

MISSOURI COOPERATIVE FISH & WILDLIFE RESEARCH UNIT REPORT

January 2017 to September 2018



Cooperating Agencies:

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

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MISSOURI COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

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The Unit Annual Report has been produced for over 30 years. If you desire any additional information, please contact Karen Decker at our address.



Above: Portrait of Aldo Leopold to Rudolph Bennett (acting leader of the Missouri Unit, 1947-1948): "With high hopes for the Missouri Unit."

Front cover: A native longhorn bee (*Melissodes trinodis*) collecting pollen from ironweed flowers (*Vernonia* sp.) growing adjacent to a neonicotinoid-treated soybean field in Missouri. This image was featured as the cover photo in the July 2018 edition of *Ecological Applications*, which published a meta-analysis by Main et al. 2018 quantifying how neonicotinoid insecticides negatively affect performance measures of non-target terrestrial arthropods.



Graduate students Zach Morris and Mike Thomas sampling catfish with the Missouri Department of Conservation.

THE TRADITION OF THE MISSOURI UNIT

Conservation and management of natural resources have changed since the Missouri Unit was established in 1937. Our long history is linked with the Missouri Department of Conservation and the Fish and Wildlife program at the University of Missouri. The first Unit Quarterly Report, dated April 19, 1938 showed a strong research focus on game management, particularly quail, turkey, and whitetail deer (even a survey on wolf and coyote damage in Missouri). The 2018 Report contains Unit research projects related to climate change, endangered and invasive species, pesticides, amphibian sampling protocols, and mussel and crayfish conservation, in addition to more traditional management such as evaluation of light goose harvest, methods to determine waterfowl abundance, and Striped Bass stocking evaluations. Some funding sources for our research are different now than in years past. In addition to our strong support and numerous projects from the Missouri Department of Conservation, we have projects supported by the US Fish and Wildlife Service, US Geological Survey, and other state agencies. The diversity of research with more emphasis on non-game species, species diversity, and landscape-level planning demonstrates how we adapt to meet the needs of our cooperators. Although the projects may be different than projects from 80 years ago, the theme of conducting applied research to meet the needs of our cooperators remains the same.

Our big change in the past couple years has been the loss of Dr. Amanda Rosenberger as she transferred to the Tennessee Cooperative Fishery Research Unit in 2017. That has left a big gap with our Assistant Leader-Fisheries vacant. There are discussions to attempt to fill that position but, as with most issues these days, it depends on numerous factors, not the least of which is budget cuts. What does this mean to the Missouri Unit? We have kept busy with research projects as the needs for fish and wildlife research is still very strong. Therefore, the Unit continues to serve the cooperators by conducting applied research, mentoring students, and teaching courses relevant to cooperator needs.



Amanda Rosenberger, Craig Paukert, and Lisa Webb.

ACCOMPLISHMENTS OF THE MISSOURI UNIT

We are very proud of our students and staff accomplishments that our highlighted in the report. During the 2-year reporting period, the Missouri Unit:

- Advise 16 current graduate students and 7 research staff
- Graduated 7 students and 1 research staff have moved on to other jobs
- Coordinated 27 active research projects and completed 10
- Received research grants totaling over \$1.92 million
- Produced a total of 50 peer reviewed publications
- Taught 25 graduate students and 21 undergraduates students
- Helped over 30 undergraduates gain experience through research technician positions
- Gave 125 presentations including 32 invited or seminars to university departments or agencies, or conference keynote addresses
- Received a total of 65 awards, including 20 international awards (all by students)
- Provided at least 70 service activities to the university, agencies, professional societies, and other organizations
- Provided at least 45 public outreach events or news releases about our science



Missouri Cooperative Fish and Wildlife Research Unit graduate students, post-doctoral fellows and research associates at the 2016 Cooperators meeting.

THE MISSOURI COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

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

The Missouri Unit is a productive member of the Unit program. Our history began in 1936 when the citizens of Missouri voted to amend the State's constitution to create a politically independent Conservation Commission. The first official act of the Conservation Commission was to establish a Cooperative Wildlife Research Unit at the University of Missouri. Objectives were *"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 as 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. Through it all, we remained 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 waterbird ecology, big river ecology and management, and stream aquatic resources have long been emphasized. An attempt is made to complement and strengthen existing research disciplines 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 state and regional fish and wildlife resources.

UNIT AND COOPERATOR PERSONNEL ROSTER

Permanent Unit Personnel

Craig Paukert, Unit Leader
 (573) 882-3524
PaukertC@missouri.edu

Lisa Webb, Assistant Leader-Wildlife
 (573) 882-2591
WebbLi@missouri.edu

Vacant, Assistant Leader-Fisheries

Karen Decker, Administrative Officer
 (573) 882-3634
deckerkf@missouri.edu

Unit Coordinating Committee

<p>Chris Daubert, Vice Chancellor and Dean College of Agriculture, Food and Natural Resources 2-69 Agriculture Building University of Missouri Columbia, MO 65211 (573) 882-3846 daubertc@missouri.edu</p>	<p>Shibu Jose, Director School of Natural Resources 103 Anheuser-Busch Natural Resources Building University of Missouri Columbia, MO 65211 (573) 882-0240 joses@missouri.edu</p>
<p>Mike Hubbard, Deputy Director Missouri Department of Conservation P O Box 180 Jefferson City, MO 65102-0180 (573) 751-4115 Ext 3217 Mike.Hubbard@mdc.mo.gov</p>	<p>Barry Grand, Southern Regional Supervisor Cooperative Fish and Wildlife Research Units U.S. Geological Survey 12201 Sunrise Valley Drive – MS 303 Reston, VA 20192 (334) 200-8458 barry_grand@usgs.gov</p>
<p>Bill Moritz, Midwest Representative Wildlife Management Institute 1608 Packwood Road Fairfield Iowa 52556 (989) 413-3115 bmoritz@wildlifemgt.org</p>	<p>Craig Czarnecki, Assistant Regional Director, Science Applications US Fish and Wildlife Service, Region 3 5600 American Blvd. West, Suite 990 Bloomington, MN 55437-1458 517-351-8470 craig_czarnecki@fws.gov</p>

COLLABORATORS

University of Missouri

<u>Name</u>	<u>Program</u>	<u>Name</u>	<u>Program</u>
Alba Argerich	School of Natural Resources	Kevin Bradley	Plant Sciences
Mike Byrne	School of Natural Resources	Lori Eggert	Biological Sciences
Matt Gompper	School of Natural Resources	Deborah Finke	Plant Sciences
Keith Goynes	School of Natural Resources	Rico Holdo	Biological Sciences
Charlie Nilon	School of Natural Resources	Erin Schliep	Statistics
Doug Noltie	School of Natural Resources	Mike Urban	Geography
Frank Thompson III	School of Natural Resources	Chris Wikle	Statistics
Mitch Weegman	School of Natural Resources		
Joanna Whittier	School of Natural Resources		
Sonja Wilhelm-Stanis	School of Natural Resources		

Missouri Department of Conservation

<u>Name</u>	<u>Division</u>	<u>Name</u>	<u>Division</u>
Max Alleger	Resource Science	Travis Moore	Fisheries
Leah Berkman	Resource Science	Nate Muenks	Wildlife
Paul Blanchard	Fisheries	Norman Murray	Wildlife
Matt Combes	Resource Science	Frank Nelson	Resource Science
Ange Corson	Fisheries	Darby Niswonger	Fisheries
Bob DiStefano	Resource Science	Doug Novinger	Resource Science
Nicole Farless	Resource Science	Jason Persinger	Resource Science
Zach Ford	Resource Science	Andy Raedeke	Resource Science
Sherry Gao	Resource Science	Darren Thornhill	Resource Science
Dave Herzog	Resource Science	Vince Travnichek	Resource Science
Bob Hrabik	Fisheries	Sara Tripp	Resource Science
Brett Landwer	Resource Science	Andy Turner	Resource Science
Del Lobb	Resource Science	Ivan Vining	Resource Science
Brian McKaegel	Fisheries	Jacob Westhoff	Resource Science
Stephen McMurray	Resource Science	Kyle Winders	Resource Science
Doreen Mengel	Resource Science	Dave Woods	Fisheries

U.S. Fish and Wildlife Service

<u>Name</u>	<u>Program</u>
Bill Beatty	Alaska Marine Mammals Division
Andy Bishop	Rainwater Basin Joint Venture
Tom Cooper	Region 3 Migratory Birds
Jason Goeckler	Columbia Fish and Wildlife Conservation Office
Lindsay Landowski	Loess Bluffs National Wildlife Refuge
Karen Mangan	Cypress Creek National Wildlife Refuge
Shauna Marquardt	Columbia Ecological Services Office
Dave Moseby	Columbia Ecological Services Office
Emily Pherigo	Columbia Fish and Wildlife Conservation Office
Landon Pierce	South Dakota Fish and Wildlife Conservation Office
Jason Wilson	Great River and Clarence Cannon National Wildlife Refuges
Darrin Welchert	Loess Bluffs National Wildlife Refuge

U.S. Geological Survey

<u>Name</u>	<u>Program</u>
Doug Beard	National Climate Adaptation Science Center
Kristen Bouska	Upper Midwest Environmental Science Center
Bo Bunnell	Great Lakes Science Center
Duane Chapman	Columbia Environmental Research Center
Wes Daniel	Nonindigenous Aquatic Species
Joe Deters	Columbia Environmental Research Center
Carrie Elliot	Columbia Environmental Research Center
Michelle Hladik	California Water Science Center
Susannah Irwin	Columbia Environmental Research Center
Robb Jacobson	Columbia Environmental Research Center
Jeff Jolley	Columbia Environmental Research Center
Abigail Lynch	National Climate Adaptation Science Center
Bonne Myers	National Climate Adaptation Science Center
Jordan Read	Center for Integrated Data Analytics
Michelle Staudinger	Northeast Climate Science Center
Jana Stewart	Wisconsin Water Science Center
Don Tillitt	Columbia Environmental Research Center

U.S. Forest Service

<u>Name</u>	<u>Program</u>
Sybill Amelon	Northern Research Station
Matthew Johnson	Plumas National Forest
Danielle Shannon	Northern Institute of Applied Climate Science
Frank Thompson III	Northern Research Station

National Park Service

Name

Nicole Athearn
Hope Dodd
Brian Healy

Program

Great Rivers Cooperative Ecosystem Study Unit
Heartland Inventory and Monitoring Network
Grand Canyon National Park

Other State/Provincial Agencies

Name

Frank Baldwin
Yushun Chen
Cindy Chu
Matthew Diebel
John Hansen
Lilian Ibengwe
Pete Jacobson
Ted LaGrange
Alex Latzka
Joe Nohner
Greg Sass
Jason Schooley
Mark Vrtiska

Organization

Province of Manitoba
Chinese Academy of Sciences
Ontario Ministry of Natural Resources
Wisconsin Department of Natural Resources
Minnesota Department of Natural Resources
Ministry of Agr, Livestock, and Fisheries (Tanzania)
Minnesota Department of Natural Resources
Nebraska Game and Parks Commission
Wisconsin Department of Natural Resources
Michigan Department of Natural Resources
Wisconsin Department of Natural Resources
Oklahoma Department of Wildlife Conservation
Nebraska Game and Parks Commission

Other Universities and Cooperative Research Units

<u>Name</u>	<u>University</u>
Steve Cooke	Carleton University
Ian Cowx	University of Hull (England)
Jeff Falke	University of Alaska-Fairbanks/USGS
Dave Fulton	University of Minnesota/USGS
Gretchen Hansen	University of Minnesota
Dave Haukos	Kansas State University/USGS
Keith Hobson	Western University
Dana Infante	Michigan State University
Dan Isermann	University of Wisconsin-Stevens Point/USGS
Trevor Krabbenhoff	University of Buffalo
Tom Kwak	North Carolina State University/USGS
Jim Long	Oklahoma State University/USGS
Steve Midway	Louisiana State University
Justin Murdoch	Tennessee Tech University
Hoa Nguyen	Nong Lam University (Vietnam)
Julian Olden	University of Washington
Angela Strecker	Portland State University
Ty Wagner	Penn State/USGS

Non-Government Organizations

<u>Name</u>	<u>Organization</u>
Michael Cooperman	Conservation International
Jeff Fore	The Nature Conservancy
Steve Herrington	The Nature Conservancy
Dylan Kesler	Institute of Bird Populations
Rodney Siegel	Institute for Bird Populations
Ian Winfield	Centre for Ecology and Hydrology (England)

IN MEMORIA



The Missouri Cooperative Fish and Wildlife Research Unit and the entire conservation community in Columbia and beyond are mourning the loss of two great friends. Rochelle (Ro) Renken and her husband, Michael Huffman, perished on June 22, 2018 while on their dream retirement backcountry hike in Wrangell-St. Elias National Park, Alaska. Ro and Mike both worked for the Missouri Department of Conservation (MDC) in various capacities over their long careers. Mike finished his career at MDC as Division Chief for Outreach and Education. Ro, who received her PhD at Mizzou, retired earlier in 2018 as a MDC Research Scientist and Unit Chief. Both were active supporters of conservation, MU and the Coop Unit. Ro was active on faculty searches at MU and facilitated faculty and unit cooperation with MDC.

Ro and Mike were not only partners in our research endeavors, but also our friends, and we enjoyed drinks at Logboat Brewing Company and dinners at our homes. They were always ready with an idea and were eager to hear about our work and lives. We will miss Mike's enthusiastic personality and Ro's ready laughter.

Craig Paukert
Lisa Webb
Amanda Rosenberger

TEACHING AND ENGAGING STUDENTS BY MISSOURI UNIT STAFF AND AFFILIATES

One aspect of the Cooperative Agreement that established the Missouri Cooperative Fish and Wildlife Research Unit is that each Unit Scientist teaches up to one graduate course in their area of expertise each year. Below is a summary of the courses taught by Unit Scientists and affiliates from Spring 2017 to Fall 2018.

Course	Credits	Instructor	Semester	Undergrad. Enroll.	Grad. Enroll.
FW 4880/7800: Waterfowl Ecology and Management	3	L. Webb	Spring 2017	10	5
FW4002/7002: Conservation of Stream Fishes	2	N. Sievert, C. Paukert	Fall 2017	5	1
FW 8001: Decision Analysis for Resource Management	1	N. Athearn, T. Jones Farrand, C. Paukert	Fall 2017	0	7
FW 8001: Community Ecology of Aquatic Organisms		A. Rosenberger	Spring 2017	0	7
FW 8001: Advanced Fisheries Science	3	C. Paukert	Spring 2018	2	5
FW 4950: Undergraduate research	1-2	Paukert/Webb/Rosenberger	Multiple	4	0
Total				21	25



The Waterfowl Ecology and Management class removing diving ducks from a swim-in trap on a field trip to visit Pool 19 on the Illinois River.

Unit Scientists and students guest lecture in many undergraduate and graduate courses. Below is a list of courses where we have given at least one guest lecture in 2017 and 2018.

Course Name and Number	Type of students
FW 8001: Grant Writing	Graduate
FW 8001: Advanced Fisheries Science	Graduate
FW 3900: Stream Ecology	Undergraduate
Adventures in Quantitative Ecology workshop: analysis methods for community ecology and mixed effects modeling	Graduate/Professional
Biological Sciences 8726: Science Outreach: Public Understanding of Science	Graduate

In addition, research projects under the direction of Unit Scientists provide valuable opportunities for undergraduate exposure to the fisheries and wildlife field to gain valuable field and laboratory skills. In 2017-2018, the Unit has supported over 30 MU undergraduate technicians on multiple projects.

Unit Scientists also facilitate student learning and professional development opportunities through means other than formal teaching. For example, Unit Scientists organized a meeting with Vince Travnichek (red shirt) from MDC on advice on applying for agency jobs.



Missouri Department of Conservation Resource Science center Chief Vince Travnichek (red shirt) discussing agency jobs with Coop Unit students.

Other student engagement activities included:

- Delivering student workshops on resume and CV writing, plus interview skills and on the job conduct
- Delivering a half day workshop on occupancy modeling for graduate students/faculty
- Developing workshops on how to get into graduate school
- Supporting undergraduate participation in professional society meetings
- Participate in student mentoring events at professional meetings
- Supporting MU Fisheries and Aquatic Sciences Society's aquarium housed in the Anheuser Bush Natural Resources Building



Graduate student Mike Thomas and Nick Sievert discussing aquatic conservation and management at the 4-H State Sportfishing Event.

CURRENT GRADUATE STUDENTS

2017 TO PRESENT

**Student received degree during the reporting period.*

Name	Research Project	Previous Education	Advisor
Robert Abney, M.S.	Effects of neonicotinoid insecticides on nesting effort and success of Missouri bees	B. S., University of Missouri	Dr. Webb
Elisa Baebler, M.S.	Habitat selection and movement of riverine fishes under regulated flows on the Lower Osage River	B.S. Colorado St. Univ.	Dr. Paukert
Hadley Boehm, Ph.D.	Evaluation of low density stocking of Striped Bass in Bull Shoals Reservoir	B.S., Alma College M.S. Univ of Wisconsin-Stevens Point	Dr. Paukert
John Brant, M.S.	Habitat selection of lithophilic spawning fishes	B.S. Kansas State Univ.	Dr. Paukert
T. Joseph Chilton, M.S.	Habitat associations of two species of endemic crayfish in the Meramec River Drainage	B.S. Missouri State University	Dr. Rosenberger
*Jackie Dearborn, M.S.	Habitat use for roosting and foraging by maternity colonies of Indiana bats (<i>Myotis sodalis</i>)	B.S. Muhlenberg College	Drs. Webb and Amelon
Corey Dunn, Ph.D.	Development of sampling protocols for mid-sized rivers	B.S. Virginia Tech M.S. Virginia Tech	Dr. Paukert
*Julia Guyton, M.S.	Development of fish and amphibian rapid assessment protocol for wetlands: linking management to wetland processes	B.A. Birmingham-Southern College	Drs. Paukert & Webb
*Brian Hidden, M.S.	Linking waterfowl distribution and abundance to spatial and temporal distribution and abundance of wetland habitat	B.S. Oklahoma State Univ.	Dr. Webb
Drew Fowler, Ph.D.	Body condition of harvested snow geese during the Light Goose Conservation Order	B.S. Texas A&M Univ. M.S. Louisiana State Univ.	Dr. Webb
Kyle Kuechle, M.S.	Neonicotinoid concentrations in Missouri wetlands and potential effects on the avian community	B.S. Bemidji State University	Dr. Webb

*Joe LaRose, M.S.	Grasshopper and bee communities on Missouri prairies: comparing reconstructions and remnants	B.S. University of Alabama	Drs. Webb & Finke
Michael Moore, Ph.D.	Dispersal and habitat selection of Lake Sturgeon in Missouri River tributaries	B.S. Univ. of Missouri M.S. Virginia Tech	Dr. Paukert
*Rory Mott, M.S.	Thermal preferences and water quality tolerances of the endangered Topeka shiner	B.S. Eastern Illinois Univ.	Dr. Rosenberger
Zach Morris, M.S.	Electrofishing immobilization thresholds for catfish and bass	B.S. Missouri St. Univ.	Dr. Paukert
Rachel Owen, Ph.D.	Effects of predicted climate change on wetland ecosystem function	B.S. Iowa State University M.S. S. Dakota State Univ.	Drs. Webb & Goyne
Emily Pherigo, M.S.	Role of tributaries for large river fish recovery	B.S. Knox College	Dr. Paukert
Landon Pierce, Ph.D.	Conservation planning of fishes in the Colorado River basin	B.S., Univ. of Nebraska M.S., S. Dakota St. Univ.	Dr. Paukert
*Travis Schepker, M.S.	Food resource availability for spring migratory waterfowl at mid-latitude wetlands	B.S. Univ. of Missouri	Dr. Webb
*Matthew Schrum, M.S.	Development of standardized sampling methods for assessing population metrics and recruitment of rare and threatened mussels species in Missouri	B.S. Univ. of Missouri	Dr. Rosenberger
Nick Sievert, Ph.D.	Influence of flows and climate change on stream fishes	B.S. Univ. of Wisconsin-Madison M.S. Univ of Missouri	Dr. Paukert
Dane Smith, M.S.	Summer habitat selection by Indiana and northern long-eared bats on National Wildlife Refuges	B.S. Middle Tennessee State University	Drs. Webb & Amelon
Mike Thomas, M.S.	Field validation of electrofishing response thresholds for sportfish	B.S. University of Idaho	Dr. Paukert

CURRENT POST-DOCTORAL RESEARCH ASSOCIATES AND RESEARCH STAFF

2017-PRESENT

**Staff obtained other employment during the reporting period.*

Name	Research Project	Previous Education	Advisor
Dr. Rachel Blakey	Occupancy, movements and habitat selection of Spotted Owls and Northern Goshawks in response to wildfires in the Plumas National Forest	B.S. Monash Univ. M.S. Univ. of Queensland Ph.D. Univ. Of New South Wales	Dr. Webb
Brandon Brooke	Development of sampling protocols for mid-sized rivers	B.S. Univ. of Missouri	Dr. Paukert
Dr. Derek Corcoran Barrios	Bats in a changing landscape: linking occupancy and traits of a diverse montane bat community to fire regime	B.A. Concepcion University PhD. Pontifical Catholic University of Chile	Dr. Webb
Dr. Garth Lindner	Modeling of channel stability in the Meramec River drainage to inform niche models of mussel concentrations; Importance of floodplains under climate change	B.A. Indiana Univ. M.S. Indiana Univ. PhD. Univ. of Maryland	Drs. Paukert and Rosenberger
Dr. Anson Main	Effects of neonicotinoids on non-target native pollinator communities in Missouri field margins	B.A. University of Alberta M.L.A. University of Toronto Ph.D. University of Saskatchewan	Drs. Webb and Goyne
Dr. Maggie McPherson	Linking life history needs of wetland-dependent species with habitat conditions and associated ecological processes	B.S. University of Guelph M.S. York Univ. Ph.D. Tulane Univ.	Dr. Webb
Dr. Ralph Tingley	Replacement cost of fishes due to a changing climate	B.S. Connecticut M.S. Michigan St Univ. Ph.D. Michigan St. Univ.	Dr. Paukert
Emily Tracy-Smith	Evaluation of ecological flows for Missouri	B.S. Univ. of Florida M.S. Univ. of Missouri	Dr. Paukert

**PAST GRADUATE STUDENTS AND RESEARCH STAFF AND THEIR CURRENT
EMPLOYMENT
2008-PRESENT**

GRADUATE STUDENTS

Name	MU Education	Current Employment	Advisor
Meagan Bradburn	M.S. 2009	Biologist, Pennsylvania Department of Environmental Protection	Dr. Rabeni
Shannon Brewer	Ph.D. 2008	Assistant Leader, USGS Oklahoma Cooperative Fish and Wildlife Research Unit	Dr. Rabeni
Justin Buckler	M.S. 2011	Environmental Scientist, Missouri Department of Natural Resources	Dr. Galat
Leslie (Crawford) Lueckenhoff	M.S. 2015	Assessment and Restoration Specialist, Missouri Department of Natural Resources	Dr. Rosenberger
Jackie Dearborn	M.S., 2017	Filling out job applications and enjoying life	Drs. Webb & Amelon
Andy Dinges	M.S. 2013	Assistant Migratory Game Bird Biologist, North Dakota Game and Fish Department	Dr. Webb
Jake Faulkner	M.S. 2015	Ecologist, U.S. Geological Survey	Dr. Paukert
Jeff Fore	Ph.D. 2012	Ecologist, The Nature Conservancy	Drs. Galat & Sowa
Daniel Garrett	Ph.D. 2010	Lead Biologist, Washington Department of Fish and Wildlife	Dr. Rabeni
Julia Guyton, M.S	M.S., 2017	Biologist, Ducks Unlimited	Drs. Paukert and Webb
Jason Harris	M.S. 2013	Fish Biologist, Minnesota Department of Natural Resources	Dr. Paukert
Brian Hidden	M.S., 2016	Private lands Biologist, U.S. Fish and Wildlife Service	Dr. Webb
Evan Hill	M.S. 2015	Biologist, Missouri Department of Transportation	Dr. Webb
Ethan Kleekamp	M.S., 2015	Biologist, Quail Forever	Dr. Paukert

Josh Lallaham	Ph.D., 2012	Assistant Professor, St. Mary's University	Dr. Galat
Joe LaRose	M.S., 2018	Filling out job applications and enjoying life	Drs. Webb & Finke
Sean O'Daniels	M.S. 2016	Biologist, Tetra Tech Environmental Consulting	Dr. Webb
Doreen Mengel	M.S., 2010	Research Scientist, Missouri Department of Conservation	Dr. Galat
Meagan Montgomery	M.S., 2016	Currently job seeking	Dr. Galat
Rory Mott	M.S., 2017	Ecologist, U.S. Geological Survey	Dr. Rosenberger
Travis Schepker	M.S., 2017	Biologist, U.S. Army Corps of Engineers	Dr. Webb
Matthew Schrum	M.S., 2017	Biologist, Tennessee Tech University	Dr. Rosenberger
Jacob Schwoerer	M.S., 2015	Environmental Scientist, City of Jefferson City	Dr. Paukert
Nick Sievert	M.S., 2014	PhD student, University of Missouri	Dr. Paukert
Jonathan Spurgeon	M.S., 2012	Assistant Professor, University of Arkansas-Pine Bluff	Dr. Paukert
Jessi Tapp	M.S., 2013	Wildlife Biologist, Missouri Department of Conservation	Dr. Webb
Andy Turner	M.S., 2009	Sportfish Ecologist, Missouri Department of Conservation	Dr. Rabeni
Jacob Westhoff	Ph.D., 2011	Research Scientist, Missouri Department of Conservation	Dr. Rabeni

PAST POST-DOCTORAL RESEARCH ASSOCIATES AND RESEARCH STAFF

Name	MU Affiliation	Current Employment	Advisor
Dr. William Beatty	Post-Doctoral Researcher, 2013-2014	Wildlife Biologist, US Fish and Wildlife Service	Drs. Webb & Kesler
Dr. Kristen Bouska	Post-Doctoral Researcher, 2014-2015	Research Ecologist, US Geological Survey	Drs. Paukert & Rosenberger
Dr. Derek Corcoran Barrios	Post-Doctoral Researcher, 2015-2017	Research Associate, University of Santiago	Dr. Webb
Danielle Fox	Sr. Research Specialist, 2015- 2016	Biologist, City of Columbia	Dr. Rosenberger
Dr. Katy Klymus	Post-Doctoral Researcher, 2012-2014	Research Ecologist, US Geological Survey	Dr. Paukert
Ryan Lueckenhoff	Sr. Research Specialist, 2013- 2015	Private Lands Biologist, Missouri Department of Conservation	Dr. Paukert
Ruth Ann Martin	Sr. Research Specialist, 2014- 2015	Nurse, University of Missouri Hospital	Dr. Rosenberger
Dr. Allison Pease	Post-Doctoral Researcher, 2010-2012	Assistant Professor, Texas Tech University	Dr. Paukert
Dr. Michelle Staudinger	Post-Doctoral Researcher, 2011-2013	Science Coordinator, US Geological Survey, Northeast Climate Adaptation Center	Dr. Paukert
Dr. Jacob Westhoff	Post-Doctoral Researcher, 2011-2014	Research Scientist, Missouri Department of Conservation	Drs. Paukert & Rosenberger
Dr. James Whitney	Post-Doctoral Researcher, 2014-2016	Assistant Professor, Pittsburg State University	Dr. Paukert

RESEARCH PROJECTS



A Missouri Ozark stream.

Dr. Craig Paukert



PhD student Michael Moore photobombing Craig Paukert holding a Lake Sturgeon collected in the Gasconade River.

DEVELOPING MEASURES OF VULNERABILITY TO CLIMATE CHANGE AND DISTURBANCE OF AQUATIC COMMUNITIES IN HEARTLAND NETWORK NATIONAL PARKS

Investigators

Jacob Schwoerer, M.S. student, MU
Dr. Craig Paukert, MU
Hope Dodd, NPS

Project Supervisors

Dr. Craig Paukert, MU

Funding

USGS, NRPP Program
NPS I and M Program
RWO 123

Objectives

How much do fish and aquatic invertebrate communities vary across time and space naturally so that we may recognize when changes occur?

What is the vulnerability of fish and aquatic invertebrate communities in Midwest NPS units?

What streams will likely experience the largest change in the future given future projections of climate and land use?

Location

Midwest U.S.

Completion

December 2017



Status

Complete

Progress

The NPS Inventory & Monitoring Program is designed (in part) to elucidate the current variability in biotic metrics typically encountered within parks. We leveraged efforts by the NPS, USGS, and universities to 1) develop baseline aquatic community variability across space and time, 2) identify aquatic communities vulnerable to climate and land use change, and 3) determine whether vulnerability to climate and land use change differs by stream size or geographic region (plains to Ozarks) and how vulnerability may be affected by landscape-level factors. Fish and aquatic invertebrate community structure was assessed using several metrics (IBI and HBI) calculated for each site and each year; variability will be determined using the coefficient of variation (cv) of these metrics among sites and years. An index of aquatic biota vulnerability to climate and land use change was developed based on fish and invertebrate taxa trait data. The final index developed may now be used to assess vulnerability of aquatic communities to environmental stressors. Geo-referenced datasets of predicted air temperature and precipitation to 2080 allowed us to identify parks that will experience the greatest aquatic community threat. The fish community at each of the NPS units was less temporally variable than spatially variable, but there was no consistent relationship found with aquatic invertebrates across park units. Invertebrates at each NPS unit were most vulnerable to an altered flow regime while the fish were most vulnerable to in-stream physical habitat alteration. Our results provide a framework for understanding community variability and for determining aquatic biota vulnerability throughout Midwestern streams, which provided park managers with tools to identify rivers sensitive to climate and land use change and of those which ones will most likely experience changes in climate and landcover.

Products

Schwoerer, J. M. 2016. Assessing the Vulnerability of Stream Communities and the Consistency and Use of Biotic Indices in Least-Disturbed Streams. MS Thesis. University of Missouri, Columbia.

SCIENCE TO INFORM MANAGEMENT OF FLOODPLAIN CONSERVATION LANDS UNDER NON STATIONARY CONDITIONS

Investigators

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Project Supervisors

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Funding

U.S. Geological Survey, Northeast
Climate Adaptation Center – USGS
RWO 129

Cooperators

Floodplain Science Network

Objectives

Identify information needs in an interactive setting wherein stakeholders will discuss floodplain-management challenges and develop conceptual models relating external drivers, climate change projections, management needs and adaptation strategies, and ecosystem responses.

Apply existing datasets to conceptual models and apply existing datasets and simulation models to the management problems identified in the first component.

Identify data and modeling gaps, and development of consensus for a way forward to address remaining information gaps.

Location

Midwest U.S.

Completion

September 2017

Status

Complete

Progress and Results

Recent extreme floods on the Mississippi and Missouri Rivers have motivated expansion of floodplain conservation lands. This project worked with floodplain managers to identify the information most needed to understand nonstationary conditions and to develop tools they can apply to conservation lands to improve decision making. Our survey revealed that time, funding, and a perceived disconnect between research and management limited the ability of managers to use new information. However, managers were willing to partner with scientists to identify science needs, relevant spatiotemporal scales, and products useful for management decisions. Floodplain managers agreed that metrics of inundation, including depth, extent, frequency, duration, and seasonality are the most useful metrics for management of floodplain conservation lands. We developed an approach to derive digital spatial layers of these metrics of inundation from numeric flood inundation models under baseline and climate change scenarios. We applied this method to the lower 500 miles of the Missouri River, making 45 spatial layers (<https://doi.org/10.5066/F7HM56KG>) available to aid in current and future management decisions of conservation properties. Climate change is estimated to increase the duration, frequency, depth, and extent of floodplain inundation. However, these patterns vary seasonally, with inundation increasing in the spring and decreasing in the fall.

Selected Products

- Bouska, K., G. Lindner, C. Paukert, and R. Jacobson, 2016, Stakeholder-led science: engaging resource managers to identify science needs for long-term management of floodplain conservation lands. *Ecology and Society* 21(3):12.
- Lindner, G., K. Bouska, E. Bulliner, R. Jacobson, and C. Paukert. 2017. Science to inform management of floodplain conservation lands under nonstationary conditions. Final Report to the Northeast Climate Science Center (<http://necsc.umass.edu/biblio/science-inform-management-floodplain-conservation-lands-under-non-stationary-conditions>).

ASSESSING THE IMPACT OF CLIMATE CHANGE ON INLAND FISHERIES

Investigators

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Project Supervisors

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Dr. Abigail Lynch, USGS

Funding

U.S. Geological Survey, National
Climate Adaptation Center

Cooperators

Dr. Doug Beard, USGS
Bonnie Myers, USGS
Doug Austen, American Fisheries
Society

Objectives

Synthesize how climate change may
affect inland fisheries

Identify the key data and knowledge
gaps related to how climate change will
affect inland fisheries

Identify climate change drivers for
inland fisheries

Location

North America

Expected Completion

August 2019

Status

In progress

Progress and Results

Understanding how climate change will impact, and is currently impacting inland fishes is a critical need. We convened an expert workshop in June 2015 to examine the effects of global climate change on inland fish and fisheries in the U. S. and Canada. This workshop culminated in a special issue of Fisheries with four peer reviewed manuscripts related to 1) individual-level responses, 2) population- and assemblage-level changes, 3) human dimensions, and 4) management and adaptation to climate change. Climate-related deviations from optimal temperatures and salinity may result in chronic stress that challenges the neuroendocrine and osmoregulatory systems of fishes, alters cardiorespiratory performance and aerobic scope, and affects immune responses. However, only 31 peer-reviewed publications between 1985 and 2015 document observed impacts of climate change on North American inland fishes. Three pathways may affect inland fisheries through climate change: by directly affecting fish populations and habitats, affecting environmental conditions that affect the fishers, and through mitigation and adaptation strategies by agencies. Managers can use traditional approaches (e.g., harvest regulations) to tackle climate change issues. Managing for a resilient ecological system may require strategies to increase age structure of populations, or provide a diversity of species for fishers.

Selected Products

Paukert, C. P., and 8 coauthors. 2016. Adapting inland fisheries management to a changing climate. Fisheries 41(7):374-384.

Lynch, A. J., and 10 coauthors. 2016. Climate change effects on North American inland fish populations and assemblages. Fisheries 41(7):346-361.

Hunt, L. and 8 coauthors. 2016. Identifying alternate pathways for climate change to impact inland recreational fishers. Fisheries 41(7):362-373.

Whitney, J. E., and 8 coauthors. 2016. Physiological basis of climate change impacts on North American inland fishes. Fisheries 41(7): 332-345.

FISH COMMUNITY RESPONSE TO STREAM FLOW ALTERATIONS IN WADEABLE MISSOURI STREAMS

Investigators

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Project Supervisors

Dr. Craig Paukert, MU

Funding

MDC 379

Objectives

This five-year study is aimed at understanding how flow alterations affect riverine systems and their biota. The goal of this project is to improve the Missouri Department of Conservation's ecological flow protection and management efforts through better understanding of fish community responses to stream flow alterations.

Use existing and newly gathered data to develop flow-ecology hypothesis and quantify relationships of fish response to flow changes by stream size, type, and season.

Conduct additional fish sampling to include both minimally altered (baseline data) and hydrologically altered sites, where our preliminary analysis identified gaps in available data.

Location

Missouri

Expected Completion

June 2020

Status

In Progress

Progress and Results

A key to ecologically informed water management is to understand the dynamic ecological responses to changes in river flow regimes. Improving detection of important relationships between stream flows and fish community responses will allow decision makers to address the concerns of stakeholders and potentially improve management recommendations in a variety of situations where ecological flow protection is needed in Missouri.

We established a spatial framework using existing data for Missouri streams and developed flow alteration metrics to understand how flow alterations affect riverine systems and their biota. Alteration metrics include basic attributes of impoundments (reservoir area, maximum storage) and metrics for the hydrologic effect of withdrawals, using their natural surrogate, losing streams. We worked with a variety of experts from the Missouri Department of Conservation to develop hypotheses linking stream flows to ecological responses. We have compiled data, which will allow us to test several of the flow-ecology hypotheses, identified data gaps, and prioritized sampling efforts for multiple field crews. In 2016 and 2017 we conducted fish community sampling, intended to expand beyond wadeable sites, and to fill a necessary data gap of both minimally (2016) and highly (2017) altered sites within the Grand, Neosho, and Meramec basins.

Products

Tracy-Smith, E., P. Blanchard. 2018. Evaluating Fish Community Changes to Stream Flow Alterations. *Organization of Fish and Wildlife Information Managers Newsletter*. <http://www.ofwim.org/wp-content/uploads/2018/04/OFWIM-Newsletter-2018-03.pdf>, page 7.

US EPA, *Fish and Shellfish Program July 2018 Newsletter*. <https://www.epa.gov/fish-tech/fish-and-shellfish-program-newsletter>

EFFECTS OF UPSTREAM IMPOUNDMENT ON STREAM FISH COMMUNITIES

Investigators

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Project Supervisors

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Funding

MDC 379

Objectives

This study is aimed at developing an understanding of how headwater impoundments impact stream flow and fish communities. The goal of this project is to provide information to the Missouri Department of Conservation to inform management efforts related to headwater impoundments, stream flow, and fish communities.

Conduct sampling to provide data which summarize fish community composition, fish reproduction, stream flow, and habitat availability.

Perform analyses which assess potential changes in stream flow, habitat availability, fish reproduction, and fish community composition in relation to differing levels of headwater impoundment.

Location

Missouri

Expected Completion

June 2020

Status

In progress

Progress and Results

Fish communities are likely to be sensitive to alterations to flow regimes, and headwater impoundments may be contributing to this issue in some Missouri streams. Currently, data is being collected to determine the extent to which headwater impoundments alter stream flow, and how those flow alterations impact habitat availability, fish reproduction, and fish community structure. In April 2017 a research proposal, "Influence of altered flow regimes, due to upstream impoundment, on Plains stream fish communities" was given at the MDC Central Regional Office to solicit feedback on the research questions and methods from agency staff. During the summer of 2017 sampling was conducted in six streams located within the South Fork of the Salt River Basin. These sites spanned the maximum range of observed upstream headwater impoundment. In 2018 the study was expanded to include 12 sites (4 repeated sites from the South Fork of the Salt River Basin, 5 sites from the Loutre/Auxvasse Basins, and 3 sites from the Cuivre Basin). All study sites are in the uppermost reaches of streams classified as creeks so they are likely the most susceptible to periods of zero discharge which may result in the temporary loss of wetted riffle/glide habitat and confinement of fish to pool habitat while still maintaining permanent pools that serve as local refugia. At all of the sites data collection included sampling larval fish with fine mesh dip nets and light traps, sampling the adult fish community with a backpack electrofisher and seines, using level-loggers and time lapse photography to quantify stream flow metrics, and using survey equipment to quantify stream bed elevation.



LAKE STURGEON HABITAT USE AND MOVEMENT IN MISSOURI RIVER TRIBUTARIES

Investigators

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Project Supervisors

Dr. Craig Paukert, MU

Funding

MDC 391

Objectives

Determine distribution, movement, and site fidelity of adult Lake Sturgeon in the Osage and Gasconade Rivers using acoustic telemetry with manual tracking and remote receivers.

Determine microhabitat selection of adult Lake Sturgeon in the Osage and Gasconade Rivers.

Determine dispersal of stocked juvenile Lake Sturgeon in the Osage and Gasconade Rivers.

Location

Missouri

Expected Completion

August 2021

Status

In progress

Progress and Results

Populations of Lake Sturgeon in Missouri plummeted in the early 1900's due to overharvest and construction of dams that blocked access to crucial spawning habitats. In response, Missouri listed the Lake Sturgeon as endangered in 1974. At the time three recovery goals for Lake Sturgeon were outlined: 1. Establish a self-sustaining population of lake sturgeon in the Mississippi and Missouri rivers. 2. Ensure public understanding of, appreciation for, and cooperation with the Lake Sturgeon recovery effort. 3. Establish a Lake Sturgeon population that can support a unique sport fishing opportunity. Restoration projects to date including the stocking of over 330,000 fingerlings. Occasional reports of anglers catching large Lake Sturgeon as well as the documentation of Lake Sturgeon spawning below Dam 26 on the Mississippi River may suggest that reproductively mature stocks of Lake Sturgeon are growing. We tracked the movements of 96 adult Lake Sturgeon in the Osage and Gasconade rivers over the past 1.5 years. Lake Sturgeon used and available habitat and found they selected deeper habitats across all seasons. Lake Sturgeon also selected habitats closer to the main channel in all seasons except spring when they moved closer to the bank in faster flows. Many Lake Sturgeon exhibited upstream spring migrations, following increases in temperature and flow. Migrations may be indicative of pre-spawn behaviors. Tributary use was high throughout the year and several instances of inter-tributary movements were observed. Movement declined as temperatures approached 28° C, a proposed threshold of thermal stress for Lake Sturgeon. In Fall 2018, we will begin tracking stocked fingerling Lake Sturgeon to identify nursery habitats and stocking site fidelity to assist MDC in updating their stocking program.



LINKING HABITAT FEATURES TO DISSOLVED OXYGEN AND RIVER FLOW IN THE LOWER OSAGE RIVER, MISSOURI

Investigators

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Project Supervisors

Dr. Craig Paukert, MU

Funding

MDC 358

Objectives

Help determine at what flows and under what conditions key habitat availability becomes a limiting factor in the lower Osage River.

Empirically demonstrate lower Osage River fish community response, including response of sport fish forage species and YOY sport fish, to dam operations.

Develop knowledge to manage dam releases to maximize fisheries benefits.

Refine knowledge of fish community and sport fish response to flow management for application to other riverine systems.

Location

Osage River, Missouri

Expected Completion

June 2019

Status

In progress

Progress

The upstream presence of several large reservoirs and hydropower facilities imposes a highly artificial flow regime and water quality regime on the lower Osage River. We monitored stage, temperature, and/or dissolved oxygen across more than 50 miles of the lower Osage River from 2011 to 2016 at mussel reintroduction sites, potential habitat enhancement sites, fish sampling sites, and areas where streamflow connectivity is impeded by training structures or gravel deposition. Water quality data from six sites were summarized and reported in 2018, including the following key findings:

- Periods with low (<5 mg/L) dissolved oxygen at RM 71.9 corresponded to discharge characterized by flood management and hydropeaking.
 - All training structure sites monitored (i.e., TS 71.2, TS 45.2, TS 30.9 and TS 27.4) showed that daily temperature fluctuation was higher during low flows and less variable during high flows. Discharge that restricted connectivity to embayments and side-channels occurred during 5 – 25% of time, depending on site and monitoring period.
 - Dissolved oxygen in Brockmans Island backchannel (RM 77) spent 45.6 – 61.6% of the month below the state standard (5 mg/L) during August 2013, 2014, 2015, 2016, and July and September 2016 corresponding to hydropeaking releases from the dam.
 - Dissolved oxygen concentrations in intermittently connected backchannels responded to hydropeaking differently than in the main channel. A response pattern in the backchannels was identified with three phases including *hydropeaking*, *recovery*, and *extended isolation*.
 - Along 47 miles of river from RM 81 to RM 34, dissolved oxygen concentration was 1.3 mg/L higher on average at the downstream site during July to October.
- Water quality results will be integrated with habitat and fish sampling data to evaluate the impact of streamflow management on fish community in the lower Osage River.

Products:

Farless N., E. Baebler, B. Landwer, and D. Lobb. 2018. Evaluation of Habitat for Mussels and Their Fish Hosts in the Lower Osage River. Final Report for U.S. Fish and Wildlife Service Task Order No. F11AC01144. Missouri Department of Conservation.

HABITAT SELECTION AND MOVEMENT OF RIVERINE FISHES UNDER REGULATED FLOWS ON THE LOWER OSAGE RIVER

Investigators

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Nicole Farless, MDC

Project Supervisors

Dr. Craig Paukert, MU

Funding

MDC 358

Objectives

Determine how movement of two common fish in the lower Osage River, Spotted Bass and Shorthead Redhorse, is related to stream flow and timing.

Determine how selection of habitat (e.g., temperature, dissolved oxygen, depth, velocity, and cover) by Spotted Bass and Shorthead Redhorse is influenced by stream flow and time of year.

Location

Osage River, Missouri

Expected Completion

June 2019

Status

In progress

Progress and Results

Hydropeaking dams alter downstream riverine habitat which can limit the persistence of certain habitats required for fishes depending on their unique life history needs. We used radio telemetry to evaluate habitat selection of two fishes from different guilds downstream of Bagnell Dam in from April 2016 to June 2017. We studied Spotted Bass, nest-building, habitat generalists and Shorthead Redhorse, fluvial dependent habitat specialists. We modeled habitat selection of Spotted Bass and Shorthead Redhorse independently using discrete choice analysis in a Bayesian framework. Two models were created for each species to evaluate habitat selection using either season or streamflow. Habitat selection results are based on 169 observations from 31 individual Spotted Bass and 94 observations from 21 individual Shorthead Redhorse. Based on the seasonal models, during spring and summer, Spotted Bass selected specific depths (2.8 – 2.9 m) and slower water velocities but selected shallower water in fall and winter (1.5 – 2.0 m). Shorthead Redhorse preferred deep water with fast velocities (3.5 m, 1.5 m/s) during spring and slower velocities (0.4 – 0.7 m/s) during the other seasons. Depth selection varied in other seasons from 1.7 m in winter to 4.8 m in summer. Both species used submerged cover nearer to the banks throughout the year. According to flow-based models, habitat selection during stable and fluctuating flows revealed that both Spotted Bass and Shorthead Redhorse exhibited about twice the selection for submerged cover during stable flow compared to fluctuating flow. Additionally, Spotted Bass selected for slower water velocities during stable flows than fluctuating conditions. In contrast, Shorthead Redhorse selected for velocities >1.0 m/s during stable flows. Under both flow categories, Spotted Bass and Shorthead Redhorse selected for mid-range water depths (2.0 – 4.0 m), although depths in the river were up to 8 m. Our results show that habitat selection of two native species with different life histories differed among season and flow fluctuation. This information will support river management in creating suitable habitat for native fish.



DETERMINING ELECTROFISHING RESPONSE THRESHOLDS OF SMALLMOUTH BASS, FLATHEAD CATFISH, AND BLUE CATFISH

Investigators

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Zach Ford, MDC
Andy Turner, MDC
Jan Dean, Dean Electrofishing, Inc.

Project Supervisors

Dr. Craig Paukert, MU

Funding

MDC 380
Midwest Lake Management, Inc.

Objectives

Determine the effective conductivity of Smallmouth Bass, Flathead Catfish, and Blue Catfish.

Determine taxis and immobilization power thresholds for fish of varying sizes of each species over a range of temperatures using a variety of waveforms.

Generate power goals and sampling recommendations for the most efficient waveform to induce taxis and immobilization each species.

Determine catchability of each species in a field or simulated field setting under waveforms and power goals identified in the previous phase.

Location

Missouri

Expected Completion

June 2020

Status

In progress

Progress and Results

As part of an ongoing effort with in MDC to standardize electrofishing methods for targeting sportfish, this project was developed to determine the capture-prone response thresholds of Smallmouth Bass, Blue Catfish, and Flathead Catfish under different electrofishing waveforms. The goal is to determine the most efficient waveform for collection of each species, and measure how this may differ by fish size and water temperature. In addition, the effective conductivity of each fish species is to be determined, which is an integral part of electrofishing standardization. In the spring of 2016, effective conductivity experiments for Smallmouth Bass were conducted in the lab at MU. Results suggest that the effective conductivity of the Smallmouth Bass may be around 120 μ S/cm, close to the standard value of 115 that is typically assumed for electrofishing standardization. In the Summer of 2017, these experiments were repeated with Blue Catfish and Flathead Catfish, and their estimated effective conductivity was near 94 and 69 μ S/cm, respectively. Since 2016, the project team conducted electrofishing thresholds tests on 600+ Smallmouth Bass, 700+ Blue Catfish, and 875+ Flathead Catfish. The results from these experiments are being evaluated to determine which electrical waveforms, if any, might be good candidates for field testing. For Smallmouth Bass, the standard 60/25 waveform remains one of the best candidates for testing. For all species, the coldest water temperature produced inconsistent results and resulted in low catch rates of both Catfish species, so our recommendation for the second phase is to conduct all trials at water temperatures above 60°F. Since the spring of 2018, 469 Blue Catfish and 200 Flathead Catfish have been transported to experimental ponds at Little Dixie Lake Conservation Area near Columbia, MO for testing catchability under recommended power goals and waveforms. These catchability experiments will be duplicated with Smallmouth Bass at field sites on the Big Piney River, Meramec River, Elk River, Eleven Point River, and Bryant Creek.

**CONSERVATION AND MANAGEMENT OF MISSOURI'S MID-SIZED RIVERS:
DEVELOPMENT OF SAMPLING PROTOCOLS AND APPLICATION TO PRIORITY
WATERSHED RIVERS**

Investigators

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Project Supervisors

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Funding

MDC 359

Objectives

What is the best combination of sampling gears that will determine the status of fish communities in mid-sized rivers throughout Missouri?

Does detection probability for select species differ by gear type, season, or river type?

How many samples of each gear are needed to detect 75% and 95% of the species estimated to be in a 2-10 km segment?

What is the distribution of fishes in selected mid-sized rivers and does that differ seasonally?

Location

Missouri

Expected Completion

June 2019

Status

In progress

Progress and Results

Substantial monitoring and research is conducted within wadeable streams and sections of the Mississippi and Missouri rivers in Missouri, but little information exists on mid-sized rivers (non- or semi-wadeable rivers). Knowing if and when mid-sized rivers are used by big-river and stream fishes and to what degree these rivers support their own unique fish communities will help the Missouri Department of Conservation identify important rivers to target for conservation planning. Moreover, the methods developed and data collected by this project will provide a standardized sampling protocol for fish communities in mid-sized rivers and might eventually lead to the development fish biocriteria for these systems.

Sampling lasted summer 2014–spring 2016. In total, we completed 38 surveys within nine rivers in three separate seasons and collected over 100,000 individual fish. The total number of species varied across sites but was seasonally static. Moreover, we typically collected between 200–300% more species than reported by historical surveys. Finally, we partnered with fisheries management biologists to offer customizable protocols capable of achieving objectives while incorporating manager preferences for efficiency, low complexity, detectability of sensitive species, and preferred gears.

Selected Products

Dunn, C., B. Brooke, R. Hrabik, and C. Paukert. In press. Intensive sampling reveals underreported use of Great-River tributaries by large-river fishes in Missouri. *Southeastern Naturalist*.

HABITAT USE AND DISTRIBUTION OF LITHOPHILIC SPAWNING AND RIFFLE FISHES IN THE EAST FORK OF THE BLACK RIVER

Investigators

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Project Supervisors

Dr. Craig Paukert, MU

Funding

MDC 389

Objectives

Determine spawning habitat selectivity of East Fork Black River lithophilic spawning fishes.

Examine summer habitat use and longitudinal differences in abundance of lithophilic spawning and riffle fishes downstream from the lower reservoir dam.

Make recommendations for particle sizes and locations for gravel addition.

Location

East Fork of the Black River, Missouri

Expected Completion

June 2020



Status

In progress

Progress and Results

Current information is not sufficient to determine how gravel enhancement in rivers may benefit macroinvertebrates and small bodied fish. This study will be complement those efforts by MDC staff with information to evaluate the potential for long-term gravel addition in the East Fork Black River to enhance habitat for lithophilic spawning fishes (which require gravel for spawning) and riffle fishes, and develop recommendations for particle sizes and locations to use for any such augmentation.

Taum Sauk Reservoir construction was completed on the East Fork Black River in 1963 creating a dam that prohibits substrate from continuing to move downstream. Small substrate has been deprived within the first four kilometers as substrate continues to move downstream, but none is able to be replaced. Studying lithophilic fish habitat on two spatial scales (microhabitat and mesohabitat) can be informative about required habitat characteristics and the impacts of the substrate deprived portions of the East Fork.

Lithophilic spawning fishes are often sensitive to changes in substrate size, embeddedness, and composition due to their spawning habitats requiring movable and silt free substrate. Mound building fishes, including the Hornyhead Chub, *Nocomis biguttatus*, are dependent on the size of available substrate to be used in creating spawning mounds which are constructed out of small gravel by fish of the *Nocomis* genus to help protect their eggs. They have been described as a keystone species before due to their mound building behavior and the spawning habitat that it provides for other fishes including Bleeding Shiner, Striped Shiner, Carmine Shiner, and Ozark Minnow that are present in the East Fork Black River and known to use Hornyhead Chub nests for spawning. Therefore, understanding the habitat requirements for these fishes and how stream alterations may affect substrate (and thus spawning) is needed to help resource management agencies guide efforts to restore or enhance habitats for lithophilic stream fishes.

POTENTIAL FOR CONSERVATION LANDS IN MIDDLE MISSISSIPPI RIVER FLOODPLAINS TO MITIGATE FLOOD FLOWS FOR ECOSYSTEM SERVICES

Investigators

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Project Supervisors

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Funding

U.S. Geological Survey, Science Support Partnership
USGS RWO 132

Cooperators

Floodplain Science Network

Objectives

Determine the spatiotemporal patterns of inundation for Middle Mississippi River NWR floodplain lands.

Determine the relationships between inundation indices and the spatiotemporal patterns of habitat availability and nutrient processing potential.

Identify how different design scenarios affect the patterns of ecological diversity, nutrient processing, and sediment distributions on MMR NWR lands.

Determine the optimal sample designs for deployment of water-quality monitoring instrumentation.

Location

Midwest U.S.

Expected Completion

September 2020

Status

In progress

Progress and Results

This project will develop computational tools to evaluate the potential of National Wildlife Refuge (NWR) lands along the Middle Mississippi River (MMR) to provide ecosystem services including flood mitigation, nutrient processing, and habitat provision. Connectivity between a river channel and the adjacent floodplain is widely recognized to provide many ecological benefits. Tools to quantify and predict benefits of connectivity, however, are lacking, diminishing the ability of refuge managers to assess present and future benefits. We will develop a framework for assessing ecosystem potential of floodplain refuge lands under current conditions and as affected by future design scenarios. Because large-river floodplains are subject to complex and dynamic patterns of inundation, we emphasize the importance of understanding floodplain hydrology and hydraulics.

To this end, we have developed a 1-dimensional hydrodynamic model of the Middle Mississippi River between St. Louis, MO and Cairo, IL. The model simulates 80-years of daily discharge in the main channel and adjacent floodplain, under two levee scenarios: 1) fully leveed to simulate the existing conditions, and 2) without the levees. The output from these models is being used to generate spatial layers that represent the extent, depth, frequency, duration, and seasonality of floodplain inundation under both a fully leveed and fully non-leveed scenario. We are also developing higher resolution, both in time and space, 2-dimensional models of two NWR properties (Horse and Wilkinson Islands) on the MMR. We will be modeling potential levee alignments for construction on these properties, seeking to identify the scenario that maximizes the ecologic benefits for which these properties are managed. We are sampling water surface elevations and velocities of flood flows at these two properties to calibrate and validate our models. The data products are being developed to aid in the short- and long-term planning of refuge properties, including identifying properties for future land acquisitions, management of habitat optimized for potential flood patterns, and the best locations for installation of water quality monitoring sites.

DEVELOPING ADAPTATION STRATEGIES AND REPLACEMENT COSTS FOR RECREATIONAL AND TRIBAL FISHERIES

Investigators

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Project Supervisors

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Funding

U.S. Geological Survey, National
Climate Adaptation Center
RWO 137

Cooperators

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Partnership
Mark Luehring, Great Lakes Indian Fish
and Wildlife Commission
Danielle Shannon, US Forest Service
Jordan Read, USGS

Objectives

Quantify the replacement cost of
recreational angling and tribal
subsistence fisheries in the upper
Midwest.

Identify strategies and develop
approaches that help glacial lakes
managers integrate climate adaptation
into current fisheries management.

Location

Upper Midwest US (Wisconsin,
Minnesota, Michigan)

Expected Completion

September 2021

Status

In Progress

Progress and Results

Recreational and tribal fisheries are popular in the upper Midwest, but there is concern that fish communities may change in the future, which may result in recreational and tribal fishers leaving the fishery. Understanding how climate change may affect walleye recruitment and how fishery managers can develop strategies for adapting to these changes is important to both recreational and tribal fishers. We will quantify the costs required to retain recreational and tribal angling opportunities in lakes in Wisconsin and identify approaches that help glacial lakes managers integrate climate adaptation into current fisheries management. This will be done by updating models that predict walleye recruitment and presence/absence and presenting this information to stakeholders to develop multiple adaptation scenarios that weigh costs associated with retaining fisheries in these glacial lakes against the benefits or costs to anglers. Our approach will engage agency biologists in the glacial lakes region to identify management strategies that are available to them, determine to what extent these strategies can maintain fisheries important to their stakeholder group (e.g., walleye). The project will collectively provide various adaptation strategies coproduced with agency managers to better manage walleyes and other glacial lakes fishes under a changing climate.



WINTER AGGREGATION POTENTIAL OF GRASS CARP IN TRUMAN RESERVOIR

Investigators

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Funding

US Geological Survey-CERC
RWO 135

Objectives

Determine if grass carp form exploitable winter aggregations in large lakes during winter.

Assess winter habitat use and selection of grass carp in large lakes.

Location

Truman Lake, Missouri

Expected Completion

September 2020

Status

In progress

Progress and Results

Invasive grass carp (*Ctenopharyngodon idella*) can have substantial effects on native ecosystems, and there is great concern of potential establishment in the Great Lakes. Understanding the ecology of grass carp in large lake systems will be useful in developing efficient control measures for the Great Lakes. One control mechanism proven successful on other species has been harvest of winter aggregations, where fish congregate in large lakes. Previous studies indicate grass carp may enter deep-water wintering areas during cold months, however it is not known if they form aggregations. If grass carp do form winter aggregations, they could be efficiently harvested for population control.

This project will use acoustic telemetry to track grass carp throughout Truman Lake, a large reservoir that could act a model for other large water bodies such as the Great Lakes. We will use tracking data to develop models of habitat selection during the winter months (December – March), which will help predict the spatial distribution of grass carp in large lakes. To assess whether grass carp form aggregations, when a marked carp is located we will use various technologies (i.e. sonar, electrofishing) to determine if the marked fish is part of an aggregation. If evidence of winter aggregations are found, we will attempt to harvest fish via electrofishing or seine netting to assess how effectively these aggregations can be harvested for control purposes.

Preliminary results from the first winter of tracking indicate that rather than moving into deep water as previous research suggested, grass carp remained in shallow water close to shore during winter. There was little evidence of winter aggregations. Additional data will be collected next winter (2018-2019).

MOVEMENT ECOLOGY OF SPAWNING GRASS CARP IN TRUMAN RESERVOIR

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Funding

US Geological Survey-CERC
RWO 136

Objectives

Determine the environmental conditions associated with spawning movements of grass carp into tributaries

Determine how far upriver grass carp in Truman Reservoir travel during spawning, and how long they reside in tributaries.

Determine if triploid grass carp exhibit similar movement patterns as diploid grass carp during spawning periods.

Location

Truman Lake, Missouri

Expected Completion

September 2020

Status

In progress

Progress and Results

Invasive grass carp (*Ctenopharyngodon idella*) can have substantial effects on native ecosystems, and there is great concern of potential establishment in the Great Lakes. Understanding the spawning ecology of grass carp in large lakes and reservoirs is critical to developing effective management actions to address control in the Great Lakes. Grass carp require flowing water to spawn and knowledge of environmental conditions associated with initiation of spawning activity (e.g. water temperature, tributary flow rates), and habitat characterization of tributaries used for spawning will help identify when and where to focus control efforts. Additionally, this information can guide monitoring efforts by identifying which rivers are most likely to be used by spawning grass carp, and when surveys of spawning activity are likely to be most effective.

Grass carp will be tracked via acoustic telemetry during April – June. A combination of manual tracking and automatic detection will allow us to identify when grass carp move into tributaries, their directionality (moving up or downstream), how far upstream spawning fish travel, and when fish return to the main reservoir. Movements will be analyzed with respect to environmental conditions including water temperature, discharge rates, and recorded stream gage height. Comparisons can be made between tributaries with different hydrological characteristics. Importantly we will compare spawning behavior of invasive diploid (reproductively active) carp, and triploid (reproductively inactive) carp that are commonly used for field research. This will allow us to assess the applicability of data from research of triploid fish to wild fish.

Preliminary results from the first season (2018) revealed that several diploid fish made upstream movements following a large rain event in May. Movements of triploid fish were much less pronounced. Additional data will be collected next spring (2019).

EVALUATION OF THE BONUS FISHERY CREATED BY THE LOW-DENSITY STOCKING OF STRIPED BASS IN BULL SHOALS LAKE

Investigators

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Project Supervisors

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Funding

MDC 424

Objectives

Describe the low-density Striped Bass fishery in Bull Shoals Lake.

Define expectations of any potential alternative stocking strategies that may be considered after the 2019 stocking.

Determine if the forage requirements of the Striped Bass population are having an impact on other sportfish populations in the reservoir.

Provide information to answer stakeholder concerns related to potential impacts the stocking of Striped Bass may have on sportfish populations in Bull Shoals Lake.

Location

Bull Shoals Reservoir, Missouri

Expected Completion

June 2023

Status

In progress

Progress and Results

The Missouri Department of Conservation started a biennial stocking in 2013 (0.36 fish/acre) of Striped Bass in Bull Shoals Lake to produce a high-quality and low-density bonus fishery that will supplement current angling opportunities. Assessing population dynamics of the developing Striped Bass population will include growth, survival, and movement and will be important in evaluating success of the current stocking plan. It will also be important to determine the potential impacts (if any) that the stocking of Striped Bass may be having on other sportfish populations in Bull Shoals Lake, which will be conducted through identifying diet overlap of Striped Bass and other sportfish, 2) comparing pre and post-stocking trends (1992-present) in relative sportfish density, population structure, and growth, and 3) estimating forage requirements of the Striped Bass population. Survival, movement, and growth of the Striped Bass population will be estimated using a combination of gill netting and acoustic telemetry tagging and tracking. Age-0 to age-1 survival will include an estimate of transport, initial stocking, and over-winter survival for each year of the project by tagging 100 age-0 individuals with acoustic transmitters. Annual survival of adult Striped Bass, seasonal location trends, areas and timing of population concentrations will be evaluated using acoustic telemetry. Active tracking will be conducted to locate tagged individuals throughout the duration of the project. Growth of Striped Bass in the Bull Shoals Lake fishery will be defined throughout the study with length-weight-age relationships of the fish collected. Age-structured population modeling will provide an estimate of the fishery being provided by current stocking rates and how this fishery may change with alternative stocking rates and various levels of exploitation that may be considered following the 2019 Striped Bass stocking.

Dr. Elisabeth Webb



Lisa Webb holding a Greater Scaup collected and banded on the Illinois River.

LINKING WATERFOWL DISTRIBUTION AND ABUNDANCE TO SPATIAL AND TEMPORAL DISTRIBUTION AND ABUNDANCE OF WETLAND HABITAT

Investigators

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Project Supervisor

Dr. Elisabeth Webb, MU

Funding

MDC 363

Cooperators

Missouri Department of
Conservation

Objectives

Develop and evaluate models predicting wetland inundation probability in north central Missouri in November.

Develop and evaluate an aerial survey to estimate waterfowl abundance in north central Missouri during fall and winter.

Evaluate the influence of wetland availability and food abundance on dabbling duck abundance and distribution in north central Missouri during fall and winter.

Location

North Central Missouri

Completion

December 2016

Status

Complete

Progress and Results

Objectives of this project were to model probability of wetland inundation (habitat availability), quantify waterfowl use of private wetlands, and assess the influence of wetland availability and food abundance on dabbling duck distribution in north Missouri.

Probability of autumn wetland inundation was modeled using observed precipitation values, presence of hydric soil, wetland area, and watershed land use. We collected Landsat 5 TM satellite images for years 2004-2006 and 2008-2010 to determine wetland inundation and develop wetland inundation models. We flew 3 aerial surveys in 2014 and 6 aerial surveys in 2015-2016 via fixed wing aircraft beginning the first week of November and ending in January. We collected seed biomass estimates from 12 public wetlands and 12 private wetlands within 30 km of the public wetlands. Seed head clippings and soil core samples collected from each site were used to quantify waterfowl food abundance in the region. We used probability of wetland inundation and food abundance estimates to assess how waterfowl use the landscape in autumn.

National wetlands inventory sites had a lower mean inundation frequency than WRP wetlands over the study period (\bar{x} = 0.21 and 0.61 respectively). Duck densities were greater within the Grand and Missouri River floodplains in both survey years (0.13 and 0.5 birds/ha, respectively) compared to outside the Grand and Missouri River floodplains (0.02 and 0.01 birds/ha, respectively). Although precision of aerial survey estimates was variable, results suggest that 9-54% of waterfowl, particularly ducks, in the region are not accounted for in autumn and winter by exclusively sampling public wetland areas. These results can inform wetland management decisions regarding the role each public wetland plays in its surrounding landscape in providing habitat for autumn migrating waterfowl.

Selected products:

Hidden, B. 2016. Linking waterfowl distribution and abundance to spatial and temporal distribution and abundance of wetland habitat. M.S. student, University of Missouri-Columbia.

DEVELOPMENT OF A SPATIALLY AND TEMPORALLY EXPLICIT RESOURCE BASED MODEL TO ESTIMATE FOOD AVAILABILITY FOR MIGRATORY WATERFOWL

Investigators

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Project Supervisor

Dr. Elisabeth Webb, MU

Funding

Great Plains Landscape Conservation
Cooperative, U.S. Fish and Wildlife
Service

Cooperators

Nebraska Rainwater Basin Joint Venture
Nebraska Game and Parks Commission
U.S. Fish and Wildlife Service

Objectives

Quantify food availability for waterfowl
during migration on wetlands within the
Nebraska Rainwater Basin.

Determine how waterfowl distribute
themselves in relation to variations of
food abundance in space and time during
spring migration.

Assess the indirect effects of
neonicotinoid insecticides on
invertebrates at wetlands in an
agricultural landscape.

Location

Nebraska Rainwater Basin

Completion

May 2017



Status

Complete

Progress and Results

Despite a 90% decrease in wetland habitats and ongoing degradation from urban and agricultural land use, Nebraska's Rainwater Basin (RWB) serves as a critical staging area for migratory waterfowl using the Central Flyway. Given the RWB's annual role in sustaining relatively large waterfowl densities with limited wetland habitat, it is necessary that conservation managers obtain accurate estimates of wetland derived food resource availability to calculate energetic carrying capacity.

We assessed spring food availability for dabbling ducks at public, cropped, and Wetlands Reserve Program (WRP) wetlands in the RWB during 2014 and 2015. Energetic quality (true metabolizable energy) for available forage was also greatest at cropped wetlands (\bar{x} = 2.3kcal/g), followed by WRP (\bar{x} = 1.8kcal/g), and finally public wetlands (\bar{x} = 1.7kcal/g). Forage density in the RWB appears comparable to other landscape scale studies at similar latitudes, however energetic quality of forage produced was significantly less than the estimate currently used by managers in the RWB (2.5kcal/g). Given the relatively favorable seed production observed in this study, conservation and inundation of WRP and cropped wetlands may be a viable option to increase energetic carrying capacity for dabbling ducks in other regions.

We also developed a suite of species distribution models to evaluate the relationship between local food availability and wetland landscape structure in determining waterfowl habitat use during migration. In 2014 and 2015 we observed a strong relationship between food availability and waterfowl density ($p < 0.05$) in all of our top models suggesting that forage may be a limited resource for waterfowl during spring.

Selected products:

Schepker, T.J., E.B. Webb and T.G. LaGrange. 2018. Are waterfowl food resources limited during spring migration? An energetic assessment of playas in Nebraska's Rainwater Basin. Wetlands 1-12

IDENTIFICATION OF SUMMER HABITAT FOR FEDERALLY ENDANGERED INDIANA BAT WITHIN THE OZARK CENTRAL RECOVERY UNIT

Investigators

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Project Supervisor

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Funding

USGS Science Support Partnership
U.S. Fish and Wildlife Service
RWO 126

Cooperators

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

Objectives

Survey forest bat communities with emphasis on distribution of Indiana bats and species of special conservation concern using mist nets and acoustic sampling.

Use radio telemetry to locate maternity colonies, monitor foraging habits and corridor use by Indiana bats and evaluate habitat selection of foraging and roosting resources by colonies.

Assess forest stand structure of roosting and foraging areas in comparison to areas without known roosting or foraging to determine Indiana bat habitat selection.

Location

Mingo NWR (Missouri)
Cypress Creek NWR (Illinois)

Completion

December 2017

Status

Complete

Progress and Results

The goal of this project was to locate maternity colonies of federally endangered Indiana bats (*Myotis sodalis*) and characterize maternity roosting sites in order to gain a better understanding of habitat selection in the Ozark – Central Recovery Unit.

We captured and used radio-telemetry to track 30 Indiana bats (20 of which we tracked for ≥ 4 days) at Cypress Creek and Mingo National Wildlife Refuges (NWRs) during summers of 2015 and 2016. We identified roost trees and used an information theoretic approach with discrete choice modeling to evaluate 19 candidate models explaining roost site selection. All three of the top models included percent canopy cover, with tree height and condition (alive, dead or artificial) included in two of the three top models. Using parametric bootstrapping, we found that a tree had a greater probability of selection as a roost when canopy cover was $< 25\%$, with close to zero probability of use for trees with $\geq 60\%$ canopy cover. Our results also indicated that trees $> 35\text{m}$ tall were almost 2 times more likely to be used as a roost tree, compared to trees less than 20m tall. Artificial roosts (telephone poles wrapped with artificial bark) were used predominantly at Cypress Creek NWR, with all 7 primary roosts in 2015 and 6 of the 8 total primary roosts in 2016 being artificial. At Mingo NWR, all primary roosts were dead trees. Maintaining existing mature bottomland hardwoods in southeast Missouri as well as promoting additional acreage of bottomland hardwoods in Illinois that will grow to maturity would likely increase roosting habitat for maternity colonies of Indiana bats. Disproportionate use of artificial roosts indicates potential for artificial roosts to be a useful tool for land managers to provide supplemental roosting habitat in an area while waiting for native forests to mature and develop the necessary roost site conditions for Indiana bat maternity colonies.

Selected products:

Dearborn, J.A., E.B. Webb, S.K. Amelon and S.R. Marquardt. *In review*. Indiana Bat Maternity Colony Roost Site Selection in Bottomland Hardwood Ecosystems: Implications for Artificial Roosts. Wildlife Society Bulletin

DEVELOPMENT OF A FISH AND AMPHIBIAN RAPID ASSESSMENT PROTOCOL FOR WETLANDS: LINKING MANAGEMENT TO WETLAND SYSTEM PROCESSES

Investigators

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Funding

MDC 370

Cooperators

Multiple wetland managers statewide

Objectives

Assess efficiency and effectiveness of a variety of sampling methods to determine probability of presence and species richness of amphibians and fish in MDC wetlands

Quantify effects of region, season, and habitat complexity on detection probability for amphibians and fish in MDC wetlands

Recommend standardized assessment protocol for use by MDC wetland area managers to evaluate amphibian and fish response to wetland management decisions

Location

Missouri

Completion

December 2017



Status

Complete

Progress

Providing habitat for migratory waterfowl has historically been the focus of management strategies for Missouri's public wetlands. However, wetlands are also used by other less visible taxa, such as fish and amphibians, which reside largely below the water's surface. Being able to identify and monitor the full suite of taxa using wetland areas would be insightful to comprehensively manage these unique habitats. Our goal was to develop a standardized rapid assessment protocol to efficiently determine fish and amphibian species presence and richness in Missouri wetlands. The objectives of this study were to 1) investigate how sampling method and wetland habitat characteristics influence measures of species richness, 2) determine the sampling effort needed to detect wetland species, and 3) investigate the influence of wetland hydrology, within wetland conditions, and upland habitat on species richness and distribution. We evaluated four sampling methods in 29 wetlands across three regions in the state of Missouri during spring and summer, 2015-2016. Results suggest that a single method, a mini-fyke net, is able to identify the majority of fish and amphibian species in Missouri wetlands with minimal effort but that consistent detection of amphibians across seasons may require additional samples with minnow traps or dipnets. Species richness measures were influenced by method, water depth, distance from shore, and vegetation density, as well as spatial and temporal variables. In general, 6-7 samples with a mini-fyke net detected the majority of fish and amphibian species in a wetland. In addition to spatial and temporal variables, wetland hydrologic connectivity and managed water source were the main factors structuring the distribution and richness of fish and amphibian wetland taxa. This study enhances our understanding of factors influencing fish and amphibian use of restored wetlands and provides conservation practitioners with information to help select the most efficient and effective fish and amphibian sampling methods to meet monitoring objectives.

EVALUATING DIFFERENCES IN INVERTEBRATE COMMUNITIES BETWEEN REMNANT AND RESTORED PRAIRIES IN MISSOURI

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Project Supervisors

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Funding

MDC 383
Prairie Fork Charitable Endowment
-Trust

Cooperators

MDC

Objectives

Identify what species of cicadas, bees, and grasshoppers inhabit three of the prairies in the Upper Osage Grasslands.

Compare invertebrate communities of reconstructions to the communities in nearby remnants, identifying which species may not be colonizing reconstructions.

Evaluate the effects of size, distance, and age of reconstruction on invertebrate species richness and community composition.

Location

Wah'Kon-Tah Prairie
Schell-Osage Conservation Area
Linscomb Wildlife Area
Tucker Prairie Natural Area
Prairie Fork Conservation Area

Completion

May 2018

Status

Complete

Progress and Results

The tallgrass prairie is one of the most endangered ecosystems in North America. MDC managers have established thousands of acres of prairie reconstruction plantings in Missouri to augment the remaining fragments of native grassland. Our goal was to evaluate how invertebrate communities have responded to reconstruction efforts by comparing reconstructions with nearby remnants.

We sampled invertebrates from four pairs of reconstructed and remnant prairies in Missouri in 2016 and 2017. We captured bees with bee bowls and grasshoppers with sweep nets, identifying individuals to the lowest taxonomic level possible. Shannon diversity of grasshoppers was higher on reconstructions than remnants at three of the four locations, and 10 of the 33 taxa were unique to remnants. In contrast, we detected no differences between reconstructions and remnants in bee species richness nor diversity. Community composition of bees and grasshoppers was different on reconstructions from that of remnants. Bee communities differed between the prairie types largely because of relative abundance of taxa; remnants and reconstructions shared all but three of the 60 taxa.

Grasshopper communities on reconstructed prairies were characterized by a few long-winged, generalist species that are typically successful in agroecosystems. Two short-winged grasshoppers that preferred either forbs or grasses were associated with remnant prairie. The species that characterized reconstructions became less abundant with reconstruction age, although they were still more common on the oldest reconstructions than remnants. The differences between remnant and reconstructed grasshopper communities likely reflects the disparities in dispersal ability between grasshopper taxa, as well as the differences in food resources between prairie types.

Our results show that prairie reconstructions in Missouri do not support the same communities of bees and grasshoppers found on remnants. Grasshoppers appear to be more diverse on remnants, and there are many species that seemingly have not colonized nearby reconstructions.

**WHICH GEESE ARE BEING HARVESTED? BODY CONDITION OF LESSER SNOW
(*CHEN CAERULESCENS CAERULESCENS*) AND ROSS'S GEESE (*C. ROSSII*)
HARVESTED BY DIFFERENT METHODS DURING THE LIGHT GOOSE
CONSERVATION ORDER**

Investigators

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Dr. Mark Vrtiska, Nebraska Game and
Parks Commission

Project Supervisor

Dr. Elisabeth Webb, MU

Funding

Nebraska Game and Parks Commission

Cooperators

Nebraska Game and Parks Commission
Missouri Department of Conservation
Arkansas Game and Fish Commission
South Dakota Game, Fish and Parks

Objectives

Evaluate body condition of lesser snow and Ross's geese harvested by various methods (e.g., over decoys vs. jump shot) during the light goose conservation order.

Assess individual variation in survival rates of lesser snow geese using random effects in Bayesian survival models.

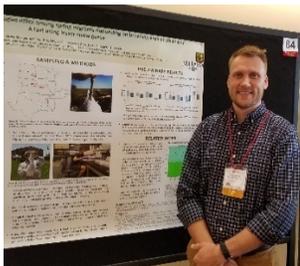
Evaluate the influence of differential winter habitat use on spring body condition using stable isotope techniques

Location

Arkansas, Missouri, Nebraska, South Dakota

Expected Completion

December 2018



Status

In progress

Progress and Results

The Light Goose Conservation Order (LGCO) was implemented in 1999 as an attempt to reduce light goose populations to a sustainable level and reduce pressure to jeopardized arctic ecosystems through liberalized hunting regulations. Despite its implementation, current efforts appear to be ineffective in reducing light goose populations. This project evaluates sources of heterogeneity in light goose populations during spring migration that may explain in part why the LGCO is ineffective. Specifically, we compared body condition between individuals harvested by LGCO participants and individuals randomly collected as a control group. Results from collections in 2015 and 2016 across Arkansas, Missouri, Nebraska, and South Dakota suggest that decoy harvested individual have reduced lipid content (~ 55 g less) compared to the general population. Secondly, we evaluated how winter habitat use and breeding destination influences spring body condition using stable isotope techniques. We found that individuals using coastal marsh habitats, instead of agricultural rice based habitats had reduced lipid content. Finally, we sought to model individual variation in survival rates of lesser snow geese using band recoveries to quantify the extent of heterogeneity, given poorer conditioned individuals are more susceptible to harvest. We found that estimating individual variation in survival using band recoveries alone is challenging and likely require further simulation tests or additional data such as live recaptures.

Products

Fowler, D.N., K.J. Kuechle, B. A. Woodall, M.P. Vrtiska and E.B. Webb. 2018. Development and evaluation of morphological indices to estimate proximate lipid and protein reserves in lesser snow and Ross' geese. Wildlife Society Bulletin 42:295-303.

Fowler, D.N., E.B. Webb, F.B. Baldwin, M.P. Vrtiska and K.A. Hobson. Accepted. A multi-isotope ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$, $\delta^{34}\text{S}$, $\delta^2\text{H}$) approach to establishing migratory connectivity in Lesser Snow Geese: Tracking an overabundant species. PLoS ONE

EFFECTS OF PREDICTED CLIMATE CHANGE ON PLAYA WETLAND ECOSYSTEM FUNCTION AND ECOLOGICAL SERVICES

Investigators

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Project Supervisors

Dr. Elisabeth Webb, MU
Dr. Keith Goyne, MU

Funding

Missouri EPSCoR, National Science Foundation

Cooperators

Dr. Bo Svoma, MU
Dr. Dave Haukos, USGS/Kansas State

Objectives

Quantify the effects of simulated climate change conditions on soil biogeochemistry, plant production, microbial processes, and greenhouse gas emissions.

Elucidate differences in these responses between soils collected from Northern playas and Southern playas.

Simulate the impact of increased nitrogen inputs (from surface runoff) on nitrogen biogeochemistry in Northern and Southern playa soils.

Create a soil assessment framework to assess the overall playa soil health in regards to wildlife habitat, nutrient filtration, and groundwater recharge.

Location

Rainwater Basin, Nebraska
Southern High Plains, Texas

Completion

May 2019

Status

In Progress

Progress and Results

We have conducted two six-month greenhouse experiments on playa soils from Nebraska and Texas to quantify hydroperiod and land use treatment effects on seed bank plant production, soil chemical properties, ion speciation, and ecological tipping point. Soil mesocosm containers were subjected to four hydroperiod treatments, representing historic and future climate conditions for the first experiment. Local data were used to create the historic climatic simulation and CMIP5 – BCCA downscaled atmosphere ocean general circulation models (AOGCMs) for the RCP 4.5 emission scenarios (years 2071-2099) were used to develop future climatic simulations. In the second greenhouse experiment, soil mesocosm containers were subjected to seven nitrogen treatments representing potential land use change scenarios. Following each greenhouse study, we conducted an incubation study to measure greenhouse gas emissions from playa soils after being subjected to various hydroperiod and land use treatments. Final results of these experiments will identify vegetative and soil properties most sensitive to hydroperiod and land use alterations and identify the greatest potential risks to playa ecosystem functions in a changing climate. As part of this project, we have also conducted a germination study to evaluate the impact of increased temperatures on Barnyardgrass (*Echinochloa crusgalli* L.) a common playa plant. Results of this study indicate that climate change will impact Texas and Nebraska playa plant germination differently. Whereas Texas may have increased germination and biomass production in future temperature regimes, Nebraska is likely to see a decline in germination density. To answer objective (4), we will use initial soil properties from our playas to indicate soil health in combination with expert opinions on relative values of ecosystem services provided by the playas used in these studies. We will compare the impact of future climate and land use conditions on playa soil health to predict vulnerability and adaptive capacity. We will also combine ecological data with socio-economic data from my second project to build a framework for assessing climate change vulnerability in the playa region, to be used by managers.

BAT OCCUPANCY PATTERNS IN THE PLUMAS NATIONAL FOREST AS A FUNCTION OF WILDFIRE AND FOREST RESTORATION

Investigators

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Project Supervisors

Dr. Elisabeth Webb, MU
Dr. Dylan Kesler, IBP

Funding

U.S. Forest Service

Cooperators

Institute for Bird Populations
Plumas Audubon Society

Objectives

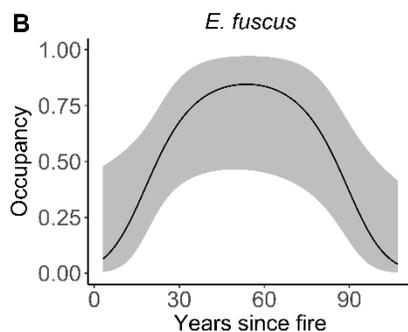
Evaluate the effects of fire severity, distance to fire, fire heterogeneity, habitat availability and forest characteristics on the occupancy, distribution, and diversity of sensitive bat species to guide restoration of the Moonlight Fire and inform post-fire management of forests for sensitive bats across the Sierra Nevada, as well as developing a protocol for acoustic monitoring of bats for the Plumas National Forest.

Location

Plumas National Forest, CA

Expected Completion

December 2018



Status

In progress

Progress and Results

Wildfires are increasing in incidence and severity across the western US, leading to changes in forest structure and wildlife habitats. Knowledge of how species respond to fire driven habitat changes in these landscapes is limited and generally disconnected from our understanding of adaptations that underpin responses to fire. We aimed to identify relationships between fire regime, physiographic and forest structure variables, and occupancy and functional traits of a diverse bat community, to inform forest management in a fire-prone landscape.

We recorded bats acoustically at 83 sites (n = 249 recording nights) across the Plumas National Forest in the northern Sierra Nevada over 3 summers (2015-2017). We investigated relationships between fire regime, physiographic and forest structure and probability of bat occupancy for 9 species. We identified ecomorphological traits (body mass; call frequency, bandwidth and duration; and open, edge or clutter (structurally complex vegetation) adapted foraging strategy) driving species-environment relationships across all 17 bat species. Relationships between bat traits and fire regime were driven by adaptations to diverse forest structure. Bats adapted to foraging in open habitats and emitting longer duration, narrow bandwidth calls were associated with higher severity and more frequent fires and bats adapted to foraging in a more cluttered environment were negatively associated with fire. Relationships between edge-adapted bat species and fire were driven by prey preference or habitat availability and configuration at a landscape scale.

Predicted increases in fire frequency and severity in the western US are likely to shift dominance in the bat community to species adapted to open environments and those able to exploit post-fire resource pulses (aquatic insects, beetles, snags). Managing for pyrodiversity within the western US is likely important for maintaining bat community diversity, as well as diversity of other biotic communities. Identifying trait-fire regime relationships will help forest managers develop appropriate management interventions and focus limited resources to provide for a broad range of species.

QUANTIFYING NEONICOTINOID CONCENTRATIONS IN MISSOURI WETLANDS, THEIR DRIVING FACTORS AND POTENTIAL EFFECTS TO THE ASSOCIATED AVIAN COMMUNITY

Investigators

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Project Supervisors

Dr. Elisabeth Webb, MU

Funding

MDC 381

Cooperators

MDC

Objectives

Quantify neonicotinoid concentrations in Missouri public wetlands and evaluate landscape characteristics correlated with those concentrations.

Develop a predictive model for temporal and spatial variation of neonicotinoid concentrations in Missouri wetlands.

Compare tree swallow (*Tachycineta bicolor*) reproductive and brood rearing efforts at wetlands with varying neonicotinoid concentrations.

Location

Missouri

Completion

June 2019



Status

In progress

Progress and Results

Neonicotinoids are the most widely used and fastest growing class of insecticides commercially available for agricultural use in North America. Objectives for this project seek to quantify neonicotinoid concentrations in Missouri public wetlands along with correlated landscape factors, and develop a model of spatial and temporal variation for neonicotinoid concentrations. Despite increased sampling efforts, little is known about neonicotinoid concentrations in intensively managed moist-soil wetlands common to Missouri. We sampled water and sediment from 40 public wetlands under different common management regimes across Missouri during four sampling periods in 2016 and 2017. We found that sediment neonicotinoid concentrations were an order of magnitude greater than associated water concentrations. We used Boosted Regression Trees to relate collected management and environmental variables to sediment concentrations across our four sampling periods. Results from this hierarchical modeling identified six variables as important predictors, ultimately accounting for 32% of environmental variation. Wetland water temperature, % wetland in agriculture, water depth, sediment silt fraction, % wetland moist-soil vegetation, and % conservation area treated were all selected as predictors of sediment neonicotinoid concentrations. Tree swallow nest boxes (100) and emergent insect traps (40) were placed at 20 experimentally treated wetlands spring of 2016. Tree swallow nesting and available insect forage was monitored at study wetlands resulting in data from 33 tree swallow nests. At each nest we recorded female age, nest start date, clutch size and egg volume. For those nests that successfully hatched we recorded nestling growth rate as well as collected feathers for stable isotope analysis.

EFFECTS OF DIRECT APPLICATION OF NEONICOTINOIDS ON AQUATIC MACROINVERTEBRATE COMMUNITIES IN MISSOURI PUBLIC WETLANDS

Investigators

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Doreen Mengel, MDC

Project Supervisor

Dr. Elisabeth Webb, MU

Funding

MDC 381

Cooperators

MDC

Objectives

Assess the impacts of direct application of neonicotinoids on MDC intensively managed wetlands on aquatic macroinvertebrate biomass, taxa richness, and secondary production.

Evaluate the effects of neonicotinoid concentrations on the survival of aquatic macroinvertebrate species with different life histories.

Evaluate sediment toxicity of neonicotinoids to common benthic dwelling invertebrates.

Location

Missouri

Expected Completion

June 2019

Status

In progress

Progress and Results

Neonicotinoids are a class of insecticide widely adopted for agricultural use throughout North America and Europe and have recently been implicated in terrestrial and aquatic insect declines. We selected 22 study wetlands at nine MDC Conservation Areas. We assigned one wetland within each pair to be planted with neonicotinoid treated corn seed and one to be planted with untreated seed. In spring 2016, we collected baseline water, sediment, and aquatic invertebrate samples. Following treatment summer 2016, we sampled November 2016 and April 2017 to quantify neonicotinoid concentrations and aquatic invertebrate community responses. We have completed laboratory processing of aquatic invertebrate data and are beginning preliminary data analysis. Preliminary results indicate declining sensitive taxa (e.g. *Chironomidae*) with increasing neonicotinoid concentrations in water and sediment as well as an overall treatment effect. Preliminary results will be used to identify study organisms and field realistic dosing concentrations for laboratory studies. Specifically we are interested in the impacts of sediment neonicotinoid contamination to benthic organisms as sediment neonicotinoid concentrations were greater than associated water concentrations. Sediment toxicity tests for the third objective will be completed at the USGS Columbia Environmental Research Center in partnership with their aquatic organism toxicologists.



EFFECTS OF NEONICOTINOID SEED-TREATMENT USE ON NON-TARGET NATIVE POLLINATOR COMMUNITIES IN MISSOURI FIELD MARGINS

Investigators

Dr. Anson Main, Post doc, MU
Dr. Elisabeth Webb, MU
Dr. Keith Goyne, MU
Doreen Mengel, MDC

Project Supervisors

Dr. Elisabeth Webb, MU
Dr. Keith Goyne, MU

Funding

MDC 383

Cooperators

MDC

Objectives

Survey levels of neonicotinoids in soils and vegetation of agricultural field margins located on MDC conservation areas.

Determine the rate of degradation and/or accumulation in Missouri soils over time.

Validate potential routes of exposure for non-target terrestrial insects.

Evaluate the effects of annual neonicotinoid seed-treatment use on a range of native pollinator species.

Location

MDC Conservation Areas:
Atlanta CA, MO
Fountain Grove CA, MO
Indian Hills CA, MO
Thomas Hill Reservoir CA, MO
Whetstone Creek CA, MO

Completion

September 2018

Status

In progress

Progress and Results

Most current neonicotinoid scholarship has focused on the effects of neonicotinoids toward social honeybee populations. By comparison, the majority of native bees found on agricultural sites are solitary, nest in the ground, and/or pollinate plants near to production crops. It is unknown how many of these species are affected by intensive insecticide use. To validate routes of exposure, we collected soils, vegetation, and representative bees at agricultural fields and analyzed for neonicotinoid residues. In year one (2016), we focused on collecting baseline data. Neonicotinoids were consistently detected in field and field-margin soil in every sampling period across all MDC Conservation Areas (range: <LOD to 55.7 µg/kg). Neonicotinoids were detected in 82% to 100% of treated crop tissues, but were rarely detected in margin plant tissues (<7%). We collected 2,407 native bees that represented 72 different species. Statistical analyses indicate that native bee abundance was lower in margins with greater neonicotinoid concentrations; however, this was not significant ($\beta = -0.09$, $P = 0.70$). By comparison, native bee richness in field-margins was negatively impacted by neonicotinoid concentrations in margin soils ($\beta = -0.22$, $P = 0.01$). In 2017 and 2018, fields were assigned one of three experimental treatments: previously treated to treated seed, previously treated to untreated seed, untreated to untreated seed. Compared to 2016, neonicotinoids were rarely detected in field-margin soils with field soil concentrations also remaining relatively low throughout the study. Mean field soil concentrations ranged between <LOD to 15 µg/kg in previously treated fields and <LOD to 27.5 µg/kg in treated fields. Across five sampling time points, ~98 bee species were collected from the 2017 study fields for a total capture of 6,672 individuals. Our goal is to understand how native pollinator communities are affected by seed-treatment use and how they respond to neonicotinoid concentration changes over time.

Products:

Main, A.R., Webb, E.B., Goyne, K.W., and D. Mengel. 2018. Neonicotinoid insecticides negatively affect performance measures of non-target terrestrial arthropods: a meta-analysis. *Ecological Applications*. doi: doi/pdf/10.1002/eap.1723

**SUMMER HABITAT SELECTION BY INDIANA BATS (*MYOTIS SODALIS*) AND
NORTHER LONG-EARED BATS (*MYOTIS SEPTENTRIONALIS*) ON NATIONAL
WILDLIFE REFUGES IN NORTHERN MISSOURI**

Investigators

Dane Smith, M.S. student, MU
Dr. Elisabeth Webb, MU
Dr. Sybill Amelon, USFS
Shauna Marquardt, USFWS

Project Supervisors

Dr. Elisabeth Webb, MU
Dr. Sybill Amelon, USFS

Funding

U.S. Geological Survey, SSP Program
RWO 130

Cooperators

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

Objectives

Determine roost locations and habitat characteristics of *M. sodalis* and *M. septentrionalis* maternity colonies on NWR lands in northern Missouri.

Compare selected habitat to overall stand characteristics in order to develop a predictive model for roost selection by species of interest.

Evaluate habitat selection of *M. sodalis* and *M. septentrionalis* in presence and absence of other species on an east-west gradient in order to assess potential for multi-species management.

Locations

Squaw Creek, Swan Lake, and Big Muddy National Wildlife Refuges

Completion

May 2019

Status

In progress

Study Design

Forest bat communities were surveyed using acoustic sampling and mist netting in the summers of 2017 and 2018 to determine occupancy and evaluate maternity habitat selection on selected NWR lands, with emphasis placed on federally listed species. Acoustic sampling was completed in August 2018. Eighty-six unique sites were surveyed over two seasons, and a variety of habitat characteristics will be used to model occupancy at multiple spatial scales. Preliminary call identification is currently underway. Once completed, occupancy data will be analyzed using the program R.

In 2017, 14 Indiana bats were captured at Swan Lake National Wildlife Refuge. Each individual was radio tagged and tracked to diurnal roosts daily for the life of the transmitter. Eight unique roost trees were identified. In 2018, nine Indiana bats were captured at Swan Lake NWR, and subsequent tracking identified 13 previously unknown roosts. Additionally, one Indiana bat was captured at the Berger Bend unit of Big Muddy NWR. Subsequent tracking identified four unique roosts. A number of habitat characteristics (canopy cover, mean stem density, available bark, and number of snags) will be used to quantify habitat characteristics of known roost sites and randomly chosen unused sites. These data will be used to better understand factors that influence roost selection and to develop a predictive model for site selection by listed species. Variation in roost selection in the presence/absence of other species will be used to assess the potential for multi-species management. Preliminary analysis using discrete choice modeling and information theoretic approaches to evaluate habitat requirements at the local, regional, and landscape scale are underway. Results of this study will inform NWR land managers of the effectiveness of specific forest management techniques to the conservation of bat habitat and reveal the relative importance of habitat resources on NWRs.

LINKING LIFE HISTORY NEEDS OF WETLAND-DEPENDENT SPECIES WITH HABITAT CONDITIONS AND ASSOCIATED ECOLOGICAL PROCESSES TO IMPLEMENT THE WETLAND PLANNING INITIATIVE

Investigators

Dr. Maggie MacPherson, Post doc, MU
Dr. Elisabeth Webb, MU
Dr. Andrew Raedeke, MDC
Doreen Mengel, MDC
Frank Nelson, MDC

Project Supervisor

Dr. Elisabeth Webb, MU

Funding

MDC 402

Cooperators

MDC

Objectives

Develop a framework to model spatially and temporally explicit processes in Missouri's wetlands that link biophysical processes to species outcomes.

Quantitatively assess how well Missouri's current extent and distribution of wetlands are meeting the life history needs of the full suite of wetland-dependent species.

Use a Bayesian belief network (BBN) modeling approach to build interactive decision-support tools that explicitly identify sources of structural uncertainty that can be addressed through research or adaptive management.

Location

Missouri

Completion

December 2019

Status

In progress

Progress and Results

In September 2017, Dr. Maggie MacPherson was hired as a postdoctoral research associate to develop BBN wetland models. In early September 2017, we participated in the Missouri Department of Conservation Annual Wetland Review, which included an introduction to BBN models and breakout groups to develop conceptual preliminary BBN models. With the assistance of the project team, we completed a literature review on the use of BBNs to study freshwater wetland-dependent taxa that is now published in the journal *Biological Conservation*. The three main gaps identified in this review were that 1) there are limited systems-oriented frameworks to allow comparisons of process models among wetlands, 2) no temporally-explicit BBN models exist to accurately represent the seasonally dynamic nature of wetlands, and 3) in contrast with other taxonomic guilds, wetland birds could represent umbrella taxa because they shared a higher proportion of specific habitat requirements with other guilds than other groups.

Dr. MacPherson attended a training workshop to learn the fundamental mathematical underpinnings of BBN approaches as well as the widely-used software program: Netica. This tool will be used to develop a multi-species BBN model representative of Missouri's wetland fauna. This BBN is expected to be informed by the current extent of Missouri's wetlands, identified in the first phase of the Missouri Department of Conservation's Wetland Planning Initiative and to quantitatively model seasonal species outcomes across Missouri's wetlands.

Products

MacPherson, M.P., E.B. Webb, A.H. Raedeke D. Mengel and F. Nelson. 2018. A review of Bayesian belief network models as decision-support tools for wetland conservation: Are water birds potential umbrella taxa? *Biological Conservation*. doi: doi.org/10.1016/j.biocon.2018.08.001

EVALUATING IMPACTS OF SEED TREATMENT PESTICIDES ON REPRODUCTION OF NATIVE BEE COMMUNITIES IN MISSOURI

Investigators

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Dr. Elisabeth Webb, MU
Dr. Keith Goyne, MU
Dr. Anson Main, Post doc, MU
Doreen Mengel, MDC

Project Supervisors

Dr. Elisabeth Webb, MU
Dr. Keith Goyne, MU
Dr. Anson Main, Post doc, MU

Funding

MDC 383

Cooperators

MDC

Objectives

Survey levels of neonicotinoids in pollen, nesting materials, and developing bees (e.g., larvae, adults).

Evaluate the impacts of multiple interacting pesticides on native bee nesting efforts, development, and reproductive success among solitary bee communities of agroecosystems.

Location

MDC Conservation Areas:
Atlanta CA, MO
Thomas Hill Reservoir CA, MO
Whetstone Creek CA, MO

Completion

August 2020

Status

In progress

Progress and Results

Currently, effects of contemporary seed treatment pesticides (incl. neonicotinoids, fungicides) on native bee communities are poorly understood beyond a select group of species. This is especially true of the United States where limited data are available linking potential effects to both seed treatments and land management of agroecosystems. Smaller native bees (e.g., *Megachile* spp., *Osmia* spp.) are invaluable pollinators of both cultivated crops and native plant species, yet, there is limited information on how neonicotinoids influence native bees. In addition, these native species typically have short flight distances (<300 m) which may increase their susceptibility to potential sub-lethal effects from annual pesticide use. Solitary bees may be more sensitive to pesticides than honeybees. Laboratory studies indicate neonicotinoids may interfere with navigation and further alter sensory responses to the visual environment by solitary bees; similarly, fungicides can disrupt nest recognition.

Our goal is to evaluate how currently used seed treatment pesticides may influence nesting efforts and reproductive success of cavity nesting solitary bees. Following a small pilot study in 2017, we placed 54 nest boxes (48 nest holes/box) in field margins ($n = 18$) surrounding neonicotinoid treated and untreated soybean fields in spring 2018. Random samples of nesting material, pollen, and early season larvae will be removed during the course of the study for pesticide residue analysis. Nesting success metrics will include counting the number of sealed nest holes over the course of the study. All cocoons will be harvested in fall, overwintered in the lab, and enumerated after emergence. Development metrics will include size and weight of individuals, surviving number of offspring, and sex ratios.



Dr. Amanda Rosenberger



Amanda Rosenberger sampling an Ozark River.

**DETERMINATION OF GEOMORPHOLOGICAL AND LANDSCAPE FACTORS
CONTRIBUTING TO DIVERSE UNIONID MUSSEL COMMUNITIES IN MISSOURI
RIVER SYSTEMS, WITH PARTICULAR EMPHASIS ON THE MERAMEC RIVER
DRAINAGE**

Investigators

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Dr. Garth Lindner Post doc, MU
Kayla Key, PhD Student, Tenn Tech
Amanda Rosenberger, Tenn Tech
Stephen McMurray, MDC

Project Supervisor

Dr. Amanda Rosenberger, Tenn Tech

Funding

MDC 367

Cooperators

Missouri Department of Conservation
U.S. Fish and Wildlife Service

Objectives

Identify sites in the Meramec Drainage to produce community metrics of mussel assemblages.

Use existing data to identify core areas in the state for mussel diversity with emphasis on the Meramec drainage.

Analyze physical characteristics of mussel beds to identify habitat requirements that support diverse mussel assemblages, with particular emphasis on landscape metrics.

Location

Meramec River, Missouri

Completion

June 2018

Status

Complete

Progress and Results

The Meramec River basin, located in the northeastern Ozark region of Missouri, has one the most diverse mussel faunas in the Midwest. Basin-wide mussel surveys documented declines in species richness and diversity in this system over the past thirty years. However, the mechanisms leading to this decline are poorly understood. A better understanding of the habitat requirements of mussels will provide insight into the causes of mussel decline, which will improve conservation management actions. In this project, we use remotely sensed datasets to identify the basic physical habitat requirements related to channel hydraulics, hydrology, and geomorphology that are needed to support diverse aggregations of mussels. The maximum entropy modeling method (Maxent) was applied to generate a fundamental niche model based on the hydrogeomorphic input variables and known locations of diverse mussel assemblages. This method uses incomplete information (i.e., presence only data) to find the probability of distribution of maximum entropy (i.e., closest to uniform) given the constraints of known locations and environmental variables. The model identifies locations throughout the Meramec Basin that provide the fundamental characteristics allowing establishment of diverse mussel aggregations. Over the next year, the model predictions will be 1) validated in the field, 2) used to identify additional biotic and abiotic limiting factors for mussels, and 3) guide site-selection for a detailed reach-scale study of habitat requirements. The results of this project improve our basic understanding of the habitat needs of freshwater mussels and the mechanisms leading to their decline, and providing key information to guide state-wide mussel conservation efforts.

PHYSIOLOGY, BEHAVIOR, AND TOLERANCES OF MISSOURI FISHES OF CONSERVATION CONCERN WITH A FOCUS ON THE TOPEKA SHINER

Investigators

Rory Mott, M.S. Student, MU
Dr. Amanda Rosenberger, Tenn Tech
Dr. Douglas Novinger, MDC

Project Supervisor

Dr. Amanda Rosenberger, Tenn Tech

Funding

MDC 374

Cooperators

Missouri Department of Conservation
Missouri Department of Natural Resources

Objectives

Establish standardized methods for examining physiological ecologies of small, native Missouri fishes.

Determine physiological endpoints for target species related to a subset of acclimation temperatures.

Conduct experiments that vary concentrations of dissolved oxygen, ammonia, chloride, or other parameters to investigate tolerance levels and interactive and cumulative effects that these factors have with temperature on physiological endpoints.

Location

University of Missouri

Completion

June 2017

Status

Complete

Progress and Results

Water quality influences growth, development, and physiology of aquatic vertebrates. Current criteria on water quality assessments are primarily based on lethal level experiments (e.g. LC50 tests), which are poorly suited for assessing optimal water quality conditions or sub-lethal effects of common stressors. We investigated the effects of dissolved oxygen, temperature (including acclimation), ammonia, nitrite, and chloride on the endangered Topeka Shiner *Notropis topeka* using non-lethal endpoints by: (1) examining behavioral responses to a reduction in oxygen, (2) determining thermal optima at different acclimation temperatures using swimming speed, and (3) determining the onset of sub-lethal levels of nitrogenous compounds and chloride concentrations on swimming speed. We determined ASR50 and ASR90 (i.e. dissolved oxygen concentrations where 50 percent and 90 percent of fish use aquatic surface respiration) to occur at 1.65mg/L and 1.08 mg/L of dissolved oxygen, respectively. At 5.52 mg/L of dissolved oxygen, fish vertical position was higher in the water column, presumably in preparation or aquatic surface respiration (ASR). The optimum swimming temperature range was determined to be 17.7 to 28.0 degrees C, while the predicted mortality to high temperature ranged from 33.7 to 40.3 C. Ammonia and sodium chloride reduced swimming speed at concentrations below LC50 values. Nitrite did not reduce swimming speed, even at concentrations higher than known LC50 measurements.

Selected Products

Mott, R. 2017. Thermal Preferences and Water Quality Tolerances of the endangered Topeka shiner. Master's Thesis, University of Missouri-Columbia.

A WATER QUALITY PROFILE OF THE LITTLE BLACK RIVER SYSTEM TO DETERMINE POTENTIAL CAUSES FOR MUSSEL DECLINE AND TO IDENTIFY POTENTIAL SITES FOR MITIGATION AND REINTRODUCTION

Investigators

Matt Schrum, Research Associate, Tenn Tech

Dr. Amanda Rosenberger, Tenn Tech
Steve McMurray, MDC

Project Supervisor

Dr. Amanda Rosenberger, Tenn Tech

Funding

MDC 385

Cooperators

Missouri Department of Conservation

Objectives

Thermally characterize the Little Black River.

Characterize water quality longitudinally along the river.

Conduct invertebrate sampling strategically along the river length.

Research records on the Little Black River to determine likely sources of spills and any fish kills.

Sample areas with mussels present and determine if recruitment is taking place.

Location:

Little Black River, MO

Completion

September 2018



Status

Complete

Progress and Results

Freshwater mussel abundance and diversity in the Little Black River of southeast Missouri declined precipitously between the late 1980s and early 1990s. Causes remain unknown; however, widespread and severe shell erosion indicates sedimentation as a potential cause. Our goal is to identify likely sources of ongoing water quality impairment to determine if sites in the Little Black River are presently suitable for recovery and restoration efforts and, potentially, determine causes of mussel decline. We characterized water quality of the Little Black River longitudinally, collecting monthly pH, dissolved oxygen, ammonium, and conductivity measurements, and continuous temperature, with attention to known springs, tributary junctions, effluent discharge, and other factors potentially impacting water quality. We conducted strategic invertebrate sampling to determine if non-mussel macroinvertebrates communities indicate chronic poor water quality. We sampled historic and new mussel beds to assess current population trends. Across the watershed, mussel CPUE declined by 78% since 1979. Macroinvertebrate and water quality surveys indicate water quality is fair to good along the affected length of stream; however, eroded banks indicate the need for erosion control and streambank restoration. The results of this study will inform future potential mussel reintroduction and recovery efforts in the Little Black River.

Selected Products

Schrum, M. and A. E. Rosenberger. 2018. An investigation of the cause of mussel population collapse, and a current habitat suitability assessment in the Little Black River system, Carter, Ripley, and Butler Counties, Missouri. Final Report to the Missouri Department of Conservation, Columbia, MO.

A SPATIAL ASSESSMENT OF THE STATUS AND RISKS TO MUSSEL CONCENTRATIONS IN THE MERAMEC DRAINAGE IN MISSOURI

Investigators

Kayla Key, Ph.D. Student, Tenn Tech
Dr. Amanda Rosenberger, Tenn Tech
Steve McMurray, MDC, MDC
Dr. Kristen Bouska, Post doc, MU
Dr. Garth Lindner Post doc, MU

Project Supervisor

Dr. Amanda Rosenberger, Tenn Tech

Funding

MDC 376

Cooperators

Missouri Department of Conservation

Objectives

Investigate the presence and absence of species-rich mussel beds in areas that meet fundamental requirements.

Spatially describe threats to species-rich mussel assemblages on the landscape and identify areas at risk.

Develop a strategic and spatially-explicit monitoring framework for freshwater mussels in the Meramec River Basin that identifies 1) areas at risk of decline and extinction 2) threats to mussel assemblages, and 3) areas most likely to be successful in management opportunities.

Location:

Meramec River Drainage, Missouri

Completion

June 2019

Status

In Progress

Progress and Results

To conserve a taxonomic group, the fundamental requirements that allow it to thrive and factors best suited to predict their current distributions must be identified. Freshwater mussels are one of the most imperiled taxa in the United States. Modeling mussel distributions in the United States has been difficult due to the unique life history and habitat requirements of mussels. Further, limitations on mussel monitoring and modeling have served as obstacles in mussel conservation. Increased focus on mussel ecology and biology has led to the identification of geomorphological and hydrological characteristics of streams as successful predictors in mussel distributions. Given limited resources, a strategic approach to describing mussel requirements and threats will improve effectiveness and lower cost of mussel conservation and monitoring programs. This project will determine the distribution and diversity of mussels within these areas and assess risks to mussel diversity. This work will provide a foundation for developing monitoring protocols to determine status of mussel communities to inform and prioritize restoration actions.

DISTRIBUTION AND HABITAT ASSOCIATIONS OF ENDEMIC CRAYFISHES IN THE MERAMEC RIVER BASIN: THE “VULNERABLE” FRECKLED CRAYFISH AND BELTED CRAYFISH

Investigators

T. Joe Chilton, M.S. student, MU
Dr. Amanda Rosenberger, Tenn Tech
Robert DiStefano, MDC

Project Supervisor

Dr. Amanda Rosenberger, Tenn Tech

Funding

MDC 390

Cooperators

Missouri Department of Conservation

Objectives

Comprehensively estimate the distribution (occupancy rate and probability of detection) of SOCC (the Freckled Crayfish and Belted Crayfish).

Determine habitat use patterns of both species and propose natural or anthropogenic factors that could be contributing to their absence in areas of the drainage.

Location:

Meramec River Drainage, Missouri

Completion

June 2019

Status

In Progress

Progress and Results

Understanding the habitat associations of rare species is important to make informed management and policy decisions. The Freckled Crayfish (*Cambarus maculatus*) and Belted Crayfish (*Faxonius harrisonii*) are two of Missouri’s rare and endemic crayfish species. Both species are listed as vulnerable on Missouri’s list of species and communities of conservation concern due to their limited range. Their native range is limited to the Meramec River drainage in eastern Missouri. We sampled 60 sites throughout the two species’ known range for presence and habitat variables. Replication was performed spatially within sites using kick-seines, drag seines, and visual timed-searches. Local- and landscape-scale habitat variables were evaluated for possible associations with the crayfishes through occupancy modeling with the R package “unmarked”. Occupancy modeling accounts for imperfect detection, which is common when sampling for rare species. This information will guide conservation managers in future projects and policy decisions regarding these two species.



PROJECTS THROUGH THE UNIT

DR. SONJA WILHELM STANIS EVALUATION OF NON-TOXIC AMMUNITION OUTREACH EFFORTS ON MIDWEST REGION NATIONAL WILDLIFE REFUGES

Investigators

John Schulz, Ph.D. student, MU

Dr. Sonja Wilhelm Stanis, MU

Project Supervisor

Dr. Sonja Wilhelm Stanis, MU

Funding

U.S. Fish and Wildlife Service

RWO 131

Cooperators

U.S. Fish and Wildlife Service, Region

3 Migratory Birds

Objectives

Evaluate the effectiveness of information delivery from the FWS implementation team to NWR field staff implementing the outreach program encouraging deer hunters to voluntarily use nonlead ammunition on 54 NWRs during 2016–2018

Evaluate the effectiveness of communication materials developed by the FWS implementation team for FWS field staff

Provide recommendations for future work throughout the country

Location

National Wildlife Refuges in Region 3 of the USFWS

Completion

June 2019

Status

In progress

Progress and Results

In 2014, the U.S. Fish and Wildlife Service's (USFWS) Midwest Region chartered a working group to reduce the risk of lead exposure to bald eagles caused by spent lead (Pb) ammunition from deer hunting on National Wildlife Refuges (NWR). Based on the working group's recommendations and guidance from leadership, the region is implementing strategic communication and outreach strategies to encourage hunters to voluntarily use non-Pb ammunition for firearms deer hunting on NWR lands.

This project focuses on the evaluation of the outreach strategies aimed to change hunters' attitudes, opinions, and behaviors to switch to non-Pb ammunition. A multi-method approach is used combining observations, interviews and surveys. Information regarding the effectiveness of information delivery and materials developed, as well as staffs' attitudes and beliefs, as well as other factors contributing to their ability or decision to use non-Pb ammunition is explored. A better understanding of the influences on behavior and the impact of outreach strategies (e.g., message and communication tool development) will guide subsequent outreach efforts in the Midwest region and possibly across the country.

To date, 12 hunter orientation sessions at four refuges, 21 interviews with staff at stations that conducted outreach, and an online survey of all refuge field station staff in the region (n=168, 52.3% response rate) have been completed. Data analysis is currently underway. 2018 hunting season data (observations, interviews and survey) will be collected October 2018-February 2019.

DR. DON TILLITT

THE EFFECTS OF REDENTICIDES ON THE HEALTH OF HAWAIIAN TRIGGERFISH

Investigators

Rachelle Riegerix, PhD student, MU
Dr. Donald Tillitt

Project Supervisor

Dr. Donald Tillitt

Funding

U.S. Geological Survey
RWO 128

Cooperators

U.S. Fish and Wildlife Service

Objectives

Determine acute toxicity testing conditions for fish exposures to anticoagulant rodenticides.

Location

Hawaii

Completion

December 2018

Status

In progress

Progress and Results

Bird colonies at certain US Fish and Wildlife Service (USFWS) Pacific Island National Wildlife Refuges (PINWR) have suffered severe losses due to rat infestations. USFWS uses anticoagulant rodenticides (ARs) for rat eradication and control programs to protect native species. Evaluations of AR-related risk to non-target species have been conducted by USFWS in PINWR; however, risks of ARs to coral reef fish have not been included in those assessments. Toxicity testing was conducted using an Up and Down Procedure for red-toothed and black triggerfish to determine median lethal dose (LD50). LD50s of AR chemicals were compared to target species and other non-target species in a species sensitivity distribution. Triggerfish were found to be less sensitive than most other vertebrate species. Sublethal effects were evaluated by clotting times of red-toothed triggerfish and freshwater fish. Bioconcentration and excretion of ARs by fish will be used for risk assessment to humans. The pharmacokinetics study has been completed and estimates of half-lives of ARs in fillet and liver are being determined. AR exposures in coral reef fishes before and after a field treatment was also conducted to evaluate environmental exposure.

Products

Riegerix R.C., M. Tanner, R. Gale, and D.E. Tillitt. *Acute toxicity of three anticoagulant rodenticides to various fish species* (in preparation) to be submitted to *Chemosphere*.

PUBLICATIONS BY UNIT SCIENTISTS AND STUDENTS

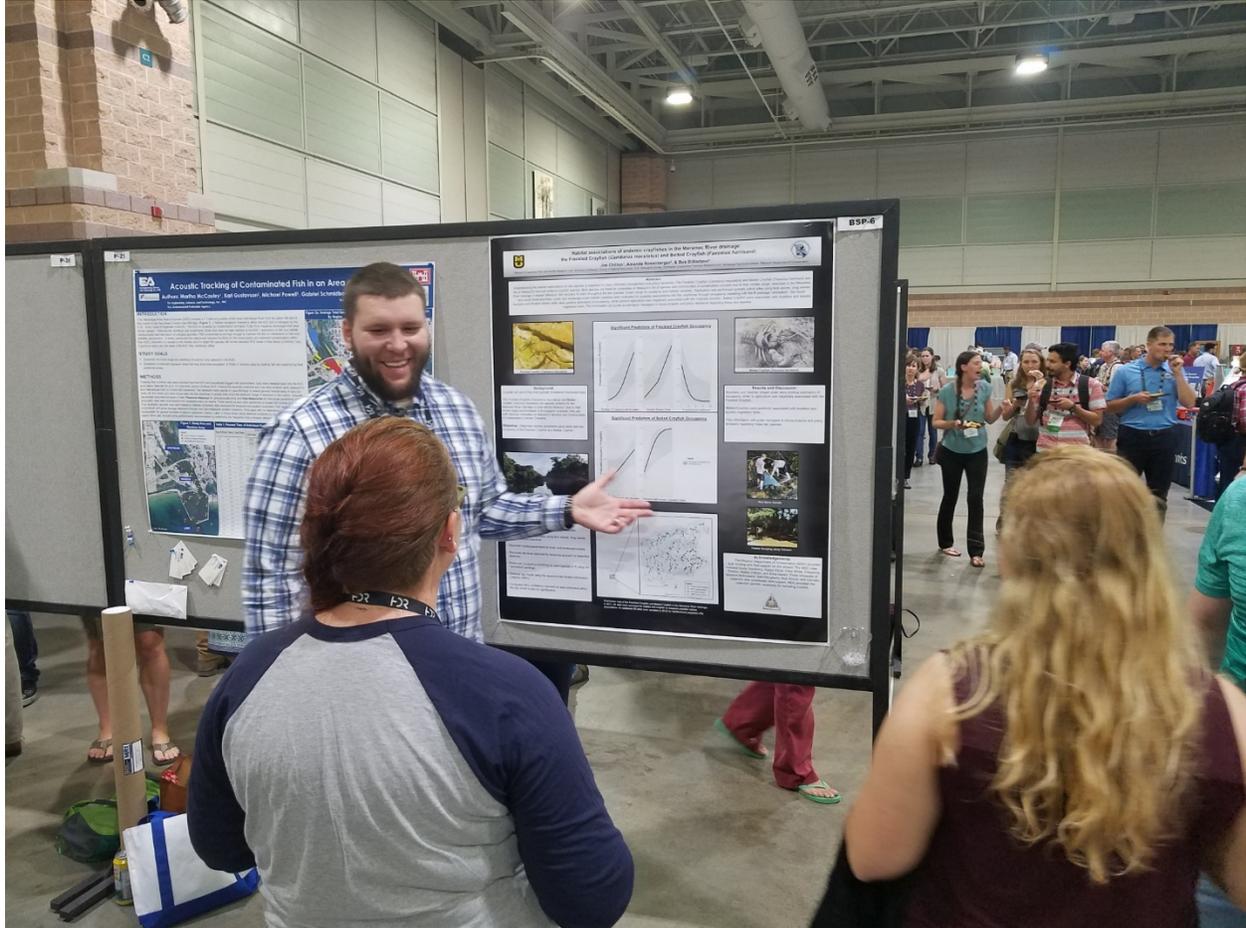
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14. Dunn, C., B. Brooke, R. Hrabik, and C. Paukert. 2018. Intensive sampling reveals underreported use of Great-River tributaries by large-river fishes in Missouri. *Southeastern Naturalist* 17(3):512-520.
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21. Harris, J. M., C. P. Paukert, S. C. Bush, M. J. Allen, and M. J. Siepkner. 2017. Diel habitat selection of largemouth bass following woody structure installation in Table Rock Lake, Missouri. *Fisheries Management and Ecology* doi/10.1111/fme.12266.
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23. Laske, S. M., A. E. Rosenberger, M. S. Wipfli, and C. E. Zimmerman. 2018. Generalist feeding strategies in Arctic freshwater fish: a mechanism for dealing with harsh environments. *Ecology of Freshwater Fish* 27: 767-784. DOI: 10.1111/eff.12391
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31. Moore, M. J., D. J. Orth, E. M. Hallerman. 2017. Densities and population sizes of Clinch Dace *Chrosomus* sp. cf. *saylori* in the Upper Clinch River Basin in Virginia. *Copeia* 105:92-99.
32. Moore, M. J., D. J. Orth, E. M. Hallerman. 2018. Accepted. Systematic conservation planning for an imperiled headwater-specialist fish species. *Proceedings of the Southeastern Fishes Council*.
33. Myers, B.E., A. J. Lynch, D. B. Bunnell, C. Chu, J. A. Falke, R. P. Kovach, T. J. Krabbenhoft, T. J. Kwak, and C.P. Paukert. 2017. Global synthesis of the projected and documented effects of climate change on inland fishes. *Reviews in Fish Biology and Fisheries* 27:339-361.

34. O'Daniels, S.D., D.C. Kesler, J.D. Mihail, E.B. Webb and S.J. Werner. 2018. Light reflectance of decayed wood varies by decay fungi: implications for woodpecker visual cues. *Wilson Journal of Ornithology* 130:200-212.
35. O'Daniels, S.D., D.C. Kesler, J.D. Mihail, E.B. Webb and S.J. Werner. 2017. Functional visual sensitivity to ultraviolet wavelengths in the Pileated Woodpecker (*Dryocopus pileatus*) and its influence on foraging substrate selection. *Physiology & Behavior* 174:144-154.
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37. Paukert, C. P., and J. Spurgeon. 2017. Age structure. Pages 221 to 232 in M. Quist and D. Isermann, editors. *Age and growth of fishes: principles and techniques*. American Fisheries Society, Bethesda, Maryland.
38. Rosenberger, A.E. In Press. Boom Review: Principles of Thermal Ecology: Temperature, Energy, and Life. Written by Andrew Clarke. New York (United States): Oxford University Press 978-0-19-955167-5 (sc). 2017. *The Quarterly Review of Biology*.
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40. Schepker, T.J., E.B. Webb and T.G. LaGrange. 2018. Are waterfowl food resources limited during spring migration? An energetic assessment of playas in Nebraska's Rainwater Basin. *Wetlands*:1-12.
41. Strauch, A. M., R. A. Mackenzie & R. W. Tingley III. 2017. Baseflow driven shifts in tropical stream temperature regimes across a mean annual rainfall gradient. *Hydrological Processes* 31: 1678-1689.
42. Tapp, J.L., M.M. Weegman, E.B. Webb, R.M. Kaminski and J.B. Davis. 2018. Waterbird communities and seed biomass in managed and non-managed restored wetlands in the Mississippi Alluvial Valley. *Restoration Ecology* 26:591-599.
43. Tingley III, R. W., D. M. Infante, R. A. Mackenzie, Y-P. Tsang & A. Cooper. In press. Identifying natural catchment landscape influences on tropical stream organisms: Classifying stream reaches of the Hawaiian Islands. *Hydrobiologia* DOI: 10.1007/s10750-018-3726-5
44. Tingley III, R. W., W. Daniel, D. Infante, K. Herreman & A. Cooper. 2017. National Fish Habitat Partnership (NFHP) 2015 Cumulative Habitat Condition Scores and Disturbance Indices for Hawaii Linked to Catchments of the Hawai'i Fish Habitat Partnership Stream Layer: U.S. Geological Survey <http://dx.doi.org/doi:10.5066/F7PC30HG>
45. Tingley III, R. W. Daniel, D. Infante, K. Herreman & A. Cooper. 2017. National Fish Habitat Partnership (NFHP) 2015 Cumulative Habitat Condition Scores and Disturbance Indices for Hawaii Linked to Catchments of the Hawai'i Fish Habitat Partnership Stream Layer: U.S. Geological Survey <http://dx.doi.org/doi:10.5066/F7PC30HG>.
46. Trentman, M.T., Atkinson, C.L., and Brant, J.D. 2018. Native freshwater mussel effects on nitrogen fluxes in benthic sediments: interactive impacts of nutrient limitation and biomass dependency. *Freshwater Science* 37:276-286.
47. Wagner, T., S. Midway, J. Whittier, J. DeWeber, and C. Paukert. 2017. Annual changes in seasonal river water temperatures in the eastern and western United States. *Water* 9(2):90; [doi:10.3390/w9020090](http://dx.doi.org/doi:10.3390/w9020090).
48. Watts, R.J., B. Wolfenden, J.A. Howitt, K. Jenkins, N. McCasker and R.V. Blakey. 2017. Contribution of Koondrook-Perricoota floodplain runoff to the productivity of the Wakool River. Report prepared for Forestry Corporation of New South Wales, Australia.
49. Whitney, J. E., J. B. Whittier, and C. P. Paukert. 2017. Environmental niche models for native and nonnative fishes in an arid-land riverscape and their similarity according to phylogeny and functionality. *Ecosphere* 27:463-479. [DOI: 10.1002/ecs2.1658](http://dx.doi.org/doi:10.1002/ecs2.1658).

50. Whitney, J. E., J. B. Whittier, C. P. Paukert, J. D. Olden, and A. L. Strecker. 2017. Forecasted range shifts of arid-land fishes in response to climate change. *Reviews in Fish Biology and Fisheries* 27:1-17.



M.S. student Joe Chilton explaining his poster at the 2018 American Fisheries Society Annual Meeting in Atlantic City, N.J.

ORAL AND POSTER PRESENTATIONS

2017-PRESENT

Invited Presentations

1. Baebler, E., and C. Paukert. 2018. Habitat selection of Spotted Bass and Shorthead Redhorse downstream of a hydropeaking dam in central Missouri, USA. American Fisheries Society Annual Meeting, Atlantic City, NJ. August 2018.
2. Blakey, R.V., R.B. Siegel, E.B. Webb, C.P. Dillingham, R.L. Bauer, M. Johnson and D.C. Kesler. 2018. Using new technology to inform forest biodiversity management: case studies with the California Spotted Owl and the Northern Goshawk on Plumas National Forest. Plumas National Forest Integrated Restoration Symposium, Quincy, California, USA. March, 2018.
3. Blakey, R.V., E.B. Webb, D.C. Kesler, R.B. Siegel, D. Corcoran Barrios, and M. Johnson. 2018. Bats in a changing landscape: Sierra Nevada habitat influences on bat occupancy. Plumas National Forest Integrated Restoration Symposium, Quincy, California, USA. March, 2018.
4. Holtswarth, J., K. Key, G. Lindner, and A. Rosenberger. 2018. Assessing the transferability of a freshwater habitat suitability model to Ozark River drainages. Poster presented to the Annual Meeting of the American Fisheries Society, Atlantic City, NJ, August 2018.
5. Key, K., A. Rosenberger, and C. Krause. 2017. A user-friendly tool to identify potential threats to species on a landscape level. Organization of Fisheries and Wildlife Information Managers Conference, Chattanooga, Tennessee. June 2017.
6. Key, K., G. Lindner, A. Rosenberger, and K. Bouska. 2017. A hierarchical approach to mussel conservation: from niche modeling to field monitoring. Freshwater Mollusk Conservation Society Annual Meeting, Cleveland, Ohio. March 2017.
7. Laske, S., A. Rosenberger, M.S. Wipfli, and C. Zimmerman. 2017. Surface water connectivity among Arctic lakes drives patterns of fish species richness and composition, and food web structure. American Water Resources Association Spring Specialty Conference 2017, April 30 – May 3, 2017, Snowbird, UT. May 2017.
8. Lindner, G.A., E.A. Bulliner, K.B. Bouska, C.P. Paukert, and R.B. Jacobson. 2017. Floodplain inundation mapping on the Lower Missouri River to support management needs, Floodplain Science Network Webinar Series, April 2017.
9. Lindner, G., K. Key, and A. Rosenberger. 2017. Using hydrogeomorphic variables for habitat modeling of unionid mussel concentrations in Missouri Ozark rivers. The Freshwater Mollusk Conservation Society Annual Meeting, Cleveland, OH, March 2017.
10. MacPherson, M.P. 2018. Habitat requirements in seasonal environments: Using physiology & mathematical modeling to understand species distributions. Department Seminar, Grinnell College. Grinnell, IA. May 2018.
11. MacPherson, M., E. Webb, A. Raedeke, D. Mengel and F. Nelson. 2018. Waterfowl as umbrella taxa for wetland management decisions: using Bayesian belief networks to evaluate potential for other taxa under the umbrella. Society of Wetland Scientists Annual Conference, Denver, CO. May 2018.
12. Jahn, A., A. Guaraldo, M. MacPherson, and T. Ryder. 2018. Drivers of molt-migration in intra-tropical migratory birds. American Ornithologists' Society Annual Meeting, Tucson, AZ. April 2018.
13. Moore, M. M. 2017. They go with the flow: movements of Lake Sturgeon in the Missouri River tributaries. Missouri River Relief Big Muddy Speaker Series, Rocheport, MO. February 2017.
14. Morris W. Z., C. Paukert, Z. Ford, A. Turner, and J. Dean. 2018. Evaluating Electrofishing Waveforms: A Critical Step in Developing Standardized Sampling Methods for Smallmouth Bass. Midwest Fish and Wildlife Conference, Milwaukee WI. January 2018.

15. Morris W. Z., C. Paukert, A. Turner, Z. Ford, J. Dean. 2017. Evaluating the Effect of Electrofishing Waveforms on Capture-Prone Responses of Smallmouth Bass. Missouri/Arkansas White River Fisheries Partnership Meeting, Mountain Home, AR, 25 October 2017.
16. Morris, Z., C. Paukert, Z. Ford, and A. Turner. 2017. Developing Electrofishing Immobilization Standards for Blue Catfish. Midwest Fish and Wildlife Conference, Lincoln, NE. February 2017.
17. Mott, R. and A.E. Rosenberger. 2017. Effects of sublethal stressors on Topeka Shiner (*Notropis Topeka*) physiology. Annual Meeting of the American Fisheries Society, Tampa, FL. August 2017.
18. Paukert, C. 2017. Climate change: what does this mean for fisheries management? *Keynote Speaker*, European Union Inland Fisheries and Aquaculture Advisory Commission, Stare Joblonki, Poland, September 2017
19. Paukert, C., A. Lynch, B. Meyers, and J. Whitney. 2017. Effects of climate change on inland fish and fisheries: global, North American, and management perspectives (team webinar). Association of Fish and Wildlife Agencies, Climate Change Committee and Fisheries and Water Resources Policy Committee, August 2017.
20. Paukert, C., and M. Moore. 2018. Conserving large river fishes in the United States. Chinese Academy of Sciences, Institute for Hydrobiology, Wuhan, China, scheduled October 2018.
21. Rosenberger, A.A. 2017. Getting into graduate school and what to do once you are there. Invited presentation for the Missouri Careers in Fisheries Workshop. Missouri Natural Resources Conference. Osage Beach, MO. February 2017.
22. Rosenberger, A.E. 2017. Towards a Spatially Explicit and Cost-Effective Statewide Conservation and Monitoring Plan for Freshwater Mussels in Missouri: Our Approach. Departmental Seminar, Tennessee Technological University. Cookeville, TN. March 2017.
23. Rosenberger, A.E. 2017. Landscape Ecology and Conservation of Alaska's Freshwater and Anadromous Fishes. Departmental Seminar, Miami University, Oxford, OH. April 2017.
24. Schrum, M., A. E. Rosenberger, and S. McMurray. 2017. Investigating sources of bias in freshwater mussel sampling methods in the Meramec River Basin, Missouri. Annual Meeting of the Freshwater Mussel Conservation Society. Cleveland, OH, March 2017.
25. Sievert, N., J. Whittier, and C. Paukert. 2017. Establishing Freshwater Conservation Priorities with Consideration of Existing Conservation Networks. American Fisheries Society Annual Meeting, Tampa, FL. August 2017.
26. Stratton, C., N. Sievert, and C. Paukert. 2018. Influences of landscape, instream habitat, and biotic interactions on stream fish communities in the Missouri Plains and Ozarks. American Fisheries Society Annual Meeting, Atlantic City, NJ. August 2018.
27. Tingley III, R., C. Paukert, and P. Jacobson. 2018. Adapting to climate change: Tools for managers of inland glacial lakes. Midwest Fish and Wildlife Conference, Milwaukee, WI. January 2018.
28. Tingley III, R., C. Paukert, G. Hansen, M. Diebel, A. Latzka, G. Sass, and A. Lynch. 2018. Assessing Climate-Driven Changes in Fisheries and Ramifications for Agencies and Anglers: A Case Study of Wisconsin's Inland Lake Walleye Fishery. Midwest Glacial Lakes Partnership Science and Data Committee Meeting, Bloomington, MN, 21 June 2018.
29. Tracy-Smith, E., P. Blanchard, M. Combes, D. Lobb, C. Paukert, J. Persinger, and N. Sievert. 2017. Ecologically Informed Water Management. Organization of Fisheries and Wildlife Information Managers Conference, Chattanooga, Tennessee. June 2017.
30. Webb, E.B. Challenges of using sportspersons to manage wildlife. Nebraska Sportspersons Summit, Nebraska City, NE, August 2018.
31. Webb, E.B. 2018. Impacts of light geese and the light Goose Conservation Order on other species during the non-breeding season. Future of the Light Goose Conservation Order workshop, Lincoln, NE, March 2018.
32. Webb, E.B. and M. Weegman. The NAWMP 'Conservation Concern' Spectrum: from Pintails and Scaup to Light Geese. Waterfowl & Wetlands Colloquium Series: Ducks, Habitat and People. University of Wisconsin-Stevens Point, WI, February 2017.

PRESENTATIONS AT PROFESSIONAL SOCIETIES, WORKSHOPS, AND CONFERENCES

1. Baebler, E, and C. Paukert. 2017. Movement of Spotted Bass and Shorthead Redhorse in the highly regulated Lower Osage River, Missouri. Midwest Fish and Wildlife Conference, Lincoln, NE. February 2017.
2. Baebler, E., and C. Paukert. 2017. Movement of Spotted Bass and Shorthead Redhorse across Season and Streamflow in the Regulated Lower Osage River, Missouri. American Fisheries Society Annual Meeting, Tampa, FL. August 2017.
3. Brant, J. E. Baebler, D. Lobb, and C. Paukert. 2017. Stream Connectivity Effects on Island Backchannel Habitat Conditions Under Regulated Flows in the Lower Osage River. Midwest Fish and Wildlife Conference, Lincoln, NE. February 2017.
4. Brant, J., C. Paukert, and D. Lobb. Hornyhead Chub Nest Site Selection in the East Fork Black River. Missouri Natural Resources C2018. Conference, Osage Beach, MO. February 2018.
5. Brant, J., C. Paukert, D. Lobb. 2018. Habitat Limitations in Spawning Site Selection for Hornyhead Chubs. American Fisheries Society Annual Meeting, Atlantic City, NJ. August 2018.
6. Brant, J., D. Lobb, and C. Paukert. 2018. Hornyhead Chub Spawning Site Selection. Wildlife and Fisheries Student Graduate Organization Seminar. Columbia, MO, May 2018.
7. Brooke, B., R. Kramer, C. Dunn, and C. Paukert. 2017. Seasonal dynamics of Blue Suckers *Cycleptus elongatus* inhabiting great-river tributaries in Missouri. Midwest Fish and Wildlife Conference, Lincoln, NE. February 2017.
8. Brooke, B., R. Kramer, C.G. Dunn, and C.P. Paukert. 2017. Seasonal population characteristics of Blue Sucker *Cycleptus elongatus* within large Missouri and Mississippi river tributaries. Missouri Natural Resources Conference. Lincoln, NE. February 2017.
9. Bulliner, E.A., G.A. Lindner, K.L. Bouska, C.P. Paukert, and R.B. Jacobson. 2017. Interactive Mapping of Inundation Metrics Using Cloud Computing for Improved Floodplain Conservation and Management, AGU Fall Meeting, New Orleans, LA, December, 2017.
10. Chen, Y., and 18 coauthors. 2018. Moving the Mississippi-Yangtze Fisheries Network Forward: Past, Current, and Future. American Fisheries Society Annual Meeting, Atlantic City, NJ. August 2018.
11. Chilton, J. and A.E. Rosenberger. 2018. Habitat associations of endemic crayfishes in the Meramec River drainage: the Freckled Crayfish (*Cambarus maculatus*) and Belted Crayfish (*Faxonius harrisonii*). Missouri Natural Resources Conference, Osage Beach, MO. February 2018.
12. Chilton, J. and A.E. Rosenberger. 2017. The Detectability of Two Rare Crayfish Species in the Meramec River Drainage: the “Vulnerable” Freckled Crayfish and Belted Crayfish. Poster Presentation for the Annual Meeting of the American Fisheries Society, Tampa, FL. August 2017.
13. Chilton, J., Rosenberger, A.E., and DiStefano, R.J. 2018. Habitat associations of endemic crayfishes in the Meramec River drainage: the Freckled Crayfish (*Cambarus maculatus*) and Belted Crayfish (*Faxonius harrisonii*). International Association of Astacology, Pittsburgh, PA. July 2018.
14. Davis, J.B., R.M. Kaminski, F.J. Vilella, P.J. Barbour, and E. Webb. 2017. Evaluations of NRCS’s Migratory Bird Habitat Initiative (MBHI). Gulf of Mexico Oil Spill and Ecosystem Science Conference. New Orleans, Louisiana. February 2017.
15. Dearborn, J., E. Webb. S. Amelon and S. Marquardt. 2017. Roost site habitat selection by maternity colonies of federally endangered *Myotis sodalis* in bottomland hardwood forests. 77th Midwest Fish & Wildlife Conference, Lincoln, Nebraska. February 2017.
16. Dearborn, J., S. Amelon, S. Marquardt and E. Webb. Habitat Characteristics Influencing Summer Occupancy of Myotis Species in Bottomland Hardwood Ecosystems. 77th Midwest Fish & Wildlife Conference, Lincoln, Nebraska. February 2017.
17. Dickson, J., S. Kambhampati, L. Williams, A. Rosenberger, and N. Ford. 2017. Using an occupancy approach to understand the distribution of three unionid species along the Upper Sabine River in East Texas. Texas Conservation Symposium, Southwestern University, Georgetown, TX, January 2017.

18. Dunn, C., and C. Paukert. 2018. Test-driving a newly developed fish sampling protocol to identify biodiversity hotspots in two Missouri mid-sized rivers. Missouri Natural Resources Conference, Osage Beach, MO. February 2018.
19. Dunn, C., and C. Paukert. 2017. Predicting potential refugia: spatially explicit determinants of great-river fish richness within two unimpounded tributaries of the Missouri and Mississippi rivers. American Fisheries Society Annual Meeting, Tampa, FL. August 2017.
20. Dunn, C., and C. Paukert. 2017. In pursuit of a silver bullet: does standardized sampling need to accommodate seasonal and regional influences on fish richness across large rivers of Missouri? Midwest Fish and Wildlife Conference, Lincoln, NE. February 2017.
21. Dunn, C., and C. Paukert. 2017. In pursuit of a silver bullet: does standardized sampling need to accommodate seasonal and regional influences on fish richness across large rivers of Missouri? University of Missouri Life Science Research Symposium, Columbia MO. April 2017.
22. Dunn, C., and C. Paukert. 2017. Influences of downriver connectivity and site conditions on richness patterns of great-river fishes within free-flowing tributary networks. Society of Freshwater Science, Raleigh, NC. June 2017.
23. Dunn, C.G., and C.P. Paukert. 2017. Temporal considerations when designing a standardized fish survey for large rivers: do richness and method efficiency vary seasonally? School of Natural Resources Research Day Symposium. Columbia, MO. May 2017.
24. Dunn, C.G., and C.P. Paukert. 2018. A flexible multi-gear survey design for documenting fish richness in large rivers. American Fisheries Society Annual Meeting, Atlantic City, NJ. August 2018.
25. Dunn, C.G., and C.P. Paukert. 2018. Predicting Riverine Refugia: Both Space and Habitat Influence the Distributions of Big-River Fishes within Large Tributaries. School of Natural Resources Research Day Symposium. Columbia, MO. May 2018.
26. Dunn, C.G., and C.P. Paukert. 2018. A flexible multi-gear survey design for documenting fish richness in large rivers. 2018. Annual Meeting of the American Fisheries Society, Atlantic City, NJ, August 2018.
27. Fowler, D.N., J.L. Dooley, M.D. Weegman, R.F. Rockwell, M.P. Vrtiska, and E.B. Webb. 2018. Evaluating heterogeneous adult survival among subpopulations in midcontinent lesser snow geese. 14th North American Arctic Goose Conference. Lincoln, NE.
28. Fowler, D.N., M.P. Vrtiska, and E.B. Webb. 2018. Selective harvest: evaluating differences in body condition of lesser snow and Ross's Geese during spring migration by harvest technique during the Light Goose Conservation Order. 14th North American Arctic Goose Conference. Lincoln, NE. March 2018.
29. Fowler, D.N., S.L. King, D.C Weindorf, and J. Vradenburg. 2018 Evaluation abiotic influences on soil salinity of inland managed wetlands and agricultural croplands in a semi-arid environment. Society of Wetland Scientists Annual Conference, Denver, CO. May 2018.
30. Fowler, D.N., M.P. Vrtiska, and E.B. Webb. 2017. Selective harvest: evaluating differences in body condition of lesser snow and Ross's Geese by harvest technique during the Light Goose Conservation Order. 77th Midwest Fish & Wildlife Conference, Lincoln, NE. February 2017.
31. Fowler, D.N., M.P. Vrtiska, K.A. Hobson and E.B. Webb. 2017. Do nutrient acquisition strategies among spring migrants differ depending on breeding area destination? A test using lesser snow geese. Annual Meeting of The Wildlife Society, Albuquerque, NM. October 2017.
32. Guyton, J. E. Webb, C. Paukert, and F. Nelson. 2017. What Lies beneath? Identifying the most effective method to sample fish and amphibian communities in Missouri wetlands. Midwest Fish and Wildlife Conference, Lincoln, NE. February 2017.
33. Guyton, J. E. Webb, C. Paukert, and F. Nelson. 2018. Influence of wetland design and hydrologic connectivity on fish and amphibian species richness in managed floodplain wetlands. Society of Wetland Scientists Annual Conference, San Juan, Puerto Rico. June 2018.
34. Guyton, J., E. Webb, C. Paukert, and F. Nelson. 2017. Integrating less visible taxa into wetland management: methods for surveying fish and amphibians. Society of Wetland Scientists Annual Conference, San Juan, Puerto Rico. June 2017.

35. Guyton, J., E. Webb, C. Paukert, and F. Nelson. 2017. What lies beneath? Identifying the most effective method to sample fish and amphibian communities in Missouri wetlands. 77th Midwest Fish & Wildlife Conference, Lincoln, NE. February 2017.
36. Guyton, J., E. Webb, C. Paukert, and F. Nelson. 2017. What lies beneath? Identifying the most effective method to sample fish and amphibian communities in Missouri wetlands. Missouri Natural Resources Conference, Osage Beach, MO. February 2017.
37. Jacobson, R.B., E.A. Bulliner, G.A. Lindner, C.P. Paukert, and K.L. Bouska. 2017. Managing Floodplain Expectations on the Lower Missouri River, USA, AGU Fall Meeting, New Orleans, LA, December, 2017.
38. Key, K., A. Rosenberger, G. Lindner, and K. Bouska. 2017. Using maxent to generate a fundamental niche model for diverse mussel assemblages within the northeastern Ozark region of Missouri. Poster Presentation, School of Natural Resources Research Day, May 2017.
39. Key, K., G. Lindner, K. Bouska, and A. Rosenberger. 2017. Generation of a fundamental niche model for diverse mussel assemblages within the northeastern Ozark region of Missouri. Missouri Natural Resources Conference, Osage Beach, MO, February 2017.
40. Key, K.N., A.E. Rosenberger, G.A. Lindner, and K.L. Bouska, 2017. Hierarchical approach to mussel conservation: from niche modeling to field monitoring. Oral presentation, American Fisheries Society Annual Meeting, Tampa, FL, August, 2017.
41. Kuechle, K, E. B. Webb, D. Mengel and A. Main. 2017. Do neonicotinoid insecticides cause trophic cascades between aquatic and terrestrial systems? A test using emerging aquatic invertebrates and tree swallows as model organisms. Society of Environmental Toxicology and Chemistry (SETAC) Annual Meeting, Minneapolis MN, November 2017.
42. Kuechle, K, E. B. Webb, D. Mengel and A. Main. 2017. Impacts of neonicotinoid seed-treatments on aquatic invertebrates in Missouri wetland ecosystems. Society of Environmental Toxicology and Chemistry (SETAC) Annual Meeting, Minneapolis MN, November 2017.
43. Kuechle, K, E. B. Webb, D. Mengel and A. Main. 2017. Neonicotinoid concentrations in Missouri wetland sediments: the relationship to watershed and wetland land practices. Ozark Prairie Society of Environmental Toxicologists and Chemists Annual Meeting, Columbia MO, May 2017.
44. Kuechle, K, E. B. Webb, D. Mengel and A. Main. 2017. Wetland sediment contamination by neonicotinoid insecticides: a study of Missouri land practices. Society of Environmental Toxicology and Chemistry (SETAC) Annual Meeting, Minneapolis Minnesota, November 2017.
45. Kuechle, K, E. B. Webb, D. Mengel and A. Main. 2018. Aquatic invertebrate response to neonicotinoid insecticide contamination of Missouri wetlands. Missouri Natural Resources Conference, Osage Beach, MO. February 2018.
46. Kuechle, K, E.B. Webb, D. Mengel and A. Main. 2018. Landscape drivers of wetland sediment neonicotinoid concentrations in Missouri public wetlands. Missouri Natural Resources Conference, Osage Beach, MO. February 2018.
47. Kuechle, K, E.B. Webb, D. Mengel and A. Main. 2018. Response of wetland food webs to neonicotinoid insecticide contamination. 78th Midwest Fish and Wildlife Conference, Milwaukee, WI. February 2018.
48. Kuechle, K, E.B. Webb, D. Mengel and A. Main. 2017. Spatial and temporal heterogeneity of neonicotinoid concentrations in Missouri public wetlands. Missouri Natural Resources Conference, Osage Beach, MO. February 2017.
49. Kuechle, K, A.R. Main, E.B. Webb and D. Mengel. 2017. Response of benthic invertebrates to experimental manipulation of neonicotinoid insecticides in Missouri wetlands. Ecological Society of America, Portland, OR. August 2017.
50. Kuechle, K., E.B. Webb, D. Mengel and A. Main. 2017. Patterns of neonicotinoid concentrations in Missouri public wetlands: implications for wetland-dependent organisms. Society of Wetland Scientists Annual Meeting, San Juan, PR. June 2017.
51. Kuechle, K., E.B. Webb, D. Mengel and A. Main. 2017. Quantifying neonicotinoid concentrations in Missouri public wetlands: the relationship to agricultural land use. 77th Midwest Fish & Wildlife Conference, Lincoln, NE. February 2017.

52. LaRose, J., D. Finke and E. Webb. 2017. Evaluating differences in invertebrate communities between remnant and restored prairies in Missouri. 77th Midwest Fish & Wildlife Conference, Lincoln, NE. February 2017.
53. LaRose, J., D. Finke and E. Webb. 2017. Are prairie reconstructions working for invertebrates? Grasshopper and bee communities in remnant vs, restored prairies. Ecological Society of America Annual Conference, Portland, OR. August 2017.
54. LaRose, J., D. Finke and E. Webb. 2018. Comparing bee and grasshopper communities in reconstructed prairies to remnant prairies in Missouri. Missouri Natural Resources Conference, Osage Beach, MO. February 2018.
55. LaRose, J., D. Finke and E. Webb. 2018. Comparing bee and grasshopper communities in Missouri's reconstructed and remnant prairies. 78th Midwest Fish and Wildlife Conference, Milwaukee, WI. February 2018.
56. Laske, S, A Rosenberger, M Wipfli, C Zimmerman. 2017. Generalist feeding strategies of Arctic fishes stabilize lentic food webs. AK Chapter AFS-AWRA, Fairbanks, AK. May 2017.
57. Lindner, G., E. Bulliner, K. Bouska, C. Paukert, and R. Jacobson. 2017. Floodplain inundation mapping under nonstationary hydro-climatic conditions on the lower Missouri River to support multi-objective management of conservation lands. Midwest Fish and Wildlife Conference, Lincoln, NE. February 2017.
58. Lindner, G., E. Bulliner, K. Bouska, C. Paukert, and R. Jacobson. 2017. Floodplain inundation mapping on the lower Missouri River to support current and future management decisions. Missouri River Natural Resources Conference, Nebraska City, NE. March 2017.
59. Lindner, G.A., K.B. Bouska, E.A. Bulliner, C.P. Paukert, and R.B. Jacobson. 2017. Floodplain inundation mapping on the Missouri River to address management needs, University of Missouri School of Natural Resources Research Day, Columbia, MO, May 2017.
60. MacPherson, M., E. Webb, A. Raedeke, D. Mengel and F. Nelson. 2018. Waterfowl as umbrella taxa for wetland management decisions: using Bayesian belief networks to evaluate potential for other taxa under the umbrella. Society of Wetland Scientists Annual Conference, Denver, CO. May 2018.
61. MacPherson, M., E. Webb, A. Raedeke, D. Mengel and F. Nelson. 2018. Are wetland birds umbrella taxa for freshwater wetlands? Bayesian belief network support tool for conservation. International Ornithological Congress, Vancouver, British Columbia, Canada. August 2018.
62. Main, A.R., E.B. Webb, K. Kuechle, and D. Mengel. 2017. Response of benthic invertebrates to experimental manipulation of neonicotinoid insecticides in Missouri wetlands. Society of Wetland Scientists Annual Meeting, San Juan, PR. June 2017.
63. Main, A.R., E.B. Webb, K.W. Goyne and D. Mengel. 2017. Impacts of neonicotinoid seed-treatment use on native pollinator abundance and diversity in Missouri agroecosystems. 38th Annual Meeting SETAC North America, Minneapolis, MN. November 2017.
64. Main, A.R., E.B. Webb, K.W. Goyne and D. Mengel. 2018. Impacts of neonicotinoid seed-treatment use on native pollinator abundance and diversity in Missouri agroecosystems". 78th Midwest Fish and Wildlife Conference, Milwaukee, WI. February 2018.
65. Main, A.R., E.B. Webb, K.W. Goyne and D. Mengel. 2017. Effects of neonicotinoid seed-treatment use on non-target native pollinator communities in Missouri agricultural fields and field margins. Ecological Society of America Annual Conference, Portland, OR. August 2017.
66. Main, A.R., E.B. Webb, K.W. Goyne, and D. Mengel. 2018. Impacts of neonicotinoid seed-treatment use on native pollinator abundance and diversity in Missouri agroecosystems. Missouri Natural Resources Conference, Osage Beach, MO. February 2018.
67. Moore M. and C. Paukert. 2018. Beat the heat: summer tributary use and movement of Lake Sturgeon in the Missouri River Basin. Missouri Natural Resources Conference, Osage Beach, MO. February 2018.
68. Moore, M, and C. Paukert. 2018. Summer Tributary Use and Movement of Lake Sturgeon on its Southern Range Margin. Midwest Fish and Wildlife Conference, Milwaukee, WI. January 2018.

69. Moore, M, and C. Paukert. Big fish outside of the big river: Lake Sturgeon habitat selection in two Missouri River tributaries. University of Missouri School of Natural Resources Research Day, Columbia, MO. May 2018.
70. Moore, M. J., C. P. Paukert. 2018. Seasonal Habitat Selection of Lake Sturgeon in Missouri River Tributaries. Poster Presentation. American Fisheries Society Annual Meeting, Atlantic City, NJ, August 2018.
71. Moore, M. M. 2017. Story time: embracing the plot twists in fisheries science. American Fisheries Society Annual Meeting, Tampa, FL. August 2017.
72. Morris, Z., C. Paukert, A. Turner, Z. Ford, and J. Dean. 2017. Evaluating the Relative Efficiency of Pulsed DC Electrofishing Waveforms to Collect Smallmouth Bass. American Fisheries Society Annual Meeting, Tampa, FL. August 2017.
73. Morris, Z., C. Paukert, Z. Ford, A. Turner, and J. Dean. 2018. Evaluating Electrofishing Waveforms: A Critical Step in Developing Standardized Sampling Methods for Smallmouth Bass. Missouri Natural Resources Conference, Osage Beach MO. February 2018.
74. Morris, Z., C. Paukert, Z. Ford, and A. Turner. 2017. Identifying Effective Electrofishing Settings for Immobilization and Capture of Blue Catfish. Missouri Natural Resources Conference, Osage Beach, MO. February 2017.
75. Mott, R. and A. Rosenberger. 2017. Water quality requirements and preferences of the Topeka Shiner (*Notropis Topeka*). School of Natural Resources Research Day. May 2017.
76. Mott, R. and A. Rosenberger. 2017. Water quality requirements and preferences of the Topeka Shiner (*Notropis Topeka*). Missouri Natural Resources Conference, Osage Beach, MO, February 2017.
77. Owen, R.K., K.W. Goyne and E.B Webb. 2017. How will changes in future precipitation affect playa plants and soils in the Rainwater Basin. 22nd Rainwater Basin Joint Venture Informational Seminar, Grand Island, NE. February 2017.
78. Owen, R.K., K.W. Goyne and E.B Webb. 2017. How will playa plant communities respond to a changing climate? Inferences from a greenhouse experiment. 77th Midwest Fish & Wildlife Conference, Lincoln, NE. February 2017.
79. Owen, R.K., K.W. Goyne and E.B. Webb. Predicting playa vulnerability to future climate conditions through a greenhouse experiment. Society of Wetland Scientists Annual Meeting, San Juan, PR. June 2017.
80. Owen, R.K., C. Li, EB Webb and KW Goyne. 2018. Playa Ecosystem Vulnerability in Future Climates: Stakeholder Perceptions in the Great Plains. Society & Natural Resources Conference, Salt Lake City, UT. June 2018.
81. Roberts, A., J. Hundley, A. Rosenberger, K.L. Bouska, D. Mosby, B. Simmons, and G. Lindner. 2017. Quantitative Survey of Freshwater Mussels (Unionoidea) and Assessment of Sediment Contamination in the Big River, Missouri. Society of Environmental Toxicology and Chemistry Annual Meeting, November 2017.
82. Rosenberger, A.E., S. McMurray, K. Bouska, G. Lindner, K. Key, M. Schrum, and L. Lueckenhoff. 2018. Towards a Statewide, Strategic, and Spatially-Explicit Mussel Conservation Assessment and Monitoring Program – our vision. Tennessee Chapter of the American Fisheries Society Annual Meeting, Knoxville, TN. January 2018.
83. Schepker, T.S., T. LaGrange and E. Webb. 2017. Is Food Availability a Limited Resource for Waterfowl During Spring Migration? An Energetic Assessment of Playas in Nebraska’s Rainwater Basin. 77th Midwest Fish and Wildlife Conference, Lincoln, NE. February 2017.
84. Schrum, M., A.E. Rosenberger, and S. McMurray. 2018. Identification of the cause of mussel population collapse, and current water quality and habitat suitability assessment in the Little Black River system, Carter, Ripley, and Butler Counties, MO. Missouri Natural Resources Conference, Osage Beach, MO. February 2018.

85. Sievert, N., and C. Paukert. 2018. Characterizing Stream Habitat Availability Using Level Loggers and Time Lapse Photography. Missouri Natural Resources Conference, Osage Beach, MO. February 2018.
86. Sievert, N., J. Whittier, and C. Paukert. 2018. Parameterization of Spatial Conservation Prioritization: Impacts on Stream Conservation Priorities. Midwest Fish and Wildlife Conference, Milwaukee, WI. January 2018.
87. Stratton, C., N. Sievert, and C. Paukert. 2018. Stream size influences relationships between fish abundance and watershed landscape, instream habitat, and biotic interactions in the Missouri Plains and Ozarks. Missouri Natural Resources Conference, Osage Beach, MO. February 2018.
88. Tingley III, R., C. Paukert, G. Hansen, G. Sass, and A. Lynch. 2018. Quantifying the costs of climate adaptation to recreational anglers and agencies: A case study of Wisconsin's inland lake walleye fishery. Midwest Fish and Wildlife Conference, Milwaukee, WI. January 2018.
89. Tingley, R., C. Paukert, G. Hansen, M. Diebel, A. Latzka, G. Sass, and A. Lynch. 2018. Assessing climate-driven changes in fisheries and ramifications for agencies and fishers: A case study of Wisconsin's inland lake walleye fishery. American Fisheries Society Annual Meeting, Atlantic City, NJ. August 2018.
90. Webb, E.B. 2018. Challenges of using sportspersons to manage wildlife. Nebraska Sportspersons Summit, Nebraska City, NE. July 2018.
91. Whitehead, B., J. Whittier, D. Lobb, J. Westhoff, and C. Paukert. 2017. Bayesian Hierarchical Modeling of Ozark Mountain Cold Water Stream Temperatures. Missouri Natural Resources Conference, Osage Beach, MO. February 2017.
92. Whitehead, B., J. Whittier, D. Lobb, J. Westhoff, and C. Paukert. 2017. Bayesian Hierarchical Modeling of Ozark Mountain Cold Water Stream Temperatures. Midwest Fish and Wildlife Conference, Lincoln, NE. February 2017.
93. Whittier, J., J. Westhoff, D. Lobb, and C. Paukert. 2017. Role of discharge in moderating temperature in Missouri streams Missouri Natural Resource Conference. Osage Beach, MO. February 2017.



Members of the Webb lab at the opening mixer for the Society of Wetland Scientists 2017 conference in San Juan, Puerto Rico (note the attention to federal safety training through the use of PFDs).

THESES AND DISSERTATIONS

2017-PRESENT

- Dearborn, J. 2017. Roost site selection by Indiana bats (*Myotis sodalis*) and comparison of foraging habitat selection by morphologically similar bat species in bottomland hardwood ecosystems. M.S. Thesis, University of Missouri-Columbia. E. B. Webb and S. Amelon, advisors.
- Guyton, J. 2017. Evaluating sampling methods and investigating distribution and richness of fish and amphibians in Missouri wetlands. M.S. Thesis, University of Missouri-Columbia. E. B. Webb and C. P. Paukert, advisors.
- LaRose, J. 2018. Grasshopper and bee communities on Missouri prairies: comparing reconstructions and remnants. Master's Thesis, University of Missouri-Columbia. D. Finke and E. B. Webb, advisors.
- Mott, R. 2017. Thermal Preferences and Water Quality Tolerances of the endangered Topeka shiner. Master's Thesis, University of Missouri-Columbia. A. R. Rosenberger, advisor.
- Schepker, T.J. 2017. Evaluating the relationship between local food availability and wetland landscape structure in determining dabbling duck habitat use during spring migration. M.S. thesis, University of Missouri-Columbia. E. B. Webb, advisor.
- Schrum, M. 2017. Development of standardized and validated visual sampling methods for assessing population metrics and recruitment of rare and threatened mussel species in Missouri. M.S. Thesis, University of Missouri, Columbia, MO. A. R. Rosenberger, advisor.

COMMITTEES AND OTHER PROFESSIONAL SERVICE

2017 TO PRESENT

Craig Paukert

- Steering Committee, Mississippi River-Yangtze River Symposium, Chongqing, China, 2018.
- AFS Committee to review possible World Fisheries Congress bid for the 2024 meeting, 2018-present
- Invited by the U.S. Fish and Wildlife Service to review the Species Status Assessment for the federally endangered Humpback Chub and Topeka Shiner, 2017
- Invited by the National Park Service to review the Heartland Inventory and Monitoring program fisheries sampling protocols, 2017
- IUCN Red List Status Report Update Lead for Paddlefish, 2016-present
- Past President, Education Section of the AFS, 2015-2017
- Invited Member, Science Committee, National Fish Habitat Initiative, 2005-present
- Guest Editor, Reviews in Fish Biology and Fisheries, 2016-2017
- Michigan St Univ and USGS Science To Action Fellowship, 2014-present
- Wildlife and Fisheries Graduate Student Organization Faculty Representative, University of Missouri, 2017-present
- Invited by the National Science Foundation to be part of an eight member workgroup to develop sampling protocols for NSF National Ecological Observatory Network (NEON) for long term monitoring of lakes and stream in this network, 2013-2017

Amanda Rosenberger

- Freshwater Mussel Conservation Society, Development Team Core Leader, Professional Development Ad-hoc Committee, 2016 - present
- American Fisheries Society, Co-Chair, Education Section Best Student Presentation Award Committee, 2016 – present
- American Fisheries Society, Awards Committee Chair, Missouri Chapter, 2016-present

Lisa Webb

- Organized and led MO Wildlife Society Professional Development Workshop on Neonicotinoids, August 2018
- USGS Representative to the Mississippi Flyway Technical Council, 2018-present
- Organized and moderated special session on ‘Neonicotinoid Insecticides – Potential Impacts on Non-target Organisms and Ecosystems’ at North American Society of Environmental Toxicology and Chemistry, November 2018
- Helped plan and facilitate MDC Wetland Review, September 2017
- Directors Faculty Advisory Council, MU School of Natural Resources, 2017-present
- Organized and moderated symposium on ‘Playa Wetland Ecology’ at Midwest Fish and Wildlife Conference, February 2017
- Diversity Committee, MU School of Natural Resources, 2017-present
- Associate Editor for The Wildlife Society Bulletin, 2011-2017

Elisa Baebler, M.S. Student Advised by Paukert

- Treasurer, Wildlife and Fisheries Science Graduate Student Organization, 2016-2017
- Communication Committee, North Central Division of American Fisheries Society, 2017
- Copy Editor: Dillard, G., A. Rosenberger & E. Tracy-Smith. In press. Still Hooked: Our First 50 years, Missouri Chapter of the American Fisheries Society, U.S.A., 2018

Hadley Boehm, Ph.D. student Advised by Paukert

- Committee member, Webinar Committee, Education Section of the American Fisheries Society, 2018p-present

John Brant, M.S. Student Advised by Paukert

- President, Wildlife and Fisheries Science Graduate Student Organization, 2017-2018
- Copy Editor: Dillard, G., A. Rosenberger & E. Tracy-Smith. In press. Still Hooked: Our First 50 years, Missouri Chapter of the American Fisheries Society, U.S.A., 2018

Corey Dunn, Ph.D. Student Advised by Paukert

- Invited by the U.S. Fish and Wildlife Service to review the Species Status Assessment for the Candy Darter, 2017.
- Serve on Rivers, Streams, and Fisheries Advisory Committee for the Conservation Federation of Missouri, 2017–2018.
Copy Editor: Dillard, G., A. Rosenberger & E. Tracy-Smith. In press. Still Hooked: Our First 50 years, Missouri Chapter of the American Fisheries Society, U.S.A., 2018

Drew Fowler, Ph.D. Student Advised by Webb

- Worked collaboratively to develop a symposium on ‘Arid Wetlands: Conservation Challenges and Research Needs’ for the Society of Wetland Scientists Conference in Denver, Colorado, May 2018
- Vice-Chair, Wetlands Working Group of The Wildlife Society, October 2017 - present.
- Co-taught a four-day Wetland and Waterbird Management Workshop for local managers and biologists in Biacheng, China, 2017
- Graduate advisor to MU Chapter of Ducks Unlimited, 2017

Julia Guyton, M.S. Student Advised by Webb and Paukert

- President, Mizzou Student Association for Fire Ecology/Tiger Fire Crew, 2016-2017

Maggie MacPherson, Post-Doctoral Researcher Advised by Webb

- Associate Editor of IBIS journal January 2018-present
- Reviewer for: Avian Conservation & Ecology, and Journal of Experimental Biology
- Facilitator of SNR’s weekly writing workshop

Michael Moore, Ph.D. Student Advised by Paukert

- American Fisheries Society Excellent in Fisheries Education Committee, 2018-present
- Member, North American Sturgeon and Paddlefish Society Student Subunit, 2016 - present
- IUCN Red List Assessment Working Group for Sturgeon and Paddlefish, 2016 – present
- President, North American Sturgeon and Paddlefish Society Student Subunit, 2017 - present
- Instructor Beginning and Intermediate GIS Workshops, AFS Annual Meeting, 2017 and 2018
- Copy Editor: Dillard, G., A. Rosenberger & E. Tracy-Smith. In press. Still Hooked: Our First 50 years, Missouri Chapter of the American Fisheries Society, U.S.A., 2018
- Mentor, American Fisheries Society Hutton Junior Fisheries Biologist Internship with Ashley Hrdina, 2018.

Rachel Owen, Ph.D. Student Advised by Webb and Goyne

- South Central Regional Director of Legislative Affairs, National Association of Graduate and Professional Students, 2018-2019
- Appointed Member and Graduate Representative, Soil Science Society of America Science Policy and Communication Committees, 2018-2019

- Graduate Student Representative, Soil Science Society of America Board of Directors, 2017-2019
- Director of National Affairs, MU Graduate Professional Council, 2017-2018
- Chair, Soil Science Society of America Graduate Student Committee, 2017
- Appointed Member, Soil Science Society of America Undergraduate Research Symposium Committee, 2016-2018

William (Zach) Morris, M.S. Student Advised by Paukert

- Board of Directors, Conservation Federation of Missouri, 2016-present
- President, Wildlife and Fisheries Science Graduate Student Organization, 2017 – 2018
- Vice Chair, Rivers, Streams, and Fisheries Committee, Conservation Federation of Missouri, 2017-2018
- Legislative Committee, Conservation Federation of Missouri, 2017 – present
- Chair, committee to discuss and take action on the Waters of the U.S. Rule, Conservation Federation of Missouri, 2017
- Board of Directors, Land Learning Foundation, 2018 – present
- Executive Committee, Mid-MO Uplanders chapter Quail Forever, 2016 – present
- Habitat Committee Chair, Mid-MO Uplanders chapter Quail Forever, 2017 – present
- Social Media Chair, Mid-MO Uplanders chapter Quail Forever, 2017 – present
- Legislative and Environmental Concerns Committee, Missouri Chapter of the American Fisheries Society, 2017 – present

Nick Sievert, Ph.D. Student Advised by Paukert

- Secretary/Treasurer, Fisheries Information and Technology Section of the American Fisheries Society, 2015 – 2017
- Vice Chair, Rivers, Streams, and Fisheries Advisory Committee for the Conservation Federation of Missouri, 2017–2018
- Newsletter Co-Editor, Missouri Chapter of the American Fisheries Society, 2016 – present
- Copy Editor: Dillard, G., A. Rosenberger & E. Tracy-Smith. In press. Still Hooked: Our First 50 years, Missouri Chapter of the American Fisheries Society, U.S.A. 2018

Cheyenne Stratton, B.S. Student advised by Sievert and Paukert

- President: Fisheries and Aquatic Science Society (FASS), Missouri Chapter American Fisheries Society Student Sub-Unit, 2017 – Present
- Fundraising Chair: Fisheries and Aquatic Science Society (FASS), Missouri Chapter American Fisheries Society Student Sub-Unit, 2016-2017

Ralph Tingley, Post-Doctoral Researcher Advised by Paukert

- Copy Editor: Dillard, G., A. Rosenberger & E. Tracy-Smith. In press. Still Hooked: Our First 50 years, Missouri Chapter of the American Fisheries Society, U.S.A., 2018

Emily Tracy-Smith, Sr. Research Specialist Advised by Paukert

- Newsletter Co-Editor, Missouri Chapter of the American Fisheries Society, 2015 – present
- Chair, Legislative and Environmental Concerns Committee, Missouri Chapter of the American Fisheries Society, 2016-present
- Chair, Rivers, Streams, and Fisheries Committee, Conservation Federation of Missouri, 2016-present
- Member of the Conference Planning Committee, Organization of Fish and Wildlife Information Managers, 2016-2017
- Member of the School of Natural Resources Director’s Staff Advisory Team, 2017-2018

- Serve on History Committee for the Missouri Chapter of the American Fisheries Society, Dillard, G., A. Rosenberger & E. Tracy-Smith. In press. Still Hooked: Our First 50 years, Missouri Chapter of the American Fisheries Society, U.S.A. – 2018
- Member, Presentation Committee for the Big Muddy Speaker Series, Missouri River Relief, 2018
- Invited to serve as an observer for the USFWS/USGS Structured Decision Making Workshop, Austin Carey Forest Campus in Gainesville, FL, 2018



Dr. Anson Main, explaining bee nesting ecology as part of a MO Wildlife Society professional development workshop on neonicotinoid insecticides.

AWARDS AND RECOGNITION

2017 TO PRESENT



Craig Paukert with PhD student Corey Dunn (Skinner Memorial Award Honorable Mention), M. S. student Elisa Baebler (Best Student Poster Honorable Mention) and B. S. student Cheyenne Stratton (Skinner Memorial Award) show off their awards at the American Fisheries Society Annual Meeting in Atlantic City, N.J. in August 2018.

Craig Paukert

- Gold Chalk Award for Outstanding Teaching and Mentoring, University of Missouri (only 4 faculty throughout the university are awarded this each year), 2018
- Quality Step Increase (raise based on sustained high performance), 2018
- USGS STAR Award, 2005-2017 for outstanding performance

Amanda Rosenberger

- Outstanding Faculty Award awarded by Fish and Wildlife Graduate Student Organization, School of Natural Resources, University of Missouri, 2017

Lisa Webb

- USGS STAR Award for outstanding performance, 2017

Elisa Baebler

- Honorable Mention Best Student Poster, American Fisheries Society Annual Meeting, 2018
- Travel Award, Equal Opportunities Section of American Fisheries Society, 2018
- Charles P. Bell Graduate Scholarship, Conservation Federation of Missouri Charitable Trust, 2018
- Student Achievement Award, Missouri Chapter of the American Fisheries Society, 2018
- Janice Lee Fenske Memorial Award Winner, 2017
- Best Student Poster finalist, American Fisheries Society Annual Meeting, 2017

Corey Dunn, Ph.D. Student Advised by Paukert

- American Fisheries Society Skinner Memorial Award Honorable Mention, 2018
- Trans World Airlines Scholarship, only 5 non law school awards given each year in the University of Missouri system, 2018
- Best Poster Award Winner, School of Natural Resources Research Day, 2018
- Winemiller Award for Excellence in Data Analytics, The University of Missouri, 2018
- Best Student Poster Honorable Mention, American Fisheries Society Annual Meeting, 2017
- Outstanding Poster for Life Sciences Week: Innovative Science, University of Missouri, 2017
- Best Poster Award Winner, School of Natural Resources Research Day, 2017
- Charles P. Bell Graduate Scholarship, Conservation Federation of Missouri Charitable Trust, 2017
- Janice Lee Fenske Memorial Award finalist, 2017
- Jimmie Pigg and Melissa Coughlin Memorial Outstanding Student Achievement Award, Southern Division of the American Fisheries Society, 2017
- Douglas D. Randall Young Scientists Travel Award, University of Missouri, 2017
- Joan Duffy Travel Grant Winner, Missouri Chapter of the AFS, 2017

Drew Fowler, Ph.D. Student Advised by Webb

- D.L. Hallett Fellowship, School of Natural Resources, MU, 2018
- 2nd place, Poster Competition, North American Arctic Goose Symposium, 2018
- North American Arctic Goose Conference Travel Grant, 2018
- The Wetland Working Group of The Wildlife Society Travel Award, 2017
- Graduate Research Fellowship, Ducks Unlimited Canada/Institute for Wetland and Waterfowl Research, 2017

Julia Guyton, M.S. Student Advised by Webb and Paukert

- The Wildlife Society, Wetlands Working Group Student Award, 2017
- Best Student Aquatics Presentation, Missouri Natural Resources Conference, 2017

Jordan Holtswarth, Undergraduate Student Advised by Webb

- Most Innovative Poster, MU Life Sciences Research Week, 2017

Kayla Key, Ph.D. Student Advised by Rosenberger

- Outstanding Graduate Student awarded by Fisheries and Wildlife Graduate Student Organization, School of Natural Resources, University of Missouri, 2017
- Best student presentation, Freshwater Mollusk Conservation Society Biennial Symposium, Cleveland, OH, March, 2017

Kyle Kuechle, M.S. Student Advised by Webb

- Ducks Unlimited Canada Echo Travel Award, 2018
- Carl Morrow Scholarship in Wildlife, Conservation Federation of Missouri, 2018
- Best Aquatic Research Presentation, Missouri Natural Resources Conference, 2018
- Audubon Society of Missouri Graduate Research Scholarship, 2017
- Best Presentation, Ozark-Prairie SETAC meeting, 2017
- Edward and Sally Futch Graduate Fellowship, Ducks Unlimited Canada/Institute for Wetland and Waterfowl Research
-

Joe LaRose, M.S. Student Advised by Finke and Webb

- Carl Morrow Award from Conservation Federation of Missouri, 2017
- Transworld Airlines Scholarship, University of Missouri, 2017

Maggie MacPherson, Post-doctoral Researcher Advised by Webb

- Important mentor to graduate Women+ in Science and Engineering (WiSE), contributing to academic and personal development of Women+ in STEM.

Michael Moore, Ph.D. Student Advised by Paukert

- Student Writing Award, Annual Meeting of the American Fisheries Society, 2018
- Best Poster Award Winner, School of Natural Resources Research Day, 2018
- Janice Lee Fenske Memorial Award finalist, 2018
- Joan Duffy Travel Grant Winner, Missouri Chapter of the AFS, 2018
- American Fisheries Society Skinner Memorial Award, 2017
- Trans World Airlines Scholarship, only 5 non law school awards given each year in the University of Missouri system, 2017

William (Zach) Morris, M.S. Student Advised by Paukert

- Outstanding Graduate Student awarded by Fisheries and Wildlife Graduate Student Organization, School of Natural Resources, University of Missouri, 2018
- American Fisheries Society Skinner Memorial Award Honorable Mention, 2017

Rachel Owen, Ph.D. Student Advised by Webb

- School of Natural Resources Outstanding Graduate Student Award, 2017
- Carl Morrow Award from Conservation Federation of Missouri, 2017
- USGS National Climate Change and Wildlife Science Center Science to Action Fellowship, 2017
- Mizzou Advantage Travel Award, 2017
- Transworld Airlines Scholarship, University of Missouri, 2017
- Janice Lee Fenske Memorial Award finalist, 2017

Nick Sievert, Ph.D. Student Advised by Paukert

- Finalist, Best Student Poster, American Fisheries Society Annual Meeting, 2018

Cheyenne Stratton, Undergraduate Student Advised by Paukert and Sievert

- American Fisheries Society Skinner Memorial Award, 2018
- Finalist, Best Student Poster, American Fisheries Society Annual Meeting, 2018
- Undergraduate Travel Assistance Award, Student SubUnit of the Education Section of the American Fisheries Society, 2018
- Joe G. Dillard Outstanding Undergraduate Scholarship, Missouri Chapter of the American Fisheries Society, 2018
- Invited to represent the School of Natural Resources and presented a poster at the University of Missouri Chancellor's address, 2018
- Kahrs-Miller Aquaculture for the Future Endowment Fund Scholarship 2017, University of Missouri School of Natural Resources
- W.H. Allen Memorial Scholarship Fund 2017, University of Missouri School of Natural Resources
- Tom & Alice Payne Scholarship 2017, University of Missouri College of Agriculture, Food and Natural Resources
- Joe G. Dillard Outstanding Undergraduate Scholarship, Missouri Chapter of the American Fisheries Society, 2017

Emily Tracy-Smith, Sr. Research Specialist Advised by Paukert

- Travel Award, Organization of Fish and Wildlife Information Managers Annual Meeting in Chattanooga, TN, 2017.



Craig Paukert receiving the Gold Chalk Award for Outstanding Teaching and Mentoring, University of Missouri. Craig was nominated for the award by his graduate students (represented by Michael Moore, far right) with a letter of support from the School of Natural Resources Director, Shibu Jose (left) which made the recognition even more meaningful.

SCIENCE IN THE NEWS AND OUTREACH

BELOW IS A SUMMARY OF OUTREACH EVENTS AND COOPERATIVE RESEARCH UNIT SCIENCE
THAT MADE THE NEWS

2017 TO PRESENT



Graduate student Drew Fowler explaining differences in wetland soils to participants of the Wetland and Waterbird Management Workshop for local managers and biologists in Biacheng, China, 2017.

Craig Paukert

- Briefed Capitol Hill Congressional staffers on the effects of extreme events on fisheries, 2018
- Accomplishments were highlighted in the [University of Missouri College and Agriculture, Food and Natural Resources website for receiving the Gold Chalk Award](#), which is given to only 4 faculty per year throughout the University for outstanding accomplishments for teaching and mentoring
- Research on how climate change affects fish and fisheries has been highlighted in [The Wildlife Management Institute's Outdoor News Bulletin](#), 2017
- [Research on the food availability and growth potential for Asian carp in Lake Michigan](#) was highlighted on the USGS webpage, 2017
- Part of a collaboration that resulted in a publication [highlighted by the USGS National Climate Change and Wildlife Science Center](#), 2017

Lisa Webb

- Meta-analysis on how neonicotinoid insecticides negatively affect performance of non-target terrestrial arthropods (published in Ecological Applications) [featured in 6 news outlets](#)
- Article on [Secretive Marsh Bird Research](#) published in Missouri Conservationist, November 2017
- Research on [pollinator response to insecticides](#) article featured on CAFNR website
- Research on [Linking Wetland Management Decision to Secretive Marsh Bird Habitat Use During Spring Migration](#) and [Effects of Wetland Management Decisions on Least Bittern Nest Selection and Breeding Success](#) published as MDC Science Notes (Volume 12, Nos. 4 & 5)
- Life history needed of Missouri's wetland birds, presented to Osher Continuing Education class, 2017
- Migratory birds and their habitats, presented at CAFNR Chestnut Roast, 2017

Elisa Baebler, M.S. Student Advised by Paukert

- Wildlife and fisheries outreach booth at Conservation Day at the Capitol, Conservation Federation of Missouri, 2018
- Guest lecturer on stream ecology at Simonsen Ninth Grade Center, Jefferson City, MO, 2017
- Volunteer boat operator, Missouri River Clean-up, Missouri River Relief, 2017
- Volunteer presenter for elementary students for Missouri River All-Stars event, Missouri River Relief, 2017
- Instructor and coordinator, Crash Course: Applied GIS for Fish & Wildlife, University of Missouri, 2017
- Wildlife and fisheries outreach booth at South Farm Showcase, University of Missouri, 2017

John Brant, M.S. Student Advised by Paukert

- Sport Fishing and Aquatic Conservation Event, Missouri 4-H, Columbia, MO, 2018
- Crash Course: Introduction to R Programming teaching assistant, 2018
- Wildlife and Fisheries Graduate Student Organization Booth, Conservation Day at the Capitol, Conservation Federation of Missouri, Jefferson City, MO, 2018
- Wildlife and Fisheries Youth Outreach Booth, South Farm Showcase, Columbia, MO, 2017

Corey Dunn, Ph.D. Student Advised by Paukert

- Volunteer educator for aquatic reading celebration at elementary school, 2018
- Led and organized four biomonitoring events as leader of the Fisheries and Aquatic Sciences Society stream team, 2017 – 2018
- Volunteer river guide for elementary school students with Missouri River Relief, 2017
- Guest presentation at annual convention of the North American Native Fishes Association, 2017

Michael Moore, Ph.D. Student Advised by Paukert

- Organized a three part series of academic enrichment activities titled “What do we know about the world around us?” for the Grade A+ program, a local non-profit that provides after school tutoring for low-income and minority students. Hands-on activities included tours of mammal specimen museum at the University of Missouri, aquatic animal sampling and identification, and lab on purifying water, 2018
- Operated a boat for Missouri River Relief Osage River Cleanup and gave demonstration on how we track our tagged Lake Sturgeon to volunteers, 2018
- Co-led interactive activity on sonar in fish research and Missouri’s ocean-going fish at Blue Ridge Elementary School’s ocean themed writing celebration in Columbia, MO, 2018
- Helped develop an educational video on Sturgeon and Paddlefish Migration with the North American Sturgeon and Paddlefish Society Student Subunit for World Fish Migration Day, 2018
- Presented on Lake Sturgeon Telemetry to 30 8th grade students at Columbia Independent School in Columbia, MO, 2018
- Presented “Where does a Sturgeon Swim” to 100 6th grade students at Lange Middle School in Columbia, MO, 2017

Rachel Owen, Ph.D. Student advised by Webb and Goyne

- Conservation Day at the Capitol, Conservation Federation of Missouri, 2017
- Presented to Fulton, MO community members during Science on Wheels event, 2017
- Presented at field days across Great Plains (Nebraska, Kansas, Texas, Colorado, New Mexico) to landowners and managers about playa wetlands and climate change as part of NCASC Science-to-Action Fellowship, 2017-2018
 - <http://northplainsgcd.org/news/respondents-needed-great-plains-wetlands-agricultural-perceptions-survey/>
 - <https://casc.usgs.gov/content/climate-change-playas>
- Coached the Mizzou Soil Judging team at a regional and national contest, also exposed students to career development opportunities
 - <https://cafnr.missouri.edu/2018/05/top-honors/>
- Presented on soil evaluation techniques to high school environmental science students at Columbia Independent School in Columbia, MO, 2018
- Virtually talked to three 6th grade science courses in Greensboro, NC about day-to-day life of a scientist and why I became a soil scientist through the program Skype with a Scientist, 2018
- Presented information on wetlands and climate change in MU Extension booth at Missouri State Fair as part of Science on Wheels programming, 2018
- Documenting field tour and workshop in China to develop videos, blogs, and articles about international science and socio-ecological issues near the Gobi Desert while traveling with MU Interdisciplinary Plant Group, 2018

Nick Sievert, Ph.D. Student Advised by Paukert

- Going with the flow: Missouri stream fish and altered flow regimes, Science on Wheels, Montgomery City, MO, 2018
- SNR Research Day. Fisheries Science at Mizzou. University of Missouri, Columbia, MO, 2017
- Fish Biology, Conservation, and Management, Missouri River All-Stars, Missouri River Relief, Huntsdale, MO, 2017
- Wildlife and Fisheries Graduate Student Organization Booth, Conservation Day at the Capitol, Conservation Federation of Missouri, Jefferson City, MO, 2017

- Instructor, Crash Course: Introduction to R Programming, Wildlife and Fisheries Graduate Student Organization, University of Missouri, 2018

Emily Tracy-Smith, Sr. Research Specialist Advised by Paukert

- Volunteer, Missouri River Days Education Program for 4th grade students, Missouri River Relief, 2017-2018
- Research evaluating fish community changes to stream flow alterations was highlighted in the Organization of Fish and Wildlife Information Managers March Newsletter, and the US EPA Fish and Shellfish Program July Newsletter, 2018



PhD student Rachel Owen at the U.S. Geological Survey Headquarters in Reston, Virginia as part of her Science to Action Fellowship.



USGS scientists at a Capitol Hill briefing on the effects of extreme events on fishes. L-R: Abby Lynch, Bo Bunnell, Clint Muhlfeld, Doug Beard, Craig Paukert, and Bonnie Myers.