS/CERC

Complete

Our research goal was to evaluate population structure and habitat use of benthic fishes along the entire main stem Missouri River, exclusive of reservoirs. The strategy of a basin-wide analysis of benthic fishes organized within a spatial habitat hierarchy offered a high probability to predict how potential changes in system operation can benefit conservation and recovery of fishes and their habitats, while maintaining the diversity of present-day public uses within the Missouri River basin. Objectives were to: (1) describe and evaluate recruitment, growth, size structure, body condition, and relative abundance of selected benthic fishes; (2) measure physical habitat features (e.g., velocity, bottom type, turbidity, temperature) where fishes are collected, and (3) describe use of dominant macrohabitats by benthic fishes. Information was collected in a standardized manner using identical techniques throughout the basin. Data were recorded, analyzed and managed following standard protocols to be useful to resource agencies and decision makers. Results of this research provides information on spatial patterns of physical habitat, distribution, abundance, growth, mortality, recruitment, condition, and size structure for important benthic fishes found throughout the main stem Missouri River. Taxa include important recreational, forage, and native fishes, including several listed as imperiled by state and federal agencies. Twenty-seven peer reviewed publications, five final report volumes and five PhD dissertations are available by contacting galatd@missouri.edu. Progress Reports and Standard Operating Procedures are also available on-line at <http://www.cerc.usgs.gov/pubs/benfish/benpubs.htm>.

GROWTH OF LARVAL GIZZARD SHAD IN THE LOWER MISSOURI RIVER CHANNEL: THE IMPORTANCE OF SHALLOW, SLOW-VELOCITY HABITATS

Kathy Doisy (Research Associate), Lori Patton (MS)

MDC special funds

Complete

Shallow, slow current-velocity habitats (SSVHs) of the nearshore ecotone in river channels contribute to successful recruitment of many age-0 fishes. This critical habitat has been greatly reduced through channelization of large rivers. We compared growth rates of larval gizzard shad (*Dorosoma cepedianum*), a common riverine habitat generalist fish in the lower Missouri River, among three channel habitat types: open channel, inshore at point bars, and inshore at wing-dike bars. Fish were aged by otolith daily growth increments and assigned temporal cohorts 1 or 2 within the three habitats. Growth rate was estimated by the Gompertz growth function and differences among habitats and cohorts related to physical variables: temperature, current velocity, depth, substrate, sandbar slope, and sandbar shoreline sinuosity. ANCOVA showed that cohort 1 larvae collected adjacent to point bars grew significantly faster than in open channel and inshore wing-dike bar habitats. Growth rate for wing-dike bar specimens was significantly slower within cohort 2 than larvae collected from point bars. Larvae collected at point bars had significantly faster growth rates than either channel or wing-dike bar specimens when the two cohorts were combined. Results indicated temperature played a role in growth, but other environmental factors may also have had an important influence. Point bars exhibited higher shoreline sinuosity, more gradual slopes, and sand dominated versus silt dominated substrate than wing-dike bars. Other variables that differed between the sandbars, including current velocity and depth, showed no clear effects on larval growth. Rehabilitation of regulated, large alluvial rivers to provide SSVH for age-0 fishes should reflect the nearshore geomorphic diversity of remnant natural features and unchannelized rivers.

MISSOURI RIVER POST-FLOOD EVALUATION SYNTHESIS

Michael Headrick (Post-doctoral Associate)

Missouri Department of Conservation

Complete

This synthesis is based on the Missouri River Post-Flood Evaluation (MRPE). Studies were prompted by the Great Flood of 1993, the greatest flood on record in the lower Missouri River. MRPE was a collaboration of agency and academic researchers assembled to investigate structure, function, and successional patterns among wetland types and their plant and animal communities following catastrophic flooding. Objectives were to determine post-flood recovery of the floodplain and its resources and to develop the information needed for floodplain planning and management. MRPE products, on which this synthesis was based, included a collection of nine Master's theses, a Ph.D. dissertation, ten reports to the Missouri Department of Conservation, and 12 scientific journal articles. The synthesis was integrated across studies to identify the ecological mechanisms that structure biological communities in the Missouri River and its floodplain. Technical language was minimized as it is primarily directed to audiences of private landowners, policy makers and resource managers. Results were presented as seven modules that allow printing independent brochures or posting web pages. These included: Floods of the 1990s; A River Is More than Running Water; A River Is Intimately Linked To Its Valley; Physical Processes; Biological Processes; Response to Disturbance, and; Floodplain Management.

RIVER RESTORATION IN THE UPPER MISSISSIPPI BASIN: A SCIENTIFIC SYNTHESIS TO INFORM POLICY AND GRASS ROOTS ACTIONS

T. Kevin O'Donnell (MS)

McKnight Foundation; Minneapolis, MN

Complete

The Upper Mississippi River is characterized by a series of locks and dams, shallow impoundments, and thousands of river channelization structures that facilitate commercial navigation between Minneapolis, Minnesota and Cairo, Illinois. Agriculture and urban development over the past 200 years have degraded water quality and increased the rate of sediment and nutrient delivery to surface waters. River enhancement has become an important management tool employed to address causes and effects of surface water degradation and river modification in the Upper Mississippi River Basin. We report information on individual river enhancement projects and contrast project densities, goals, activities, monitoring, and cost between commercially non-navigated and navigated rivers (Non-navigated and Navigated Rivers, respectively). The total number of river enhancement projects collected during this effort was 62,108. Cost of all projects reporting spending between 1972 and 2006 was about US \$1.6 billion. At least 75% of spending and 86% of projects occur in Non-navigated Rivers and their watersheds. Water quality management was the most cited project goal within the basin and also for Navigated Rivers. Other important goals in Navigated Rivers included instream habitat improvement and flow modification. Most projects collected for Non-navigated Rivers and their watersheds originated from the U.S. Department of Agriculture. The U.S. Army Corps of Engineers and the U.S. Department of Agriculture were important sources for projects in Navigated Rivers. Collaborative efforts between agencies that implement projects in Non-navigated and Navigated Rivers may be needed to more effectively address river impairment. However, the current state of data sources tracking river enhancement projects deters efficient and broad-scale integration.

USE OF MAIN CHANNEL AND SHALLOW-WATER HABITAT BY LARVAL FISHES IN THE LOWER MISSOURI RIVER

Kerry Reeves (PhD)

MDC special funds

Complete

The larval stage of a fish's life cycle is the most environmentally sensitive and loss of suitable habitat is a primary cause of increased mortality, yet the understanding of habitat requirements of larval fishes lags far behind other life stages. I developed a series of research objectives organized in a spatial hierarchy to characterize larval fish nursery habitat within the lower Missouri River. The larval fish assemblage, native carpsucker spp./buffalo spp. (*Carpionodes* spp./*Ictiobus* spp.) and invasive silver and bighead carp (*Hypophthalmichthys molitrix/nobilis*) catch-per-unit-effort (CPUE) differed significantly among three years (2002-2004) within the main channel, whereas native chub spp. (*Macrhybopsis* spp.) did not. Native carpsucker spp./buffalo spp. and chub spp. CPUE was significantly higher within sandbar aquatic terrestrial transition zone (ATTZ) than the main channel. Local-environmental factors accounted for the

greatest proportion of variance in larval fish CPUE within sandbar ATTZ, followed by hydrologic and finally geomorphic factors at macro- and meso-habitat scales. At the microhabitat scale, the larval fish assemblage and carpsucker spp./buffalo spp. selected areas ≤ 10 cm deep with current velocities ≤ 5 cm/s. Silver/bighead carp exhibited no selection based on water depth or current velocity. Chub spp. selected depths between 20-50 cm and areas 2-3 m from the water's edge. The larval fish assemblage and several taxa exhibited a significant nocturnal increase in CPUE within the primary channel and sandbar ATTZ at the macrohabitat scale in contrast to previous research indicating turbid rivers lacked a diel cycle in larval fish drift.

ASSEMBLAGE STRUCTURE AND SHALLOW-WATER HABITAT USE BY SMALL-BODIED FISHES AT LOWER MISSOURI RIVER SANDBARS

Clayton Ridenour (MS)

MDC special funds

Complete

Populations of many native big-river fishes have declined since channelization and flow regulation contributed to losses of shallow-water habitat (SWH) on lower Missouri River (LMOR). Existing point and wing-dike sandbars represent a potentially important source of SWH to fishes during early ontogeny within the main channel of LMOR. Small-bodied fishes were sampled using pre-positioned electrofishing devices from 0.0-0.5 m water depths adjacent to four point and four wing-dike sandbars on LMOR between July and October, 2005. A suite of associated environmental factors were also measured. Habitat use and assemblage structure relative to three spatial (sandbar type, region within sandbars, and distance from shoreline within region) and two temporal (month, diel), and environmental factors were evaluated using Analysis of Variance, Detrended Correspondence Analysis, and Canonical Correspondence Analysis.

Samples yielded 49 species from 13 families in depths 0.0-0.5 m; most fishes were ≤ 105 mm TL. Fish mean length increased but abundance decreased from July to October. Ordination analyses revealed that the assemblage was organized into body-length subgroups. Fish assemblages were not different between point and wing-dike sandbars. Instead, fishes aligned along a depth-velocity gradient relative to body length. Shallow (*ca.* 0.12m), near-shore areas were dominated by fishes < 35 mm TL during the day, but larger fishes (e.g., 70 mm TL) moved nearer to shore at night. This research shows that main-channel sandbars provide nursery to many fluvial fishes during early ontogeny and that sandbars play an important role as nursery in large regulated rivers.

RELATION OF MISSOURI RIVER FLOWS TO SANDBAR MORPHOLOGY WITH IMPLICATIONS FOR SELECTED BIOTA

Emily Tracy (MS)

RWO # 90 - USGS/CERC, MDC special funds

Complete

Sandbars provide a variety of aquatic and terrestrial habitats in large rivers important to resident and migratory fishes, invertebrates, turtles, and birds. Channel modification and flow regulation of the lower Missouri River have reduced sandbars and contiguous shallow water, low velocity habitats they provide by over 90%. Resource agencies have identified the need to increase sandbars and their associated aquatic habitats as one of their highest priorities.

Predictive models of sandbar morphometry (area, wetted perimeter, elevation, and water-surface slope) were developed to determine how changes in discharge affect the quantity of submergent-sandbar ATTZ (depth) and emergent-sandbar ATTZ (elevation) for a representative sample of sandbars within a segment of the lower Missouri River. Topographic maps were created for 13 sandbars classified as: point sandbars (formed on the inside of river bends) and wing-dike sandbars (formed behind wing-dikes). River discharge-surface area predictive models of sandbar ATTZ were applied to high- and low-flow scenarios proposed by resource agencies to explore the effect of sandbar habitat availability on foraging of migratory shorebirds and wading birds, nesting of softshell turtles, and nursery of riverine fishes.

Point sandbars were as much as 22 times greater in area than wing-dike sandbars for shallow-water and exposed-sandbar area, but wing-dike sandbars were more abundant, composing 85% of all sandbars in the Grand River to Osage River segment of the lower Missouri River. Reduced summer flows associated with flow-management alternatives GP1528 and GP2021 increased available wetted perimeter in July and August for post breeding wading birds and during the beginning of autumn shorebird migration while also creating more emergent sandbar habitat during softshell turtle nesting. River discharge-sandbar area models indicate management of low summer flows within the current channel could increase sandbar habitat, providing ecological benefits, while maintaining flows necessary for navigation. Results can be used to further understand the effects of river management on sandbar habitat availability and provide guidance in selecting future flow management alternatives to benefit this critical resource.

ASSESSING THE EFFECTIVENESS OF THE WETLANDS RESERVE PROGRAM IN MISSOURI THROUGH ANALYSIS OF EXISTING EASEMENT DATA AND LINKAGE TO PREVIOUS FLOODPLAIN INVESTIGATIONS

Scott Frazier (Research Associate)
Natural Resources Conservation Service

Current

The Wetlands Reserve Program (WRP), authorized in the 1990 Farm Bill, is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The purpose of this project was to evaluate data from Wetlands Reserve Program easements collected during 2003-2005 in Missouri to assess initial effectiveness regarding wetland functions and values and to enhance future monitoring and evaluation protocols.

The State of Missouri has a vibrant Wetlands Reserve Program (WRP) and a unique ecological monitoring data set. Data clearly show land cover changes associated with wetland restoration, with major shifts from open crop fields to forested wetlands through time. Habitat quality for select wetland wildlife species has improved due to restoration, as represented by Habitat

Suitability Index values. Habitat quality for non-forest species (e.g., least bittern) is better in the early years (herbaceous years) following restoration than in older easements as forest succeeds from open habitat. Habitat quality for forest species is expected to continue to improve in the future as trees mature. Missouri WRP wetlands (floodplain and bottomland hardwood forests) are representative of wetlands in the Mississippi Alluvial Valley and Midwest. Data from Missouri illustrate ecological and wildlife benefits of WRP beyond Missouri. Continued ecological monitoring of WRP easements is needed to track value of habitat and other wetland functions through time to maximize benefits derived from the program.

SCIENCE PANEL TO GUIDE IMPLEMENTING ADAPTIVE MANAGEMENT FOR ECOSYSTEM SUSTAINABILITY OF THE UPPER MISSISSIPPI RIVER SYSTEM

David L Galat (Assistant Unit Leader)

U.S Army Corps of Engineers and USGS, Upper Mississippi Environmental Sciences Center
Current (*Ongoing*)

The Navigation and Ecosystem Sustainability Program (NESP) is a long-term program of navigation improvements and ecological restoration for the Upper Mississippi River System (UMRS) that will be implemented in 15-year increments through integrated, adaptive management. The primary goal of the program is implementation of an integrated, dual-purpose plan to ensure the economic and environmental sustainability of the UMRS. The NESP Science Panel was convened as a standing advisory group to provide scientific expertise needed for adaptive management of the UMRS. Dr. Galat has served on this SP since 2006 and chairs the Goals and Objectives Work Group. The Science Panel develops a science framework for five primary functional areas: (1) project sequencing; (2) developing evaluation criteria for ecosystem outcomes including goods and services; (3) monitoring, including selection of response variables, adequacy of pre- and post- project monitoring, and addressing issues of scale; (4) creating tools for adaptive management such as selection of relevant ecological metrics, endpoints, and development of a 'report card' to assess ecosystem function; and, (5) integration of ecological, socio-economic, and physical models and use of information technology to facilitate the decision making process.

The Goals and Objectives working group addressed five topics during 2006-2007: (1) reviewed and operationally revised the existing Vision Statement for the NESP; (2) proposed and discussed goals for addressing the ecological component of the UMRS vision; (3) outlined examples of potential Upper Mississippi River (UMR) system- and reach-wide ecosystem objectives and performance criteria; (4) recommended initial guidelines for addressing system-wide ecosystem objectives, and; (5) identified next steps to implement the process.

Our rationale for a system-wide approach to UMRS restoration stresses that a system-wide approach is *process*, rather than *site* based. Restoring ecosystem structure and function will be more effective at achieving a sustainable Upper Mississippi River System (UMRS) than restoring places because a functionally intact UMRS will be more resilient to human and natural disturbances. Five reach- and system-wide strategic objectives were identified to achieve the goal of long-term sustainability of the economic uses and ecological integrity of the Upper Mississippi River System. These include: (1) manage for a more natural hydrologic regime

[hydrology & hydraulics]; (2) manage for processes that shape a diverse and dynamic river channel [geomorphology]; (3) manage for processes that input, transport, assimilate, and output materials within UMR basin river-floodplains: water quality, sediments, and nutrients [biogeochemistry]; (4) manage for a diverse and dynamic pattern of habitats to support native biota [habitat], and; (5) manage for viable populations of native species and diverse plant and animal communities [biota]. Guidelines for addressing system-wide ecosystem objectives and identified next steps to implement the process were proposed.

MULTI-SCALE ANALYSES OF HISTORICAL AND CONTEMPORARY REFERENCE CONDITIONS TO FACILITATE BEST ATTAINABLE CONDITIONS FOR ECOLOGICAL IMPROVEMENT ALONG THE LOWER MISSOURI RIVER

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Current

The Missouri River ecosystem has experienced significant reductions in natural habitat and the abundance of native species and communities over the past century. Causes include removal of snags from the river in the mid 1800s; introduction of nonnative fish species beginning in the late 1800s; navigation enhancement beginning in the early 1900s; and damming and flow regulation of the Missouri River beginning in the 1930s. Land use changes (including urbanization, agriculture, transportation infrastructure, recreational development, etc.) and population growth have also affected the ecosystem in less direct, but probably more important ways.

Protection and recovery of plant and animal species would probably be enhanced to the extent that recovery efforts are cast in terms of ecosystem-level restoration and protection, as opposed to protecting only the habitat of an individual species.

Currently, the US Fish and Wildlife Service developing a long-term management plan for Big Muddy National Fish and Wildlife Refuge (NFWR). This Comprehensive Conservation Plan (CCCP) will guide management of wildlife, habitats, and recreational opportunities for the Refuge over the next 15 years. Restoring the Missouri River, its wildlife, and associated habitat is the primary goal. The term ‘restoration’ evokes the image that work is being done to return the land and river back to a state that was “natural” and unimpeded by human activity. This “image” is probably an unattainable and unrealistic goal given the problem of defining what is/was “natural” and the lack of societal support to return the landscape to a state unimpeded by humans.

This research, will offer historical and contemporary reference conditions to present the best-available pre-EuroAmerican land/river conditions from the original GLO survey notes, the earlier French/Spanish survey documents, Lewis and Clark notes, etc. and contemporary land/river conditions via satellite, aerial photo, soil, geological, and hydrological data. These reference conditions will be analyzed on broad river reaches (regional) and also site-specific reaches. The total study area for the broader-reaches will extend from the NW corner of Missouri River to its mouth. The study’s broad reaches are geo-defined as: 1) Platte River to the Kansas River, 2) Kansas River to the Grand River, 3) Grand River to the Osage River, 4) Osage River to the Mississippi River. The site-specific reaches are the current eight Big Muddy NFWR units. The

dual analysis and implementation of the broad and site-specific scales should conceptually satisfy the contemporary lack of the ecosystem/landscape approach and still satisfy the locally-based individual habitat approach. Ideally it should somewhat mitigate the holistic versus reductionist approaches. More significantly, it should offer foundational comparative ecological data from which to judge and model how recovery might be directed and just how far any given reach or location of the Lower Missouri River could go toward attaining that “natural, historical condition”. This should optimally result in the realization of the “Best Attainable Condition” toward ecological improvement, but not necessarily restoration.

REPRODUCTIVE DEVELOPMENT OF SELECTED *MACRHYBOPSIS* CHUBS IN THE LOWER MISSOURI RIVER, MISSOURI

Jennifer Johnson (MS)

U.S. Fish & wildlife Service

Current

Sicklefin (*Macrhybopsis meeki*), speckled (*M. aestivalis*), and sturgeon (*M. gelida*) chubs are archetypical small-bodied, short-lived, turbid river Cyprinids that have experienced >50% reduction in their former distribution along the Missouri River mainstem. Knowledge of spawning modes and patterns of reproductive development is essential for conservation and management of these fishes because their relatively low fecundity and short life span can result in abrupt extirpation if environmental or habitat conditions remain unsuitable. This research has six objectives. (1) Determine age/length of first sexual maturity in the three species. (2) Estimate fecundity for each of the three species and compare among different ages/lengths. (3) Determine if reproductive senescence occurs in any of the three species. (4) Determine the type of ovarian development in the three species. (5) Determine if vitellogenesis (Stage 4) and spawning (Stage 5) differ among age classes for sicklefin and speckled chubs. (6) Determine the sex ratio for each species and compare among age/length groups. *Macrhybopsis* chubs were collected as part of the Pallid Sturgeon Population Assessment Program and Habitat Assessment and Monitoring Program from the lower Missouri River between river miles 4.3 and 237.9 in 2005 and 2006. Ten percent of sturgeon chubs were sexually mature at age-2, but it was not until age-3 that the criterion for sexual maturity (i.e., 50% of females with ovaries at stage III) was met. Sexually mature female sturgeon chubs had total lengths >80 mm. Five percent of speckled chub females were sexually mature age-1, but >50% matured at age-2 and at total lengths >60 mm. Thirteen percent of sicklefin chubs examined were sexually mature at age-2, and the species was considered to be mature at age-3 and at total lengths >90 mm. No females older than age 3 were collected for any of the three species, despite aging a total of 631 females collected from 295 samples between February and March over the two years. Only 2% of sturgeon, 4% of speckled, and 1% of sicklefin chubs collected over the two years were sexually mature. Absolute fecundity for age-3 speckled chubs (N= 10) ranged from 1,598 – 4,500 (mean \pm 1 SD = 3,078 \pm 994) and for age-3 sicklefin chubs (N=3) absolute fecundity ranged from 3,304 to 4,456 (mean \pm 1 SD = 3,740 \pm 625). Too few mature female sturgeon chubs were collected (N= 2) to accurately estimate fecundity. No significant differences in mean oocyte diameter coupled with no significant decrease in absolute fecundity with age or length indicate speckled chub and sicklefin chub do not experience senescence by age 3. Objectives 4-6 will be completed during 2008.

MOVEMENT, HABITAT USE, AND REPRODUCTION OF PADDLEFISH, *POLYODON SPATHULA*, IN THE LOWER OSAGE RIVER, MO

Joshua Lallaman (PhD)

MDC Special Funds

Current

Paddlefish, *Polyodon spathula*, were once an abundant species throughout the major river systems of the Central United States. Dramatic declines in paddlefish populations during the 20th century are primarily the result of large scale river modification. Paddlefish are currently extirpated, endangered, threatened, or of special concern in a large proportion of their range. An inadequate knowledge base on paddlefish ecology and population dynamics is one of the major limitations to rehabilitation. The objectives of my study are to 1) characterize paddlefish spawning migrations and habitat use, 2) determine under what stream conditions (temperature, velocity, discharge, and hydraulic head) paddlefish pass through a low-head structure, Lock and Dam #1, and 3) identify and characterize paddlefish spawning habitat in the lower Osage River. Twenty paddlefish (16 male and 4 female) were tagged with Combined Acoustic and Radio Transmitters (CART) in 2007 and an additional 40-60 fish will be tagged in 2008. Paddlefish were monitored using stationary receivers, boat, and helicopter tracking in 2007 and will continue in 2008 and possibly 2009. A total of 560 paddlefish locations were obtained within the lower Osage River in 2007. Ten paddlefish (9 males and 1 female) successfully moved upstream of Lock and Dam #1 between April 30th and May 15th, 2007. Paddlefish passage past Lock and Dam #1 will be modeled using a counting process formulation of the Cox hazard regression. Egg mats were unsuccessful at collecting paddlefish eggs in 2007, but will be redeployed in 2008 to try and document paddlefish spawning areas. Understanding paddlefish movement and habitat use will allow for better management recommendations concerning regulated flow releases and habitat protection in Missouri.

ASSESSMENT OF WETLAND RESERVE PROGRAM RESTORATION EFFORTS AS MEASURED BY OCCUPANCY OF AMPHIBIAN METAMORPHS

Doreen C. Mengel (MS)

MDC special funds

Current

The goal of the Natural Resources Conservation Service's Wetland Reserve Program (WRP) is "to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program." A key unanswered question is to what extent is this goal being achieved? Approximately 125 WRP tracts are located within the Lower Grand River basin, north central Missouri. We identified three management strategies applied to these WRP tracts over time: walkaways, maximize hydrology, and naturalistic; the latter emphasizing restoring process as well as structure. Amphibians enable quantifying the WRP goal due to their life history requirements and explicit incorporation of their habitat needs into WRP plans. Research objectives are to determine (1) if relative species richness of amphibians varies between the three management strategies, and (2) proportion of area occupied by selected metamorphic amphibian species whose life history requirements span the continuum from ephemeral to permanent

wetland conditions. Assessing wetland restoration efforts by linking amphibian habitat requirements to the role WRP tracts play in meeting these needs provides an ecological basis to evaluate the success of WRP restoration efforts.

We conducted amphibian sampling on 50 of the 125 WRP tracts within the Lower Grand River basin during summer 2007. Additional information characterizing topography of sample sites will be collected spring 2008. Data analysis and synthesis will occur summer 2008.. Results will assist making informed decisions regarding wetland development design, future management directions, and allocation of limited resources.

USE OF A PASSAGE FACILITY BY MISSOURI RIVER FISHES FOR SPAWNING AND NURSERY IN SEASONAL WETLAND POOLS AT EAGLE BLUFFS CONSERVATION AREA

Meagan Montgomery (MS)

MDC special funds

Current

Anthropogenic modifications to the Missouri River have greatly altered it from its historical state, reducing lateral floodplain connectivity and thus denying riverine fishes access to seasonally-flooded wetland pools for spawning and nursery. Improving river-floodplain connectivity is critical for recruitment of many large river fishes. 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 fish passage into EBCA to facilitate spawning and nursery. Our research goal is to assess the use of EBCA fish passage structures and wetland pools for spawning and nursery habitats of Missouri River fishes. Research objectives include: (1) modeling the discharge-stage relationship between the lower Missouri River (LMOR) and wetland pools to determine connectivity; (2) predicting fish species that would potentially use wetland pools based on reproductive guilds and timing of connectivity events, (3) quantifying ingress and egress of LMOR fishes to and from EBCA during periods of LMOR connection, (4) characterizing spawning and nursery habitats available to fishes in EBCA pools, and; (5) determining growth rates of selected fish species using EBCA pools.

Stage data from the USGS Boonville, MO, gauging station were correlated with EBCA pool 14 and 15 water stage data to determine LMOR stage necessary for connection and frequency of flood events. Predictions of probable fish use were based on integration of habitat use and reproductive guild information with water temperature, discharge, and stage-height data for LMOR. Fish sampling was conducted during spring/summer 2007 to quantify composition of the assemblage entering and exiting the wetland complex from LMOR. Fishes collected from ingress events through the water control structures and an overbank flood were compared with predictions of fish immigration into EBCA. Composition of the fish assemblage using EBCA passage structures was dominated by silver carp (21%), gizzard shad (19%), and orangespotted sunfish (16%). A total of 25 fish species used the wetland complex during the 2007 study season. Spawning and nursery habitats available in EBCA pools were assessed by measuring physiochemical parameters and aquatic habitat patches. Physiochemical variables include: air

and water temperature, dissolved oxygen, pH, total ammonia, turbidity, and water level. Different aquatic habitat patches such as deep ($\geq 0.5\text{m}$) and shallow ($< 0.5\text{m}$) open water, vegetation types (narrow or complex emergent), riprap along pool margin containing the passage structure, and woody debris were delineated throughout the pool. Growth analysis will incorporate length frequencies and length-weight relationships. Quantifying the fish assemblage accessing EBCA during connectivity events strengthens current knowledge of riverine fish use of floodplain areas by providing species-specific data and comparing the corresponding temperature of the river at the time of their migration to what is stated in the literature. Knowledge of the fish assemblage using Missouri River floodplains will enable EBCA management, future conservation efforts, and future fish mitigation projects to design for promotion or regulation of targeted fish species.

MATTHEW E. GOMPPER

ECOLOGY AND STATUS OF THE SPOTTED SKUNK IN MISSOURI

Mundy Hackett (PhD)

Matt Gompper

MDC, Love

Complete

In 1991, Missouri officially listed the eastern spotted skunk (*Spilogale putorius*) as endangered due to severe declines in estimated population numbers. Statewide, harvest numbers for spotted skunks declined from 55,000 specimens in 1940-41 to 1 in 1989-90, and nationwide harvest data show a similar pattern (248,230 in 1934-35 to 875 in 1983-84). Little research has investigated the numerous possible causes of the apparent decline in the species. We have started a study to systematically survey natural areas in the Missouri Ozarks for the eastern spotted skunk and mesocarnivore populations in areas where they are found within similar habitat types using a combination of region-wide surveys, and site-specific remotely triggered camera and track plate surveys. These data are being used to design predictive species habitat models and to discern how inter specific interactions among carnivore species interacts with habitat preferences to determine presence or absence of a species in a region. This work supports one doctoral student and has resulted in two papers to date on spotted skunk declines and spotted skunk survey techniques. Additional analyses are underway.

THE ECOLOGY, EVOLUTION AND CONSERVATION OF THE DWARF CARNIVORES OF COZUMEL

Katherine McFadden (PhD; Columbia University), Alfredo Cuarón (Universidad Nacional Autónoma de México), David Valenzuela (Universidad Autónoma del Estado de Morelos)

Complete

The carnivore taxa inhabiting Cozumel Island, Mexico, are unique and intriguing for their greatly reduced stature and their survival in a habitat notably different from the mainland. Yet the ecology, evolution, and conservation status of these endemic species are poorly understood. We attempted to (1) identify the current status of the endangered dwarf coati and pygmy raccoon on the island, (2) resolve phylogenetic and taxonomic controversies regarding the distinctness of these animals, (3) examine the role of Mayan peoples in the origin of these animals, (4) identify the risks posed by hybridization with congeneric mainland animals released on the island, (5) assess the extent of dwarfism of these taxa, (6) survey the parasites and pathogen exposure history of these animals and identify the risks and history of disease spill-over, and (6) lay the groundwork for future ecological studies. Field work, laboratory genetic analyses, laboratory parasitology, laboratory stable isotope analyses, and laboratory analyses of subfossil bones are complete. Kate McFadden completed her dissertation on the topic at Columbia University (NY). Four papers on the conservation status, morphology, parasitology and feeding ecology of these taxa have been published. Two additional manuscripts on evolutionary genetics and population biology are in review.

ECOLOGY OF THE SPOTTED SKUNK IN THE OUACHITA NATIONAL FOREST, ARKANSAS

Joshua Millspaugh

Damon Lesmeister (MS)

Arkansas Game & Fish Commission

Complete

There is a need to better understand the basic population ecology of eastern spotted skunks in states such as Arkansas to provide information that will allow for more informed management decisions. Our objectives for this work, which ran from early 2005 through late 2007 were to: 1. Determine spotted skunk home range size and movement dynamics in the Ouachita Mountain; 2. Determine spotted skunk habitat use patterns in the Ouachita Mountains, including habitat use in relation to restored pine-bluestem areas on the Ouachita National Forest; 3. Survey spotted skunks inhabiting the Ouachita Mountains for evidence of exposure to disease-causing pathogens, and to identify the prevalence of ectoparasites and fecal-borne endoparasites of the species; and 4. Determine spotted skunk foraging habits in the Ouachita Mountains. This research resulted in 1 MS thesis (Lesmeister), one published paper on spotted skunk survey approaches, and three manuscripts on home range use and habitat selection, den site selection, and parasitology are in review.

EXPERIMENTAL ANALYSES RELATING HOST CONTACT AND PARASITE COMMUNITY STRUCTURE

Ryan Monello (PhD)

Morgan Wehtje (MS)

National Science Foundation

Current

This research uses an experimental approach to better understanding how contact between host organisms influences the structure of parasite communities. Parasites can dramatically affect individuals, populations, communities and even ecosystems. But how do changes in the ecology of host populations influence communities of parasites? We know that individual hosts may harbor multiple species of parasites, and that the broader community of parasites within a population of hosts is even more diverse. Poorly understood, however, is how changes in the contact rates of hosts influence this broader parasite community. Evidence suggests that variation in parasitism by particular species can be accounted for by variation in the extent of host contact. At the parasite community-level, however, whether and how the shift from a solitary, low-contact lifestyle to one with high contact rates alters parasite community structure is not well known. The research addresses this issue in an experimental context with the aims of 1) establishing a naturalistic study system for examining issues pertaining to vertebrate-parasite community interactions; 2) replicating (additional sites and species) and building on recent work which found that increasing host contact rates resulted in drastic shifts in parasite community structure at the level of the individual (the parasite infracommunity) and across the host population (the parasite component community), and 3) assessing the stability and resilience of parasite communities at multiple combinations of hosts, sites, and resource perturbations. Using raccoons as model hosts, baseline assessments of respective parasite communities will be made at 4 sites, after which each site will be subdivided into 2-3 populations, half of which will be perturbed to induce contact among hosts. Comparisons of control (host contact rates low) and experimental (hosts aggregate; contact rates high) populations will elucidate the influence of social contact on the structure of parasite infracommunities and component communities. The experiment will also quantify the rate at which changes can occur, and the resilience of the parasite community once perturbations have ceased. Two graduate students are currently working on the project, and two papers have been published on tick ecology and raccoon genetics. Additional analyses, field work, and laboratory work continue.

THE DISEASE ECOLOGY OF COMMON MESOCARNIVORES OF THE BRAZILIAN PANTANAL

Natalie Olifiers (PhD), Guilherme Mourão (IMBRAPA, Brazil), Ana Jansen (FIOCRUZ, Brazil), Paulo Concado (FIOCRUZ, Brazil)

Support: University of Missouri (Graduate School Fellowship, Rucker), Embrapa/MACRO project and FUNDECT-MS

Current

Diseases caused by parasites can have dramatic effects on individuals, populations, communities, and entire ecosystems. Despite this putative importance, our understanding of the impact of long-term parasitic infection on individuals is poorly developed, and there is a general assumption that the majority of infections by parasites have only minor impacts on hosts. Yet for the vast majority of parasites the influence of infection on host vital rates has never been examined, nor has the simultaneous influence of infection by multiple parasitic species been closely examined. In part this is because we know so little about the parasites infecting most hosts; we can identify their presence, but in natural systems where co-infection by diverse micro and macroparasites

occurs, and where infection by some parasites may be defeated by the host, identifying the impact of any one parasitic species is problematic, as is identifying which parasites from a diverse pool are most important to host population. As part of an international collaboration with Brazilian researchers examining the ecology and epidemiology of several species of mammalian carnivores and their parasites in the world's largest wetland ecosystem, the Pantanal, we are examining how exposure of a host to a diverse array of parasitic organisms (including ecto- and endomacroparasites, and tripanosomatid, viral and bacterial microparasites) influences the vital rates of a population. We will use an information theoretic approach which combines data on the health, fecundity, and survival of hosts with data on the parasitic infections of these same hosts. In this way we can identify which parasitic organisms, which quantitative descriptors of the parasite community, and which interaction effects best explain variability in host health and vital rates. Field work has been underway since 2005, with a focus on the two most common Carnivora of the Pantanal (*Nasua nasua*, *Cerdocyon thous*). This project supports one doctoral student.

THE USE OF BAT HOUSES TO MODIFY PREDATION BY BATS ON AGRICULTURAL PESTS

Bob Pierce

MU Alumni Association Award, MU Plant Protection Program Grant

Current

Recent realization that bats may consume large numbers of insects, and that many of these insects are agricultural pests, has led to speculation that the conservation, augmentation, and manipulation of bat populations may bring novel opportunities in the field of agricultural pest control. Much of this interest has occurred on small-scale family or organic farms where pesticide applications may be undesirable or difficult to use with precision because of mixed crop systems that may have both insect pests and insect pollinators in adjacent localities. Because pesticide use is avoided or reduced on these farms, crop damage from pests may be high. Even on large monoculture farms, however, management for bats has been suggested as an inexpensive mechanism that benefits both farmers and wildlife. This study examined the potential for erection of bat houses to attract bats to farms. Objectives of this study were to: 1) identify the percentage of bat houses erected that are colonized, 2) identify the species of bats that will colonize bat houses, 3) determine the time frame of colonization, and the extent to which houses remain occupied, 4) assess whether bats colonize farms cultivating single crop systems, and 5) assess whether bats will colonize farms that use pesticides. Field work is completed. Data analysis is underway.

POPULATION ECOLOGY OF COYOTES, AND INTER-RELATED RESPONSES OF COYOTES AND OTHER CARNIVORES TO LANDSCAPE CHANGE IN ADIRONDACK STATE PARK, NEW YORK

Justina Ray (Wildlife Conservation Society), Roland Kays (NY State Museum)

National Science Foundation, National Geographic Society, New York State Museum, Geraldine R. Dodge Foundation, Wildlife Conservation Society, New York Department of Conservation

Current

By virtue of their position at the top of the food-chain, carnivores can play pivotal roles in structuring ecosystems. In spite of this ecological importance, we know remarkably little about many aspects of carnivore ecology in northeastern North America—where natural landscapes have been extensively altered through deforestation, farming, urbanization, and even reforestation, with resultant changes in habitat and resources for resident carnivores. An additional influence on local carnivore communities has been the remarkably rapid colonization of northeastern North America by the coyote, which spread from the Midwest in the mid-1800s and has now colonized virtually an entire region from which it was absent 30-50 years ago. The shifts in carnivore community structure that accompany the interactions of anthropogenic land use changes and the newly emerging role of the coyote as a top predator in northeastern forests have not been investigated, and we also know little about scale-dependent responses of individual carnivore species (e.g., coyote, fisher, marten, bobcat, raccoon, red fox, skunk, weasels, and bear) to changes in habitat structure, subsequent impacts on inter-species relationships, and their diseases and parasites and potential for inter-species transmission. This multi-year project will use information collected at 54 sites in the Adirondacks to increase understanding of scale-dependent habitat requirements of individual carnivore species, their responses to human altered landscapes, and interactions among species. Field work and laboratory work is completed. Five papers have been published on coyote parasitology, coyote habitat landscape ecology, coyote range expansion, and carnivore survey techniques. Additional analyses are underway.

ECOLOGY AND INTERACTIONS OF INDIAN FOXES AND FREE-RANGING DOMESTIC DOGS IN RURAL ANDHRA PRADESH

Abi Vanak (PhD)

MU Research Board, Mizzou Tigers for Tigers

Current

Mammalian carnivores can dramatically influence ecosystems. Yet the world's most common carnivore, the domestic dog, is rarely studied in an ecological context, especially in the undeveloped world where dog populations are very large, where dogs are typically free-ranging and able to interact directly with wildlife, and where risks to biodiversity preservation are critical. This research examines interactions of domestic dogs and wildlife, focusing in particular on the endangered wildlife of central India, where native foxes may be negatively influenced by free-ranging dogs. Interactions of dogs and foxes are of particular interest, as theoretical and empirical work from temperate zone ecosystems suggests that large mammalian carnivores, and canids in particular, should have negative impacts on smaller carnivores such as foxes. However, the behavioral mechanism by which this impact occurs is poorly understood, and so this project also addresses this broader ecological issue. A three-pronged approach is being used to understand dog-wildlife interactions in rural India. First, a telemetry-based study will define the ranging patterns of dogs and the interactions that dogs have with foxes. Second, a dietary study will identify the foraging habits of free-ranging dogs. Third, a series of experimental analyses will examine the effects of domestic dogs on fox behavior and ecology. This work will provide immediate applied and theoretical insights by identifying how free-ranging dog populations

interact with wildlife. This work supports one doctorla student and has resulted in two papers to date on Indian fox biology. Additional analyses of the field data are underway.

ROBERT S. HAYWARD

WARM WATER EFFECTS ON WHITE CRAPPIE: A BIOENERGETICS APPROACH

Przemyslaw Bajer (PhD student)

Missouri Department of Conservation Special Funds

Complete

A bioenergetics model for adult white crappie was constructed from laboratory experiments that described maximum consumption and metabolic costs as functions of fish weight and temperature. Metabolic rates were determined through swim respirometry. In addition to capacity to simulate white crappies' growth in weight at daily time steps, a regression equation that was constructed from additional laboratory data was incorporated to allowed daily prediction of fish growth in length as well. The combination of simultaneous predictions of white crappies' weight and length growth permitted simulations of these fishes body condition in response to consumption rates, temperature and body weight. Thermal experiences of white crappies throughout summers in representative warm and cool years in Missouri impoundments were estimated from discrete choice models, based on determined white crappie temperature selections in impoundments from radiotelemetry. Bioenergetics model simulations of white crappies growth in weight over annual growth periods during years with warm versus those with cool summers, demonstrated pronounced slowing of white crappies annual growth (over a range of consumption levels) in years with warm summers unlike in years with cool summers. Similarly, bioenergetics modeling indicated that in years with warm summers, adult white crappies relative weights (W_r) tended to decline markedly by late summer; under lower, but realistic consumption levels, when poor prey condition was incorporated into simulations, sufficient loss of condition was indicated for summer mortality of large crappies to occur. Even under more favorable feeding conditions, bioenergetics modeling showed that experiencing warm summers resulted in white crappies reaching lower levels of condition by fall, which according to an empirical relationship, resulted in lower numbers of mature eggs being produced in mature female (and potentially lower recruitment) in subsequent springs. Overall, modeling of warm versus cool summer effects on adult white crappies suggested that shifts in summer thermal conditions among years may underlie the well-known fluctuations in white crappie growth, recruitment and population sizes structures that have long been problematic to managers of these fishes.

COMPENSATORY GROWTH FEEDING REGIMES FOR REARING BLUEGILL TO FOOD-MARKET SIZE

Przemyslaw Bajer (Research Associate)
USDA (Ohio Aquaculture)

Complete

Compensatory-growth (CG) feeding regimes involving repeating cycles of off/on feeding were previously applied to hybrid bluegill in the experimental setting with individually held fish. In such studies, fish fed on certain CG feeding schedules gained up to twice the weight of controls fed every day. A subsequent experiment suggested that gains beyond controls may not occur when bluegill are held in groups, the way they are typically reared in aquaculture. The present study evaluates responses of group-held bluegill fed on a CG schedule (repeating cycles of 3-days-off/9-days-on) relative to controls fed every day. Trials are being run in a true culture setting, involving 1100-L re-circulating aquaculture systems (tanks). Responses to be compared include weight gain, FCR, size variation, relative weight, production and total mortality. Monitoring for the presence of dominance hierarchies among bluegills in the tanks showed that these hierarchies were weak during the first three months of rearing under the CG feeding regime, but strong during the subsequent three months. During the initial 3-month period when dominance hierarchies were weak, bluegills fed on the CG-eliciting schedule outgrew daily fed control fish. In contrast, during the final 3-month period under strong hierarchies, the reverse response was observed with daily fed bluegills

DETERMINING MAXIMUM HANDLING SIZE AND CONSUMPTION RATES OF POND SNAILS BY HYBRID REDEAR SUNFISH

Przemyslaw Bajer (Research Associate)
MDC special funds

Complete

Pond snails serve as intermediate hosts for fish parasites (monogenetic trematodes) that reduce fish market values in the aquaculture setting. Removing pond snails interrupts parasite life cycles and ameliorates this problem. Previously, we evaluated the potential to stock reard sunfish into fish production ponds to reduce or eliminate snail populations. Findings indicated that one common pond snail, *Helisoma*, could not be readily consumed by reard sunfish when the former reached its larger sizes. However, the ability of reard sunfish to consume *Helisoma* over most of its full size range may be sufficient to eliminate this problematic snail species in production ponds given that smaller, younger individuals would be continually removed.

PRODUCING ALL-MALE BLUEGILL GROUPS FOR FOOD-FISH AQUACULTURE

Adam Doerhoff (MS)
NCRAC; College of Agriculture, Food and Natural Resources, MU, special funds

Complete

Potential exists to profitably rear Lepomid sunfish for food markets. Fish of at least 225 g are

required for food markets as opposed to sunfish reared to smaller sizes primarily for pond stocking. Efforts have therefore been underway to develop techniques for increasing growth rates of sunfish--primarily bluegill and bluegill x green sunfish hybrids--so that fish of 225 g can be produced within 2 years of grow-out. It was widely believed that hybrid sunfish grow faster than bluegill, but a recent study at the University of Missouri has demonstrated that bluegill actually possesses the higher growth capacity. This study also showed that male bluegills grow faster and larger than females, reaching ~70% of food market weights in recirculation tanks in just 11 months. The first of my studies was aimed at developing an approach to form all- or mostly-male bluegill groups, when the sexes are largely indistinguishable at 2-3 inches. Size-grading allowed males to be separated from females based on size differences arising from sexually dimorphic growth. The second of my studies aimed to produce all- or mostly-male bluegill groups by sex-reversing genotypic females through a series of androgen (trenbolone acetate, TBA) immersions at 2 time periods. The third and final study aimed to assess differences in growth between mixed-sex and mostly-male bluegill groups. Although male bluegills have higher growth capacity, they may also carry higher potential for aggression which could negatively affect growth rates in predominantly male groups. Results indicated good potential to efficiently and repeatedly separate male and female bluegills through size grading to produce groups that were ~70% male. This approach may be desirable in that it can be readily carried out by fish producers at their facilities and potentially facilitate growing larger bluegill in ponds. Some potential to influence phenotypic sex ratios towards males was indicated through immersion of fish in TBA at key post-hatch time periods, however, results were equivocal. Results from 11-month tank studies elucidated an overriding influence from dominance hierarchies that became established during the initial one-third of the study period and persisted thereafter. Hierarchy formation overrode any treatment effects of mixed-sex versus mostly-male fish. While males clearly grew larger than females in both treatments, hierarchy effects resulted in a fish ranging in weight from ~90% of market size down to those that grew negligibly. Regression analyses supported the hypothesis that overall fish growth (SGR), feed efficiency, and condition (Wr) in tanks were strongly influenced by the progressive development of social hierarchies. Findings demonstrate a need to ameliorate social hierarchy influences to effectively rear bluegill to large sizes in indoor tanks.

INCREASING SURVIVAL OF RESTOCKED PELLET-TRAINED LARGEMOUTH BASS FINGERLINGS

Brandon Hanquist (Graduate Research Assistant) North Central Regional Aquaculture Center
Current

Substantial interest exists in the capacity to efficiently rear largemouth bass in producer ponds to better meet the strong demand for this species both as a sportfish and food fish. In Phase-1 (to begin in June), pellet-trained LMB (2-3 in) will be stocked into longitudinally divided halves of eight, 0.1 ha production ponds providing a control and treatment half in each pond in June. Two treatments, fish crowding and also middle-grading, will be evaluated for their abilities to improve overall survival of the stocked LMB fingerlings versus controls that will receive neither treatment. Throughout the 30-d study period, mortality due to 1) transporting of fish, 2) fish going “off-feed”, and 3) cannibalism, and also 4) total mortality will be quantified, through

regular determinations of CPUE and sampling of fish for gut contents. In Phase-2 (to begin in July), a similar experimental design will be implemented but for larger LMB (4-6 in). A key objective will be to compare survival rates between the smaller and larger size groups to determine whether higher costs paid for larger, fingerling LMB are justified by substantially higher survival rates. This study was scheduled to begin in 2007 but was postponed until 2008 due to pellet-trained fingerling LMB being unavailable.

DEVELOPMENT OF EFFECTIVE LOW-COST DIETS FOR BLUEGILL

Karthik Masasgounder (PhD student)

North Central Regional Aquaculture Center

Current

Feeds typically account for 50-60% of commercial fish producer's annual variable costs. The high cost of fish feeds owes in part to the tendency for fishmeal to serve as the primary protein source in formulated diets. Fishmeal's advantages include favorable amino acid profiles, high digestibility, and its tendency to increase feed palatability. However, declining supplies of ocean fishes harvested to produce fishmeal are leading to increasing and highly variable fishmeal prices. In the present study we seek to formulate a diet for bluegill that produces growth equivalent to that achieved when these fish are fed a standard trout diet containing a high percentage of fishmeal as protein. As part of this study, we recently replaced fish meal in a trout with poultry by-product meal at 20% increments up to 100%. Growth trials showed capacity to replace 100% of the high-cost fishmeal protein by poultry by-product meal, with no loss of growth or noticeable change in fish health. A capacity to reduce feed ingredient cost by 62% was indicated.

JOHN R. JONES

FIELD VALIDATION STUDIES OF LONG-TERM SEDIMENT TOXICITY TESTS WITH *HYALELLA AZTECA* AND *CHIRONOMUS TENTANS*

Jeannie Roper Hayward (PhD)

RWO #s 50 and 71 - USGS/CERC

Complete

The purpose of this project was to evaluate whether laboratory exposures to a contaminant concentration series (acute and chronic toxicity tests) with *Hyaella azteca* and *Chironomus tentans* were indicative of field exposures with the same contaminant concentrations (benthic colonization assessments). This comparison was performed with sediment spiked with the pesticide dichlorodiphenyldichoroethane (DDD). Analytical chemistry ensured the DDD concentrations were known. Potential results of this study include the following: 1) that

laboratory tests are equally sensitive to native environment effects and results should be an adequate means of protecting the environment, 2) that laboratory tests are less sensitive than what occurs in the native environment and laboratory test results should be considered an unreliable means of protecting the environment, and 3) that laboratory tests are more sensitive than what happens in the native environment and results should be considered a reliable means of protecting the environment. The material was summarized in Ingersoll, et al. 2005.

EUTROPHICATION OF AN OKLAHOMA RESERVOIR

Ben Lakish (MS)

RWO # 73 - USGS/CERC

Complete

Fort Cobb Reservoir, a 16.6 km² waterbody located in Caddo County, Southwestern Oklahoma was sampled for nutrients and chlorophyll approximately bimonthly from June 2000 to July 2002 and intermittently from March 2003 to July 2004. Results were compared to nationwide, Midwestern and statewide models predicting algal biomass. Phosphorus, nitrogen, light, zooplankton and sediment concentration were manipulated in 1 liter cubitainers (*in situ* algal bioassays) to test which factors were most important for controlling algal biomass. Profiles of Photosynthetically Active Radiation (PAR) and *in situ* algal bioassays indicated substantial light limitation of algal biomass especially in the lacustrine zone. TN: TP ratios and *in situ* algal bioassays suggest that phosphorus was secondarily limiting in the springtime and nitrogen in summer and fall. Data from other Oklahoma reservoirs indicated nitrogen and light limitation were more common than phosphorus limitation. The reservoir contains more phosphorus than 83%, more nitrogen than 94% and more chlorophyll than 98% of other reservoirs in the state. Results indicate that reduction of phosphorus loading is likely to reduce chlorophyll, but at a lesser rate than in other regions.

SEASONAL TRENDS AND VARIABILITY OF TROPHIC PARAMETERS IN MISSOURI RESERVOIRS

Daniel V. Obrecht (MS)

MDNR

Complete

Eutrophic reservoirs in Missouri, as a group, do not display the bimodal pattern of algal biomass that constitutes the accepted phenology in eutrophic temperate lakes. Instead, Missouri's eutrophic reservoirs display a range of temporal patterns, influenced by both nutrient and non-volatile suspended solid concentrations. Oligo- and mesotrophic reservoirs mimicked patterns of algal biomass identified in a previous study of temperate lakes. Seasonal trends in the trophic state parameters influenced trophic state assessments, with spring time sampling over-estimating trophic state. Seasonal patterns in abundance and variability also influenced the number of samples needed to estimate mean trophic conditions. Four samples collected throughout summer would lead to a coefficient of variance of ~25% for algal chlorophyll. Seven samples would be required to achieve the same level of precision in chlorophyll estimation if the sampling period

were expanded to spring-fall. Nitrogen and phosphorus display lower temporal variability than chlorophyll, so a greater level of precision in estimating mean conditions is achieved with a given sampling effort. Nutrient stimulation experiments indicate that the nutrient limiting algal growth in Missouri reservoirs does not remain constant temporally, and that limitation of algal growth by a single nutrient is generally not acute.

SURVEY OF CHLORINE DEMAND, SUVA AND TOTAL TRIHALOMETHANE FORMATION POTENTIAL IN MISSOURI RESERVOIRS

Kristen Sloan Veum (MS)

EPA

Complete

Dissolved organic carbon (DOC) in surface waters affects finished drinking water quality, in particular the formation of halogenated disinfection by-products (DBP). In Missouri, 62% of the public is served by 221 drinking water systems utilizing surface waters. Both the quality and quantity of DOC impacts DBP formation and it is known that allochthonous DOC is more reactive with halogens than autochthonous DOC. Our goal in this study was to determine the relative influence of allochthonous and autochthonous DOC on the DBP precursor pool. Samples were collected from 76 reservoirs spanning a 12 month period from January 2004 through December 2004 and regression models were developed for DBP surrogates. In a cross-system analysis of annual reservoir means, 77% of the variation in DOC [1.35 – 12.37 mg/L] was explained by hydraulic flushing rate. Total phosphorus [4 – 32 ug/L] and DOC accounted for 97% of the variation in chlorine demand [4.5-19.2 mg/L] while total phosphorus and hydraulic flushing rate explained 88%. Additionally, time-series plots were compared to stream gauge data and absorbance peaks in the ultra-violet range coincided well with peaks in the hydrographs. Chlorophyll [0.6 – 195 ug/L] was weakly correlated with the DBP surrogates within and across seasons. These results indicate that watershed hydrology and allochthonous inputs controlled the DBP precursor pool in Missouri reservoirs in 2004 and that hydraulic flushing rate may have more predictive value modeling DBP formation than chlorophyll.

SEASONAL PATTERNS OF LIMNOLOGICAL CHARACTERISTICS AMONG 4 RESERVOIRS IN AN AGRICULTURALLY DOMINATED WATERSHED

Aaron Carlson (MS)

EPA

Current

Grindstone Reservoir and the Cameron City reservoirs of NW Missouri are prime examples of reservoirs that have experienced degrading water quality as a result of agricultural practices in their catchments. The seasonal dynamics of the reservoirs and their watersheds must be understood before remediation and restoration can commence. Objectives of the study are to 1) describe seasonal changes of limnological characteristics in the reservoirs, 2) describe runoff from the landscape and its impact on limnological characteristics of the reservoirs, and 3) describe seasonal variation of atrazine inputs and the effects it has on water quality within

reservoirs.

IMPACT OF SUBSTRATE ON SESTONIC ALGAL CONCENTRATIONS

Carol Pollard (MS)

John R. Jones Advisor

Current

Water quality is a growing issue in this country and around the world. To be able to tell whether a stream or river has been impacted by pollution (particularly nitrogen and/or phosphorus), we need to be able to predict its unimpaired condition. To do this we need to understand what natural factors affect the abundance of nutrients and suspended algae in a stream. One factor which may have an effect is the material the streambed is composed of, whether it be rock, sand or mud. Algae attach to the substrate, grow and slough cells into the flowing water. However, when the substrate is disturbed by high flows, the algae may be removed from the substrate and have to start growth over. Since sand and mud are more easily disturbed than rock, one would expect less algal growth on these unstable substrates, and therefore fewer algae suspended in the water. The purpose of this study is to investigate whether streambed material causes differences in the level of nutrients or suspended algae in unimpaired streams.

FECAL INDICATORS IN RECREATIONAL WATERS OF LAKE OF THE OZARKS, MISSOURI

Rebecca Wright O'Hearn (MS)

Dr. John R. Jones

University of Missouri, Columbia, Missouri

Current

Lake of the Ozarks is a popular whole body contact recreational reservoir in South Central Missouri. The reservoir's shoreline and watershed are highly developed with residential and business units. Fecal contamination is a health concern for visitors and residents because of extensive use of septic systems in the local porous soils. A study conducted in the early 1980s showed septic systems may potentially leach human fecal material into the water, which is used for whole body contact recreation. This study was repeated during summer 2007 to determine if conditions had changed with increased development. We correlated housing density, a human development index, of 35 coves (undeveloped, low, intermediate, and highly developed) with fecal coliform (FC) analysis to determine water quality. Three main channel sites were used for controls. FC values ranged from 0 to 3,325 CFU in 1981-82 recreational seasons. In 2007, FC and *E. coli* values ranged from 0 to 4,880 and 0 to 546.67 CFU, respectively. From 1980 to 2007, FC increased in main channel, undeveloped, low, and intermediate developed sites 66.8%, 207.3%, 77.7%, and 59%, respectively. FC in highly developed coves decreased 57% in 2007. FC increased with development in both 1980 and 2007, except in highly developed coves in 2007. *E. coli* also increased with development, except that levels in highly developed and intermediate developed coves were similar.

JOSHUA J. MILLSPAUGH

ASSOCIATION OF BLACK-BACKED WOODPECKERS WITH AREAS OF MOUNTIAN PINE BEETLE INFESTATION IN THE BLACK HILLS, SOUTH DAKOTA

Thomas Bonnot (MS)

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

Complete

Although commonly associated with recently burned forests, the spatial and temporal variability of fires in the Black Hills, South Dakota suggests that black-backed woodpeckers (*Picoides articus*) (BBWP) also use other habitats for nesting. We examined nest survival and habitat associations of BBWPs nesting in mountain pine beetle (*Dendroctonus ponderosae* Hopkins) (MPB) infestations in the Black Hills, South Dakota in 2004 and 2005. BBWP nesting success was 75% ($n = 12$) in 2004 and 47% ($n = 32$) in 2005, and fledged 2.0 pair/year \pm 1.13 SD ($n = 12$) and 1.43 pair/year \pm 1.4 SD ($n = 28$) in 2004 and 2005, respectively. Nest survival was best explained by temporal effects, such as age, date, and year. Nests later in development had higher survival and those initiated lower in the nesting season experienced lower survival. At the territory scale, increased availability of food resources best explained BBWP selection of MPB infestations versus the surrounding forest. Within MPB infestations, BBWPs selected nest areas with increased snag densities and selected snags over live trees for nesting. The use of MPB infestations by BBWPs and the similarity of demographics in these areas to those in burned habitat suggest that MPB infestations are likely unique and important habitats for BBWPs, and therefore, should be maintained in the Black Hills National Forest.

VALIDATION OF FECAL GLUCOCORTICOID ASSAYS FOR MEASUREMENT OF STRESS IN FREE-RANGING SOUTH AFRICAN WILDLIFE

Sathya Chinnadurai (MS)

MU; Dorris D. & Christine M. Brown Graduate Research Fellowship

Complete

Fecal glucocorticoid metabolite (FGM) assays are popular means of monitoring adrenal activity (i.e., stress) in wildlife. Species-specific differences in the glucocorticoid metabolism and excretion require assay validation, including both laboratory (biochemical) and biological components, before use in new species. Laboratory validation involves an evaluation of parallelism and exogenous hormone recovery tests, to test the reliability of the assay antibody. A biological validation involves comparison of FGM levels at times when glucocorticoid excretion is expected to differ, either due to natural stressors (e.g., cold vs. hot temperatures) or pharmacological stimulation (i.e., adrenocorticotropin injection). We validated a commercially available radioimmunoassay (MP I¹²⁵ corticosterone RIA) for measuring FGM of several South African herbivores, including giraffe (*Giraffa camelopardalis*), impala (*Aepyceros melampus*),

nyala (*Tragelaphus buxtoni*), kudu (*Tragelaphus strepsiceros*), wildebeest (*Connochaetes taurinus*) and zebra (*Equus burchelli*). Our laboratory validation produced sample dilution curves that were parallel to the standard curve with 90-110% exogenous recovery for all species. Our biological validation showed that the technique was sensitive enough to detect changes in FGM production associated by season. Samples collected during the dry season (June-August) contained significantly higher FGM levels than those from the wet season (December-February) in all species except zebra. We established optimal sample dilutions and baseline fecal corticosterone metabolite levels for monitoring the effects of manipulation of the ecosystem for management and tourism purposes.

RESOURCE SELECTION BY BLACK-FOOTED FERRETS IN RELATION TO THE SPATIAL DISTRIBUTION OF PRAIRIE DOGS

David S. Jachowski (MS)

U.S. Fish and Wildlife Service; U.S. Forest Service; Love

Complete

Once extinct in the wild, the black-footed ferret (*Mustela nigripes*) is one of the rarest mammals in North America. Reintroductions of ferrets to 13 sites over 10 years have resulted in only 3 self-sustaining populations. Current knowledge of ferret habitat requirements is inadequate to understand why previous reintroductions have failed at many sites, and it is inadequate to guide the selection of sites for future reintroductions. Space use by predators is known to be influenced by the spatial distribution of prey. For ferrets, prairie dogs (*Cynomys sp.*) compose over 90% of the diet. However, the way we currently assess ferret habitat does not account for fine-scale variations in prey distribution. In 2005, we measured the location of all black-tailed prairie dog (*Cynomys ludovicianus*) burrows at two study sites to test the hypothesis that prairie dogs are unevenly distributed within a colony. We found that prairie dog burrows were unevenly distributed, forming areas or patches of high density that changed in shape and location over relatively short time periods. We also tested the hypothesis that ferrets were selecting for areas of high prairie dog burrow density. In 2005 and 2006, we monitored ferret resource use at a site with a self-sustaining ferret population in South Dakota, as well as at a site with a non-self-sustaining ferret population in Montana. Using an information theoretic approach, we tested models that assessed observed ferret resource selection patterns against a suite of resource attributes including prairie dog distribution, territoriality measures, and edge effects. We found that prairie dog burrow distribution strongly influenced ferret resource selection. We also found that territoriality and home range size of ferrets were correlated with prairie dog distribution. Our results show that assessing the suitability of prairie dog colonies for ferret habitat requires spatially explicit, fine-scale measurement of prairie dog burrow distribution. Further managers should focus on preserving and enhancing large contiguous areas or patches of high prairie dog density as a key requirement for successful establishment and maintenance of ferret populations.

SPACE USE AND RESOURCE SELECTION BY EASTERN SPOTTED SKUNKS IN THE OUACHITA MOUNTAINS, ARKANSAS

Damon Lesmeister (MS), Matthew Gompper (Co-Advisor)

MU; U.S. Forest Service; Arkansas Game and Fish Commission

Complete

Once a common and economically important furbearer, the eastern spotted skunk (*Spilogale putorius*) is now listed as endangered, threatened, or a species of conservation concern throughout much of its historical range. Virtually nothing is known about the fundamental ecology of the species or the potential effects of forest management strategies on habitat use. To elucidate home range dynamics and habitat selection, we conducted telemetry-based field work in the Ouachita National Forest of western Arkansas. During two years of field work we collected locations at 28-hour intervals for 33 eastern spotted skunks. Using kernel-based utilization distributions and the volume of intersection indices, we found significant seasonal and intersexual differences in the home range dynamics. Adult males maintained spring ranges of 866 (\pm 235 SE) ha, which were much larger than the 76 to 175 (\pm 22-62 SE) ha ranges during the nonbreeding season and the 54 to 135 (\pm 7-30 SE) ha ranges of females. We observed little home range overlap between adults, especially between adult females. Using weighted compositional analysis we determined that during each season young shortleaf pine and hardwood stands were selected over other available habitat types. A comparison of used and available resting and denning sites using discrete choice analysis revealed similar patterns; selection for sites with young pine and old hardwood stands, higher canopy closures, rock and vine densities, steeper slopes, and smaller site entrances. These findings suggest that eastern spotted skunks are solitary carnivores that select structurally complex habitat that enhances protection from predators. The species may be vulnerable to forest ecosystem changes that result in a more open canopy and herbaceous understory, a management strategy used extensively in parts of the Ouachita National Forest.

EFFECTS OF CULLING ON BISON DEMOGRAPHICS IN WIND CAVE NATIONAL PARK, SOUTH DAKOTA

Millsbaugh
National Park Service

Complete

We used a stochastic Leslie matrix model parameterized with demographic data from Wind Cave National Park to evaluate effects of 4 culling strategies on population growth rates and age and sex structure of bison (*Bison bison* Linnaeus). The four culling scenarios we modeled included removal of: (1) yearlings only; (2) calf/cow combination; (3) a herd-wide proportional cull (i.e., individuals taken in proportion to their availability); and (4) calves only. We also allowed either 1, 2, or 3 years to elapse between culls to mimic current management activities, and chose culling values for each scenario that would maintain a stable population (i.e., $\lambda \approx 1.00$). In the absence of culling, our model projected a growth rate of 16% per year ($\lambda = 1.16$) (SD = 0.02) for the Wind Cave bison population. The modeled population was characterized by a unimodal age structure for bulls and cows and a 1:1 bull: cow ratio. Removal of 75% of the yearlings or 75% of the calves every year was needed to maintain abundance at current size. These culling strategies altered the age distribution from baseline conditions, resulting in nearly equal proportions of age classes 2-15. When yearling culling or calf removal was skipped one year or

two consecutive years, the yearling or calf removal option resulted in positive population growth even in the presence of a 90% cull. Because these strategies nearly removed entire cohorts, corresponding gaps were introduced in the age structure. About 40% of calves and 20% of cows needed to be removed under the annual calf/cow cull to stabilize population growth, producing a unimodal age structure of cows. However, the proportion of bulls in the 2-16 age classes increased, and the proportion of males was nearly equal across the middle age classes. The proportional cull, regardless of time between culling operations, resulted in the most symmetric age structure for males and females. To achieve $\lambda \approx 1.00$ under a proportional cull strategy 16% of all animals would need to be removed annually, 33% every other year, or 50% once every three years. Sensitivity and elasticity analysis indicated that adult females (5-13 years old) were the most important group of bison affecting λ . These modeled effects, along with factors such as logistical constraints, costs, efficacy, viewing opportunities for tourists, genetics, behavior, and agency policies should be considered when managers choose among culling strategies. When considering historical predation and harvest by Native Americans, we hypothesize that the calf/cow combination cull would have most closely approximated natural bison demographics after the widespread availability of horses in the year 1735. Before 1735, we hypothesize that the proportional cull would most closely represent historic conditions, although even this option might not reproduce the variability inherent in historical bison dynamics. We discuss the possibility and management implications of variable culling that might more closely mimic historical influences on bison populations on the Northern Great Plains.

SURVIVAL, HOME RANGE AND RESOURCE SELECTION OF TRANSLOCATED CAPTIVE-REARED OZARK HELLBENDERS

Cathy Bodinof (MS)

Missouri Department of Conservation; St. Louis Zoo

Current

Hellbender (*Cryptobranchus alleganiensis*) salamanders have recently experienced widespread declines throughout their range. Populations in Missouri have decreased by almost 80% over the past two decades, yet causes for this decline are poorly understood. Illegal and over collection, alterations to water quality, introduced predators (i.e. non-native game fish) and the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) have all been implicated for declines of hellbenders in Missouri. The Missouri Department of Conservation and the St. Louis Zoo have collaborated to captively rear 46 Ozark hellbenders (*C.a.bishopi*) that originated from clutches taken from the wild in 2003. These animals were intended for reintroduction as a method to maintain wild populations until causes for the decline could be identified and arrested. In spring 2008, these juvenile hellbenders will be surgically implanted with radio transmitters and released at two sites on one Ozark River. Our objectives include continuous monitoring of individuals for over one year in order to document survival rates, home range and resource selection of translocated animals. Results from the study will identify resource attributes associated with juvenile hellbender use and will provide management agencies with valuable information concerning viability of repatriation as a conservation strategy for this species.

EVALUATION AND ESTIMATION OF BLACK-FOOTED FERRET RESOURCE SELECTION MODELS: CONSERVATION AND MANAGEMENT IMPLICATIONS

David A. Eads (MS)

U.S. Fish and Wildlife Service; U.S. Forest Service; South Dakota Department of Game, Fish, and Parks; Prairie Wildlife Research; National Fish and Wildlife Foundation

Current

Increased understanding of the resource selection patterns of wildlife is an important step in designing conservation actions, particularly for black-footed ferrets (*Mustela nigripes*), an endangered musteline carnivore. A recent evaluation of resource selection by released and free-ranging ferrets in South Dakota and Montana, USA, suggested selection of high active prairie-dog-burrow densities (*Cynomys spp*), and intraspecific and edge-of-colony influences on the selection patterns of individual ferrets; these aforementioned variables comprised the best approximating resource utilization function (RUF) of resource selection by individual ferrets during that study. Using independent data collected between 2007 and 2008 on a black-tailed prairie dog (*C. ludovicianus*) colony in the Conata Basin of western South Dakota, and methods of prospective model-evaluation, we will evaluate the ferret RUF. Validation of the model would suggest high predictive capabilities of the model, and applicability in evaluations of potential and current black-footed ferret habitat. We will also develop a new site-specific model using an alternative approach to resource selection estimation. This approach might facilitate continued model refinement, and general scientific understanding of the habitat-attractions and requirements of black-footed ferrets, thereby facilitating management and conservation of this endangered carnivore.

DEVELOPMENT OF A MONITORING PLAN FOR THE NORTHERN GREAT PLAINS I&M PROGRAM

Robert Gitzen (Postdoc)

National Park Service

Current

The National Park Service (NPS) Inventory and Monitoring Program was initiated by the National Parks Omnibus Management Act of 1998. This act directs the NPS to "undertake a program of inventory and monitoring of National Park System resources to establish baseline information and to provide information on long-term trends in the condition of the National Park System resources." The 13 park units in the Northern Great Plains Network are working collectively to meet this mandate and to conserve natural resources unimpaired for future generations. The network is wrapping up the inventory phase of this effort and beginning planning for the monitoring phase. NPS managers are confronted with increasingly complex and contentious issues that require a broad understanding of the status and trends of park resources. Knowing the condition of natural resources in park units—and the human impacts on those resources—is critical to meeting the NPS mission to manage resources in a manner that leaves them “unimpaired for the enjoyment of future generations” (16 U.S.C. 1 § 1). Achieving this mission generally requires a collaborative ecosystem approach towards monitoring and management because parks are open systems with external threats such as invasive species and

air and water pollution. Furthermore, no single spatial or temporal scale addresses all system components and processes; i.e., the appropriate scale for understanding and effectively managing a resource might be at the genetic, individual, population, community, or landscape level. Consequently, management of resources may require local, regional, national, or international collaborative efforts. We are developing a monitoring program to track a subset of physical, chemical, and biological elements and processes affecting park ecosystems.

DEVELOPMENT OF A SITE-OCCUPANCY MODEL FOR RUFFED GROUSE MONITORING IN THE BLACK HILLS NATIONAL FOREST

Chris Hansen (MS)

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

Current

Monitoring of ruffed grouse (*Bonasa umbellus*) has been largely nonexistent in the Black Hills National Forest (BHNF). Because of its identification as a management indicator species for aspen (*Populus* sp.), it is essential that monitoring occur to measure ruffed grouse and aspen population trends in the Black Hills. Due to limited time and manpower, a monitoring protocol must be established that minimizes survey effort while offering statistical validity. We propose to develop and test a monitoring protocol based on occupancy modeling which will allow us to evaluate the occurrence of ruffed grouse throughout the Black Hills while determining what characteristics of aspen patches (eg., size) most affect ruffed grouse metapopulation dynamics (i.e., extinction and colonization rate). By incorporating occupancy models with drum counts, it is our objective to determine the probability of occupancy and detection of ruffed grouse throughout the BHNF, while establishing a monitoring protocol that will be consistently completed in the future. Results obtained from drum count surveys will provide managers with a better knowledge of ruffed grouse population trends and resource selection, thereby making management decisions more robust.

EVALUATION OF A FORAGE PRODUCTION/ALLOCATION MODEL FOR UNGULATE MANAGEMENT IN CUSTER STATE PARK, SOUTH DAKOTA

Barbara Keller (PhD)

Custer State Park; South Dakota Department of Game, Fish, and Parks; Rocky Mountain Elk Foundation; Love

Current

Forage production/allocation models are used by wildlife managers to predict range condition and carrying capacity, and to facilitate management of ungulate populations to reach specific goals. Custer State Park (CSP), located in the Black Hills of South Dakota, uses a forage production/ allocation model to manage ungulate populations. CSP hosts several dominant species of forage utilizers, including elk (*Cervus elaphus*), bison (*Bison bison*), mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), bighorn sheep (*Ovis canadensis canadensis*), and pronghorn (*Antilocapra americana*). One goal of the CSP

management plan is to maintain a balance between forage demands of Park ungulates and range production; and specifically to have 80% of each pasture unit in good or excellent condition. Soil Conservation Service (now Natural Resource Conservation Service, NRCS) guidelines were developed 30–50 years ago to estimate Park forage production and associated carrying capacity of large ungulate species; these production estimates remain untested. The Park also utilizes various untested assumptions as to utilization and overlap in range and diet among ungulates. The result of this modeling exercise is a major determinant of production and therefore carrying capacity estimates to improve ungulate management in CSP. Decisions based on these results have a significant impact on habitat condition and directly influence hunting and culling quotas (stocking rates), principally of bison and elk. This project is in its third year of involvement. Radio-telemetry data has been collected over the past 3 years during spring, summer, fall and winter seasons from radio-collared bison and pronghorn. An analysis of interspecific resource selection and spatial overlap is currently underway. Forage production data from fall 2005, 2006, and 2007 is being analyzed to determine range-site specific forage production throughout CSP. Forage production data collection will be completed in fall 2008. Microhistological analysis of fecal samples from all 6 ungulate species to determine seasonal diet composition and diet overlap is currently underway.

DISTRIBUTION AND RESOURCE SELECTION OF PRONGHORN IN SOUTHWESTERN NORTH DAKOTA

Jesse L. Kolar (MS)

North Dakota Department of Game and Fish; Bureau of Land Management

Current

As the only endemic ungulate species in North America, pronghorn are a culturally significant species in the arid plains. In southwestern North Dakota pronghorn are recreationally valuable for hunters and wildlife viewing. Though once exploited to near extinction, pronghorn populations have rebounded and hunting is now an important management tool. The North Dakota Game and Fish Department (NDGF) regulates the pronghorn harvest by limiting the number of licenses in specific hunting units, and the number of licenses is determined largely by an annual aerial survey. However, landowners and sportsmen have raised concerns about the inadequacy of a mid-summer survey for a fall hunting season. For the past four years, the NDGF has collared pronghorn with VHF and GPS collars. In this project we will investigate migration patterns to evaluate assumptions made in current management methods, specifically the hunting and survey units. Furthermore, we will use kernel estimates developed from the GPS data to analyze resource selection. As a result of this research, managers will better understand causes of migration and target seasonally important range with the resource selection analysis.

MOURNING DOVE DEMOGRAPHICS AND HARVEST MANAGEMENT IN AN AGROFORESTRY COMPLEX

Millsbaugh

MU Center for Agroforestry; Missouri Department of Conservation; James A. Reed Conservation Area; U.S. Fish and Wildlife Service

Current

Future improvements in mourning dove harvest management will rely on information that cannot be obtained from simple roadside trend data. Rather, the National Mourning Dove Strategic Harvest Management Plan shows that future harvest management decisions will be based upon mechanistic population models, requiring modern estimates of demographic characteristics (e.g., recruitment, survival). Broad spatial scale estimates of survival and recruitment can be obtained from a sample of banded individuals along with a sample of wings from hunter-killed doves. However, the impacts of intensively utilized local populations are uncertain. Therefore, our objectives are (1) to estimate local mourning dove population characteristics (e.g., recruitment, survival) and local harvest characteristics (e.g., harvest rates, crippling rates) during 2005-2010, and (2) evaluate agroforestry practices while determining the efficacy of associated number of sunflower fields and field size to attract mourning doves for harvest on James A. Reed Memorial Wildlife Area (JARMWA) during 2005-2010. Knowledge generated from this project will also guide management decisions for private landowners combining agroforestry practices and managed dove hunting fields, provide information about relationships between observed recruitment from radio marked doves and fall age-ratios from hunter-killed doves, provide comparisons of actual and reported crippling rates during the hunting season, and provide information on harvest rates on a heavily harvested local population of mourning doves. During 2005–2007 we implanted subcutaneous transmitters with external antennas in 589 doves. Of the 589 dove implanted with transmitters, 66 were implanted in nestling doves prior to fledging (2005 = 10 nestlings, 2006 = 35 nestlings, 2007 = 21 nestlings). Time needed to implant transmitters required approximately 9–10 minutes per procedure. For survival analysis, the maximum number of birds at risk during a given day during a field season ranged from 26–46 for AHY and 36–44 for HY; we increased our sample size in late summer each year to increase the precision of survival estimates during the hunting season. We used the Kaplan–Meier product limit estimator with staggered entry to initially estimate survival by age class and year. Crippling rates reported by hunters as the number of birds shot and not retrieved averaged 16.8% during the month of September compared to an actual crippling rate estimate of 9.0% using available radio-marked doves available on the area during opening day of the hunting season.

DEVELOPMENT OF AN ANIMAL-BORNE AND ENVIRONMENTAL DATA COLLECTION SYSTEM FOR WHITE-TAILED DEER

Remington Moll (MS)

MU; Missouri Department of Conservation; National Science Foundation

Current

In the past 20 years, technological advances have produced dramatic changes in ecological investigations. Recently, animal-borne video and environmental data collection systems (AVEDs) have emerged as an advanced form of biotelemetry that combines video with other animal-borne sensors (e.g., audio, GPS). AVEDs open numerous doors for fine-scale behavioral research, including investigations into animal interactions, contact rates, disease transmission, bioenergetics, and rare behaviors (e.g., predation events). This project has 3 objectives: 1) to publish a critical review of AVED technology, discussing past contributions of AVED studies,

technological and logistical challenges to surmount, and future directions for AVED research, 2) to evaluate the physiological stress response of white-tailed deer to AVED attachment through fecal glucocorticoid analysis, and 3) to develop and demonstrate the utility of a small, long-lasting, energy-efficient system for white-tailed deer. Our project will further the field of AVED research by evaluating the opportunities and challenges associated with AVEDs through the review, increasing the robustness of AVED applications through the stress assessment, and creating research opportunities through the development of our system.

WILDLIFE RESPONSE TO SPATIAL AND TEMPORAL CHANGES IN FOREST HABITAT

Chadwick Rittenhouse (PhD), Frank Thompson III (Co-Adviser)

U.S. Forest Service

Current

Advancements in landscape simulation software (e.g., LANDIS) and geographic information systems (GIS) provide a means for quantifying the effects of alternative forest management practices on wildlife habitat across large spatial scales. We developed GIS-based habitat suitability models for 9 wildlife species that use forest inventory-type data, such as tree species, tree age, and ecological land type, as primary inputs. Additionally, these models included important spatial relationships such as patch area, edge sensitivity, and interspersed habitat types. We used these models to evaluate changes in habitat suitability under 5 alternative forest management strategies for the Hoosier National Forest, Indiana. Substantial shifts in the mean and distribution of HSI values for individual species occurred due to differences in harvest methods and prescribed burning between alternatives. The Hoosier National Forest planning team used the information on vegetation conditions and habitat suitability to select the current plan, with the addition of a focal area to concentrate harvest activities, as the preferred alternative. We validated a subset of the habitat suitability models for two species, wood thrush and yellow-breasted chat, using an independent data set on within-site territory density, site-level territory density, and nest success. We demonstrated a statistically significant, positive link between HSI values and all three types of demographic responses for the yellow-breasted chat and site-level territory density for the wood thrush. Based on our validation results, our habitat suitability models represented wildlife demographic response. However, a large amount of variation, indicated by deviance ratio tests, was not captured by the models. Differences in species ecology may contribute to model significance and model selection uncertainty.

CHARLES H. NILON

PROVISION OF NECTAR SOURCES AND LARVAL HOST PLANTS: EFFECTS ON BUTTERFLY SPECIES AND NUMBERS IN SUBURBAN AND URBAN YARDS

Donna Brunet (MS)

Complete

Butterflies are considered to be good indicators of a healthy environment and reflect the environmental impact of urban development. The popularity of butterflies with the general public and declining butterfly populations, combined with the fact that lawns now occupy more than 12 million hectares in the United States, make a compelling case for a systematic survey of garden butterflies.

This study looked at which species occur in Columbia, Missouri and which nectar sources they use. In addition, surveys examined the attitudes of people toward butterflies and other insects. We also looked at the impact of different lawn maintenance regimes on attracting butterflies to yards.

We recruited volunteers to count butterflies in their yards once a week for 15 minutes from May through September 2002 and 2003. Volunteers observed most of the butterfly species expected in mid-Missouri. In addition to identifying and counting butterflies, they recorded the flowers on which any butterflies landed. Based on a literature search, flower genera were categorized as “recommended” or “not recommended” for use in butterfly gardens. Approximately 90% of the butterflies that were observed on flowers each year were on genera typically recommended for use in flower gardens. Genera most heavily used included *Asclepias*, *Buddleja*, *Coreopsis*, *Echinacea*, *Eupatorium*, *Liatris*, *Rudbeckia*, *Salvia*, *Sedum*, *Tagetes*, *Trifolium* / *Melilotus* / *Medicago*, *Verbena*, *Zinnia*. Yards in which homeowners tolerated a more “weedy” appearance had both more butterflies and more species per count.

AN EVALUATION OF MISSOURI MASTER NATURALIST PROGRAM: CHANGES IN VOLUNTEER KNOWLEDGE AND THE EFFECT OF MOTIVATIONS ON CHANGES IN KNOWLEDGE

Caroline Buenger (MS), Bob Pierce (Co-adviser)

MDC special funds

Complete

The Missouri Master NaturalistTM (MN) program educates adults who then volunteer to help manage their community’s natural resources. Our research evaluated Missouri’s MN training program. Our first objective was to determine if the training program resulted in changes in volunteers’ knowledge of ecological processes and conservation issues in Missouri. Our second objective identified volunteer’s motivations for participating in the program, and sought to

determine if a relationship existed between volunteer's motivations and any improvement in knowledge.

We found that there was an improvement in volunteer's overall knowledge score after participating in the MN program ($F(2, 76) = 50.678, p < 0.000$). Scores improved from the pre-training to the post-training survey ($t(77) = -10.356, p < .000$). No significant improvement occurred from post-training to the six-month follow-up survey ($t(38) = -.057, p > .955$), though volunteers maintained their level of knowledge. Volunteers' primary motivations were values/altruism and a desire to learn. There was no significant relationship between any particular motivation and improvement in knowledge at the end of the MN training program.

ECOLOGY AND BEHAVIOR OF EASTERN GRAY (*SCIURUS CAROLINENSIS*) SQUIRRELS IN URBAN AREAS

Tommy Parker (PhD)

Gus T. Ridgel Fellowship; George Washington Carver Fellowship, MU School of Natural Resources; Brown Fellowship, College of Agriculture, Food, and Natural Resources; Wildlife Research Equipment Grant; Sandpiper Technologies

Complete

Recent trends in ecological studies have displayed increases in the studying of urban systems and wildlife. Investigations on various urbanized taxa have often described similar behavioral (reduced fear of humans, altered activity patterns, and increased intraspecific aggression) and population dynamics (higher densities and reduced dispersal) modifications. In addition to the presence of these changes in urbanized wildlife, little is known regarding the habitat and landscape features associated with these changes. The objective of my study was to identify habitat and landscape characteristics correlated with behavioral and life history adaptations of urban wildlife.

In the summer and fall of 2003 and 2004, I sampled gray squirrels (*Sciurus carolinensis*) at six urban parks for density, wariness, intraspecific aggression, and activity patterns. I then used combinations of each park's ecological characteristics (size, canopy cover, tree basal area, and number of trees) and the characteristics of the adjacent landscapes (tree cover, number of trees, building cover, and number of buildings) to develop models to predict gray squirrel wariness (fear of humans), intraspecific aggression, activity patterns, and density. Akaike's Information Criterion (AIC) was used to evaluate candidate models and determine the best approximating models. Density and canopy cover were the most efficient predictors for wariness (AIC = 48.42, $W_i = 0.500$); density, patch tree basal area, and matrix tree cover for aggression (AIC = 39.54, $W_i = 0.567$); patch size, canopy cover, and number of matrix trees for density (AIC = 57.40, $W_i = 0.237$), and density for activity (AIC = 34.02, $W_i = 0.253$).

MUSKRAT MANAGEMENT IN AN URBAN WETLAND

Matt McCloud (PhD)

Current

Forest Park sits within the city of Saint Louis, Missouri and is considered to be an active participant and catalyst in the Saint Louis community. Forest Park at 1293 acres (5.2 sq. km) is one of the largest urban green spaces in the United States. In accordance to the master plan that was created in 1993, the St. Louis City Parks Department, in collaboration with the private, not-for-profit organization Forest Park Forever, began a restoration of the park to return it to its former status as an urban oasis for both people and wildlife. One of the specific goals of the master plan was to return a natural stream to the park. Construction started in 1997 to connect all the lakes and lagoons from Jefferson Lake in the southeast corner of the park, all the way to the Cascades in the western end. In the process of recreating some of the bygone natural areas problems have arisen in managing certain animal populations that have increased to nuisance levels due to the lack of natural predators. One species that has responded well to implemented wetland manipulations is the muskrat (*Ondatra zibethicus*). However, the high muskrat population has not only resulted in wetland degradation through the clearing of beneficial wetland vegetation, but has also had an effect on the overall trophic dynamics of the wetland system by reducing the overall nursery/feeding habitat for planktivores. Park managers are currently exploring non-lethal methods in which to control the muskrat population and sustain the wetland areas as designed.

My proposed research topic will address two questions concerning muskrats in urban wetlands: 1) What effect does muskrat densities have on the overall health of the wetland as a feeding/nursery for planktivores, and 2) What type of control (trapping or cattail control) is most effective in controlling muskrat densities?

THE EVALUATION OF THE ABILITY OF AN ENVIRONMENTAL EDUCATION PROGRAM TO ALTER THE PRECONCEIVED NOTIONS OF WILDLIFE BY INNER-CITY YOUTH

Brandon Pope (MS)

George Washington Carver Fellowship

Current

My study will focus will on perceptions of wildlife by inner-city children before and after their participation in an after-school environmental education program. I will use the 4-H Wildlife Habitat Evaluation Program (WHEP, <http://www.whep.org/>) as a tool for involving children in 4-5 middle schools in Kansas City, MO in an assessment of wildlife habitat in and around their school. Small groups of students will be interviewed before and after their participation in WHEP to assess their perceptions of wildlife and wildlife habitat.

My goal is to ascertain if an environmental education program can foster enthusiasm in inner-city children about wildlife. In one dimension, this interest can encourage the children to recognize that although they live in areas not associated with wildlife, animals do reside in cities and should be given some level of concern. On a larger scale, this awareness can lead to a

diverse group of future natural resource managers, an aspect lacking in our field.

URBAN DEER MANAGEMENT: DETERMINING HUNTER'S DEMOGRAPHICS AND PERCEPTIONS AND THEIR INFLUENCES ON PARTICIPATION AND LANDSCAPE PREFERENCE IN AN URBAN ARCHERY HUNTING SEASON

Nathan Weber (MS)

Current

Management of urban, white-tailed deer has been an important issue in many communities within their geographical range. White-tailed deer are both the most sought after game species in North America and rated as one of the top species wildlife viewers like to encounter, but they also are the cause of more damage and injury than any other North American Species. Some municipalities like Columbia, Missouri, have used archery hunting as a tool to reduce deer densities within their boundaries. My research, obtained through hunter surveys, focuses on what factors lead hunters in Columbia to choose to take part in urban management seasons. Additionally, I focus on how demographics, motivations, and preferences of landscape relate to harvest and a hunter's idea of success. The research will hopefully lead to a better understanding of factors that determine participation, motives, and habitat preferences of urban archery hunters, which can lead to the formation of more effective policies to control white-tailed deer populations.

DOUGLAS B. NOLTIE

INTERACTIONS BETWEEN THIAMINE AND TCDD IN FISH EMBRYOS

Peggy J. Wright (PhD)

Don Tillet (CERC)

RWOs #s 41, 50, and 56 - USGS/CERC

Complete

Salmonid populations in the Great Lakes experienced a decline in the early twentieth century, presumably due to over-fishing combined with the introduction of exotic parasites such as the sea lamprey. Despite intensive rehabilitation and stocking programs, today significant natural reproduction exists only in Lake Superior. Dioxin-like contaminants (i.e., PHHs) are known to cause adverse effects in early life stage lake trout, and results indicate that even the low levels currently present in Lake Michigan can result in sublethal physical lesions or behavioral alterations such as diminished C-start response. 2,3,7,8-TCDD caused significant adverse effects of both C-start behavior and feeding in rainbow trout and lake trout young. In addition to the presence of contaminants, a nutritional thiamin deficiency has been shown to cause high mortality, termed Early Mortality Syndrome (EMS), in Great Lakes swim-up fry. In the current

study, fry eventually succumbing to EMS exhibited reduced embryo C-start behavior. It appears that neither the presence of PHHs nor EMS mortality can fully account for the total lack of lake trout recruitment in the lower Great Lakes. However, it is possible that an interaction between the two stressors can result in greater than expected effects on fry health and survival.

AN ASSESSMENT OF IN SITU HABITAT UTILIZATION BY OZARK CAVEFISH

Ken Lister (MS)

MDC special funds, USGS Missouri Water Resources Research Center, The Nature Conservancy – Oklahoma Chapter

Current

The Ozark cavefish, a federally endangered species, occurs mainly in limestone cave systems in southwest Missouri. Systematic surveys of existing, potential, and previously unexamined cave systems were used to update the species' distribution in the state. Habitat evaluations repeated through time within occurrence and nonoccurrence locations were used in an attempt to characterize the physical and hydrological environments which sustain the species. This information will be used to guide and structure recovery efforts based on habitat preservation and restoration, or the establishment of additional populations.

REPRODUCTIVE BEHAVIOR AND TEMPERATURE, PHOTOPERIOD, AND SUBSTRATE SIZE REQUIREMENTS FOR PROPAGATING THE TOPEKA SHINER (NOTROPIS TOPEKA) IN THE LABORATORY

Chris Witte (MS)

Mark Wildhaber (CERC)

RWO # 94 USGS/CERC

Current

The Topeka shiner inhabits prairie streams having intermittent summer flows. Historically, it ranged from southern Minnesota and South Dakota through Iowa, Nebraska, Missouri, and Kansas. While remnant populations are still found in all of these states, the species has been extirpated from approximately 90% of this area. The Topeka shiner was officially added to the Federal Endangered Species list in 1998 and efforts are being made to recover the species. However, little is known about its reproductive behavior or environmental requirements for spawning. This research will expose test animals to different temperature and photoperiod combinations to determine which induces the highest level of reproductive activity. Behavior will be recorded by means of surveillance cameras connected to a time-lapse videocassette recorder for subsequent analysis. An additional experiment will test whether the Topeka shiner demonstrates a preference for substrates of specific sizes while spawning. Overall, study results will aid in the propagation and recovery of Topeka shiners, and contribute to knowledge of the species' life history.

CHARLES F. RABENI

THE INFLUENCE OF HABITAT TYPE ON SECONDARY PRODUCTION OF THREE SPECIES OF CRAYFISH (*ORCONECTES SPP.*) IN AN OZARK STREAM

Shannon Brewer (PhD)

Robert DiStefano (MDC)

Advisor: Charles Rabeni

Funding Source: Missouri Department of Conservation

Complete

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.

A FISH IBI FOR MISSOURI STREAMS

Kathy Doisy (Senior Research Specialist)

Matt Combs (MDC)

Randy Sarver (MDNR)

USEPA, MDNR

Complete

The objective of this project was to develop a fish Index of Biological Integrity for wadeable streams in Missouri. Fish collections (>450) used in this project were made using identical protocols (EPA – REMAP) between 1994 and 2005. Out of 72 candidate reference sites 43 were retained. The two major ecoregions of Missouri (Plain and Ozark) were quantitatively evaluated, and the differences were sufficient to warrant the development of a unique IBI for each ecoregion. Forty-two candidate fish metrics were evaluated (Ozark n = 26, Plain n = 17). Criteria relating to the range, normality and variability with reference conditions resulted in elimination of 3 Plain metrics and 1 Ozark metric. Responsiveness to anthropogenic disturbance was

evaluated by statistically testing metric scores between reference and impaired sites. The data support the conclusion that, for the Plain ecoregion, reference site conditions are scarcely better than those for the impaired sites. We concluded that the development of a useful IBI for the Plain ecoregion is not possible at this time. Additional work focused exclusively on development of an IBI for the Ozark ecoregion. Metric precision and Metric redundancy were examined. Final metric selection consisted of five metrics from the richness category: number of native darter species, number of native benthic species, number of native water column species, number of native minnow species, number of all native lithophilic species, two metrics from the balance/diversity/composition category: proportion of native sunfishes, and proportion of the 3 dominant species; one metric from the trophic and reproductive category: proportion of native insectivore cyprinid species, and one metric from the abundance category: number of native individuals.

A validation data set (n = 19) containing a wide range of habitat scores was assembled with sites different than those used in the calibration tests. Several statistical tests indicated a good ability for the IBI to distinguish the “good” from “poor” sites. The development of a fish IBI for the Ozark ecoregion was successful and should serve as a useful indicator of the biological condition of wadeable streams in this area. We suggest that future work on IBI development in Missouri be to produce a viable IBI for the Plain ecoregion, and be directed towards a more data-based approach to the screening process of the reference and impaired sites.

DEVELOPING A BIOMONITORING PROTOCOL FOR SPRINGS WITHIN THE OZARK NATIONAL SCENIC RIVERWAYS, MISSOURI

Kathy E. Doisy (Senior Research Specialist)

Victoria Grant, (NPS)

RWO # 93 – NPS

Complete

The Ozark National Scenic Riverways (OZAR) located within the Ozark Plateau is renowned for its concentration and abundance of large freshwater springs, whose discharges provide more than 60% of the flow for the Current and Jacks Fork Rivers. Although benthic macroinvertebrates metrics have been developed to monitor the health of these rivers, no such set of metrics has been developed for the spring habitats within the OZAR. 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. Due to the information derived from this review indicating high variability among spring communities of different size and types, the focus of this research was restricted to 8 of the primary and secondary magnitude springs within OZAR in an effort to develop a standardized biomonitoring protocol that would be applicable for at least the major springs. The first collections (performed in October 2003) were used to assess different aspects of the communities including: 1) baseline information on the invertebrate communities; 2) effects of various sampling techniques on the community assessments; and 3) determining communities associated with the various springs. Analyses showed that despite focusing on 8 of the largest springs within the region, the invertebrate communities were widely variable among springs and

the primary influence on the invertebrate communities was discharge. This indicated that any effort to establish a protocol that would be applicable to all the sites would not be adequately sensitive to disturbance. Further analyses indicated that while subsampling was acceptable, variability within individual springs was high enough to require an unacceptable number of samples to achieve precision within 30% of the mean (unacceptable = high cost, effort, and potential physical damage to springs). Thus a qualitative sampling method using specific biological criteria for each of the springs was proposed. A protocol narrative and the preliminary standard operating procedures were developed according to NPS specifications. These have been submitted to NPS personnel for review.

SEDIMENT IN MISSOURI STREAMS: CONTROLLING FACTORS AND EFFECTS ON BIOTA.

Kathy E. Doisy (Senior Research Specialist),

Scott Sowa (MoRAP)

Shannon Brewer (PhD candidate)

EPA

Complete

We were interested in determining whether we could detect differences in inchannel deposited sediment conditions due to landscape factors of geology, soil characteristics and land use that are generally available as GIS coverages. We designed the study, not initially on landscape features, but instead on the distribution of smallmouth bass *Micropterus dolomieu*, whose distribution roughly coincides with the Ozark and Ozark border physiographic regions. Thirty-six stream segments were selected for study using a hierarchical set of criteria that allowed us to assess both natural and human-induced variations in stream sediment conditions across Missouri. The Missouri Resource Assessment Partnership (MoRAP) generated numerous stream segment-specific watershed statistics for various landscape/land use features for each of the nearly 150,000 stream segments in the state. Then 2,664 fish community samples were spatially linked to a specific stream segment. Decision tree analysis was used to model the relations between smallmouth bass *Micropterus dolomieu* abundance and physical features. Important physical features related to smallmouth bass abundance and presence were aspects of soil texture and soil permeability and these factors were used to develop four groupings or “clusters” of sites. Each of the four groups was assigned 9 streams where the predominant land use was forest (n=3), pasture (n=3), or urban (n=3). This design allowed evaluation of relations between in-stream deposited sediment and both natural factors and land uses. A field crew performed an evaluation of physical habitat and deposited sediment conditions. Each site was evaluated for reach-scale habitat conditions including in-channel sediment conditions using USEPA-EMAP protocols. Additional intensive sediment and substrate sampling was done. The GIS watershed and segmentshd variables were more strongly related to multiple measures of deposited sediment than were the EMAP channel and riparian variables taken on site. There were particularly strong associations of multiple measures of deposited sediment with the natural factors of watershed elevation, geology, two of the Hydrologic Soils groups, cherty soils and loamy soils, and spring flow. For the land use/land cover variables significant associations were found with % bare land (-), % cropland (+), and % cool grasses (-).

IMPACTS OF SUSPENDED AND DEPOSITED SEDIMENT ON BENTHIC INVERTEBRATES AND FISHES IN A MISSOURI OZARK STREAM

Zachary L. Ford (MS)

Leanna Zweig (MDC)

MDC Special Funds

Complete

Sediment is suspected in the decline of sensitive-aquatic organisms in the Osage River basin of Missouri. In this study, I monitored sediment dynamics and evaluated corresponding linkages with benthic invertebrate and fish assemblages as it related to highway construction activity adjacent to an Ozark stream in southwest Missouri. The most notable effect of road construction on the sediment dynamics in the Brush Creek watershed was the overall change in suspended sediment concentration which was 53% greater downstream of the highway versus upstream during road construction. The lack of a significant shift in biomonitoring metrics and composition of macroinvertebrate and fish assemblages during construction reflected similar, non-significant trends in deposited sediment. Correlations between sediment measurements and biomonitoring metrics were found for macroinvertebrate and fish assemblages but were inconsistent among habitats. Ordination analysis showed suspended sediment and surface cover of deposited sediment influenced the composition of the macroinvertebrate assemblage immediately before and after the start of road construction. This research showed that effects of road construction were minimal on sediment variables and were not conclusive regarding biotic variables in Brush Creek. This may be attributed to extensive efforts made during road construction to limit sedimentation. Another possible explanation for this minimal impact is the integrity of Brush Creek was already degraded (e.g., pasture and grazing) so road construction was imposed on a fauna that had “pre-adapted” to an altered sediment regime. Therefore, construction impacts were minor and were within the natural range of variability in Brush Creek. The results of this study will help future investigators identify normal and excessive sediment conditions in Ozark highland streams with similar landuse types. Furthermore, the additional resolution of sediment dynamics and linkages with aquatic biota gained by this study will aid in the development of water-quality standards for sediment in Missouri streams.

MACROINVERTEBRATE AND CRAYFISH COMMUNITY INVESTIGATIONS AT MULTIPLE SPATIAL SCALES

Kristi Williams (MS)

USGS Missouri Water Resources Research Center, MoRAP

Complete

This project analyzed crayfish and macroinvertebrate distributions within and between ecounits of a newly proposed aquatic ecosystem classification system developed by the Missouri Resource Assessment Partnership (MoRAP). Macroinvertebrates showed strong similarities within ecounits suggesting that communities correspond to ecounits created by the MoRAP system. Crayfish communities differed between ecounits, but also showed strong species correspondence to macrohabitat units (riffles, runs, backwaters, and vegetation plots). An analysis of longitudinal distribution of crayfish along the Meramec River, where crayfish were captured

from 4 stream sizes (headwater, creek, small-river, and big-river) within run habitats indicated our predictions of distributions were weak. A gear evaluation comparing a quadrat sampler to a seining methods resulted in correction factors relating seine densities to those of the quadrat sampler under some conditions of depth and flow.

ECOLOGY OF FRESHWATER MUSSELS OF THE MARAIS DES CYGNES NATIONAL WILDLIFE REFUGE

Megan Bradburn (MS)

Tim Minard (USFWS)

USFWS

Current

Freshwater mussels (Bivalvia: Unionidae) are considered one of the most rapidly declining components of freshwater biodiversity with an estimated 70% of the 300 North American species classified as extinct, endangered, threatened, or a species of special concern. Possible reasons for the decline include impoundments, exotic species, sedimentation, and declining water quality. Our project examines the current status of a freshwater mussel population on the Marais des Cygnes River in Linn County, Kansas. The study takes place on the 15-km portion of the Marais des Cygnes that flows through the Marais des Cygnes National Wildlife Refuge. We estimated mussel density, species richness, and the age/size-structure of mussels at four sites by employing a systematic sampling regime. A representative number of shells from four species were aged by counting internal growth annuli and we developed age-length equations from this data. Ages will be estimated for the sampled population from lengths measured in the field and this information will allow us to examine historical recruitment trends. We will test whether there is a relationship between annual variation in discharge, temperature, and other factors with mussel recruitment success. Finally, we will relate the current distribution of mussel beds and density trends on the river with a variety of habitat variables measured out in the field. This information will allow us to examine the “disturbance potential” under various flow regimes at each site as we examine factors that may influence the current mussel distribution. The research project will facilitate future research and long-term monitoring projects on the river and will assist managers in remediative decisions.

LANDSCAPE INFLUENCES ON RIVERINE SMALLMOUTH BASS POPULATIONS IN MISSOURI

Shannon Brewer (PhD)

Mike Roell (MDC)

Advisor: Charles Rabeni

Funding Source: Missouri Department of Conservation

Estimated Completion Data: May 2008

Current

Many Missouri streams are perceived to be deteriorating and resulting in declines of sportfish populations (e.g., smallmouth bass *Micropterus dolomieu*). Protecting and restoring fish

populations on a regional basis are most effective if the multi-scale factors for the relative quality of a fishery are known. I spatially linked statewide historical fish collections to natural-occurring landscape and in-channel features in a geographic information framework to identify each stream reach's potential in Missouri to support a smallmouth bass population. Identifying the geographic range of smallmouth bass throughout Missouri was accomplished using a few broad landscape variables: the percentage of coarse-textured soils in the watershed, the percentage of soils with low permeability in the watershed, and watershed relief. The within-range model included landscape and in-channel features. As with the statewide model, soil permeability was particularly significant. Relative abundance was further influenced by channel gradient, stream size, spring-flow volume, and local slope. I combined the most significant features (HSGD, CTS) from these models to investigate land-use impacts at multiple spatial scales. Multivariate cluster analyses of > 150,000 stream segments indicated four out of eighteen clusters met my criteria for varying natural conditions influential to smallmouth bass and had the potential for replication. I assigned stream segments to land-use categories (forest, pasture and urban) within each cluster and examined the relation between habitat factors and fish densities at multiple spatial scales. Decision tree analyses revealed land use was the most significant variable used to predict densities of different age classes (young-of-year [YOY], age 1, and age-2⁺) of smallmouth bass. Densities of all age classes were approximately three fold higher in forested watersheds than pasture or urban watersheds. Increases in discharge, a moderate amount of fines in the channel and water temperatures > 21° C further increased the predicted densities of fish. Streams located in forested watersheds had significantly higher densities in cluster two (CTS < 50%, HSGD < 7%) and cluster three (CTS > 90%). In cluster four (CTS 50-90%), streams located in urban watersheds had significantly lower densities than other land-use types. Cluster eleven (CTS < 50%, HSGD > 7%) had extremely low densities, regardless of land-use attribute. All life stages of smallmouth bass were more likely to be present than absent depending on land-use category and channel unit (CU) but only age-2⁺ presence depended on the interaction between land use and CU. These results suggest land-use activities have a unique, interactive effect depending on the natural conditions in the watershed and that adult smallmouth bass success is influenced by land use, even at small spatial scales. Recognition of the connections between anthropogenic and natural conditions is necessary to increase the effectiveness of management strategies. Subsequent objectives address the significance of groundwater in highly altered landscapes at multiple spatial scales and microhabitat use by young-of-year fish in a variety of landscape settings. These combined efforts will result in a better understanding of the biological potential for smallmouth bass populations in stream segments in the Ozark physiographic region and how natural-occurring conditions interact with watershed land use to alter the relative quality of the fishery.

THE EFFECTS OF PL-566 HEADWATER IMPOUNDMENTS ON THE ECOLOGICAL INTEGRITY OF MISSOURI STREAM SYSTEMS

Kathy E. Doisy (Senior Research Specialist)

Greg Wallace (Senior Technician)

Scott Sowa (MoRAP)

MDNR

Current

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. Through this law, hundreds of watershed projects were developed and completed within the U.S. In the early 1980's, in response to concerns about the effects of large impoundments, Missouri NRCS changed its approach from constructing a few large impoundments within a watershed to constructing numerous small impoundments in 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 PI566 structures and half without. Objective 1 is complete and objective 2 is ongoing.

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

Kathy E. Doisy (Senior Research Specialist)

Greg Wallace (Senior Technician)

Victoria Grant (NPS)

NPS

Current

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 state 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. The park has an immediate need to establish existing biological conditions for major tributary streams. 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 selected and sampling for macroinvertebrates was conducted three times. Data is currently being analyzed. Sampling these tributaries prior to the proposed regulatory changes will establish the status of these tributaries should perturbations occur.

MOVEMENT, HABITAT USE, AND SPAWNING CHRONOLOGY OF FLATHEAD CATFISH AND BLUE CATFISH IN THE MISSOURI RIVER AND TRIBUTARIES

Daniel L. Garrett (PhD)

MDC special funds

Current

Flathead catfish *Pylodictis olivaris* and blue catfish *Ictalurus furcatus* are native to the lower Missouri, Mississippi, and Ohio River basins of the central and southern United States. Both species thrive in large rivers and constitute significant sport fisheries. Characterizing movement, home range and habitat use has become increasingly important due to rapid expansion of the sport fishery. Home range information will provide a spatial scale for the implementation of future management decisions. When coupled with indicators of spawning, this movement data will allow for a more informed and holistic approach to catfish management. In April 2006, 37 flathead and 40 blue catfish from the lower Missouri River were implanted with combination acoustic-radio tags and relocated weekly throughout the annual cycle. Acoustic tracking by boat was used on the Missouri, Lamine, Chariton, and Grand Rivers during 2006-2007. Additional radio tracking was conducted via helicopter in July-August 2006. In April 2007, 40 additional individuals of each species were tagged with acoustic transmitters, and a similar tracking design was scheduled for 2007-2008. In 2006, 14% of flathead catfish and 8% of blue catfish were relocated in a tributary to the mainstem Missouri River during the putative spawning period (May 15-July 15). In 2007, tributary usage increased to 18% and 24% for flathead and blue catfish, respectively. Flood conditions in May 2007 may have contributed to this increase. Reported exploitation of tagged individuals was high in 2006-2007, with 16% of flathead catfish and 28% of blue catfish being harvested. Between April 2006 and May 2007, the majority of flathead (51%) and blue catfish (55%) moved less than 100-river km from where they were tagged. Traditional home range estimates for the entire annual cycle revealed a mean (max.) of 68.2(356)-river km and 109.2(856)-river km for blue catfish and flathead catfish, respectively. Seasonal structure to annual movements was evident with periods of both restricted (Dec-March; July-Sept) and migratory (March-June; Oct-Dec) behavior. Future work will address space use within a defined home range (e.g., kernel density estimators), habitat use and reproductive hormone levels to estimate spawn timing and location.

IDENTIFYING LINKAGES BETWEEN WATERSHED ATTRIBUTES, SEDIMENT, AND FISH IN THIRD ORDER STREAMS OF MISSOURI'S OSAGE RIVER BASIN

Andy Turner (MS)

MDC Special funds

Current

Sedimentation is an important variable influencing the complex physical and biological features of streams. The linkages among a streams watershed, physical attributes, and biotic composition are only generally understood. A hierarchical model of watershed characteristics, within third-order streams of the Osage River Basin in Missouri, was developed to better understand these linkages. 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-assembly 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. Ongoing analysis of fish-sediment relations shows that varying levels of sedimentation are related to various aspects of fish assemblages. Completion of this analysis will identify linkages on a system-wide level and provide insights into the processes of stream sedimentation.

BIOMONITORING POTENTIAL OF BENTHIC INVERTEBRATES IN LOW-FLOW STREAMS

Greg Wallace (Senior Technician)

Bob DiStefano (MDC)

MDC special funds

Current

We began evaluating water quality and benthic invertebrate communities of the Brush Creek watershed in southwest Missouri in relation to projected land use changes in the mid 1990s. It quickly became evident that in many small headwater streams, naturally occurring factors affecting water discharge were likely to obfuscate changes in benthic invertebrates due to land use changes. We shifted our focus to a study examining the potential to assess small, sometimes intermittent, streams. For 8 years twice-yearly collections were made at 15 sites of varying flow permanence. Streams were assigned to intermittent, intermediate, and perennial categories based on relative discharges over time. Each category of stream had a distinctive invertebrate community structure, due more to relative abundance differences than to presence or absence. The intermittent stream community could be considered a subset of the perennial stream community. Indices of community structure were positively related to flow permanence, and variability of indices increased as flow decreased. We believe that biomonitoring of intermediate streams is appropriate using current standards. Biomonitoring of intermittent streams is possible if appropriate reference standards are developed, and if reduced metric sensitivity is acceptable.

EVALUATING AND REFINING BIOLOGICAL MONITORING PROTOCOLS IN PRAIRIE CLUSTER LONG-TERM MONITORING PROGRAM

Greg Wallace (Senior Technician)

RWO # 81 – USGS Northern Prairie Wildlife Research Center and

RWO #s 83 and 91 – National Park Service (NPS)

Current

Development of the NPS Prairie Cluster Long-term Ecological Monitoring (LTEM) Program has been a cooperative effort of the NPS and USGS's Missouri Cooperative Fish and Wildlife Research Unit. Since 1996, USGS scientists and associated University researchers have been involved in the Prairie Cluster LTEM macroinvertebrate monitoring project, reviewing and revising the original monitoring protocol of Peterson (1996), summarizing annual monitoring data for 1996-98, coordinating sample collection, and performing species identification for 1996-

2003. University researchers and Unit scientists have concurrently been involved with state-wide effort to develop protocols for monitoring prairie streams. These complementary efforts have resulted in new understandings of streams in the prairie region of the USA—an area where streams have been little studied and rarely monitored for biological condition.

EXAMINATION OF MULTI-SCALE HABITAT ASSOCIATIONS, HUMAN INDUCED STRESSORS, AND MONITORING OPTIONS AS A MEANS TO PROTECT TWO IMPERILED CRAYFISH SPECIES EXPOSED TO AN INVASIVE CRAYFISH

Jacob Westhoff (PhD)

Bob DiStefano (MDC)

MDC Special Funds

Current

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, this project is in the design phase and data collection is scheduled to begin in summer 2008.

MARK R. RYAN

EVALUATING WILDLIFE RESPONSE TO HERBACEOUS RIPARIAN FILTER STRIPS IN NORTHEAST MISSOURI

D. Todd Farrand (PhD), Robert A. Pierce (Co-PI)
Missouri Cooperative Agricultural Research Grant
Complete

Government programs to idle agricultural lands, especially multi-year set-aside programs such as the Continuous Enrollment Conservation Reserve Program (CCRP), provide opportunities to diversify agroecosystems in a way that benefits wildlife populations. Differences in implementation within a program create variability in the potential to beneficially impact a specific wildlife population or community. Initiated in 2002, this 3-year study investigated factors influencing wildlife use of CCRP plantings, particularly herbaceous riparian filter strips. We evaluated wildlife response to 3 common filter strip planting mixes (cool-season grass monoculture, warm-season grass monoculture, or cool-season grass and forb mixture). We empirically compared small mammal and avian abundances and species richness in filter strips to crop field sites suitable for filter strips. We measured avian nesting success for comparison to reported values for alternative habitats (e.g., pasture, CRP). We monitored 126 nests of 10 species (field sparrow [*Spizella pusilla*], song sparrow [*Melospiza melodia*], red-winged blackbird [*Agelaius phoeniceus*], indigo bunting [*Passerina cyanea*], and common yellowthroat [*Geothlypis trichas*] were the most frequent nesters. Interval nest success was low (5-24%) for these common species, with predation accounting for 74% of nest failures. The most supported model of predation risk (weight = 85%) contained variables related to nest concealment (top and side), and top concealment of the nest patch. Model selection results suggest that mid-size mammals were likely the most important predator group in filter strips. Overall, this study suggested that filter strips provide some wildlife benefits by increasing usable space for common species, but contribute little to wildlife conservation based on the near absence of species of conservation concern.

EFFECT OF INCIDENTAL TAKINGS OF NESTS AND CHICKS IN THE MISSOURI RIVER MAIN STEM ON POPULATION VIABILITY OF PIPING PLOVERS IN THE GREAT PLAINS

Conor McGowan (PhD)
Love, RWO # 97 – USGS/FWS Initiative, Science Support Partnership Program
Current

Piping plover is a threatened species under the federal Endangered Species Act (ESA). Populations in the Great Plains continue to decline despite intensive protection and management efforts. One uninvestigated aspect of piping plover population viability is the potentially negative impact of the flooding of nests and chicks on river systems due to U.S. Army Corps of Engineers water management actions on dammed rivers. These actions are permitted under the

Section 10 “incidental take” provisions of the ESA. On the Missouri River, the Corps tries to balance the needs of farmers, navigation interests, power generation, and recreation, with the needs of nesting birds by minimizing, and timing the inundation of breeding habitat to least impact nesting birds. This study will attempt to determine the long term impact of nest flooding on population viability and recovery probability of piping plovers in the Great Plains. We modified the demographic simulation model developed by Ryan et al. in 1993 and updated by Larson et al. 2003 to explore how various take scenarios will impact the population. The FWS and the Corps of Engineers contributed piping plover reproductive success data for the research. The model incorporated environmental stochasticity and variation due to sampling variance. In the model, eggs and chicks were taken out of the population as a harvest to simulate incidental take that currently occurs on Piping Plover nesting in the Missouri River system. We used least squares regression and an AIC model selection approach to evaluate the relationship between measures of population viability (population abundance, growth and quasi-extinction probability) and covariates relating to incidental take. Models that included combinations of egg take rate, renesting rate, an egg take squared term, and chick take as covariates all received support to explain variation in final abundance, population growth rate, and quasi-extinction probability. The model selection analysis clearly indicates that incidental take of eggs and chicks is likely to depress population viability of Piping Plovers in the Great Plains. Population growth, and final abundance were reduced and the probability of quasi-extinction was increased in simulations where egg take and chick were applied.

EVALUATION OF PATCH BURN GRAZING ON DIVERSITY, ABUNDANCE, AND DENSITY OF GRASSLAND BIRDS

David Stroppel (MS)

Missouri Department of Conservation

Current

Many studies in tallgrass prairie have shown that both fire and grazing are critical for the maintenance of this ecosystem (Collins and Wallace 1990, Collins et al. 1998, Knapp et al. 1999, Briggs et al. 2005). Recently, patch burn grazing (PBG) has emerged as a technique managers can use to mimic the interaction of fire and grazing. Patch burn grazing may help to create the mix of plant communities similar to what occurred historically. PBG has been shown to create diverse plant structure scattered across the landscape where it is applied (Fuhlendorf and Engle 2001). PBG has potential for enhancing grassland bird populations on public and private lands. Our overall objective is to evaluate the effects of PBG on diversity, abundance, and density of grassland birds. Specifically, we will quantify the relationship between vegetation heterogeneity (variation in mean % obstruction) at maximum height and avian diversity, abundance, and density at PBG and control (burn only) sites; quantify the relationship between vegetation heterogeneity (variation in mean % obstruction) at maximum height and avian diversity, abundance, and density at the scale of the GMU, in four PBG sites; quantify the relationship between mean % obstruction and avian diversity, abundance, and density at the patch scale in four PBG sites and develop models to predict avian response to habitat structure produced by PBG. Field work has been completed and data analyses are in progress.

FRANK R. THOMPSON III

NEST PREDATION AND PREDATORS OF GOLDEN-CHEEKED WARBLERS IN RURAL AND URBAN LANDSCAPES

Jennifer Reidy (MS), Beaky Peak (Cooperator)
Department of Defense, The Nature Conservancy,
US Forest Service Northern Research Station

Complete

The golden-cheeked warbler is an endangered songbird that breeds exclusively in the juniper-oak woodlands of central Texas. Information on rates of predation and predator identification in different landscapes is important for conservation of golden-cheeked warblers because of increasing urbanization and habitat loss throughout its breeding range. We monitored nests in Austin, a highly urbanizing landscape, from March-June 2005 and 2006. We used video surveillance to identify nest predators and determine importance of individual predators to overall nest survival. We compared nest survival and nest predators between Austin and Fort Hood, situated in a rural landscape. We modeled nest survival to determine which factors and spatial scales affect nest survival. We conducted point counts in 2006 to determine density in Austin. Overall nest survival was similar between urban and rural landscapes and predator species were similar between the two landscapes. Three manuscripts are in review for publication; the project was completed in 2007.

MULTI-SCALE FACTORS INFLUENCING DETECTION, SITE OCCUPANCY AND RESOURCE USE BY FORAGING BATS IN THE OZARK HIGHLANDS OF MISSOURI

Sybill K. Amelon (PhD)
US Forest Service Northern Research Station, Mark Twain National Forest

Current

Conservation of bat populations requires understanding the associations between bats and their use of resources. We applied a maximum likelihood approach to estimate probability of site occupancy using acoustic detection data for ten species of forest bats in the Ozark Region of Missouri. We evaluated a priori hypotheses relative to both probability of detection and site occupancy using AIC. Estimated species-specific detection probabilities varied among species. Time, temperature, moisture, vegetative clutter, and date influenced detection probability. Habitat, patch, and landscape characteristics influenced site occupancy and varied among species. Species responded to landscape pattern at different spatial scales. We evaluated use of resource utilization functions (RUFs) to assess habitat and landscape factors affecting foraging resource use by red bats, *L. borealis*, during the maternity season. Highest foraging use was associated with open deciduous forest on ridges and upland drainages in areas close to non-forest edge and relatively high road density. Resource selection was highly variable among individuals, geographic location, stage of lactation and temperature regime. The strong positive relationship between edge factors in a forested landscape suggests that management strategies that provide a

range of composition and structural diversity will favor foraging use by *L. borealis*.

A METHODOLOGICAL FRAMEWORK FOR ECOREGIONAL-SCALE LANDBIRD CONSERVATION PLANNING IN FORESTED AVIFAUNAL BIOMES

D. Todd Jones-Farrand (Postdoctoral Fellow), John M. Tirpak (cooperator), Charles K. Baxter (Cooperator), Bill Uihlein (Cooperator), Daniel J. Twedt (Cooperator), Jane A. Fitzgerald (Cooperator),

USGS/FWS Science Support Partnership Program, US Forest Service Northern Research Station, American Bird Conservancy

Current

The North American Landbird Conservation Plan establishes the creation of landscapes capable of sustaining bird populations range-wide at prescribed levels as an overarching conservation target. Implementation of the Conservation Plan has created a demand for reliable models that can inform resource managers on the linkage between bird numbers and habitat conditions at regional scales. We used 6 national geospatial datasets, including Forest Inventory and Analysis (FIA) data and the National Land Cover Dataset (NLCD), as input variables to Habitat Suitability Index (HSI) models for 40 priority forest-associated species to assess, monitor, and predict landscape suitability in the Central Hardwoods (CH) and West Gulf Coastal Plain/Ouachitas (WGCP) Bird Conservation Regions (BCRs). We evaluated the models by comparing model outputs to abundance data from the Breeding Bird Survey (BBS). Utilizing FIA and NLCD provided a built-in habitat monitoring capability to the models because these datasets are updated at regular intervals. We generated model outputs for 2 points in time (1992, 2001) and linked these outputs to BBS abundance within ecological subsections in each BCR (CH=59; WGCP=29). We converted predicted abundance in each subsection in each period to total populations using a procedure developed by Partners In Flight, yielding spatially-explicit estimates of population change over time. Currently, we are developing a decision support tool to assist conservation partners in each BCR set population objectives based on changes in habitat due to management, restoration, urbanization or other factors.

EFFECTS OF PLANTATION FORESTRY AND FOREST FRAGMENTATION ON BREEDING SUCCESS OF FOREST PASSERINE BIRDS IN THE MISSISSIPPI ALLUVIAL VALLEY

Shane Pruett (PhD), Mickey E. Heitmeyer (Cooperator)

USDA/ARS, US Forest Service Northern Research Station

Current

This study is part of a larger project investigating the role of various types, sizes, and locations of forest patches in sustaining wildlife communities in the 100-year floodplain of the Mississippi River in southeast Missouri. Study sites are in private and state ownership and have typical agricultural and rural land uses in the upper MAV. This study is investigating the effects of landscape composition (the amount of forest) and forest habitat type on nesting success of songbird communities with a focus on several common breeding species. We are comparing

forest habitats resulting from artificial regeneration of commercially valuable species such as cottonwood and ash to native floodplain forest. Nest predation, often considered the major cause of nest failure, will be monitored at selected nests using micro-video cameras and portable VCR systems. Our goal is to identify the major predators in this system and determine if they differ between native forest fragments and plantations. We are also comparing time of detection and distance based methods for estimating density of the focal species in plantation and native forests. The study will be completed in 2008.

EVALUATION OF METHODS FOR ESTIMATING ABUNDANCE FROM AVIAN POINT COUNT DATA

Kerri Cornell-Duerr (Post-doc), Jennifer Reidy (Research Specialist), Jane Fitzgerald (Cooperator).

Central Hardwoods Joint Venture, USFWS, Southern Region US Forest Service, US Forest Service Northern Research Station.

Current

Several new analytical methods have recently been developed for analyzing point count data and estimating bird abundance or density. We are investigating the efficacy of various field protocols for conducting point count surveys of landbirds; comparing distance-based and time of detection models for estimating abundance, and comparing the effects of analysis methods on trend estimates. We are addressing these objectives through use of existing datasets from national forests and wildlife refuges and through design and implementation of bird surveys in the Central Hardwoods Joint Venture. The study will be completed in 2008.

COMPARISON OF THREE APPROACHES FOR SPATIALLY MODELING AVIAN-HABITAT RELATIONSHIPS IN THE CENTRAL HARDWOODS BIRD CONSERVATION REGION

Todd Jones-Farrand (Post-doc), John Tirpak (Cooperator), Wayne Thogmartin (Cooperator), Todd Fearer (Cooperator).

US Fish and Wildlife Service, USGS Upper Midwest Environmental Sciences Center, Virginia Tech.

Current

The objective of the study is to compare three approaches for avian habitat or abundance modeling habitat (HSI models, CART models, and hierarchical Bayesian models) to determine the advantages and disadvantages of these approaches for bird conservation planning. We are focusing on three species of interest to Region 3 of the United States Fish and Wildlife Service: Cerulean Warbler (*Dendroica cerulea*), Prairie Warbler (*Dendroica discolor*), and Red-headed Woodpecker (*Melanerpes erythrocephalus*). These methodologies represent the state of the art in avian habitat modeling across broad geographic scales. All three approaches utilize nationally available land cover data to assess the effects of habitat configuration and composition on avian presence and density. Further, all incorporate Forest Inventory and Analysis (FIA) data to assess the effects of forest age and structure, which has been lacking in previous large-scale models.

Assessing how well these approaches capture the conditions in the field and how well they agree with each other would provide important insights to conservation planners who rely on these models to guide their habitat restoration and management efforts.

SCIENTIFIC PUBLICATIONS

- Azerrad, J.M. and C.H. Nilon. 2006. An evaluation of agency conservation guidelines to better address planning efforts by local government. *Landscape and Urban Planning* 77:255-262.
- Bajer, P. G., and R. S. Hayward. 2006. A combined multiple regression and bioenergetics model for simulating fish growth in length and condition. *Transactions of the American Fisheries Society* 135:695-710. (50%) [paper ranked 2nd most accessed out of ~70 articles in June; on AFS top 20 papers list]
- Bajer, P. G., J. J. Millspaugh, and R. S. Hayward. 2007. Application of discrete choice models to predict white crappie temperature selection in two Missouri impoundments. *Transactions of the American Fisheries Society* 136:889-901
- Benkobi, L., M. A. Rumble, C. H. Stubblefield, R. S. Gamo, and J. J. Millspaugh. 2006. Timing and course of seasonal migration by female elk in the Black Hills of South Dakota and Wyoming. *Prairie Naturalist* 37:151-166.
- Beringer, J., J. J. Millspaugh, T. Meyer, and K. C. VerCauteren. 2006. Use of parotid lymph node tissues for chronic wasting disease surveillance in hunter-killed and live white-tailed deer. *Missouri Academy of Sciences*: In press.
- Beringer, J., J. Millspaugh, and M. Hubbard. 2007. Recruitment and retention of Missouri youth turkey hunters. *Proceedings of the 9th National Wild Turkey Symposium, Grand Rapids, Michigan*.
- Bernhardt, E. S., M.A. Palmer, J.D. Allan, G. Alexander, K. Barnas, S. Brooks, J. Carr, S. Clayton, C. Dahm, J. Follstad-Shah, D. Galat, S. Gloss, P. Goodwin, D. Hart, B. Hassett, R. Jenkinson, S. Katz, G. M. Kondolf, P. S. Lake, R. Lave, J.L. Meyer, T.K. O'Donnell, L. Pagano, B. Powell, and E. Sudduth. 2005. Synthesizing U. S. river restoration efforts. *Science* 308: 636-637.

- Brewer, S. K and C. F. Rabeni. 2008. Seasonal and diel habitat shifts by juvenile ictalurids in a flow regulated prairie river. *American Midland Naturalist*. 156:42-54
- Brewer, S. K. D. Papoulias, and C. F. Rabeni. 2006. Habitat selection by fishes in a prairie river: A focus on reproductive fitness. *Transactions of the American Fisheries Society*. 135:763-778.
- Brewer, S. K., C. F. Rabeni and D. C. Heimann. 2006. The importance of day versus night fish sampling for instream flow determination. *Proceedings, Annual Conference of Southeastern Association of Fish and Wildlife Agencies* 59:336-347.
- Brewer, S. K., C. F. Rabeni, and D. Papoulias. 2007. Comparing histology and gonadosomatic index for determining spawning condition of small-bodied riverine fishes. *Ecology of Freshwater Fishes* 17:54-58.
- Brewer, S.K., C.F. Rabeni, S.P Sowa and G. Annis. 2007. Natural-occurring landscape and in-channel factors affecting the distribution and relative abundance of riverine smallmouth bass in Missouri. *North American Journal of Fisheries Management*. 27:326-341.
- Bryan, J.L., M.L. Wildhaber, and D.B. Noltie. 2005. Examining Neosho madrom reproductive biology using ultrasound and artificial photothermal cycles. *North American Journal of Aquaculture* 67:221-230.
- Bryan, J.L., M.L. Wildhaber, and D.B. Noltie. 2006. Influence of water flow on Neosho madtom (*Noturus placidus*) reproductive behavior. *American Midland Naturalist* 156:305-318.
- Burhans, Dirk E.; Thompson, Frank R., III. 2006. Songbird abundance and parasitism differ between urban and rural shrublands. *Ecological Applications* 16(1):394-405.
- Buskirk, S. W., and J. J. Millspaugh. 2006. Metrics of use and availability in studies of resource selection. *Journal of Wildlife Management* 70:358-366.
- Chadwick D. Rittenhouse; William D. Dijak; Frank R. Thompson, III; Joshua J. Millspaugh. 2007. Development of landscape-level habitat suitability models for ten wildlife species in the Central Hardwoods Region. Gen. Tech. Rep. NRS-4. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 47p.
- Dieterman, D. D. and D. L. Galat. 2005. Variation in body form, taste buds, and brain patterns of the sicklefin chub, *Macrhybopsis meeki*, in the Missouri River and lower Yellowstone River, USA. *Journal of Freshwater Ecology* 20:561-573
- Dieterman, D. J., E. Roberts, P. J. Braaten, and D. L. Galat. 2006. Reproductive development of the sicklefin chub, *Macrhybopsis meeki*, in the Missouri River. *Prairie Naturalist*. 38(2):113-130.

- Dijak, W. D.; C. D. Rittenhouse; M. A. Larson; F. R. Thompson, III; J. A. Millspaugh. 2007. Landscape habitat suitability index software. *The Journal of Wildlife Management*. 71(2):668-670.
- Dijak, W. D., C. D. Rittenhouse, M. A. Larson, F. R. Thompson, III, and J. J. Millspaugh. 2007. Software review: Landscape HSI Models Software. *Journal of Wildlife Management* 71:668-670.
- Fan, Zhaofei; Shifley, Stephen R.; Spetich, Martin A.; Thompson, Frank R. III; Larsen, David R. 2005. Abundance and size distribution of cavity trees in second-growth and old-growth Central Hardwood Forests. *Northern Journal of Applied Forestry*. 22(3); 162-169.
- Fang, Y., X. Huang, P. Li, C. Zhang, D. Wu, Z. He, and J. J. Millspaugh. 2007. A closer look at animals: real-time video enabled wireless sensor network for wildlife monitoring. Submitted to *IEEE Communications* in April 2007.
- Farrand, D. T., and J. J. Millspaugh. 2006. Effects of scale and land cover map resolution on estimating bobwhite habitat quality in northeast Missouri. *Missouri Academy of Sciences*: In press.
- Farrand, D. T., and M. R. Ryan. 2005. Impact of the CRP on wildlife conservation in the Midwest. Pages 41-62 in J. Haufler and T. Franklin, editors. *Fish and Wildlife Benefits from Farm Bill Programs: 2000-2005 Update*. The Wildlife Society. Washington, D.C.
- Fener, H.M., Ginsberg, J.R., Sanderson, E. and Gompper, M.E. 2005. Chronology of range expansion of the Coyote *Canis latrans*, in New York. *Canadian Field Naturalist*. 119:1-5.
- Fink, Alix, D.; Thompson Frank R., III; Tudor, April A. 2006. Songbird use of regenerating forest, glade, and edge habitat types. *Journal of Wildlife Management*. 70(1):180-188
- Frank A. LaSorte; Frank R. Thompson, III. 2007. Poleward shifts in winter ranges of North American birds. *Ecology*. 88(7): 1803-1812.
- Frank A. LaSorte; Frank R. Thompson, III; Margaret K. Trani; Timothy J. Mersmann. 2007. Population trends and habitat occurrence of forest birds on southern national forests, 1992-2004. Gen. Tech. Rep. NRS-9. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 260p.
- Fuller, M. R., J. J. Millspaugh, K. E. Church and R. E. Kenward. 2005. Wildlife Radiotelemetry. Pages 377-417 in *Techniques for wildlife investigations and management*. Sixth edition. The Wildlife Society, Bethesda, Maryland, USA. Invited.
- Galat, D. L., C. R. Berry, W. M. Gardner, J. C. Hendrickson, G. E. Mestl, G. J. Power, C. Stone, and M. R. Winston. 2005. Spatiotemporal patterns and changes in Missouri River fishes. Pages 249-291 in J. N. Rinne, R. M. Hughes, and B. Calamusso (editors). *Historical*

changes in large river fish assemblages of the Americas. American Fisheries Society Symposium 45, Bethesda, Maryland.

- Galat, D. L., C.R. Berry, Jr., E. J. Peters, and R. G. White. 2005. Missouri River. Pages 427-480 in A. C. Benke and C. E. Cushing (editors). Rivers of North America. Elsevier, Oxford.
- Galat, D., J. Barko, M. Davis, K. Lubinski, C. Theiling, P. West, D. Wilcox. 2006. Goals and Objectives. Pages 7-26 in Barko, J.W. Barko, B.L. Johnson, and C.H. Theiling (eds). 2006. *Environmental Science Panel Report: Implementing Adaptive Management. Upper Mississippi River System Navigation and Ecosystem Sustainability Program – Environmental Report 2*. U.S. Army Corps of Engineers, Rock Island, St. Louis, and St. Paul Districts. 112pp. + appendices.
- Gittleman, J.L. and Gompper, M.E. 2005. Plight of Predators: The Importance of Carnivores for understanding Patterns of Biodiversity and Extinction Risk. Pp 370-388 In: Ecology of Predator-Prey Interactions (P. Barbosa, I. Castellanos eds). Oxford University Press.
- Gitzen, R. A., and J. J. Millspaugh. 2007. Nomograms aid interpretation of complex regression models. *Journal of Wildlife Management* 71:2438-2443.
- Gitzen, R. A., J. J. Millspaugh, and B. J. Kernohan. 2006. Bandwidth selection for fixed kernel analysis of animal range use. *Journal of Wildlife Management* 70:1334-1344.
- Goldstein, E. J., J. J. Millspaugh, B. E. Washburn, G. C. Brundige, and K. J. Raedeke. 2005. Relationships among fecal glucocorticoids, lungworm levels, and recruitment in bighorn sheep in South Dakota. *Journal of Wildlife Diseases* 41:416-425.
- Gompper, M.E. 2005. Review of R. M. Nowak's Walker's Carnivores of the World. *Journal of Mammalogy* 86: 1259.
- Gompper, M.E. and A. N. Wright 2005. Increased prevalence of raccoon roundworm, *Baylisascaris procyonis*, owing to manipulated contact rates of hosts. *Journal of Zoology* 266:215-219.
- Gompper, M.E. and A. T. Vanak 2006. *Vulpes bengalensis*. *Mammalian Species* 795:1-5.
- Gompper, M.E. and Gittleman J.L. 2006. Coatis. In: The new encyclopedia of mammals. 2nd Edition. (D.W. Macdonald, ed.) Facts of File, London.
- Gompper, M.E. and Hackett, H.M. 2005. The long-term, range-wide decline of a once abundant carnivore: the eastern spotted skunk (*Spilogale putorius*). *Animal Conservation* 8:195-201.
- Gompper, M.E., A.E. Petrites, and R. L. Lyman. 2006. Cozumel Island fox (*Urocyon* sp.) dwarfism and possible divergence history based on subfossil bones. *Journal of Zoology*

270: 72-77.

- Gompper, M.E., H.M. Hackett, D.S. Jachowski, R.J. Monello, & N. Olifiers. 2006. Review of Ray, J.C., K. H. Redford, R.S. Steneck, & J. Berger's Large Carnivores and the Conservation of Biodiversity. *Animal Conservation* 9:355.
- Gompper, M.E., R.W. Kays, J.C. Ray, S.D. LaPoint, D.A. Bogan, and J. R. Cryan. 2006. A comparison of non-invasive techniques to survey carnivore communities in Northeastern North America. *Wildlife Society Bulletin* 34:1142-1151.
- Hackett, H. M., D. B. Lesmeister, J. Desanty-Combes, W. Montague, J. J. Millspaugh, and M. E. Gompper. 2007. Variation in detection rates of eastern spotted skunks (*Spilogale putorius*) in Missouri and Arkansas using live-capture and non-invasive techniques. *American Midland Naturalist* 158:123-131.
- Hartman, K.J., and R. S. Hayward. 2007. Bioenergetics. Pages 515-560 in C.S.Guy and M.L. Brown, eds. *Analysis and interpretation of freshwater fisheries data*. American Fisheries Society. Bethesda, Maryland.
- Hayward, R. S., and H. P. Wang. 2006. Rearing male bluegills indoors may be advantageous for producing food-size sunfish. *Journal of the World Aquaculture Society* 37:496-508. (90%)
- Heimann, D.C., Richards, J.M., Brewer, S.K., and Norman, R.D. 2005 Quantification of fish habitat in selected reaches of the Marmoton and Marais des Cygnes Rivers, Missouri: U.S. Geological Survey Scientific Investigations Report 2005-5180, 58 p., appendices, film, illustrations and tables on CD.
- Herzog, C., R.W. Kays, J.C. Ray, M.E. Gompper, W.J. Zielinski, R. Higgins, and M. Tymeson. 2007. Using Patterns in Track Plate Footprints to Identify Individual Fishers. *Journal of Wildlife Management* 71: 955-963
- J. Wesley Bailey; Frank R. Thompson, III. 2007. Multiscale nest-site selection by black-capped vireos. *Journal of Wildlife Management*. 71(3):828-836.
- Jacobs, Brad; Koford, Rolf R.; Thompson, Frank R., III; Woodward, Hope; Hubbard, Mike; Fitzgerald, Jane A. 2005. Grassland bird conservation efforts in Missouri and Iowa: How will we measure success? In: Ralph, C. John; Rich, Terrell D., eds. *Bird conservation implementation and integration in the Americas: Proceedings of the 3rd International Partners in Flight conference*. Volume 1, 2002 March 20-24; Asilomar, CA. Gen. Tech. Rep. PSW-191, Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station; 78-82.
- Jacobson, R. B. and D. L. Galat. 2006. Flow and form in rehabilitation of large-river ecosystems: an example from the lower Missouri River. *Geomorphology*. 77:249-269.

- Jones, B.D., and D.B. Noltie. 2007. Flooded flatheads: evidence of increased growth in Mississippi River *Pylodictis olivaris* following the Great Flood of 1993. *Hydrobiologia* 592:183-209 + erratum.
- Jones-Farrand, D. T., D. H. Johnson, L. W. Burger, and M. R. Ryan. 2007. Grassland establishment for wildlife conservation. Pages 25-44 in J. B. Haufler, editor. *Fish and Wildlife Response to Farm Bill Conservation Practices*. Technical Review 07 - 1. The Wildlife Society, Bethesda, MD. 113 pp.
- Junge, R.E., K. Bauman, M. King, and M.E. Gompper. 2007. A serologic assessment of exposure to viral pathogens and *Leptospira* in an urban raccoon (*Procyon lotor*) population inhabiting a large zoological park. *Journal of Zoo and Wildlife Medicine* 38:18-26.
- Kays, R.W., M.E. Gompper, and J.C. Ray. The landscape ecology of coyotes based on large-scale estimates of abundance. *Ecological Applications*. In press.
- Kesler, D. C., and S. M. Haig. 2007a. Conservation biology for suites of species: population demography for the *Todiramphus* kingfishers. *Biological Conservation* 136:520-530.
- Kesler, D. C., and S. M. Haig. 2007b. Multi-scale resource use and selection in cooperatively breeding Micronesian kingfishers. *Journal of Wildlife Management* 71:765-772.
- Kesler, D. C., and S. M. Haig. 2007c. Territoriality, prospecting, and dispersal in cooperatively breeding Micronesian Kingfishers (*Todiramphus cinnamominus reichenbachii*). *Auk* 124:381-395.
- Kesler, D.C. 2007. The role of science in avian conservation: examples from Pacific Island Kingfishers. Lamont, M, ed. *Proceedings from The IV International Symposium on Breeding Birds in Captivity*. Toronto, Canada. In Press.
- Koepfli, K.-P., M.E. Gompper, E. Eizirik, C.-C. Ho, L. Linden, J.E. Maldonado, and R.K. Wayne. 2007. Phylogeny of the Procyonidae (*Mammalia: Carnivora*): Molecules, morphology and the Great American Interchange. *Molecular Phylogenetics and Evolution* 43:1076-1095
- Licht, D., R. Slotow, and J. Millsaugh. A comparison of wildlife management in mid-size parks in South Africa and the United States. *Proceedings of the George Wright Society*, In press. (accepted)
- Masagounder, K., J. D. Firman, R.S. Hayward, S. Sun, and P.B. Brown. 2007. Apparent digestibilities of common feedstuffs for bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*) using individual test ingredients. *Aquaculture Nutrition*. In press.
- McFadden, K. W., R. Sambrotto, R. Medellin and M. E. Gompper. 2006. Feeding habits of the

- endangered pygmy raccoon (*Procyon pygmaeus*) based on stable isotope and fecal analyses. *Journal of Mammalogy* 87:501-509.
- McFadden, K.W., S. E. Wade, E.J. Dubovi, and M.E. Gompper. 2005. A serology and fecal parasitology survey of the critically endangered pygmy raccoon (*Procyon pygmaeus*). *Journal of Wildlife Diseases* 41:615-617.
- Michaletz, P. H., K. E. Doisy and C. F. Rabeni. 2005. Influences of productivity, vegetation, and fish macroinvertebrate abundance and size in Midwestern USA impoundments. *Hydrobiologia* 543:147-157.
- Middendorf, G. and C. Nilon. An Environmental Cross-town Walk. Teaching Issues and Experiments in Ecology, Vol. 3: Experiment [online]
<http://www.tiee.ecoed.net/vol/v3/experiments/crosstown/abstract.html>.
- Middendorf, G. and C.H. Nilon. 2007. Invited. Linking ecology and environmental justice. *Bulletin of the Ecological Society of America* 88(2):160-165.
- Millsbaugh, J. J., B. E. Washburn, T. M. Meyer, J. Beringer, and L. P. Hansen. 2005. Immobilization of Clover-trapped white-tailed deer, *Odocoileus virginianus*, with medetomidine and ketamine, and antagonism with atipamezole. *Canadian Field-Naturalist* 118:185-190.
- Millsbaugh, J. J., R. M. Nielson, L. McDonald, J. M. Marzluff, R. A. Gitzen, C. D. Rittenhouse, M. W. Hubbard, and S. L. Sheriff. 2006. Analysis of resource selection using utilization distributions. *Journal of Wildlife Management* 70:384-395.
- Millsbaugh, J. J., T. Burke, G. van Dyk, R. Slotow, B. E. Washburn, and R. J. Woods. 2007. Stress response of working African elephants to transportation and safari adventures. *Journal of Wildlife Management* 71:1257-1260.
- Moll, R. J., J. J. Millsbaugh, J. Beringer, J. Sartwell, and Z. He. 2007. A new 'view' of ecology and conservation through animal-borne video systems. *Trends in Ecology and Evolution* 22:660-668.
- Monello, R.J. and M.E. Gompper. 2007. Biotic and abiotic predictors of tick (*Dermacentor variabilis*) abundance and engorgement on free-ranging raccoons (*Procyon lotor*). *Parasitology* 134:2053-2062
- Nilon, C.H. 2007. Invited. Ecology and environmental justice in context: The Sierra Club's Toxic Tour of Memphis. *Bulletin of the Ecological Society of America* 88(2):199-203.
- Nilon, C.H. Approaches to comparative studies of urban fauna. In M.J. McDonnell, A. Hahs and J. Breuste, eds. *Comparative Ecology of Cities and Towns*. Cambridge University Press. (accepted)

- O'Donnell, T. K. and D. L. Galat. 2007. River enhancement in the upper Mississippi River basin: approaches based on river uses, alterations, and management agencies. *Restoration Ecology*. 15: 538-549. In press.
- O'Donnell, T. K. and D. L. Galat. Evaluating success criteria and project monitoring in river enhancement within an adaptive management framework. *Environmental Management*. (accepted)
- Palmer, M. A. E.S. Bernhardt, J.D. Allan, P.S. Lake, G. Alexander, S. Brooks, J. Carr, S. Clayton, C. Dahm, J. Follstad Shah, D.L. Galat, S. Gloss, P. Goodwin, D.H. Hart, B. Hassett, R. Jenkinson, G.M. Kondolf, R. Lave, J.L. Meyer, T.K. O'Donnell, L. Pagano, P. Srivastava, E. Sudduth. 2005. Standards for ecologically successful river restoration. *Journal of Applied Ecology*. 42:208-217.
- Parker, T.S. and C.H. Nilon. Gray squirrel density, habitat suitability, and behavior in urban Parks. *Urban Ecosystems*. (accepted)
- Peak, Rebecca G.; Thompson, Frank R., III. 2006. Factors affecting avian species richness and density in riparian areas. *Journal of Wildlife Management*. 70(1):173-179.
- Phillips, J.M., D.B. Noltie, J.Hunt, and C.L. Phillips. Development and characterization of microsatellites in largemouth bass, *Micropterus salmoides*: use in determining parentage. *Molecular Ecology - Primer Notes*. (accepted)
- Pickett, S.T.A., M.L. Cadenasso, J.M. Grove, L.E. Band, C.G. Boone, W.R. Burch, Jr, C.S.B. Grimmond, J. Hom, J.C. Jenkins, N.L. Law, C. H. Nilon, R.V. Pouyat, K. Szlavecz, P.S. Warren, and M.A. Wilson. Beyond urban Legends: New, unexpected, or complex results from the Baltimore Ecosystem Study. *BioScience*. (accepted)
- Pierce, R.A. II, J. Parcell, C. Boessen, R. Hayward and C. Hicks. 2007. Paddlefish production: opportunities for Missouri pond and lake owners. *MU Extension Guide G9470*. 4pp.
- Pierce, R.A. II, S. Hime and K. Akers. 2007. Missouri Master Naturalist website: www.monaturalist.org
- Rabeni, C. F., K. E. Doisy, and L.D. Zweig. 2005. Stream invertebrate community functional responses to deposited sediment. *Aquatic Sciences* 67:395-402
- Rahm, E.R., S.A. Griffith, D.B. Noltie, and R.J. DiStefano. 2005. Laboratory agonistic interactions demonstrate failure of an introduced crayfish to dominate two imperiled endemic crayfishes. *Crustaceana* 78:437-456.
- Rittenhouse, C. D., J. J. Millspaugh, A. Cooper, M. Hubbard, and S. Sheriff. Modeling resource selection using polytomous logistic regression and kernel density estimates. *Environmental and Ecological Statistics*: In press.

- Rittenhouse, C. D., J. J. Millspaugh, B. E. Washburn, and M. Hubbard. 2005. Effects of radio transmitters on fecal glucocorticoid metabolite levels in captive three-toed box turtles. *Wildlife Society Bulletin* 33:706–713.
- Rittenhouse, C. D., J. J. Millspaugh, M. W. Hubbard, and S. L. Sheriff. 2007. Movements of translocated and resident three-toed box turtles. *Journal of Herpetology* 41: 114-120.
- Roberts, N. M., C.F. Rabeni, and J. S. Stanovick. 2007. Distinguishing Centrarchidae genera using lateral-line scales. *North American Journal of Fisheries Management*. 27:215-219.
- Ryan, M. R., and H. Campa, III. 2005. Teaching wildlife research and management techniques. Pages 1-23 in C. Braun, editor. *Techniques for wildlife investigations and management*. Sixth Edition, The Wildlife Society, Bethesda, Maryland, USA.
- Ryding, K., J. J. Millspaugh, and J. R. Skalski. 2007. Using time series to estimate the finite rate of population increase from abundance data. *Journal of Wildlife Management* 71:202-207.
- Sasse, D.B. and M.E. Gompper 2006. Geographic distribution and harvest dynamics of the eastern spotted skunk in Arkansas. *Journal of the Arkansas Academy of Science* 60:119-124.
- Schulz, J. H., A. J. Bermudez, and J. J. Millspaugh. 2005. Monitoring presence and annual variation of trichomoniasis in mourning doves. *Avian Diseases* 49:387–389.
- Schulz, J. H., J. J. Millspaugh, A. J. Bermudez, X. Gao, T. W. Bonnot, L. G. Britt, and M. Paine. 2006. Experimental acute lead toxicosis in mourning doves. *Journal of Wildlife Management* 70:413-421.
- Schulz, J. H., J. J. Millspaugh, B. E. Washburn, A. J. Bermudez, J. L. Tomlinson, T. W. Mong, and Z. He. 2005. Physiological effects of radio transmitters on mourning doves. *Wildlife Society Bulletin* 33:1092-1100.
- Schulz, J. H., P. I. Padding, and J. J. Millspaugh. 2006. Will mourning dove crippling rates increase with nontoxic shot regulations? *Wildlife Society Bulletin* 34:861-865.
- Schulz, J. H., R. A. Reitz, S. L. Sheriff, and J. J. Millspaugh. 2007. Attitudes of Missouri small game hunters toward nontoxic shot restrictions. *Journal of Wildlife Management* 71:628-633.
- Schulz, J. H., X. Gao, J. J. Millspaugh, and A. J. Bermudez. 2007. Experimental lead ingestion in Mourning doves (*Zenaida macroura*). *American Midland Naturalist* 158:177-190.
- Shifley, S. R., F. R. Thompson, III, W. D. Dijak, M. A. Larson, and J. J. Millspaugh. 2006. Simulated effects of forest management alternatives on landscape structure and habitat

- suitability in the Midwestern United States. *Forest Ecology and Management* 229:361-377.
- Shifley, S. R.; Thompson, F. R., III; Dijak, W. D.; Larson, M. A.; Millspaugh, J. J. 2006. Simulated reflects of forest management alternatives on landscape structures and habitat suitability in the Midwestern United States. *Forest Ecology and Management* 229: (1-3) 361-377
- Siripunkaw, C., C. Kongrit, K. M. Faries, R.J. Monello, M. E. Gompper, and L. S. Eggert. Isolation and characterization of polymorphic microsatellite loci in the raccoon (*Procyon lotor*) *Molecular Ecology Resources*.
- Skalski, J. R., and J. J. Millspaugh. 2006. Application of multidimensional change-in-ratio methods in program USER. *Wildlife Society Bulletin* 34:433-439.
- Skalski, J. R., J. J. Millspaugh, and K. E. Ryding. 2006. The impact of hunter postseason survey design on harvest estimation. *Wildlife Society Bulletin* 34:329-337.
- Skalski, J. R., J. J. Millspaugh, and R. D. Spencer. 2005. Population estimation and biases in paint-ball mark-resight surveys of elk. *Journal of Wildlife Management* 69:1043-1052.
- Skalski, J. R., J. J. Millspaugh, P. Dillingham, and R. A. Buchanan. 2007. Calculating the variance of the finite rate of population change from a matrix model in Mathematica. *Environmental Modelling & Software* 22:359-364.
- Skalski, J. R., K. E. Ryding, and J. J. Millspaugh. *Wildlife Demographics: Analysis of Sex, Age, and Count Data*. Elsevier Science, San Diego, California, USA. 656 pages. (accepted)
- Stake, Mike M.; Thompson, Frank R. III; Faaborg, John; Burhans, Dirk E. 2005. Patterns of snake predation at songbird nests in Missouri and Texas. *Journal of Herpetology*. 39(2):215-222.
- Suedkamp Wells, K. M., M. R. Ryan, J. J. Millspaugh, F. R. Thompson, III, and M. W. Hubbard. 2007. Survival of post-fledging grassland birds in Missouri. *Condor* 109:781-794.
- Suedkamp Wells, K., M. R. Ryan, H. Campa, III, and K. A. Smith. 2005. Mentoring guidelines for wildlife professionals. *Wildlife Society Bulletin* 33:565-573.
- Thompson, Frank R., III, ed. 2006. Conservation assessments for five forest bat species in the Eastern United States. Gen. Tech. Rep. NC-260. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 82 p.
- Thompson, Frank R., III. 2004. The Hoosier-Shawnee ecological assessment. Gen. Tech. Rep. NC-244, St. Paul, MN: Department of Agriculture, Forest Service, North Central Research Station: 267 p.

- Thompson, Frank R., III. 2005. Landscape level effects on forest bird populations in eastern broadleaf forests: principles for conservation. In: Ralph, C. John; Rich, Terrell D.; eds. Bird conservation implementation and integration in the Americas: Proceedings of the 3rd International Partners in Flight conference. Volume 1, 2002 March 20-24; Asilomar, CA. Gen. Tech. Rep. PSW-191, Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station; 290-295.
- Tirpak, J. M., D. T. Jones-Farrand, F. R. Thompson, III, D. J. Twedt, and M. Nelson. Predicting bird habitat quality from a geospatial analysis of FIA data. In R. E. McRoberts, G. A. Reams, P. C. Van Deusen, and W. H. McWilliams, editors. Proceedings of the Eighth Annual Forest Inventory and Analysis Symposium. U.S. Forest Service General Technical Report. In Press.
- Van Velsor, S.W. and C.H. Nilon. 2006. A qualitative investigation of the urban African American and Latino adolescent experience with wildlife. *Human Dimensions of Wildlife* 11:359-370.
- Vanak, A.T. and Gompper, M.E. 2007. Effectiveness of non-invasive techniques for surveying activity and habitat use of the Indian fox in southern India. *Wildlife Biology* 13:219-224.
- Vokoun, J. C. and C. F. Rabeni. 2006. Summer diel activity and movement paths of flathead catfish (*Pylodictis olivaris*) in two Missouri streams. *American Midland Naturalist*. 155:113-122.
- Vokoun, J. C. and C. F. Rabeni. 2005. Home range and space use patterns of flathead catfish during the summer-fall period in two Missouri streams. *Transactions of the American Fisheries Society* 134:509-517.
- Vokoun, J. C. and C. F. Rabeni. 2005. Variation in annual movement cycle of flathead catfish within and between two Missouri watersheds. *Transactions of the American Fisheries Society*. 25:563-572.
- Washburn, B. E., J. J. Millspaugh, D. L. Morris, J. H. Schulz, and J. Faaborg. 2007. Using a commercially available enzyme immunoassay to quantify testosterone in avian plasma. *Condor* 109:181-186.
- White, Jennifer D.; Gardall, Thomas; Thompson, Frank R., III; Faaborg, John. 2005. Resource selection by juvenile Swainson's Thrushes during the postfledging period. *The Condor* 107(2): 388-401.
- Whitledge, G. W., Bajer, P.G. and R. S. Hayward. 2006. Improvement of bioenergetics model predictions for fish undergoing compensatory growth. *Transactions of the American Fisheries Society* 135:49-54.
- Whitledge, G. W., Bajer, P.G. and R. S. Hayward. 2006. Improvement of bioenergetics model

predictions for fish undergoing compensatory growth. Transactions of the American Fisheries Society 135:49-54.

Whitledge, G. W., C. R. Rabeni, G. Annis and S. P. Sowa. 2006. Riparian shading and groundwater enhance growth potential for smallmouth bass in Ozark streams. Ecological Applications. 16:1461-1473.

Wicks, C.W., D.B. Noltie, T. Dogwiler, and R.N. Lerch. Submitted. Disturbance events in streambed habitats of *Macrocotyla glandulosa*. Ecohydrology. (25% contribution) (submitted)

Wisdom, J., and J. Millspaugh. 2005. Movements, resource selection, and intraspecific interactions of the eastern cottontail rabbit. McNair Journal (University of Missouri) 13:15-18.

Wright, A.N. and M.E. Gompper. 2005. Altered Parasite Community Structure in Raccoons in Response to Manipulated Resource Availability. Oecologia 144:148-156

TECHNICAL AND SEMI-TECHNICAL PUBLICATIONS

Berry, C. R., M. L. Wildhaber, and D. L. Galat. 2005. Fish distribution and abundance. Vol 3. Population structure and habitat use of benthic fishes along the Missouri and lower Yellowstone rivers. U. S. Geological Survey, Cooperative Research Units, South Dakota State University, Box 2140b, Brookings, South Dakota 57007. charles_berry@sdstate.edu

Bonnot, T. W., and J. J. Millspaugh. 2006. Annotated bibliography of habitat requirements and resource selection of Black-backed woodpeckers. U.S. Forest Service, Rocky Mountain Research Station, Rapid City, South Dakota. 29 pages.

Dinsdale, T., B. White, P. Graham, A. Jeffries and R.A. Pierce II, ed. 2007. Covey Headquarters Newsletter. Quarterly Newsletter. Missouri Department of Conservation, USDA NRCS and MU Extension.

Galat, D., J. Barko, M. Davis, K. Lubinski, C. Theiling, P. West, D. Wilcox. 2006. Goals and

Objectives. Pages 7-26 in Barko, J.W. Barko, B.L. Johnson, and C.H. Theiling (eds). *Environmental Science Panel Report: Implementing Adaptive Management. Upper Mississippi River System Navigation and Ecosystem Sustainability Program – Environmental Report 2*. U.S. Army Corps of Engineers, Rock Island, St. Louis, and St. Paul Districts. 112pp. + appendices.

Gouni, A., D. Kesler, G. Coulombe, A. Lichtlé. 2007. Etude du Martin-chasseur des Gambier, *Todiramphus gambieri niauensis*, Sur l'atoll de Niau. Société d'Ornithologie de Polynésie Manu, Tahiti, French Polynesia. (Please note that I am awaiting a copy of the final version of this report so the citation is tentative)

Millsbaugh, J. J. (Chair), M. S. Boyce, D. R. Diefenbach, L. P. Hansen, K. Kammermeyer, and J. R. Skalski. 2006. An evaluation of the SAK model as applied in Wisconsin. Wisconsin Department of Natural Resources, Madison, Wisconsin. 122 pages.

Millsbaugh, J. J., and R. A. Gitzen. 2005. User's manual for the Great Plains bison population model. Final report and software submitted to the National Park Service, Keystone, South Dakota. 32 pages.

Millsbaugh, J. J., and R. A. Gitzen. 2005. User's manual for the Great Plains elk population model. Final report and software submitted to the National Park Service, Keystone, South Dakota. 25 pages.

Millsbaugh, J., S. Amelon, T. Bonnot, D. T. Farrand, R. Gitzen, D. Jachowski, B. Keller, C. McGowan, S. Pruet, C. Rittenhouse, and K. Suedkamp Wells. 2005. Natural herd demographics and effects of population control strategies in National Park Service bison (*Bison bison*) and elk (*Cervus elaphus*) herds. Final report submitted to the National Park Service, Keystone, South Dakota. 192 pages.

Pierce, R.A. II and M. Seek. 2007. Missouri Master Wildlifer Manual. MU Extension and Missouri Department of Conservation. 200pp.

Pierce, R.A. II and M. Seek. 2007. Missouri Master Wildlifer Program: 8 session shortcourse for Missouri landowners. MU Extension and Missouri Department of Conservation. Interactive TV and Centra Videoconferencing System. University of Missouri ETCS.

Pierce, R.A. II. 2007. Armadillos in Missouri: techniques to prevent and control damage. MU Extension Guide G9456. 2pp.

Pierce, R.A. II. 2007. Tree squirrels: managing habitat and controlling damage. MU Extension Guide G9455. 4pp.

Pierce, R.A., R.S. Hayward, J. Parcell, C. Boessen, and C. Hicks. 2007. Paddlefish Production: Opportunities for Missouri pond and lake owners. MU Extension, University of Missouri-Columbia

- Quist, M.C., A.M. Boelter, J.M. Lovato, N. Korfanta, H.L. Bergman, D.C. Latka, C. Korschgen, D.L. Galat, S. Krentz, M. Oetker, M. Olson, C.M. Scott, and J. Berkley. 2005. Research and Assessment Needs for Pallid Sturgeon Recovery in the Missouri River. Final report to the U.S. Geological Survey, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and U.S. Environmental Protection Agency. William D. Ruckelshaus Institute of Environment and Natural Resources, University of Wyoming, Laramie, WY, 82071.
- Rittenhouse, C. D., F. R. Thompson, III, W. D. Dijak, and J. J. Millspaugh. 2007. Development of landscape-level habitat suitability models for ten wildlife species in the central hardwoods region. USDA Forest Service General Technical Report, NRS-4.
- Slotow, R., B. Page, A. Delsink, J. Millspaugh, H. Prins, F. De Boer, I. Whyte, and R. Grant. 2006. Spatial demography and food habits of elephants: implications for management. KwaZulu Natal Region Parks, South Africa. 8 pages.
- Whitledge, G. W., D. L. Galat, and G. T. Gelwicks. 2005. Habitat use by fishes in periodically and continuously connected lower Missouri River floodplain water bodies. Final Report to Missouri Department of Conservation. Missouri Cooperative Fish and Wildlife Research Unit, Columbia. 68 pp.

THESES

- Bailey, J. W. 2005. Hierarchical nest-site selection and the effects of habitat characteristics on black-capped vireo nest survival. MS. 73pp. F. R. Thompson III, advisor.
- Bajer, P. P. G. 2005. Bioenergetics evaluations of warm water effects on white crappie populations in Missouri impoundments. PhD. 223pp. R. S. Hayward, advisor.
- Bajer, P.G. 2005. Bioenergetics evaluations of warm water effects on White Crappie populations in Missouri impoundments. PhD. 223pp. R. S. Hayward, advisor.
- Bonnot, T. W. 2006. Nesting ecology of Black-Backed Woodpeckers in Mountain Pine Beetle infestations in the Black Hills, South Dakota. 77pp. J. J. Millspaugh, advisor.
- Brunet, D. 2006. Butterfly gardening: Using volunteers to provide data on flower use. 134pp. C. H. Nilon, advisor.

- Chamberlain, E. J. 2005. Covey behavior and habitat selection: a physiological ecology approach. PhD. 95pp. R. D. Drobney, advisor.
- Chinnadurai, S. K. 2006. Evaluation of fecal glucocorticoid metabolite assays for short-term stressors and validation for stress monitoring in African herbivores. 52pp. J. J. Millspaugh, advisor.
- D'Errico, M. A. 2006. Hydrology, vegetation and waterbird response to land management strategies in the San Luis Valley. 138pp. L. H. Frederickson, advisor.
- Ederington, B. 2005. Transitional wetland habitats in southern forested ecosystems: dynamics and use by wildlife in the upper Mississippi alluvial valley. MS. 106pp. L. H. Fredrickson, advisor.
- Farrand, D. T. 2005. Wildlife response to farm conservation practices in northeast Missouri. PhD. 237pp. M. R. Ryan and R. A. Pierce II, advisors.
- Ford, Z. L. 2006. Impacts of suspended and deposited sediment on benthic invertebrates and fishes in a Missouri Ozark stream. 169pp. C. F. Rabeni, advisor.
- Garcia, D. M. 2006. The role of the Giant Canada Goose (*Branta Canadensis maxima*) cecum in nutrition. 117pp. R. D. Drobney, advisor.
- Horton, K. 2005. Roadway effects on the hydrologic regime of temporary wetlands in the Missouri River floodplain in Missouri. MS. 107pp. L. H. Fredrickson, advisor.
- Hulse, S. N. 2005. Reach scale and sample design influences on middle Mississippi River fishes. MS. 195pp. D. L. Galat, advisor.
- Jachowski, D. S. 2007. Resource selection by black-footed ferrets in relations to the spatial distribution on prairie dogs. 61pp. J. J. Millspaugh, advisor.
- Lakish, Benjamin. 2007. Nutrients and Chlorophyll Dynamics in Fort Cobb Reservoir. MS Thesis, University of Missouri. J. R. Jones, advisor.
- Obrecht, D. V. 2007. "Temporal Patterns and Variability of Trophic State Parameters in Missouri Reservoirs". J. R. Jones, advisor.
- O'Donnell, T. K. 2006. River restoration in the Upper Mississippi River Basin. 183pp. D. L. Galat, advisor.
- Parker, T. S. 2006. Habitat and landscape characteristics that influence population density and behavior of gray squirrels in urban areas. 101pp. C. H. Nilon, advisor.
- Reeves, K. 2006. Use of main channel and shallow-water habitat by larval fishes in the lower

- Missouri River. 266pp. D. L. Galat, advisor.
- Reidy, J. L. 2007. Golden-Cheeked Warbler nest success and nest predators in urban and rural landscapes. 84pp. F. R. Thompson, advisor.
- Ridenour, C. 2007. Assemblage structure and shallow-water habitat use by small-bodied fishes at lower Missouri River sandbars. 175pp. D. L. Galat, advisor.
- Sowa, S. P. 2005. A multiscale investigation of factors influencing local biophysical conditions within headwater streams of the Missouri Ozarks. PhD. 397pp. C. F. Rabeni, advisor.
- Suedkamp Wells, K. M. 2005. Resource selection, movement patterns, and survival of post-fledging grassland birds in Missouri. PhD. 219pp. M. R. Ryan and J. J. Millsbaugh, advisors.
- Veum, K. S. 2006. Disinfection by-product precursors and formation potentials of Missouri reservoirs. MS University of Missouri.
- Vradenburg, J. 2005. Distribution and abundance of Anurans in southeast Missouri. L. H. Frederickson, advisor.

PRESENTATIONS

- Bajer, P. B., and R. S. Hayward, 2006. Advancing bioenergetics models to predict effects of warm water on growth, W_r , and fecundity of white crappie. 136th Annual Meeting of the American Fisheries Society, September 10-14, Lake Placid, NY.
- Bajer, P. G., J. J. Millsbaugh, and R. S. Hayward. 2006. Application of discrete choice models to predict white crappie temperature selection in two Missouri impoundments. Midwest Fish and Wildlife Conference, Omaha, Nebraska. December, 2006.
- Bisch, R., and D.B. Noltie. 2005. Poster. A GPS model for assessing threats to cavefish sites. MU Undergraduate Research and Creative Achievements Forum, MU.
- Bonnot, T. W., J. J. Millsbaugh, M. A. Rumble. 2006. Nest site selection of black-backed

woodpeckers in mountain pine beetle infestations in the Black Hills, South Dakota. Midwest Fish and Wildlife Conference, Omaha, Nebraska.

Bonnot, T. W., M. A. Rumble, and J. J. Millspaugh. 2005. Association of black-backed woodpeckers with mountain pine beetle infestations in the Black Hills, South Dakota. 12th Annual Wildlife Society Meeting, Madison, Wisconsin.

Bonnot, T. W., M. A. Rumble, and J. J. Millspaugh. 2006. Nest survival of black-backed woodpeckers in mountain pine beetle infestations in the Black Hills, South Dakota. South Dakota Annual Wildlife Society Meeting, Pierre, South Dakota.

Bonnot, T. W., M. L. Wildhaber, J. J. Millspaugh, A. DeLonay, R. Jacobson, and D. Papoulias. 2007. Habitat use of gravid shovelnose sturgeon. Missouri River Natural Resource Conference. Invited.

Bonnot, T. W., M. L. Wildhaber, J. J. Millspaugh, A. J. DeLonay, R. B. Jacobson, D. M. Papoulias. 2007. Resource selection of gravid shovelnose sturgeon in the Lower Missouri River. 137th Annual American Fisheries Society Meeting, San Francisco, California. Invited.

Brewer, S.K. C.F. Rabeni, and D.C. Heimann. 2005. The importance of day versus night fish sampling for in-stream flow determinations. Southeast Association of Fisheries and Wildlife Agencies Meeting, St. Louis, Missouri.

Brewer, S.K., S.P. Sowa, G. Annis, M.E. Morey, and C.F. Rabeni. 2005. Using GIS to isolate local and watershed factors affecting the distribution and abundance of riverine smallmouth bass in Missouri. Symposium: Geographic Information System and Geospatial Analyses in Fisheries Research and Management. American Fisheries Society Annual Meeting, Anchorage, Alaska.

Broun, C., C. Nilon and R. Pierce. 2007. Poster. Missouri Master Naturalists: Leading Through Natural Resources Volunteerism. The Wildlife Society Annual Conference, Tucson, AZ.

Broun, C., C. Nilon, and R.A. Pierce II. 2007. Impacts of the Missouri Master Naturalist Program: leading through community-based conservation. The Wildlife Society Annual Conference.

Brunet, D. and C. Nilon. 2007. Butterfly garden journal: butterfly gardening in central Missouri. *Butterfly Gardener* 12(1)4-6.

Buenger, C., C. Nilon, R. Pierce, and G. Wallace. 2005. Evaluation of the Missouri Master Naturalist Program. National Master Naturalist Annual Conference. Estes Park, Colorado.

Buenger, C., C. Nilon, R. Pierce, and G. Wallace. 2005. Poster. Missouri Master Naturalists:

Leading Through Community-Based Natural Resources Volunteerism. 59th Annual Conference. Southeastern Association of Fish and Wildlife Agencies. St. Louis, Missouri.

Buenger, C., C. Nilon, R. Pierce, and G. Wallace. 2005. Poster. Missouri Master Naturalists: volunteers applying ecological concepts and approaches in community-based conservation programs. Natural Areas Conference, Flagstaff, AZ.

Buenger, C., C. Nilon, R. Pierce, G. Wallace. 2006. Poster. Missouri Master Naturalists: volunteers applying ecological concepts and approaches in community-based conservation programs. Annual Meeting of the Ecological Society of America.

Burger, E. K., Hayward, R. S., Brown, P. B., and E. P. Berg. 2005. Effect of Creatine Supplementation on *Lepomis macrochirus* (Bluegill). 51st International Congress of Meat Science and Technology. Baltimore, Maryland.

Chinnadurai, S. K., J. R. Dodam, and J. J. Millspaugh. 2006. Use of fecal corticosterone metabolites to quantify the stress response to anesthesia and surgery in the dog. University of Missouri Veterinary School Research Day, Columbia, MO.

Clevenstine, R., J. Barko, B. Johnson, S. Bartell, D. Galat, M. Davis, K. Lubinski, J. Nestler, and L. Weber. 2007. Implementing adaptive management for Upper Mississippi River navigation and ecosystem sustainability. 2nd National Conference on Ecosystem Restoration, Kansas City, MO.

Crimmins, S. M., J. J. Millspaugh, and M. A. Larson. 2005. Developing a comprehensive internet resource for radio-tracking studies. 12th Annual Wildlife Society Meeting, Madison, Wisconsin.

Dailey, T.V., C.D. Scroggins, R.A. Reitz, H.J. Scroggins, T.B. Treiman, R.A. Pierce II, W.B. Kurtz, K. Coleman and J. Pinkowski. 2007. Abstract and poster. Use of habitat and landowner suitability models as tools for selecting large-scale quail habitat restoration areas on private land in Missouri. Missouri Natural Resources Conference.

Dailey, T.V., R.A. Reitz, H.J. Scroggins, T.B. Treiman, C.D. Scroggins, R.A. Pierce II and W.B. Kurtz. 2007. Paper and poster. Use of human dimensions information as a tool for selecting large-scale quail restoration areas. Missouri Natural Resources Conference.

Dijak, W. D., M. A. Larson, C. Rittenhouse, F. R. Thompson, III, and J. J. Millspaugh. 2005. Landscape HSI models version 2.0. 12th Annual Wildlife Society Meeting, Madison, Wisconsin.

Farrand, D. T., J. Tirpak, F. R. Thompson, III, D. Twedt, and B. Uihlein. 2006. *Application of FIA data to spatial modeling of landscape change and bird habitat suitability*. Presented to the Partners In Flight Conservation Design Workshop, St. Louis, MO.

http://www.lmvjv.org/library/PIF2006/Farrand_PIF.pps

- Galat D. L. February 2006. The role of goals and objectives in adaptive management. Upper Mississippi Navigation & Environmental Coordination Committee annual meeting, St. Louis, MO. Invited.
- Galat, D. L. 2005. Challenges to restoring U. S. great rivers. Missouri State University, Department of Biology. Invited seminar.
- Galat, D. L. 2007. Challenges to Developing a Functional Adaptive Science Process for Great Rivers of the Upper Mississippi Basin. Collaborative Adaptive Management *Network (CAMNet)* Rendezvous, Estes Park, Colorado. Invited
- Galat, D. L. and K. O'Donnell. 2005. Large river restoration. Mississippi-Missouri River Confluence Region Field Manager's Restoration Workshop, Grafton, IL
- Galat, D. L. 2007. Floods and floodplains. Meeting of the waters: cooperative conservation, recreation and economic development in the St. Louis Region. Invited educational strand speaker.
- Galat, D. L. and R. Jacobson. 2006. Re-engineering the Missouri River: integrating sound science into river rehabilitation. International Conference on Rivers and Civilization. Special Session – Civilizing the Mississippi: river engineering and its consequences. La Crosse, WI. Invited.
- Galat, D. L. 2005. Conserving *Scaphirhynchus* Sturgeons in the Missouri River: A Plea for More Ecology. Evolution, Ecology and Management of Scaphirhynchus Conference, St. Louis.
- Galat, D. L., C. Fleming, M. George, and J. Ledwin. 2007. Challenges to effective rehabilitation of the Missouri River. 2nd National Conference on Ecosystem Restoration, Kansas City, MO.
- Galat, D. L., K. E. Doisy and K. S. Reeves. 2006. Importance of shallow, slow-velocity habitats to growth of larval gizzard shad in the Lower Missouri River channel. 67th Midwest Fish & Wildlife Conference, Omaha, NE.
- Galat, D. L., R. B. Jacobson, and M. R. Headrick. 2006. Reconnecting the channel and floodplain of large rivers: reconciling theory and practice along the lower Missouri River. Special Symposium: Exchanges between Channel and Floodplain in Large Rivers, Ecological Society of America, Annual Meeting, Memphis, TN. Invited.
- Galat, D., E. Bernhardt, K. Lubinski, M. Palmer, C. Theiling, and D. Wilcox. 2006. Poster. Large river rehabilitation within an adaptive management framework: setting achievable goals and objectives. Ecological Society of America, Ecology in an Era of Globalization, Merida, Mexico.;

- Missouri River Natural Resources Conference S. Sioux City NE. 2006.;
- International Conference on Rivers and Civilization, La Crosse WI. 2006.
- Galat, D., L. Beran, C. Cox, Lubinski, K. 2007. The pros and cons of scaling-up stream restoration in the Mississippi River Basin. 2nd National Conference on Ecosystem Restoration, Kansas City, MO. Invited Panel Member.
- Galat, D.L. 2007. Invited Lecture/discussion. Agriculture Journalism 3201/Journalism 8001: Topics in agricultural Journalism- Field Reporting on Food and the Environment. Ecological History of the Missouri River
- Garrett, D. and C. F. Rabeni 2007. Movement and habitat use by Flathead and blue catfish in the Missouri River. Midwest Fish and Wildlife Conference, Madison, Wisconsin.
- Gitzen, R. A., and J. J. Millspaugh. 2005. A review of bandwidth smoothing options for kernel density estimators. 12th Annual Wildlife Society Meeting, Madison, Wisconsin. September. Invited.
- Gitzen, R. A., and J. J. Millspaugh. 2005. Use of nomograms for visual interpretation of logistic regression models. 12th Annual Wildlife Society Meeting, Madison, Wisconsin.
- Gitzen, R., S. West, K. Aubry, J. Millspaugh, and M. Kroeger. 2007. The space-time continuum and responses by small mammals to forest management experiments. Annual Wildlife Society Conference, Tucson, Arizona.
- Gompper, M.E. and A.T. Vanak. Subsidized predators, landscapes of fear, and disarticulated carnivore communities. Animal Conservation. Invited.
- Gompper, M.E. 2005. Experimental Disease Ecology research, Dept. of Biology, St Louis University. Invited seminar.
- Gompper, M.E. 2007. Biotic and abiotic predictors of tick (*Dermacentor variabilis*) abundance and engorgement on free-ranging raccoons (*Procyon lotor*). Annual meeting, Wildlife Disease Association, Estes Park, Colorado (with R.J. Monello)
- Gompper, M.E. 2006. Current population and conservation status of the critically endangered dwarf carnivores of Cozumel Island, Mexico. Annual meeting of the Society for Conservation Biology, San Jose, California (with Katherine McFadden and Rodrigo A. Medellín)
- Gompper, M.E. 2006. Feeding habits of a dwarf insular carnivore (*Procyon pygmaeus*) using stable isotope and fecal analyses. Annual Meeting, Ecological Society of America, Memphis, Tennessee (with Katherine McFadden, Rodrigo Medellín, Ray Sambrotto)

Gompper, M.E. 2005. Spotted skunk historical declines, Joint Furbearer Workshop, Bismarck, North Dakota (with M. Hackett) Invited.

Gompper, M.E. 2005. Long-term, range-wide decline of a once common carnivore: the eastern spotted skunk, *Spilogale putorius*. Annual meeting of the American Society of Mammalogists, Springfield, Missouri (with M Hackett) Invited.

Gompper, M.E. 2007. Mammal-parasite interactions: moving beyond simple surveys. Keynote talk, Annual Meeting of the Central Plains Society of Mammalogists, Bull Shoals Field Station, Missouri State University, Springfield, Missouri.

Gompper, M.E. 2007. Mammal-parasite interactions: moving beyond simple surveys. Keynote talk, Annual Meeting of the Central Plains Society of Mammalogists, Bull Shoals Field Station, Missouri State University, Springfield, Missouri.

Gompper, M.E. 2006. Noninvasive Surveys and Density Estimation for Fisher and Coyote. Annual Meeting of the North East Natural History conference, Albany, New York (with Roland Kays, Justina Ray)

Gompper, M.E. 2006. Parasites in the Classroom. Midwestern Area Conference, National Science Teachers Association, Omaha, Nebraska (with Deanna Lankford, Gerard Ritzka)

Gompper, M.E. 2005. Scale and interactions in predictive distribution models for the Adirondack carnivore community. 12th Annual Conference on the Adirondacks, Saranac Lake, New York. (with R. Kays and J. Ray)

Gompper, M.E. 2007. Space Use and Mortality of Eastern Spotted Skunks in the Ouachita Mountains, Arkansas, Annual Meeting, American Society of Mammalogists, Albuquerque, New Mexico (with D. Lesmeister, J. Millspaugh);

Annual Meeting of the Central Plains Society of Mammalogists, Bull Shoals Field Station, Missouri State University, Springfield, Missouri. (with D. Lesmeister, J. Millspaugh), 2007.;

2007 Midwest Fish & Wildlife Conference Meeting (with D. Lesmeister, J Millspaugh)

Gompper, M.E. 2007. Spatial Ecology of Eastern Spotted Skunks in the Ouachita National Forest, Arkansas. Annual Meeting, Arkansas Chapter of the Wildlife Society, Barling, Arkansas (with D. Lesmeister, J. Millspaugh)

Gompper, M.E. 2007. Spillover of canine distemper virus from free-ranging dogs to Indian foxes in central India. Annual Meeting, Society for Conservation Biology, Port Elizabeth, South Africa (with A.T. Vanak, A. Belsare)

Annual Meeting of the Central Plains Society of Mammalogists, Bull Shoals Field Station,

Missouri State University, Springfield, Missouri. (with A.T. Vanak, A. Belsare)

Gompper, M.E. 2007. The influence of increased contact rate among raccoons on a directly transmitted nematode, *Baylisascaris procyonis*. Summer Undergraduate Research and Creative Achievements Forum, Columbia, Missouri (with K.D. Purnell, R.J. Monello)

Annual Meeting of the Central Plains Society of Mammalogists, Bull Shoals Field Station, Missouri State University, Springfield, MO. (with K.D. Purnell, R.J. Monello), 2007.;

Annual Biomedical Research Conference for Minority Students, Austin, TX (with K.D. Purnell, R.J. Monello), 2007.;

Summer Undergraduate Research and Creative Achievements Forum, Columbia, MO (with K.D. Purnell, R.J. Monello), 2007.

Hayward, R. S. 2006. Symposium on Sunfish and black bass culture: an update on progress. Aquaculture America 2006 Annual Meeting, February 15, Las Vegas, NV. Symposium Organizer and Chair.

Hayward, R. S. 2005. Novel bioenergetics modeling of fish growth-in-length and condition: expanding the scope of application. Invited presentation given at: Living Marine Resources Cooperative Science Center, University of Maryland--Eastern Shore's Current Topics in Fisheries Science Seminar Series. April 15. Invited.

Hayward, R. S. 2005. Presented a two-day workshop with assistance from my doctoral student Przemek Bajer on the topic of FISH BIOENERGETICS MODELING to the Centrarchid Technical Committee of the American Fisheries Society, at Prairie du Chien, Wisconsin. This involved a series of seven, ~1-hr presentations to the group of 20-30 participants, demonstrating how to run fish bioenergetics models, recent developments and applications with bioenergetics models, and also cautions associated with applying these models that are rapidly increasing in popularity. Invited.

Hayward, R. S. 2007. Laboratory evaluations of redear sunfish and hybrid redear sunfish as pond snail biocontrollers. Meeting of the Missouri Aquaculture Coordinating Council, April 10, Jefferson City. Invited.

Hayward, R. S., and K. Masagounder. 2007. Examination of two impediments to beneficial use of compensatory growth in aquaculture. In Symposium titled: Physiological Insights Towards Improving Fish Culture. Aquaculture 2007, February 26-March 2, San Antonio, Texas. Invited.

Hayward, R. S., and P. B. Bajer. 2007. Fish Bioenergetics Modeling Workshop: Basics Pluses and Minuses, Novel Developments and Applications. 68th Midwest Fish and Wildlife Conference, Madison, WI. (Note: R. Hayward, the primary invitee, provided presentation slides but was unable to attend meeting due to poor traveling conditions; co-presenter, P.

Bajer, delivered workshop material) Invited Workshop.

Hayward, R. S., H. P. Wang, and A. J. Doerhoff. 2006. Potential advantages of indoor rearing of male bluegills for food-market sunfish production. Symposium on sunfish and black bass culture: an update on progress. Aquaculture America 2006 Annual Meeting, Las Vegas, Nevada.

Hayward, R. S., K. Masagounder, and A. J. Doerhoff. 2007. Developing capacity to rear large sunfish efficiently. Mid-continent Warm-water Fish Culture Conference, Kansas City, Kansas. Invited.

Hayward, R. S., and P. B. Bajer. 2005. Bioenergetics evaluation of warm water effects on white crappie in Missouri impoundments. 66th Midwest Fish and Wildlife Conference, Grand Rapids, Michigan.

Headrick, M. R., D. L. Galat, and R. Renken. 2007. Ecological lessons learned from the great Missouri River flood of 1993. 2nd National Conference on Ecosystem Restoration, Kansas City, Missouri.

Heimann, D.C., S.S. Licher, J.M. Richards, S.K. Brewer, and R.D. Norman. 2005. Poster. Quantifying the effects of streamflow regulation on aquatic habitat in the upper Osage Basin, west-central Missouri. US Geological Survey Workshop, Linking hydrological change and ecological response in streams and rivers of the eastern United States, Herndon, Virginia.

Jachowski, D. S., and J. J. Millspaugh. 2006. Spatial distribution and patch dynamics of black-tailed prairie dogs. Midwest Fish and Wildlife Conference, Omaha, Nebraska.

Jacobson, R. and D. Galat. 2006. The design of the spring rise on the Lower Missouri River. Symposium: Managing Rivers, Floodplains, and Flood Hazard for the New Millennium. American Association for the Advance of Science, Annual Meeting, St. Louis, Missouri. Invited.

Jacobson, R. B., D. L. Galat, and C. H. Hay. 2005. Prospects for the designed hydrograph, lower Missouri River. North American Benthological Society Annual Meeting, New Orleans, Louisiana.

Jacobson, R., and D. Galat. 2007. Design of naturalized flow regimes on large, multi-purpose river systems: an example from the Lower Missouri River. 2nd National Conference on Ecosystem Restoration, Kansas City, Missouri.

Johnson, J. D. Papoulias, and D. Galat. 2006. Poster. Reproductive Development of the Sicklefing Chub (*Macrhybopsis meeki*) in the lower Missouri River. Missouri Natural Resources Conference, Osage Beach, Missouri;

Missouri River Natural Resources Conference S. Sioux City Nebraska, 2006.;

International Conference on Rivers and Civilization, La Crosse Wisconsin, 2006.

Johnson, J., D. Papoulias, and D. Galat. 2005. Poster. Reproductive development of Missouri River chubs in relation to environmental variables. Missouri River Natural Resources Conference. Pierre, South Dakota.

Jones, J. R. 2007. Keynote address. Cyanobacterial blooms and the potential for toxins. National US COE meeting on algal toxins. Portland, Oregon.

Jones, J. R. 2007. Keynote address. Empirical evidence of Monsoon influences on Asian Lakes. Climate Change: Impact, Assessment and Management. Tropical Ecology Congress, Dehra Dun, India

Jones, J. R. 2006. Regional patterns and natural variability in Missouri reservoirs: Implications for monitoring and setting nutrient criteria." Brno, Czech Republic. 5th International Conference on Reservoir Limnology and Water Quality. Invited Keynote Address.

Jones, J. R. 2006. "Perspectives in Tropical Limnology: Challenges in Costa Rica." University of Costa Rica, 25th Anniversary Symposium of the Research Center on Marine Sciences and Limnology. Invited Plenary Address.

Jones-Farrand, D. T. M. Tirpak, F. R. Thompson, D. J. Twedt, and W. B. Uihlein. 2007. *Spatial modeling of changes in avian habitat quality for eco-regional-scale conservation planning*. Bird Numbers 2007: Monitoring for Conservation and Management – 17th International Conference of the European Bird Census Council. Chiavenna, Italy.

Jones-Farrand, D. T., J. M. Tirpak, F. R. Thompson, D. J. Twedt, and W. B. Uihlein. 2006. *Predicting avian habitat quality for eco-regional-scale conservation planning*. 67th Midwest Fish & Wildlife Conference. Omaha, Nebraska.

Kesler, D.C. 2007. The role of science in avian conservation: examples from Pacific Island Kingfishers. The IV International Symposium on Breeding Birds in Captivity. Toronto, Canada.

Lesmeister, D., M. Gompper, and J. Millspaugh. 2007. Space use of eastern spotted skunks (*Spilogale putorius*) in the Ouachita Mountains, Arkansas. Arkansas Chapter of The Wildlife Society.

Lesmeister, D., M. Gompper, and J. Millspaugh. 2007. Space use and mortality of eastern spotted skunks in the Ouachita Mountains, Arkansas. American Society of Mammalogists, 87th Annual Meeting, Albuquerque, New Mexico;

Midwest Fish and Wildlife Conference, Madison, Wisconsin, 2007..

- Licht, D., R. Slotow, and Millspaugh, J. J. 2007. A comparison of park management in South Africa and the United States. George Wright Society, Minneapolis, Minnesota.
- Lohman, K. and J.R. Jones. 2007. Longitudinal patterns in nutrient chemistry below point source additions in three northern Ozark streams. 30th Congress of the International Association of Theoretical and Applied Limnology.
- Lubinski, K. S., J. Barko, D. Galat, J. Nestler, and C. Theiling. 2006. Application of the concept of ecological health to adaptive management of the Upper Mississippi River. International Conference on Rivers and Civilization. La Crosse, Wisconsin.
- Martin, D., J. Persinger, and D. Noltie. 2005. Poster. Status of the blacknose shiner, *Notropis heterolepis*, in western Missouri. 59th Annual Conference, Southeastern Association of Fish and Wildlife Agencies, St. Louis, Missouri. Received first runner-up in student poster competition;
- 5th Annual Student Colloquium, American Fisheries Society, East Carolina University, 2005.
- Missouri Natural Resources Conference, Lake of the Ozarks, Missouri, 2006.
- Masagounder, K. and R. S. Hayward. 2006. Evaluation of a compensatory growth feeding regime for bluegills in recirculating aquaculture systems. Symposium on sunfish and black bass culture: an update on progress. Aquaculture America Annual Meeting, Las Vegas, Nevada.
- Mattingly, H. T. and D. L. Galat. 2005. Poster. Predictive performance of a microhabitat model for a rare Ozark stream fish. Tennessee EPSCoR Environmental Summit, Cookeville, Tennessee.
- Middendorf, G. and C. Nilon. 2006. Linking ecology and environmental justice. Annual Meeting of the Ecological Society of America. Memphis, Tennessee.
- Bulletin of the Ecological Society of America. Invited.
- Miller, L. J., J. J. Millspaugh, and D. C. Dey. 2005. Survival of eastern cottontail rabbits (*Sylvilagus floridanus*) within Missouri river bottomland agroforestry habitats. Missouri Natural Resources Conference.
- Millspaugh, J. J. (Chair), M. S. Boyce, D. R. Diefenbach, L. P. Hansen, K. Kammermeyer, and J. R. Skalski. 2007. An evaluation of the SAK model as applied in Wisconsin. Wisconsin Department of Natural Resources, Madison, Wisconsin. 146 pages.
- Millspaugh, J. J., 2007. Integrated camera and sensor system for wildlife monitoring: present

and future applications (w/ Henry He). Princeton University, New Jersey (NSF-sponsored workshop) Invited.

Millspaugh, J. J. 2005. Natural herd demographics and effects of population control strategies in National Park Service bison and elk herds. National Park Service. Badlands National Park. Invited.

Millspaugh, J. J., R. M. Nielson, L. McDonald, J. M. Marzluff, R. A. Gitzen, C. D. Rittenhouse, M. W. Hubbard, and S. L. Sheriff. 2005. Analysis of resource selection using utilization distributions. 12th Annual Wildlife Society Meeting, Madison, Wisconsin. Invited.

Millspaugh, J. J. 2005. Reconstructing historical bison demographics in the Northern Great Plains. Fisheries and Wildlife Sciences seminar series, University of Missouri. Invited.

Ecology and evolution seminar series, University of Missouri (Division of Biological Sciences). Invited. 2005.

Millspaugh, J. J., S. Amelon, T. Bonnot, T. Farrand, C. McGowan, S. Pruett, C. Rittenhouse, K. Suedkamp Wells. 2005. Combining problem-based learning and cooperative learning: a new model with high realism and application. University of Missouri.

Millspaugh, J. J., S. Amelon, T. Bonnot, T. Farrand, R. Gitzen, C. McGowan, S. Pruett, C. Rittenhouse, K. Suedkamp Wells. 2005. Natural demographics of bison and elk in the Great Plains. Natural Areas Conference, Lincoln, Nebraska.;

Millspaugh, J. J., S. Amelon, T. Bonnot, T. Farrand, R. Gitzen, D. Licht, C. McGowan, S. Pruett, C. Rittenhouse, K. Suedkamp Wells. 2007. Natural demographics of bison in the Great Plains. George Wright Society, Minneapolis, Minnesota.

Millspaugh, J. J. 2007. Stress assessment as related to instrument deployment. National Geographic Society, Washington, D.C. Invited.

Millspaugh, J. J. 2005. Using physiological measures to assess costs of wildlife habituation. Invited by National Park Service to present at The Wildlife Society Conference, Madison, Wisconsin.

Millspaugh, J. J. 2005. Wildlife population modeling workshop. National Park Service. Badlands National Park. Invited.

Millspaugh, J. J., Z. He, R. Kays, J. Beringer, J. Sartwell, W. Cheng, J. Eggert, R. Moll, and X. Zhao. 2007. Integrated camera and sensor system for wildlife monitoring: present and future applications. Princeton University, New Jersey, NSF Sponsored Workshop.

Moll, R. J. J. Millspaugh, J. Beringer, J. Sartwell, and Z. He. 2006. Development of an animal-mounted video system for terrestrial ecology research. Midwest Fish and Wildlife

Conference, Omaha, Nebraska.;

Missouri Natural Resources Conference, Osage Beach, Missouri, 2007.

Mong, T. W., J. H. Schulz, R. Bredesen, J. J. Millspaugh, and D. Dey. 2006. Increasing the economic viability of agricultural landscapes through agroforestry and lease hunting. Midwest Fish and Wildlife Conference, Omaha, Nebraska.

Mong, T. W., J. H. Schulz, R. Bredesen, J. J. Millspaugh, and D. Dey. 2007. Using agroforestry and lease hunting to increase the economic viability of agricultural landscapes. Missouri Natural Resources Conference, Osage Beach, Missouri.

Montgomery, M. and D. Galat. 2007. Poster. Use of a passage facility by Missouri River fishes for spawning and nursery in seasonal wetland pools at Eagle Bluffs Conservation Area. 2nd National Conference on Ecosystem Restoration, Kansas City, MO.

Nestler J., L. Weber, D. Galat, and M. Davis. 2007. Large rivers from a fish's perspective: integrating stream habitat and flood pulse concepts. 2nd National Conference on Ecosystem Restoration, Kansas City, Missouri.

Nielsen, R., H. Sawyer, and J. Millspaugh. 2005. An alternative to utilization distribution smoothing. 12th Annual Wildlife Society Meeting, Madison, Wisconsin.

Nilon, C.H. 2007. Bird Species and Abundance in Urban Areas. Biology Seminar Series, St. Louis University. St. Louis, Missouri. Invited.

Nilon, C. H. 2006. Everyday nature: A key to understanding the ecology of cities. Center for Urban Environmental Studies. Florida Memorial University. Miami Gardens, Florida. Invited.

Nilon, C. H. 2006. Wildlife Research in the Inner City / Ecology and Nearby Nature. University of Wisconsin-Milwaukee. Milwaukee, Wisconsin. Invited.

Nilon, C.H. 2005. Ecology and Nearby Nature. Department of Geography, University of Maryland, College Park, Maryland. Invited.

Nilon, C.H. 2005. Ecology of Nearby Nature. Ecology, Evolutionary Behavior and Biology Distinguished Speaker (Fall 2005). Michigan State University, Lansing, Michigan. Invited.

Nilon, C.H. 2005. Human Dimensions and Urban Wildlife Conservation. Department of Fisheries and Wildlife, Michigan State University, Lansing, Michigan. Invited.

Nilon, C.H. 2005. The Ecology of Nearby Nature. Plenary Talk. Mid-Atlantic Ecology Conference. Mid-Atlantic Chapter, Ecological Society of America. Baltimore, Maryland

Invited.

- Nilon, C.H. 2006. The ecology of nearby nature: exploring diversity in urban neighborhoods. Cleveland Museum of Natural History Explorers Series, Cleveland, Ohio. Invited.
- Nilon, C.H. and D. Eller. 2006. Bird conservation in North St. Louis. Bringing Researchers and Practitioners Together, Missouri Natural Resources Conference, Lake of the Ozarks, Missouri. Invited.
- Nilon, C.H. and P.S. Warren. 2007. Modeling bird species distribution and abundance in urban areas. International Association of Landscape Ecology Workshop: Current and Future Research in Urban Ecology. Ede, The Netherlands. Invited.
- Nilon, C.H. and P.S. Warren. 2007. Poster. Modeling bird species distribution and abundance in urban areas. Midwest Fish and Wildlife Conference, Madison, Wisconsin.
- Nilon, C.H. and R.A. Pierce II. 2005. Poster. Interacting human and natural systems and urban residents. The 11th Japan-U.S. Workshop on Global Change. Biodiversity, Ecosystem Function, and Dynamic Human-Nature Interactions. Yokohama Institute for Earth Sciences, Yokohama, Japan.
- Nolan, J.M., M.C. Robbins, T.R. Gemeinhardt, and D.B. Noltie. 2005. Catching on to ethnoichthyology: the effects of formal taxonomic training on freshwater fish classification. Society of Ethnobiology, 28th Annual Conference, University of Alaska, Anchorage, Alaska.
- O'Donnell, T. K. and D. L. Galat. 2007. Including quantifiable objectives and project monitoring in river restoration: the case of the Upper Mississippi River Basin. 2nd National Conference on Ecosystem Restoration, Kansas City, Missouri.
- O'Donnell, T. K. and D. L. Galat. 2006. River restoration in the Upper Mississippi River basin: Insights from project managers and Practitioners. International Conference on Rivers and Civilization, La Crosse, Wisconsin.
- Obrecht, D.V., A. Thorpe and J.R. Jones. 2007. Poster. Short-term temporal variability of water quality in three reservoirs in mid-Missouri. 30th Congress of SIL, Montreal.
- Papoulias, D. M., Braaten, P. J., Delonay, A. J., Doyle, W. J., Fuller, D. B., Simpkins, D. G., Wildhaber, M. L., and Galat, D. L. 2007. Evidence for protracted spawning in shovelnose sturgeon from the Missouri River. Annual Meeting American Fisheries Society, San Francisco, California.
- Pierce, R.A. II, S. Hime, C. Nilon and C. Broun. 2007. Evaluation tools developed for the Missouri Master Naturalist Program: a multi-faceted approach. 3rd Annual ANSROP Conference, Cloquet, Minnesota.;

Annual Conference of the Alliance of Natural Resource Outreach and Service Programs, Cloquet, Minnesota, 2007.

Reeves, K. G. Gelwicks, and D. Galat. 2005. Diel patterns in habitat use by larval fishes in the lower Missouri River. Missouri River Natural Resources Conference. Pierre, South Dakota.

Reinbott, T., R. Wright and R.A. Pierce II. 2007. Quail on an agronomy farm. International Annual Meeting of the Agronomy Society of America. New Orleans, Louisiana.

Reitz, R.A., S.J. Sheriff, T.V. Dailey, H.J. Scroggins, T.B. Treiman. R.A. Pierce II, and W.B. Kurtz. 2007. The relationship between landowners' demographics and attitudes and their willingness to participate in a quail restoration cooperative. Missouri Natural Resources Conference. Paper and poster.

Reitz, R.A., T.V. Dailey, H.J. Scroggins, T.B. Treiman, R.A. Pierce II and W.B. Kurtz. 2007. Attitudes of north Missouri landowners toward large-scale quail habitat restoration areas on private lands. Southeast Quail Study Group and Conference. Paper and Poster.

Ridenour, C. J. and D. L. Galat. 2005. Poster. Shallow-water microhabitat use and distribution of small fishes at lower Missouri River sandbars. Missouri River Natural Resources Conference. Pierre, South Dakota. ;

International Conference on Rivers and Civilization La Crosse, Wisconsin, 2006.

67th Midwest Fish & Wildlife Conference, Omaha, Nebraska, 2006.

Ridenour, C. J. and D. L. Galat. 2006. Abundance, distribution, and habitat use of small-bodied fishes in relation to shallow-water areas at lower Missouri River sandbars. 10th Annual Meeting, Missouri River Natural Resources Conference, South Sioux City, Nebraska.

Rittenhouse, C. D., J. J. Millspaugh, M. W. Hubbard, and S. L. Sheriff. 2006. Movements of translocated and resident three-toed box turtles. Joint Meeting of Ichthyologists and Herpetologists, New Orleans, Louisiana.

Rittenhouse, C. D., J. J. Millspaugh, M. W. Hubbard, S. L. Sheriff, and W. D. Dijak. 2007. Resource selection by translocated three-toed box turtles in Missouri. Annual Wildlife Society Conference, Tucson, Arizona.

Rittenhouse, C. D., W. D. Dijak, F. R. Thompson, III, J. J. Millspaugh, and S. R. Shifley. 2006. Cumulative effects of forest management on wildlife species: implications for forest management planning. Midwest Fish and Wildlife Conference, Omaha, Nebraska.;

13th Annual Wildlife Society Meeting, Anchorage, Alaska, 2006.

- Rittenhouse, C. D., W. D. Dijak, F. R. Thompson, III, J. J. Millspaugh, and S. R. Shifley. 2006. Simulating changes in vegetation and avian habitat suitability for forest management planning. 4th North American Ornithological Conference, Veracruz, Mexico.
- Rittenhouse, C. D., W. D. Dijak, F. R. Thompson, III, J. J. Millspaugh, and S. R. Shifley. 2007. A landscape-level approach to forest-wildlife planning: the Hoosier National Forest Management Plan. Midwest Fish and Wildlife Conference, Madison, Wisconsin,
- Schulz, J. H., J. J. Millspaugh, A. J. Bermudez, X. Gao, T. Bonnot, L. Britt, and M. Paine. 2006. Acute lead toxicosis in mourning doves. Midwest Fish and Wildlife Conference, Omaha, Nebraska.;
- Missouri Natural Resources Conference, Osage Beach, Missouri, 2007.
- Schulz, J. H., P. Padding, and J. J. Millspaugh. 2007. Will mourning dove crippling rates increase with nontoxic shot regulations? Missouri Natural Resources Conference, Osage Beach, Missouri.
- Schulz, J. H., R. Reitz, S. Sheriff, and J. J. Millspaugh. 2007. Attitudes of Missouri small game hunters toward nontoxic shot regulations. Missouri Natural Resources Conference, Osage Beach, Missouri.
- Shifley, S., F. R. Thompson, III, W. D. Dijak, Z. Fan, J. J. Millspaugh, and C. D. Rittenhouse. 2006. Application of a landscape-scale decision support system to assess long-term changes in vegetation and wildlife habitat on the Hoosier National Forest. Society of American Foresters Conference.
- Shifley, S. R.; Thompson, F. R. III; Fan, Z.; Dijak, W. D. 2006. Simulating landscape change for forest management planning the Central Hardwood Region, USA. International workshop of forest landscape modeling. Advances in forest landscape modeling: approaches, standardization, validation, and application. Beijing, China
- Shifley, S. R.; Thompson, F. R., III; Dijak, W. D.; Larsen, M. A.; Millspaugh, J. J.; Fan, Z. 2006. Predicting landscape-scale cumulative effects of even- and uneven-aged silviculture on upland oak forest structure, composition, and wildlife habitat quality. IUFRO Oak 2006. Stevens Point, Wisconsin.
- Shifley, S. R.; Thompson, F.R., III; Dijak, W. D.; Fan, Z.; Millspaugh, J. J.; Rittenhouse, C. D. 2006. Application of a landscape-scale decision support system to assess long-term changes in vegetation and wildlife habitat on the Hoosier National Forest. In: Our woods: wild and working, Society of American Foresters 2006 National Convention. Pittsburgh, Pennsylvania.
- Sobbing, J. L., D. C. Ashley, J. H. Schulz, A. J. Bermudez, and J. J. Millspaugh. 2005. The occurrence of avian haematozoa in Missouri mourning doves (*Zenaida macroura*).

Missouri Natural Resources Conference.

Suedkamp Wells, K. M., J. J. Millspaugh, M. R. Ryan, and M. W. Hubbard. 2005. Resource selection and movements of post-fledging grassland birds. 12th Annual Wildlife Society Meeting, Madison, Wisconsin;

Missouri Natural Resources Conference, 2005.

Thompson, F. R. 2007. Importance of monitoring vital rates of bird populations. Bird Numbers 2007: Monitoring for Conservation and Management – 17th International Conference of the European Bird Census Council. Chiavenna, Italy.

Thompson, F. R. 2006. Factors affecting nest predation of woodland birds in North America. Workshop on Woodland Birds: Their Ecology and Management. British Ornithologists Union, England

Thompson, F. R., W. D. Dijak, C. D. Rittenhouse, J. J. Millspaugh, and S. R. Shifley. 2006. Linking wildlife habitat suitability and population models with landscape change models for conservation planning. International Association of Landscape Ecology, Beijing China,

Thompson, Frank R., III. 2005. Making meaningful predictions of nesting success from logistic exposure models and other model based methods. Cooper Ornithological Society 75th Annual Meeting; Humbolt State University; Arcata, California.

Thompson, F. R., III; Dijak, W. D.; Rittenhouse, C. D.; Millspaugh, J. J.; Shifley, S. R. 2006. Linking habitat suitability and population models with landscape change models for conservation planning. International workshop of forest landscape modeling. Advances in forest landscape modeling: approaches, standardization, validation, and application. Beijing, China

Thompson, K., W., F. R. Thompson, III, J. J. Millspaugh, and J. Beringer. 2006. Factors affecting long-term counts of drumming ruffed grouse in Missouri. Midwest Fish and Wildlife Conference, Omaha, Nebraska.

Tracy, E. K. D. L. Galat, and R. B. Jacobson. 2005. Availability of lower Missouri River sandbar habitats in relation to discharge. Missouri River Natural Resources Conference. Pierre, South Dakota.

Tracy-Smith, E. K., D. L. Galat, and R. B. Jacobson. 2007. Effects of flow dynamics on lower Missouri River sandbar morphology with implications for selected biota. 2nd National Conference on Ecosystem Restoration, Kansas City, Missouri.

Tracy-Smith, E. K., D. L. Galat, and R. B. Jacobson. 2006. Effects of discharge on Lower Missouri River sandbars and their use by riverine fishes. 67th Midwest Fish & Wildlife Conference, Omaha, Nebraska.

- Turner, A., J. Hillis and C. Rabeni. 2007. A new device for quantifying deposited sediment in streams North American Benthological Society 55th Annual Meeting, Columbia, South Carolina.
- Turner, A., J. Hillis and C. Rabeni. 2007. A new device for quantifying deposited sediment in streams American Fisheries Society 137th Annual Meeting. San Francisco, California.
- Turner, A. 2007. A Hierarchical Perspective of Stream Sedimentation. Midwest Fish and Wildlife Conference, Madison, Wisconsin.
- Underwood, M., G. Shurvington, S. Noll, B. White, P. Graham and R.A. Pierce II. 2007. Characteristics of winter escape habitat for bobwhite quail compared with predicted values determined by conservation managers and the Missouri bobwhite quail habitat appraisal guide. Missouri Department of Conservation, USDA NRCS and MU Extension. Southeast Quail Study Group Meeting and Conference. Quartz Mountain, Oklahoma. Paper and poster.
- Wallace, G., R. Pierce, and C. Nilon. 2005. Missouri Master Naturalists: Community-based Natural Resource Volunteers Annual Meeting. Missouri Community Development Society.
- Watanabe, S., M.F. Knowlton, W.F. Vincent and J.R. Jones. 2007. Poster. Variability in the optical properties of colored and dissolved organic matter in Missouri reservoirs. 30th Congress of the International Association of Theoretical and Applied Limnology. Montreal, Canada.
- Wells, K. M., J. J. Millsbaugh, M. R. Ryan, J. Cao, and C. He. 2007. Modeling nest survival of a grassland passerine: A Bayesian approach. Western Section of The Wildlife Society, Monterey, California.
- Wilcox, D. B., D. L. Galat, C. H. Theiling and K.S. Lubinski. 2006. Goals and objectives for condition of the upper Mississippi River ecosystem. Mississippi River Research Consortium, LaCrosse, Wisconsin;
- 2nd National Conference on Ecosystem Restoration, Kansas City, Missouri, 2006.
- Witte, C., M. Wildhaber, and D. Noltie. 2007. Poster. The effects of temperature and photoperiod on the growth and reproductive development of the Topeka shiner (*Notropis topeka*). 134th American Fisheries Society Annual Meeting, San Francisco, California.
- Witte, C., M. Wildhaber, D. Noltie, and A. Arab. 2006. Substrate preference of breeding Topeka shiners (*Notropis topeka*) in the absence of sunfish (*Lepomis* sp.). Midwest Fish and Wildlife Conference, Omaha, Nebraska.
- Witte, C.C., M.L. Wildhaber, and D.B. Noltie. 2005. Poster. Reproductive behavior and temperature, photoperiod, and substrate size preferences of the Topeka shiner (*Notropis*

topeka) for propagation in the laboratory. Fish and Wildlife Research Exposition, University of Missouri, Columbia, Missouri.

AWARDS and HONORS

Faculty:

David Galat –

- ✓ Certificate of Appreciation for Outstanding Service. Committee to Assess the U.S. Army Corps of Engineers Methods of Analysis and Peer Review for Water Resources Project Planning: Panel on Methods and Techniques of Project Analysis, Member (2001-2004). Water & Science Technology Board, National Research Council (2005)
- ✓ USGS Star Award for superior performance during FY2005

Matthew Gompper –

- ✓ Keynote Speaker, Central Plains Society of Mammalogists (2007)

Robert Hayward –

- ✓ Received "Outstanding Faculty Award in the School of Natural Resources" (2005)
- ✓ Elected (by membership) as Chair of the Research Technical Committee for the North Central Regional Aquaculture Center (Michigan State University), and also as a member of the Board of Directors. (2006)

Dylan Kesler –

- ✓ The Milwaukee County Zoo honored my research with captive Micronesian Kingfisher recovery program by naming one of the 100 extant Micronesian Kingfishers after me (Described in "Connect", September 2007).

John Jones –

- ✓ Distinguished Award in Administration, Missouri Chapter of Gamma Sigma Delta, Honor Society (2006)
- ✓ Editorial Board, 01/2006 - To present. Editor for the International Journal of Theoretical and Applied Limnology. Associate Editor for Journal of Lake and Reservoir Management. As Editor, serves on the Executive Committee of SIL.

Joshua Millspaugh –

- ✓ Recipient, University of Missouri, William T. Kemper Fellowship for Excellence in Teaching (2005)
- ✓ Selected, College of Agriculture, Food, and Natural Resources Teaching Academy (2005)
- ✓ Missouri Department of Conservation Research Collaborator of the Year (2006)
- ✓ Superior Teaching Award from the MU Chapter of Gamma Sigma Delta (2006)
- ✓ Mentor of Mizzou '39 student (one of 39 top seniors at University of Missouri) (2006)
- ✓ My deer camera research was highlighted in National Science Foundation Special Report titled "The Secret Lives of Wild Animals" (see at http://www.nsf.gov/news/special_reports/animals/) (2006)
- ✓ Recipient, The Wildlife Society Award for Best Article for "Metrics of use and availability in studies of resource selection" published in The Journal of Wildlife Management by Steven Buskirk and Joshua Millspaugh. Works recognized by this award of excellence are scientific writing characterized by originality of research or thought and a high scholastic standard in the manner of presentation. Publications from any scientific journal are eligible for the award. (2007)

Doug Noltie –

- ✓ Included among Campus Writing Program Writing Intensive Faculty ePortfolios. "This digital portfolio project is the ongoing work of CWP staff exploring WI faculty approaches to the teaching of writing. The portfolios represent our effort to showcase selected WI faculty as well as to recast their experiences in teaching WI courses through the lens of Campus Writing Program." (2006)
http://cwp.missouri.edu/resources/Faculty_ePortfolios/Portfolio_index/eportfolio_index.htm.

Mark Ryan –

- ✓ Named Curator’s Teaching Professor, University of Missouri (2006)
- ✓ MU Alumni Association Faculty-Alumni Award (2006)

Frank Thompson –

- ✓ Named as one of the recipients of the 2005 Wings Across The Americas Award for Habitat Conservation for his contributions to the Southern Region Bird Conservation Strategy and Partnerships.
- ✓ Named a Fellow by the Wildlife Society (2005).
- ✓ With Todd Jones-Farrand, received the 2007 Wings Across the Americas Bird Conservation Award for Research and Partnerships for their work on “Mapping landbirds across Bird Conservation Regions: Decision Support for Joint Ventures”.

Students:

- ✓ **Shannon Brewer** (PhD candidate) received an Award for Best Paper, Runner Up at the 59th Annual Conference of the Southeastern Association of Fish & Wildlife Agencies held October 16 – 19, 2005 in St. Louis, MO. Her paper was titled, “The Importance of Day versus Night Fish Sampling for In-Stream Flow Determination”.
 - Served as guest editor for The Northeast Naturalist.
- ✓ **Sathya Chinnadurai** received an award for clinical skills and instruction from the College of Veterinary Medicine, University of Missouri.
- ✓ **Danny Garret** (PhD candidate), received a presentation award at the 68th Midwest Fish and Wildlife Conference held in Madison, Wisconsin on December 9 -12, 2007, for his paper titled “Movement, Habitat Use, and Spawning Chronology of Flathead Catfish and Blue Catfish in the Missouri River and Tributaries”.

Danny also received the following scholarships:

- Costa del Mar B.A.S.S. Conservation Scholarship
March 2007
Financial award (\$10,000) to conduct research on the movement and habitat use of flathead and blue catfish on the Missouri River and tributaries.

- **Skeeter Scholarship**
August 2007
Financial award (\$1,000) to be used for books, tuition, or room and board while attending graduate school.
- ✓ **David Jacowski** (MS) was awarded a Graduate Student Fellowship from the Missouri Chapter of the Wildlife Society, and a Conservation Biology Fellowship from the University of Missouri.
- ✓ **Alyce Johnson**, an undergraduate senior, received a presentation award at the Annual Biomedical Research Conference for Minority Students (ABRCMS) in Austin, Texas held on November 7 - 10, 2007. Alyce was recognized for a poster presentation associated with her bison research the previous summer in Custer State Park, South Dakota.
- ✓ **Socheata Lor** (PhD) received an award for Performance in Research from the US Fish and Wildlife Service.
- ✓ **Dustin Martin** Poster was awarded first runner up among student posters at the SEAFWA conference (2005) and won the Missouri AFS Chapter's Best Student Poster Presentation at the 2006 Missouri Natural Resources Conference.
- ✓ **Conor McGowan** (MS) received an award for academic and research excellence from the Missouri Chapter of the Wildlife Society.
- ✓ **Ryan Monello** (PhD) received the Graduate Student Award from the Missouri Chapter of the Wildlife Society.
- ✓ **Megan Montgomery** (MS), won the Best Student Poster award at the Missouri Natural Resources Conference in January 2008, title: "Composition of Missouri River fishes accessing Eagle Bluffs Conservation Area through a 'fish friendly' passage structure" (coauthor: David Galat).
- ✓ **Natalie Olifiers** (PhD) was awarded a William Gregory Fellowship from the Graduate School, University of Missouri.
- ✓ **Tommy Parker** (PhD) received a Graduate Professional Council award for Academic Performance and Service.
- ✓ **Abi Tamin Vanak** (PhD) was awarded a fellowship from the Wildlife Conservation Society.
- ✓ **Kristen Veum** (MS) received a travel award to attend the annual meeting of the North

American Benthological Society from the Graduate Professional Council, University of Missouri.

- ✓ **Rebecca Wright** (MS) was awarded a George Washington Carver Fellowship, from the University of Missouri Graduate School.