

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

**January 2019 to December 2020**



## **Cooperating Agencies:**

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

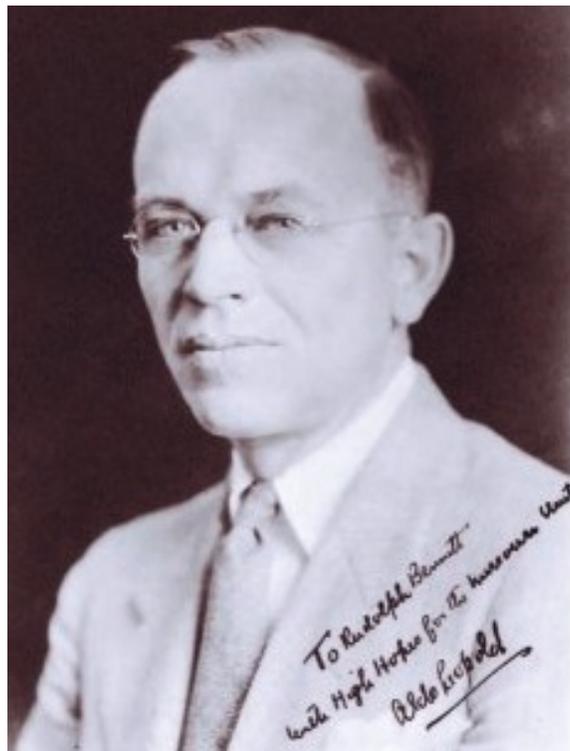
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# MISSOURI COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

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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 Rudolf Bennitt (acting leader of the Missouri Unit, 1947-1948): "With high hopes for the Missouri Unit."

Front cover: M.S. student Brett Leach and LA Department of Wildlife and Fisheries Biologist Paul Link releasing marked blue-winged teal near Krotz Spring, LA.

## THE TRADITION OF THE MISSOURI UNIT

Conservation and management of natural resources have changed since the Missouri Unit was established in 1937. I am not sure what past Unit Leaders and scientists like Rudy Bennett, Tom Baskett, or Dick Anderson would say if I mentioned the Unit is solving management-related questions related to neonicotinoids, or using technology like drones, environmental DNA, and data-logging telemetry transmitters, and that our primary mode of communication is Zoom. The year 2020 brought whole new challenges both professionally and personally for the students and staff of the Missouri Unit. Since March 2020 most of the students and staff have been working from home or have limited laboratory time on campus. However, just like everyone else we are making it work.

This report highlights the research, teaching, service, outreach, and awards by the Missouri Cooperative Fish and Wildlife Research Unit from 2019-2020. What is not shown is the sacrifices our student and staff made to continue their projects, be productive and provide outreach and service in the era of social distancing. This report is a testament to their commitment, adaptability and accomplishments. You would not know that a global pandemic hit in the middle of this reporting period. I am proud that we have collectively tackled these tough times with relatively limited interruptions to projects and well-being of our students.

There also has been some bright spots. Thanks to the University of Missouri's commitment to fill a tenure-track fisheries faculty position, and favorable federal budgets, the Missouri Unit will be filling our Assistant-Leader-Fisheries in 2021. As with all Unit positions, the expertise of Unit scientists is based on cooperator needs. Therefore, the cooperators agreed that our Assistant Leader position will focus on how environmental stressors affect crayfish and mussels. As I write this our search is underway and we are hopeful to have someone in place in summer 2021. We are excited to have the new Unit scientist with a discipline that complements existing Unit scientists as well as agency biologists and University faculty and staff.

We are proud of the relationships we have with our cooperators and truly appreciate the commitment they provide to the Missouri Unit. These commitments go well beyond financial. Our university and agency collaborators serve on our student's committees, work hand in hand with our students, and generally make our student feel welcome. I hope you are able to appreciate the perseverance of our student and staff in difficult times. I know Lisa and I do.



The Missouri Unit Covid Christmas, 2020. As many students and staff did not travel to be with families (including Lisa and Craig), we hosted a Covid Christmas for all of those around over the holiday.

## ACCOMPLISHMENTS OF THE MISSOURI UNIT

We are very proud of our students and staff accomplishments highlighted in the report. During the 2019-2020 reporting period, the Missouri Unit:

- Advise 9 current graduate students and 2 research staff
- Graduated 11 students and 8 post docs or research staff have moved on to other jobs
- Coordinated 31 active research projects with 16 of those completed
- Had \$6.7 million in research during the reporting period
- Produced a total of 43 peer reviewed publications
- Taught 29 graduate students and 38 undergraduate students
- Helped over 20 undergraduates gain experience through research technician positions
- Gave 52 presentations including 16 invited or seminars to university departments or agencies, or conference keynote addresses
- Received a total of 36 awards, including 29 to our graduate students and post docs
- Provided at least 45 service activities to the university, agencies, professional societies, and other organizations
- Provided at least 21 public outreach events or news releases about our science



A male Eucerini bee (longhorned bees) on a yellow flower

## 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. 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](mailto:PaukertC@missouri.edu)

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

Vacant, Assistant Leader-Fisheries

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

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### Unit Coordinating Committee

<p>Pat Market, Director          School of Natural Resources          103 Anheuser-Busch Natural Resources Building          University of Missouri          Columbia, MO 65211          (573) 882-0240  <a href="mailto:joses@missouri.edu">joses@missouri.edu</a></p>	
<p>Mike Hubbard, Deputy Director          Missouri Department of Conservation          P O Box 180          Jefferson City, MO 65102-0180          (573) 751-4115 Ext 3217  <a href="mailto:Mike.Hubbard@mdc.mo.gov">Mike.Hubbard@mdc.mo.gov</a></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  <a href="mailto:barry_grand@usgs.gov">barry_grand@usgs.gov</a></p>
<p>Bill Moritz, Midwest Representative          Wildlife Management Institute          1608 Packwood Road          Fairfield Iowa 52556          (989) 413-3115  <a href="mailto:bmoritz@wildlifemgt.org">bmoritz@wildlifemgt.org</a></p>	<p>Craig Czarniecki, 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  <a href="mailto:craig_czarniecki@fws.gov">craig_czarniecki@fws.gov</a></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
Tom Bonnot	School of Natural Resources	Lori Eggert	Biological Sciences
Mike Byrne	School of Natural Resources	Deborah Finke	Plant Sciences
Matt Gompper	School of Natural Resources	Erin Schliep	Statistics
Keith Goyne	School of Natural Resources	Yi Shang	Computer Science
Ben Knapp	School of Natural Resources	Lauren Sullivan	Biological Sciences
Charlie Nilon	School of Natural Resources	Mike Urban	Geography
Robin Rotman	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	RRM	Nate Muenks	SWRM
Leah Berkman	Science	Norman Murray	SWRM
Paul Blanchard	Science	Frank Nelson	Science
Matt Combes	Science	Darby Niswonger	RRM
Ange Corson	Science	Doug Novinger	Science
Bob DiStefano	Science	Jason Persinger	Science
Nicole Farless	Science	Andy Raedeke	Science
Zach Ford	Science	Eric Rahm	Science
Sherry Gao	Science	Nathan Recktenwald	RRM
Dave Herzog	Science	Darren Thornhill	Science
Bob Hrabik	SWRM	Vince Travnichek	Science
Brett Landwer	Science	Sara Tripp	Science
Brian McKaegel	RRM	Andy Turner	Science
Stephen McMurray	Science	Ivan Vining	Science
Doreen Mengel	Science	Jacob Westhoff	Science
Travis Moore	RRM	Kyle Winders	Science

RRM=Regional Resource Management

SWRM=Statewide Resource Management

## **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 Bell	Big Muddy National Wildlife Refuge
Tom Cooper	Region 3 Migratory Birds
Andy Forbes	Region 3 Migratory Birds
Jason Goeckler	Columbia Fish and Wildlife Conservation Office
Heath Hagy	National Wildlife Refuge System
Vona Kuczynska	Missouri Ecological Services Field Office
Lindsay Landowski	Loess Bluffs National Wildlife Refuge
Shauna Marquardt	Region 3 Ecological Services Office
Anne Mini	Lower Mississippi Alluvial Valley Joint Venture
Dave Moseby	Missouri Ecological Services Field Office
Emily Pherigo	Columbia Fish and Wildlife Conservation Office
Landon Pierce	South Dakota Fish and Wildlife Conservation Office
Darrin Welchert	Loess Bluffs National Wildlife Refuge
Jason Wilson	Great River and Clarence Cannon National Wildlife Refuges

## **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
Thea Edwards	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
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
Jeff Steevens	Columbia Environmental Research Center
Ralph Tingley	Great Lakes Science 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

## Other Federal/State/Provincial Agencies

<u>Name</u>	<u>Organization</u>
Frank Baldwin	Province of Manitoba
Derek Brasher	NRCS - Tennessee
Yushun Chen	Chinese Academy of Sciences
Cindy Chu	Ontario Ministry of Natural Resources
Reid Cripps	NRCS - Kentucky
Matthew Diebel	Wisconsin Department of Natural Resources
Hope Dodd	National Park Service, Heartland I. and M. Network
John Hansen	Minnesota Department of Natural Resources
Pete Jacobson	Minnesota Department of Natural Resources
Ted LaGrange	Nebraska Game and Parks Commission
Alex Latzka	Wisconsin Department of Natural Resources
Paul Link	Louisiana Department of Wildlife and Fisheries
Joe Nohner	Michigan Department of Natural Resources
Charlie Rewa	NRCS – Resource, Inventory and Assessment
Greg Sass	Wisconsin Department of Natural Resources
Jason Schooley	Oklahoma Department of Wildlife Conservation
Mark Vrtiska	Nebraska Game and Parks Commission

## Other Universities

<u>Name</u>	<u>University</u>
Steve Cooke	Carleton University
Ian Cowx	University of Hull (England)
John Eadie	University of California - Davis
Michael Flinn	Murray State University
Gretchen Hansen	University of Minnesota
Keith Hobson	Western University
Dana Infante	Michigan State University
Trevor Krabbenhoff	University of Buffalo
Steve Midway	Louisiana State University
Justin Murdoch	Tennessee Tech University
Tom Neeson	University of Oklahoma
Julian Olden	University of Washington
Kevin Ringelman	Louisiana State University

### Other Cooperative Research Units (CRU)

<u>Name</u>	<u>Cooperative Research Unit</u>
Jeff Falke	Alaska CRU/University of Alaska-Fairbanks
David Fulton	Minnesota CRU/University of Minnesota
Chris Guy	Montana CRU/Montana State University
Dave Haukos	Kansas CRU/Kansas State University
Dan Isermann	University of Wisconsin-Stevens Point/USGS
Tom Kwak	North Carolina State University/USGS
Jim Long	Oklahoma State University/USGS
Jim Peterson	Oregon CRU/Oregon State University
Kevin Pope	Nebraska CRU/University of Nebraska
Mark Rogers	Tennessee CRU/Tennessee Tech University

### Non-Government Organizations

<u>Name</u>	<u>Organization</u>
Dana Baxley	The Nature Conservancy
Michael Brasher	Ducks Unlimited
Michael Cooperman	PlusFish
Jeff Fore	The Nature Conservancy
Steve Herrington	The Nature Conservancy
Dale James	Ducks Unlimited
Dylan Kesler	Institute of Bird Populations
Shelley Morris	The Nature Conservancy
Rodney Siegel	Institute for Bird Populations



Reid Viegut, Yang Zang, and Zhicheng "Robert" Tang at Grand Pass Conservation Area preparing for a sUAS count of waterfowl with a flock of snow geese in the background

## 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 2019 to Fall 2020.

Course	Credits	Instructor	Semester	Undergrad. Enroll.	Grad. Enroll.
FW 4880/7800: Waterfowl Ecology and Management	3	L. Webb	Spring 2020	13	2
FW 8001: Perspectives for Emerging Professionals	1	C. Paukert	Spring 2020	0	9
FW 4300/7300: Fisheries Management	3	M. Moore (co taught)	Fall 2020	25	0
FW 8460: Wetland Ecology	3	L. Webb	Fall 2019	0	8
FW 8001: Perspectives for Emerging Professionals	1	C. Paukert	Spring 2019	0	10
				38	29
<b>Total</b>					



The Spring 2020 Perspectives for Emerging Professionals course panelists from the National Park Service, Ducks Unlimited, US Forest Service, US Geological Survey, and US Fish and Wildlife Service.

Research projects under the direction of Unit Scientists provide valuable opportunities for undergraduate exposure to the fisheries and wildlife field to gain field and laboratory skills. In 2019-2020, the Unit has supported over 20 MU undergraduate technicians on multiple projects.

Unit Scientists also facilitate student learning and professional development opportunities through means other than formal teaching. Other student engagement activities included:

- Delivering student workshops on resume and CV writing, plus interview skills and on the job conduct
- Readings and lab meetings focused on science communication
- Readings and lab meetings focused on proposal development
- Organized discussion with a panel of state and federal agency staff focused
- 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 activities



Ashly Hrinda, American Fisheries Society Hutton Jr Fisheries Biology student, and Michael Moore. The Hutton Program is an internship to expose high school students to fisheries profession.



Emily Tracy-Smith showing kids radio telemetry.

## CURRENT GRADUATE STUDENTS

**2019-2020**

*\*Student received degree during the reporting period.*

<sup>1</sup> *Student received degree in December 2018, after reporting period for 2017-2018 report.*

<b>Name</b>	<b>Research Project</b>	<b>Previous Education</b>	<b>Advisor</b>
Robert Abney, M.S.	Effects of neonicotinoid insecticides on nesting effort and success of Missouri bees	B. S. University of Missouri	Dr. Webb
* <sup>1</sup> 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 WI 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
*Corey Dunn, Ph.D.	Development of sampling protocols for mid-sized rivers	B.S. Virginia Tech M.S. Virginia Tech	Dr. Paukert
* <sup>1</sup> 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
David Hicks, M.S.	Assessing vegetative and invertebrate communities on restored bottomland hardwood wetlands	B.S. Univ. of Missouri	Dr. Webb
* <sup>1</sup> Kyle Kuechle, M.S.	Neonicotinoid concentrations in Missouri wetlands and potential effects on the avian community	B.S. Bemidji State University	Dr. Webb
Brett Leach, M.S.	Identifying migration phenology, routes and habitat use of blue-winged teal	B.S. Univ of WI Stevens Point	Dr. Webb
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

*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
John Podoliak, Ph.D.	Evaluating the role of Wetland Reserve Program easements in providing for multiple ecosystem functions	B.S. Clarkson Univ M.S., SUNY- Brockport	Dr. Webb
Gaby Ruso, Ph.D.	Evaluating impacts of agricultural contaminant drift on alpine lake ecosystems of the Sierra Nevadas	B.S. Humboldt State University M.S. Univ of Saskatchewan	Drs. Webb and Paukert
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
Reid Viegut, M.S.	Assessing feasibility of using unmanned aircraft systems (UAS) and deep learning computing techniques for waterfowl and wetland habitat monitoring	B.S. Steven F. Austin State University	Dr. Webb

## CURRENT POST-DOCTORAL RESEARCH ASSOCIATES AND RESEARCH STAFF

**2019-2020**

*\*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. 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. Ph.D. 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. Kristen Malone	Meta-analysis and synthesis of secretive marsh bird habitat requirements across the full annual cycle	B.S. Univ. Missouri M.S. Central Michigan Univ. Ph.D. Univ. of Florida	Dr. Webb
*Dr. Jane Rogosch	Prioritizing streams reaches throughout Missouri for aquatic conservation	B.S. Univ. of New Mexico M.S. Kansas State Univ. Ph.D. Univ. of Washington	Dr. Paukert
*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
Hunter Styka	Evaluation of low-density stocking of Striped Bass in Bull Shoals Reservoir	B.S. Univ of WI-Stevens Point	Dr. Paukert

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



Newly minted PhD students Dr. Landon Pierce and Dr. Rachel Owen with their advisors Craig Paukert and Lisa Webb at Mizzou graduation, 2019.

**GRADUATE STUDENTS**

Name	MU Education	Current Employment	Advisor
Elisa Baebler	M.S. 2018	Aquatic Biologist, Missouri Department of Natural Resources	Dr. Paukert
Meagan Bradburn	M.S. 2009	Biologist, Pennsylvania Department of Environmental Protection	Dr. Rabeni
John Brant	M.S. 2020	Aquatic Biologist, Ft Leonard Wood Military Base	Dr. Paukert
Shannon Brewer	Ph.D. 2008	Leader, USGS Alabama Cooperative Fish and Wildlife Research Unit	Dr. Rabeni
Justin Buckler	M.S. 2011	Environmental Scientist, Missouri Department of Natural Resources	Dr. Galat
T. Joe Chilton	M.S. 2019	Environmental Scientist, Missouri Department of Natural Resources	Dr. Rosenberger
Leslie (Crawford) Lueckenhoff	M.S. 2015	Fish and Wildlife Biologist, U.S. Fish and Wildlife Service	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
Corey Dunn	Ph.D. 2020	Assistant Leader, USGS Mississippi Cooperative Fish and Wildlife Research Unit	Dr. Paukert
Jake Faulkner	M.S. 2015	Ecologist, U.S. Geological Survey	Dr. Paukert
Jeff Fore	Ph.D. 2012	Ecologist, The Nature Conservancy	Drs. Galat & Sowa
Drew Fowler	Ph.D. 2018	Waterfowl Research Ecologist, Wisconsin Dept. of Natural Resources	Dr. Webb
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
Kyle Kuechle	M.S. 2018	Research Biologist, Duck Unlimited	Dr. Webb
Josh Lallaman	Ph.D. 2012	Assistant Professor, St. Mary's University	Dr. Galat
Joe LaRose	M.S. 2018	Habitat Specialist, University of Missouri Extension	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	Aquatic Ecologist	Dr. Galat

Rory Mott	M.S. 2017	Ecologist, U.S. Geological Survey	Dr. Rosenberger
William (Zach) Morris	M.S. 2018	Biologist, MITICO Environmental Consultants	Dr. Paukert
Rachel Owen	Ph.D. 2019	Founder and Director, Missouri Science & Technology Policy Fellows	Dr. Webb and Goyne
Emily Pherigo	M.S. 2019	Biologist, U.S. Fish and Wildlife Service	Dr. Paukert
Landon Pierce	Ph.D. 2019	Biologist, U.S. Fish and Wildlife Service	Dr. Paukert
Travis Schepker	M.S. 2017	Biologist, U.S. Army Corps of Engineers	Dr. Webb
Matthew Schrum	M.S. 2017	Aquatic Biologist, Arkansas Department of Transportation	Dr. Rosenberger
Jacob Schwoerer	M.S. 2015	Environmental Scientist, City of Jefferson City	Dr. Paukert
Nick Sievert	M.S. 2014	Database Specialist, USGS National Climate Change and Wildlife Science Center	Dr. Paukert
Dane Smith	M.S. 2020	Ecologist, USGS North American Bat Monitoring Program	Dr. Webb
Jonathan Spurgeon	M.S. 2012	Assistant Leader, USGS Nebraska Cooperative Fish and Wildlife Research Unit	Dr. Paukert
Jessi Tapp	M.S. 2013	Wildlife Biologist, Nebraska Game and Parks Commission	Dr. Webb
Michael Thomas	M.S. 2020	Biologist, Idaho Fish and Game Department	Dr. Paukert
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

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## 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	Dr. Webb
Dr. Rachel Blakey	Post-Doctoral Researcher, 2017-2019	Post-doctoral Researcher, UCLA La Kretz Center for California Conservation Science	Drs. Webb & Kesler
Dr. Kristen Bouska	Post-Doctoral Researcher, 2014-2015	Research Ecologist, US Geological Survey	Drs. Paukert & Rosenberger
Brandon Brooke	Sr. Research Technician	Resource Assistant, Missouri Department of Conservation	Dr. Paukert
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. Garth Lindner	Post-Doctoral Researcher, 2014-2020	Engineer, Indiana Dept. of Natural Resources	Drs. Paukert & 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
Dr. Maggie MacPherson	Post-Doctoral Researcher, 2017-2019	Post-doctoral Researcher, Max Planck Institute for Evolutionary Anthropology	Dr. Webb
Dr. Anson Main	Post-Doctoral Researcher, 2016-2018	Environmental Scientist, California Dept. of Pesticide Regulation	Dr. Webb
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. Jane Rogosch	Post-Doctoral Researcher, 2020	Assistant Leader, USGS TX Cooperative Fish and Wildlife Research Unit	Dr. Paukert

Dr. Michelle Staudinger	Post-Doctoral Researcher, 2011-2013	Science Coordinator, US Geological Survey, Northeast Climate Adaptation Center	Dr. Paukert
Dr. Ralph Tingley	Post-Doctoral Researcher, 2016-2020	Fish Biologist, U.S. Geological Survey, Great Lakes Science 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

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David Hicks conducting invertebrate sample in Kentucky as part of his M.S. project.

## RESEARCH PROJECTS



Mizzou PhD student Hadley Boehm working with Missouri Department of Conservation to stock Striped Bass in Bull Shoals Lake as part of Hadley's PhD project.

## Dr. Craig Paukert



Craig Paukert holding a Paddlefish collected in Grand Lake, Oklahoma in December 2020 as part of film shoot for a new Discovery Channel nature series Planet Snoop.

## COMPLETED PROJECTS

### ASSESSING THE IMPACT OF CLIMATE CHANGE ON INLAND FISHERIES

**Investigators**

Dr. James Whitney, Post doc, MU  
Dr. Craig Paukert, MU

**Project Supervisors**

Dr. Craig Paukert, MU  
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

**Completion**

August 2019

**Status**

Complete

**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.

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

## Investigators

Elisa Baebler, M.S. student, MU  
Dr. Craig Paukert, MU  
Del Lobb, WY Game and Fish Dept.  
Nicole Farless, MDC

## 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

## Completion

June 2019

## Status

Complete

## 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, 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 were integrated with habitat and fish sampling data to evaluate the impact of streamflow management on fish community in the lower Osage River.

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

## Investigators

Elisa Baebler, M.S. student, MU  
Dr. Craig Paukert, MU  
Del Lobb, WY Game and Fish Dept.  
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

## Completion

June 2019

## Status

Complete

## Progress and Results

We used radio telemetry to determine the habitat selection and daily and seasonal movement of Spotted Bass and Shorthead Redhorse downstream of a hydropeaking dam on the Osage River, Missouri, where river stage may fluctuate up to 5 m daily. We determined flow to be “steady” or “fluctuating” based on the range of discharge measured during the 24-hour period prior to a fish location, where the threshold corresponded to minimum or maximum daily discharge being within (steady) or exceeding (fluctuating) 30% of the mean daily flow. Fluctuating flow corresponded to increased movement rate of Spotted Bass and Shorthead Redhorse and selection of slower velocity (<0.5 m/s) nearshore habitat by Spotted Bass. Shorthead Redhorse did not select specific velocity during fluctuating flow, yet used fast velocities (>1 m/s) during steady flow. Both Spotted Bass and Shorthead Redhorse selected moderate depth (1.5 – 4.0 m) with submerged cover during both steady and fluctuating flow. Spotted Bass movement rate peaked when 3-day average discharge was 500 m<sup>3</sup>/s, which occurred during consecutive days of hydropeaking or flood management at the dam. This discharge occurred or was exceeded during 25% of the study period, primarily during spring and summer, but did not occur during winter. Smaller adult Spotted Bass had greater movement rates than larger bass, whereas increased movement rate of Shorthead Redhorse was related to increased barometric pressure and Julian day. Both Spotted Bass and Shorthead Redhorse movement rates were greatest during spring (10 – 23°C) and differed among seasons. Both species responded to flow disturbance by moving more during fluctuating flow than during steady flow, presumably to relocate to suitable habitat. These effects occurred on a short timescale (10 hours to 3 days) and should be considered when informing ecologically-sustainable river management in highly flow-altered systems.

## Products:

Baebler, E. N., C. P. Paukert, M. D. Lobb III, B. Landwer, and T. W. Bonnot. 2020. Seasonal selection of riverine habitat by Spotted Bass and Shorthead Redhorse in a regulated river in the Midwestern U.S. River Research and Applications: doi.org/10.1002/rra.3637

# FISH COMMUNITY RESPONSE TO STREAM FLOW ALTERATIONS IN WADEABLE MISSOURI STREAMS

## Investigators

Emily Tracy-Smith, Sr. Research Specialist,  
MU

Dr. Craig Paukert, MU

Jason Persinger, MDC

Paul Blanchard, MDC

Del Lobb, WY Game and Fish Dept

## Project Supervisors

Dr. Craig Paukert, MU

## Funding

MDC 379

## Objectives

This five-year collaborative study was designed to improve our understanding of fish community responses to stream flow alterations. The goal of this project was 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 and determine if existing data would be adequate to test flow-ecology hypotheses developed as part of the overall project.

This study used existing and newly gathered data to establish a baseline of credible information to support management decisions in evaluating ecological responses to flow alteration.

The project outcome is a summary of flow needs and key flow-ecology relationships identified through workshops and literature review. Flow-ecology relationships and hypotheses address the range of flow conditions relevant to ecosystem processes, including seasonal base flows, seasonal flow pulses, and high (including overbank) flows.

## Location

Missouri

## Completion

June 2020

Page Break

## Status

Completed

## Progress and Results

Ensuring adequate water quantity and quality in stream, riparian, and wetland systems is a pressing issue worldwide and the science related to flow management is rapidly evolving. Currently, MDC's management recommendations for ecological flows rely heavily on hydrologic analysis and habitat availability as a proxy for how the biology of the stream will respond to various management alternatives. Increasingly, stakeholders want a demonstration of a direct connection between a change in the hydrology and a response by the ecology. Determining flow-ecology relationships would allow MDC to address the concerns of stakeholders and potentially improve management recommendations in a variety of situations where ecological flow protection is needed across the state.

We completed the following steps to develop flow-ecology relationships for Missouri streams and evaluate the effects of flow alterations:

Consulted with experts to develop a list of flow-sensitive fish species, habitat types and physical stream processes. Surveyed the literature to provide background information on the relationships between flow alteration and ecological response.

Drafted flow hypotheses through expert workshops.

Tested flow-ecology relationships with available data.

Conducted additional field sampling based on identified data gaps.

Developed new methods and metrics for evaluating flow statistics and flow alteration.

Summarized key flow needs for Missouri streams, priority data gaps for future projects, and prioritized statewide and site-specific hypotheses.

# EFFECTS OF UPSTREAM IMPOUNDMENT ON STREAM FISH COMMUNITIES

## Investigators

Nick Sievert, Ph.D. student, MU  
Dr. Craig Paukert, MU  
Jason Persinger, MDC  
Emily Tracy-Smith, MU  
Del Lobb, WY Game and Fish Dept  
Paul Blanchard, MDC

## Project Supervisors

Dr. Craig Paukert, MU

## 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

## Completion

June 2020

## Status

Completed

## 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. This study examined whether headwater impoundments influence stream flow, particularly the magnitude of high flow events and the degree of stream drying. Our analysis showed that there were no quantifiable relationships between various impoundment and stream flow metrics, although this may partially be attributable to the influence of landscape scale factors such as geology and land-use. We also evaluated potential linkages between flow conditions and larval recruitment and a number of fish species. Our study revealed that there was substantial synchrony in hatch date of both White Suckers, Johnny Darters and Orangethroat Darters. The conflicting estimates of incubation time in the literature limited our ability to confidently estimate the exact date of spawning events and therefore link it to potential flow directed cues. Conditions varied greatly between years and allowed us to assess differences in fish community structure. Populations of long-lived stream species such as Bluegills, Green Sunfish, Creek Chubs, and White suckers experienced the largest declines in abundance between 2017 which had higher and more stable flows compared to 2018 which experienced much more substantial stream drying. Headwater specialists and tolerant species such as Central Stoneroller, Yellow Bullhead and Mosquitofish all experienced increases in abundance during the drier year (2018). Although our results were inconclusive regarding the role of headwater impoundments in determining stream flow, we were able to observe potential impacts of stream flow on stream fish reproduction and community structure.



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

## Investigators

Zach Morris, M.S. Student, MU  
Mike Thomas, M.S. student, MU  
Dr. Craig Paukert, MU  
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

## Completion

June 2020

## Status

Complete

## Results

We examined the response to electrofishing of three Missouri sportfish: Smallmouth Bass, Blue Catfish, and Flathead Catfish. We had three objectives for this research effort: 1) determine the effective conductivity of each species and whether this value differs from recommended values; 2) determine the effect of waveform, fish size, and water temperature on capture-prone response thresholds of each species; and 3) develop power goals and sampling recommendations for each species. The effective conductivity of Smallmouth Bass was  $123\mu\text{S}/\text{cm}$ , which is near the previously used estimate ( $115\mu\text{S}/\text{cm}$ ), so existing goals may be adequate. For Flathead Catfish, we estimated an effective conductivity of  $69\mu\text{S}/\text{cm}$ . For Blue Catfish, we estimated an effective conductivity of  $94\mu\text{S}/\text{cm}$ . For Smallmouth Bass, waveform had little effect on response thresholds and suggest that current methods using a waveform of 60/25 are appropriate for sampling, assuming the response thresholds are related to conductivity. For catfish, although differences among waveforms were present, we were unable to identify a particular waveform that was more effective, so more research is needed. However, we recommend the use of the current standard waveform, 15/30, as this tended to have a reduced length effect relative to other waveforms. Results of this study differ by species and suggest potential size bias and depth limitations. For Smallmouth Bass, capture probability increased with total length from 12% (18 cm; TL) to 25% (38 cm; TL), but not across water temperatures (13 – 28 °C), at or 20% below a target power output. For Blue Catfish and Flathead Catfish, mean estimates of capture efficiency were 4.5% ( $SE = 2.5\%$ ) and 5.4% ( $SE = 3.2\%$ ), respectively. Electrofishing was selective for smaller Blue Catfish and larger Flathead Catfish. The influence of water temperature on capture efficiency of either catfish species was limited in our study. Electrical field mapping of multiple depths (0.5 m, 0.9 m, 1.8 m) and distances (up to 58.5 m), suggest that electrofishing is less effective at depths greater than 1 m for Smallmouth Bass and reveals new insights into the unique response of Blue Catfish and Flathead Catfish to low-frequency electrofishing

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

## Investigators

Corey Dunn, Ph.D. student, MU  
Dr. Craig Paukert, MU  
Dave Herzog, MDC  
Dr. Doug Novinger  
Dr. Vince Travnichuk, MDC  
Matt Combes, MDC

## Project Supervisors

Dr. Craig Paukert, MU

## 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

## Completion

June 2020

## Status

Complete

## Results

Missouri's "mid-sized" rivers support over 200 fish species, yet no standardized methods exist to monitor fish communities inhabiting these biologically diverse and varied systems. First, we surveyed nine sites seasonally across Prairie and Ozark regions with six gears (36 surveys). We detected 140 species, including at least 23 new distributional accounts. Richness per survey was 2–3 times higher than historically reported per survey and ranged from 25–75 species per survey and 39–87 species per site. Boat electrofishing, seining, and mini-fyke nets were the most effective gears across all seasons and regions, but no gear on average solely detected >63% of richness. Species richness was temporally variable but seasonally balanced across spring ( $48.7 \pm 13.5$  [SD]), summer ( $50.1 \pm 14.8$ ), and fall ( $50.2 \pm 15.4$ ). Missouri Department of Conservation Fisheries Management Biologists selected Standard Protocols targeting 80% and 95% of richness from among 287,496 candidate protocols nested within the original survey design. These protocols were only 34% (80% richness) and 71% (95% richness) of our original survey effort but still likely require 2–4 and 3–8 eight-hour field days (6 hours of sampling per day) with three crew members to complete depending on river size, respectively. Our second study quantified species richness and compositional change among non-wadeable sites in the lower Grand (200 river km) and Meramec (240 river km) river systems. We detected 61% (48 species) and 79% (102 species) of species historically recorded in these respective drainages. Species richness peaked mid-course in both rivers before declining downriver likely due to channelization and hydrogeomorphic changes near the Missouri and Mississippi rivers. These studies developed flexible sampling protocols that can collect up to 95% of our observed species richness in 3 to 8 days.

## Products:

Dunn, C. G., and C. P. Paukert. 2020. A Flexible Survey Design for Monitoring Spatiotemporal Fish Richness in Non-wadeable Rivers: Optimizing Efficiency by Integrating Gears. *Canadian Journal of Fisheries and Aquatic Sciences* 77(6): 978-990. doi.org/10.1139/cjfas-2019-0315

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

## Investigators

John Brant, M.S. student, MU  
Del Lobb, WY Game and Fish Dept.  
Brett Landwer, MDC  
Nicole Fairless, MDC  
Dr. Craig Paukert, MU

## 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

## Completion

June 2020



## Status

Complete

## Results

The goal of our project was to determine if substrate size and distribution are limiting habitat characteristics for lithophilic spawning fishes of the East Fork Black River downstream of Taum Sauk Reservoir in the Missouri Ozarks. Our questions were: 1) What habitat characteristics do Hornyhead Chubs select for spawning in the East Fork Black River? and 2) What habitat characteristics are associated with fish communities within riffles and runs in the East Fork Black River? Spawning mounds were identified in riffle-run habitats, and habitat characteristics measured at the microhabitat and mesohabitat scale. Discrete-choice models within a Bayesian framework were used at the microhabitat scale, and selected habitat characteristics for spawning mounds included depths of 0.20 m to 0.35 m, velocities of 0.10 m/s to 0.30 m/s, wetted widths of 7 m to 10 m, and the presence of velocity shelters for Hornyhead Chub spawning mounds. At the mesohabitat scale, shallower mean depths and increased amounts of small substrate were the most important habitat characteristics for the presence of spawning mounds. We also sampled fish from riffle-run habitats on the East Fork Black River downstream of Taum Sauk Reservoir using backpack electrofishing and prepositioned grid electrofishing. Hill number diversity indices were used with Generalized Linear Models to predict the relationship between habitat characteristics (area, distance from dam, mean depth, mean wetted width, mean canopy cover, water surface gradient, and substrate size distribution) and fish diversity. Increased reach area and smaller substrate size were the most important habitat characteristics for increased diversity in the overall fish community and Hornyhead Chub spawning associates. For fishes sampled with prepositioned electrofishing grids, lesser mean depths lead to increased diversity. Substrate size distribution was an important habitat characteristic for both objectives, based on our research, and we believe that riffle-run habitats in the East Fork Black River have diminished substrate sizes in the range 8 mm to 32 mm. The lack of this small substrate may be influencing the fish communities within riffle-run habitat downstream of Taum Sauk reservoir.

## WINTER AGGREGATION AND HABITAT SELECTION OF GRASS CARP IN TRUMAN RESERVOIR

### Investigators

Tyler Hessler, M.S. student  
Dr. Mike Byrne, MU  
Duane Chapman, USGS-CERC  
Joe Deters, USGS-CERC  
Dr. Craig Paukert, MU

### Project Supervisors

Dr. Mike Byrne, MU  
Dr. Craig Paukert, MU

### Funding

US Geological Survey-CERC  
RWO 135 and 136

### 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

### Completion

September 2020

### Status

Complete

### Progress and Results

Grass Carp were introduced in North America to control aquatic vegetation but have the potential to cause significant declines and alterations in aquatic vegetation communities, which in turn can affect native species dependent on aquatic vegetation. Increased captures and observations of spawning have elevated concerns of Grass Carp establishment in new locations, with particular concern for establishment in Lake Erie and its tributaries. The Judas-fish method, in which telemetered fish co-locate with wild conspecifics, sometimes in aggregations that are susceptible to harvest, has been used successfully to control invasive Common Carp *Cyprinus carpio* populations. If Grass Carp aggregate in winter similarly to Common Carp they might be susceptible to similar control or harvest methods. During the winters (November-March) from 2017-2019, we tracked 86 Grass Carp tagged with acoustic transmitters on Truman Reservoir, Missouri, to evaluate winter habitat selection and to determine the effectiveness of using Judas fish in locating and removing wild fish. We compared harvest between reservoir sites where tagged Judas fish were located to control sites we believed were suitable Grass Carp habitat based on observed behaviors of telemetered fish. Discrete-choice models showed Grass Carp exhibited strong selection for shallow water, as 75% of locations were in littoral habitats  $\leq 3$  m deep. We found little difference in number of fish harvested at sites where Judas fish were located (1.9 fish/attempt) and control sites (1.2 fish/attempt) in the lake proper. Full guts in individuals that were harvested may be indicative that fish were using shallow water habitats to feed. Our results suggest that Grass Carp were not forming large aggregations and efforts to reduce populations via harvest may be difficult in large lake systems when fish are dispersed throughout the available littoral habitat.

## ONGOING PROJECTS

### LAKE STURGEON HABITAT USE AND MOVEMENT IN MISSOURI RIVER TRIBUTARIES

#### Investigators

Michael Moore, Ph.D. student  
Dr. Craig Paukert, MU  
Travis Moore, MDC  
Nicole Farless, MDC  
Del Lobb, WY Game and Fish Dept.  
Dave Herzog, MDC  
Sara Tripp, MDC  
Ivan Vining, MDC

#### 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

Migratory fishes exploit disparate habitats for feeding, reproduction, and avoidance of physiological stress. Missouri is among several states that have instituted reintroduction programs for Lake Sturgeon; however, biologists lack an understanding of their migrations in southern rivers. Therefore, we studied movements of 100 Lake Sturgeon over 3 years in the hydrologically altered Osage and the free-flowing Gasconade rivers in Missouri. We sought to describe seasonal variation in movement and identify the flow and temperature metrics influencing migrations. We obtained fish locations actively and passively with acoustic telemetry and identified important environmental variables using generalized linear mixed effects models. Movement was greatest during spring and lowest during the winter and summer. Spring migrations began around 10°C and ended around 18°C. However, distinct thermal regimes affected timing in each river with spring migrations beginning 15 days earlier and ending 27 days earlier on average in the Gasconade than the Osage. Asynchronous migration periods in each river allowed up to 9 individuals to make migrations up multiple tributaries in a single year. Spring upstream migrations were positively associated with daily discharge at intermediate temperatures in the Osage although in both rivers fish were more likely to migrate during the receding limb of the hydrograph. This research suggests that both flow and temperature are migratory cues for Lake Sturgeon. Consequently, management of hydroelectric operations may have impacts on migratory phenology of Lake Sturgeon in hydrologically altered systems.

#### Products:

Moore, M., C. Paukert, and T. Moore. 2020. Effects of latitude, season and temperature on Lake Sturgeon movement. *North American Journal of Fisheries Management* doi.org/10.1002/nafm.10416.

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

## Investigators

Dr. John Remo, Southern IL Univ.  
Dr. Craig Paukert, MU  
Dr. Robert B Jacobson, CERC  
Jason Wilson, USFWS

## Project Supervisors

Dr. Craig Paukert, MU

## 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 2021

## Status

In progress

## Progress and Results

We will develop computational tools to evaluate the potential of National Wildlife Refuge lands along the Middle Mississippi River 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. Because large-river floodplains are subject to complex and dynamic patterns of inundation, we emphasize the importance of understanding floodplain hydrology and hydraulics. 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 currently developing 2-D hydraulic modeling of the Middle Mississippi River National Wildlife Refuge's Wilkinson Island Management Unit of the Middle Mississippi River for the detailed assessment of flood inundation. The goals for the hydraulic modeling are as follows: 1) develop flood inundation metrics such as flood water residence time to better understand the linkage between inundation and nitrogen process across the management unit; and 2) map shear stress and / or stream power for a range of flood discharges to assess the 2-D hydraulic models' ability to predict areas of floodplain sedimentation and erosion. We will also collect biogeochemical samples to assess the 2-D hydraulic model's ability to predict areas of floodplain sedimentation or erosion and nutrient fluxes that will help further validate the modeling results.

## DEVELOPING ADAPTATION STRATEGIES AND REPLACEMENT COSTS FOR RECREATIONAL AND TRIBAL FISHERIES

### Investigators

Colin Dassow, Research Specialist, MU  
Dr. Ralph Tingley, Great Lakes Science Center, USGS  
Dr. Craig Paukert, MU

### Project Supervisors

Dr. Craig Paukert, MU  
Dr. Abigail Lynch, USGS

### Funding

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

### Cooperators

Dr. Doug Beard, USGS  
Dr. Gretchen Hansen, University of Minnesota  
Pete Jacobson, MN DNR  
Dr. Greg Sass, WI DNR  
Dr. Matthew Diebel, WI DNR  
Alex Latzka, WI DNR  
Joe Nohner, Midwest Glacial Lakes 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. We developed current and future predictions of adult walleye presence in lakes and streams and of successful natural recruitment in lakes, classifying lakes based on ability to support walleye at each life stage. We predict that less than 20% of current walleye lake fisheries will be self-sustaining at mid-century, and that connectivity to fluvial walleye populations appears to increase system resiliency. Nearly 75% of lakes with current natural recruitment are predicted to lose self-sustaining populations but will remain stocking opportunities, with additional costs to retain fisheries up to \$900,000 (USD 2017) annually. Our results can also be integrated into scenario planning exercises to better inform management now and in the future. We provide a new conceptual model of lake fisheries and user types (e.g., walleye specialist anglers, tribal spearers) in the Ceded Territory of Wisconsin (where fisheries are co-managed to support recreational and tribal subsistence fishing), which when paired with our results, may be valuable in assessing tradeoffs among costs and user well-being.

### Products:

Krabbenhof, T., Myers, B., Wong, J., Chu, C., Tingley, R., Falke, J., Kwak, T., Paukert, C., and A. Lynch. 2020. Fish and Climate Change (FiCli) Database: Informing management actions for responding to climate change effects in fishes. *Scientific Data*. 7:124. doi.org/10.1038/s41597-020-0465-z

Tingley III, R. W., C. Paukert, G. G. Sass, P. C. Jacobson, G. J. A. Hansen, and A. J. Lynch. 2019. Adapting to climate change: Guidance for the management of inland glacial lake fisheries. *Lake and Reservoir Management* 35: 435-452. doi.org/10.1080/10402381.2019.1678535

Tingley, R. W., Hansen, J. F., Isermann, D. A., Fulton, D. C., Musch, A. and Paukert, C. P. 2019. Characterizing Angler Preferences for Largemouth Bass, Bluegill, and Walleye Fisheries in Wisconsin. *North Am J Fish Manage* 39:676-692. doi:10.1002/nafm.10301

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

## Investigators

Hadley Boehm, Ph.D. student  
Hunter Styka, Technician  
Andy Turner, MDC

## Project Supervisors

Dr. Craig Paukert, MU  
Andy Turner, MDC

## 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 experimentally stocked Striped Bass (STB) into Bull Shoals Lake (2013-19) to produce a high-quality, low-density bonus fishery to supplement current angling opportunities. To evaluate this stocking and inform future STB management in Bull Shoals, we are assessing growth, survival, and distribution of stocked STB, and exploring potential impacts (if any) of stocking STB on other sportfish populations. We are estimating survival and distribution of STB using manual and passive acoustic telemetry. Growth will be defined throughout the study using length at age relationships for STB obtained by anglers. We are using stable isotope analysis to explore diet overlap between STB and other sportfishes. To date, 63 adult (>305 mm) and 200 age-0 STB implanted with acoustic transmitters have been stocked into Bull Shoals Lake with additional stockings of both groups planned for 2021. Tissue samples for stable isotope analysis were collected from STB and other sportfish species during 2019-20 in spring and fall from both ends of the lake. Preliminary analysis based on passive receiver detections suggest an apparent overwinter survival of 28% for stocked age-0 STB, and an apparent annual survival of 61% for stocked adults. Early results of stable isotope analysis from 2019 samples suggest some diet overlap between White Bass, Walleye, and smaller STB. Population modeling using growth and survival estimates will describe the fishery being provided by the current stocking rate and enable exploration of alternative stocking rates. Distribution patterns and extent of diet overlap between STB and other sportfishes will also inform future STB management in Bull Shoals.

# CREATION OF STATEWIDE FRAMEWORK FOR ECOLOGICAL LIMITS OF HYDROLOGIC ALTERATION BASED ON AQUATIC COMMUNITY CLASSIFICATION

## Investigators

Emily Tracy-Smith, Research Associate,  
MU

## Project Supervisors y

Dr. Craig Paukert, MU  
Jason Persinger, MDC  
Dr. Paul Blanchard, MDC

## Funding

MDC number TBD

## Objectives

Define the natural community (fish) of Missouri's streams based on combinations in flow, drainage area, and water temperature that change on a segment basis.

Evaluate natural hydrologic variation (based on flow-based aquatic community classification developed in Objective 1) to determine which species are most sensitive to changes in stream flow and water temperature.

Determine the fish community response(s) associated with hydrologic alteration based on our understanding of natural hydrologic variability and flow sensitive species from objective 2.

## Location

State of Missouri

## Expected Completion

June 2023

## Status

In progress

## Progress and Results

In Missouri, development of flow-ecology relationships has been an iterative process, whereby workshops, discussions and exploratory analysis have directed the process for developing flow ecology relationships, and the next steps include developing a aquatic classification systems using biota. The process for developing flow duration curves is an expansion of previous work that developed Aquatic Ecological System (AES) types for Missouri, which have been used extensively for landscape-level conservation decision by MDC and others, approximates hydrology, however it did not account for losing streams or actual spring flow. Therefore, we developed reference (least disturbed) flow duration curves based on groups of hydrologically similar AES types that were further split based on stream gaged data, which reflected geologic differences not captured in the AES cluster analysis. Flow estimates derived from this work will incorporate natural hydrologic variability into our flow-ecology relationships and serve as the foundation of a flow-based classification of streams from which natural fish communities can potentially be differentiated. Our proposed flow-based classification is designed to be integrated into an existing ecological limits of hydrologic alteration framework for Missouri streams that provides a scientific foundation for informed water-use decisions specific to species or guilds and the entire fish community. Our model will leverage ongoing and recent efforts including the RAM program data to characterize the structure of fish assemblages in different types of Missouri streams based on catchment size, predicted flow, and temperature. Our flow-based classification is an important step that addresses a MDC strategic action: Support the creation of a statewide framework for ecological limits of hydrologic alteration based on aquatic community classification by the end of FY23. The goal of this project is to provide the scientific foundation for ecological flow assessments to inform internal decision making and enhance the Department's ability to advocate for water resources within the context of interagency efforts on site-specific projects or any future partner-initiated effort to establish environmental flow standards.

**Dr. Elisabeth Webb**



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

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

**Investigators**

Drew Fowler, Ph.D. student, MU  
Dr. Elisabeth Webb, MU  
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

**Completion**

December 2018

**Status**

Complete

**Progress and Results**

The Light Goose Conservation Order (LGCO) was implemented in 1999 as an attempt to reduce light geese 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 requires further simulation tests or additional data such as live recaptures.

**Products:**

Fowler, D.N., E.B. Webb, M.P. Vrtiska and K. A. Hobson. 2020. Winter carry over effects on spring body condition driven by agricultural subsidies to lesser snow geese (*Anser caerulescens caerulescens*). Avian Conservation and Ecology 15:21.

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

## Investigators

Rachel Owen, Ph.D. student, MU  
Dr. Elisabeth Webb, MU  
Dr. Keith Goyne, MU

## 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

Complete

## Progress and Results

We 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.. We also conducted a germination study to evaluate the impact of increased temperatures on Barnyardgrass 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.

## Products

Owen, R.K., E.B. Webb, D.A. Haukos, F.B. Fritschi and K.W. Goyne. 2020. Barnyardgrass (*Echinochloa crusgalli*) emergence and growth in a changing climate in Great Plains wetlands. *Wetlands Ecology and Management* 28:35-50.

Owen, R.K., E.B. Webb, D.A. Haukos, F.B. Fritschi and K.W. Goyne. 2020. Projected climate and land use changes drive plant community composition in agricultural wetlands. *Environmental and Experimental Botany* 175:104039.

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

## Investigators

Dr. Rachel Blakey, Post doc, MU  
Dr. Elisabeth Webb, MU  
Dr. Dylan Kesler, IBP  
Dr. Matthew Johnson, USFS

## 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

## Completion

December 2019

## Status

Complete

## 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.

## Products

Blakey, R.V., E.B. Webb, D.C. Kesler, R.B. Siegel, D. Corcoran Barrios, and J.M. Johnson. 2019. Bats in a changing landscape: linking occupancy and traits of a diverse montane bat community to fire regime. *Ecology and Evolution* 9:5324-5337.

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

## Investigators

Kyle Kuechle, M.S. student, MU  
Dr. Elisabeth Webb, MU  
Doreen Mengel, MDC

## 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 2020

## Status

Complete

## 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.

## Products

Kuechle, K.J., E.B. Webb, D. Mengel and A.R. Main. 2019. Factors influencing neonicotinoid insecticide occurrence and concentration in floodplain wetlands sediments across Missouri. *Environmental Science & Technology* 53: 10591-10600.

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

## Investigators

Kyle Kuechle, M.S. student, MU  
Dr. Elisabeth Webb, MU  
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

## Completion

June 2020

## Status

Complete

## 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 investigated invertebrate community response to planting of chemically-treated seed in managed wetland ecosystems in Missouri. In 2016, we sampled water, sediment, and aquatic invertebrates from 22 paired wetlands during spring (pre-water level drawdown) and fall (post-water level flood-up) followed by a third sampling period (spring 2017). During summer 2016, portions of study wetlands were planted with either seed treated corn (treated; thiamethoxam and fungicides) or untreated corn (control; fungicides only). Water and sediment concentrations of the three most common neonicotinoids were used to calculate overall neonicotinoid toxicity equivalents (NI-EQs) based on an additive model of neonicotinoid toxic equivalency factors. Mean total NI-EQs for sediment (0.58  $\mu\text{g}/\text{kg}$ ) were an order of magnitude greater than water (0.02  $\mu\text{g}/\text{L}$ ). Additionally, one fungicide component of the seed treatment (azoxystrobin; mean=0.10  $\mu\text{g}/\text{kg}$ ) was frequently detected and therefore further evaluated to determine effects on aquatic invertebrates. Results indicate an overall decrease in aquatic insect richness and abundance with increasing NI-EQs in both wetland water and sediments, as well as a similar negative relationship with sediment fungicide concentration. Post-treatment, treated wetlands had lower insect richness and abundance compared to untreated wetlands, followed by a recovery in abundance and richness in spring 2017. Our results have implications for aquatic invertebrates and wetland-dependent species (e.g., migrating waterbirds), as neonicotinoids are impacting aquatic invertebrates and potentially wetland food webs. Information on timing and magnitude of aquatic insect declines will be useful in making decisions regarding use of seed-treatments, and potentially, provide broader considerations of the role agricultural production has in future wetland management and conservation planning.

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

### Investigators

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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

June 2020

### Status

Complete

### Progress and Results

Most current neonicotinoid research 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. By comparison, native bee richness in field-margins was negatively impacted by neonicotinoid concentrations in margin soils. In 2017 and 2018, we planted 23 Missouri agricultural fields to soybeans (*Glycine max*) using one of three seed treatments: untreated (no insecticide), treated (imidacloprid), or previously-treated (untreated but use prior to 2017). During both years, wild bees were collected in study field margins monthly (May to September) in tandem with soil and flowers from fields and field margins that were analyzed for neonicotinoid residues. Insecticide presence in soils and flowers varied over the study with neonicotinoids infrequently detected in both years within margin flowers (0%), soybean flowers (<1%), margin soils (<8%), and field soils (~39%). Field treatment resulted in greater abundance of aboveground-nesting bees in previously-treated fields. In contrast, neonicotinoid presence in field soils was associated with significantly lower abundance (ground-nesting, diet generalists) and richness (ground- and aboveground-nesting, diet generalists) of wild bee guilds. Our findings suggest that land managers and growers may want to carefully consider the long-term persistence of neonicotinoids in field soils, which may lead to greater declines in regional bee communities. Future reduction or elimination of neonicotinoid seed treatment use on areas managed for wildlife may benefit conservation goals to sustain viable wild bee populations.

**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  
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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 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**

Loess Bluffs, Swan Lake, and Big Muddy National Wildlife Refuges

**Completion**

July 2020

**Status**

Complete

**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.

To identify drivers of maternity roost selection of *M. sodalis* in Northern Missouri, we used mist nets to capture pregnant and lactating females during the summers of 2017 and 2018 and applied radio transmitters to individuals with sufficient body mass. We tracked 24 *M. sodalis* for an average of 5.8 days and identified 21 roost trees. We conducted emergence counts at each roost to classify them as primary or alternate and collected habitat data for each tree and the surrounding area. We then collected the same habitat data at available roosts and used discrete choice models to compare selected roosts with available trees within the study area. The top ranked model for primary roosts included tree diameter (DBH), tree height, and canopy cover while the top ranked model for alternate roosts included DBH, snag basal area, and canopy cover. Our results indicate that the probability of primary roost selection was greatest for trees with DBH ~ 50 cm and height of ~ 17 m. Roost site selection probability decreased with canopy closure, falling to 0 above ~ 75% closure. The probability of selection for alternate roosts was associated with greater canopy closure (~ 75%), smaller trees (~ 35 cm) and was positively associated with snag basal area.

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. Elisabeth Webb, MU  
Dr. Tom Bonnot, MU  
Dr. Andrew Raedeke, MDC  
Doreen Mengel, MDC  
Frank Nelson, MDC  
Dr. Maggie MacPherson, former  
postdoc

**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

**Expected Completion**

December 2021

**Status**

In progress

**Progress and Results**

The aim of this project is to 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. To accomplish this goal, we are developing a framework to model spatially and temporally explicit processes in Missouri's wetlands that link biophysical processes to species outcomes. The first phase of the recently completed Missouri Department of Conservation Wetland Planning Initiative was to identify past and present extents and distributions of wetlands in Missouri. Our project pairs this landscape information with expert and empirical knowledge of dynamic wetland processes to build predictive distribution models for state-wide adaptive management planning. We are using a Bayesian belief network (BBN) modeling approach to build 8 models of wetland-dependent taxa that are surrogates for wetland ecological and landscape settings along 3 axes: inundation duration, annual inundation frequency, and land cover. BBNs are superior to other modeling approaches because they explicitly estimate sources of uncertainty for each aspect of the model (rather than solely the uncertainty of the entire model) that can be addressed through research or adaptive management.

In 2019, the entire team worked to refine species-specific beta models by removing nodes that contribute to wetland dynamics ('process nodes') and incorporating additional nodes pertaining to probability of population occupancy (as opposed to individual occupancy). We identified the spatial data layers necessary to apply the models across Missouri and partition individual models into separate sub-models. Sub-models included (1) complex-scale variables believed to influence habitat suitability beyond the individual wetland, and (2) wetland-scale variables believed to influence overall suitability of an individual wetland. 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.

# EVALUATING IMPACTS OF SEED TREATMENT PESTICIDES & AGROECOSYSTEM LAND MANAGEMENT PRACTICES ON SOLITARY BEE COMMUNITIES IN MISSOURI

## Investigators

Robert Abney, M.S. student, MU  
Dr. Elisabeth Webb, MU  
Dr. Anson Main, CDPR  
Doreen Mengel, MDC

## Project Supervisors

Dr. Elisabeth Webb, MU

## Funding

MDC 383

## Cooperators

MDC

## Objectives

Evaluate the impacts of annual pesticide use and land management practices on abundance and diversity of native solitary bees in agroecosystems.

Evaluate the impacts of neonicotinoids on native bee nesting efforts and reproductive success among solitary bee communities of agroecosystems.

Survey levels of neonicotinoids in bee nesting materials, dust produced during planting activities, wildflowers, and field soil.

## Location

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

Private landscapes enrolled in CRP

## Expected Completion

June 2021

## Status

In progress

## Progress and Results

Smaller native bees (e.g., *Megachile* spp.) are invaluable pollinators of both cultivated crops and native plant species, yet, there is limited information on how neonicotinoids influence native bees. Native species typically have short flight distances (<300 m) which may increase their susceptibility to potential sub-lethal effects from annual pesticide use. Limited data are available linking potential effects to both seed treatments and land management practices.

In order to evaluate how currently used seed treatment pesticides and land management practices may impact native solitary bee abundance and diversity, we conducted visual surveys of bee populations in field margins surrounding neonicotinoid treated and untreated soybean fields from May – September 2019 ( $n = 29$ ). During the planting season, we collected ‘dust’ that settled in field margins for pesticide residue analysis. Random samples of field soil and wildflower biomass were also collected during each sampling period for pesticide residue analysis. Finally, we conducted random quadrat sampling of field margin vegetation and used GIS technology to enumerate a number of site and landscape-level habitat variables (e.g., floral richness in field margins) that may impact native solitary bee abundance and diversity.

With the intent of evaluating how currently used seed treatment pesticides may influence nesting efforts and reproductive success of cavity nesting solitary bees, we placed 54 nest boxes in field margins ( $n = 18$ ) surrounding neonicotinoid treated and untreated soybean fields on Conservation Areas in spring 2018. In 2019, we expanded our placement of nest boxes to include additional field margins on private land enrolled in the Conservation Reserve Program (CRP) ( $n = 24$ ). Each year, all cocoons were harvested in fall, overwintered in the lab, and enumerated after emergence. Samples of nesting material were removed for pesticide residue analysis. Analysis of nesting effort (e.g., number of nests) and nesting success metrics (e.g., surviving number of offspring) is ongoing.



**INVESTIGATING THE POTENTIAL EFFECTS OF AGRICULTURAL CONTAMINANT  
DRIFT ON HIGH ELEVATION LAKE ECOSYSTEMS IN THE SOUTHERN SIERRA  
NEVADA, CALIFORNIA**

**Investigators**

Gabrielle Ruso, Ph.D. student, MU  
Dr. Elisabeth Webb, MU  
Dr. Craig Paukert, MU  
Dr. Thea Edwards, USGS – Columbia  
Environmental Research Center  
Erik Meyer, NPS – Sequoia and Kings  
Canyon National Parks

**Project Supervisor**

Dr. Elisabeth Webb, MU  
Dr. Craig Paukert, MU

**Funding**

NPS/USGS Water Quality Partnership  
RWO 140

**Cooperators**

U.S. Geological Survey  
National Park Service

**Objectives**

Evaluate the patterns and relationships of water concentrations of nitrogen and copper in high elevation lakes with lake- and watershed-level variables

Determine the extent to which copper contamination acts synergistically with nitrogen to increase algal growth using environmentally-realistic concentrations in lab exposure studies.

Evaluate the toxicity of copper contamination on Pacific chorus frog (*Pseudacris regilla*) tadpole health (size, liver histology) and the potential for copper to bioaccumulate and biomagnify lake food webs.

**Location**

Sequoia National Park, CA

**Expected Completion**

July 2024

**Status**

In progress

**Progress and Results**

Agricultural fertilizers and pesticides are commonly used to improve crop productivity and protect crops from a variety of pests. The extensive agricultural industry of the Central Valley of California represents a global hotspot of application of these agricultural chemicals. While the study of agrochemical contaminant effects on aquatic ecosystems *downstream* of agricultural landscapes is well established, the same is not as true for *upwind* ecosystems. However, the Sierra Nevada mountains are geographically positioned such that they are easily exposed to non-target, atmospheric drift of these contaminants from the Central Valley. High elevation lakes of the Sierra Nevada are susceptible to effects of this contaminant drift given their oligotrophic status and other biogeochemical characteristics. It is known that these lakes are experiencing nutrient loading, primarily of nitrogen, and this has been implicated in growing observations of increased algal growth and blooms. Recently, an atmospheric drift model has also indicated that copper from pesticides applied in the Central Valley is likely to drift to these lakes and may act synergistically with nitrogen, as a micronutrient, to fuel algal growth. Consequently, Sequoia and Kings Canyon National Parks have expressed concern as to how these nutrients may affect these sensitive lake ecosystems.

Observations of increased algal growth in otherwise clear, oligotrophic lakes is a growing, concerning trend in mountain ranges globally. Thus, this research will serve as an ideal study case to investigate the effects that agricultural contaminants transported as atmospheric drift may have on both the algal ecology and ecotoxicology of these lake ecosystems. The primary goals are to identify variables and relationships that influence lake concentrations of nitrogen and copper, determine whether these contaminants act synergistically to drive algal growth, and to evaluate copper's toxicity throughout the lake food web.

# ASSESSING THE FEASIBILITY OF USING SMALL UNMANNED AERIAL SYSTEMS AND ARTIFICIAL INTELLIGENCE FOR MONITORING WATERFOWL ABUNDANCE

## Investigators

Reid Viegut, M.S. student, MU  
Dr. Elisabeth Webb, MU  
Dr. Yi Shang, MU  
Dr. Andy Raedeke, MDC

## Project Supervisors

Dr. Elisabeth Webb, MU  
Dr. Yi Shang, MU

## Funding

MDC 433

## Cooperators

MDC  
USGS

## Objectives

Evaluate the response of waterfowl to small unmanned aerial system surveys for abundance

Evaluate the influences of environmental factors on waterfowl detection and abundance estimation of computer algorithms in small unmanned aerial system surveys

Evaluate the potential for small unmanned aerial systems to precisely estimate waterfowl abundance on managed wetlands in Missouri

## Location

MDC Conservation Areas:  
Eagle Bluffs CA, MO  
Grand Pass CA, MO  
Fountain Grove CA, MO

## Expected Completion

August 2022

## Status

In progress

## Progress and Results

The synergies of new technologies, including UAS, improved camera sensors, and deep learning computer algorithms, offer the opportunity to develop novel and improved techniques for monitoring waterfowl populations and wetland habitats and overcome some of the existing challenges with current survey methods. The purpose of this project is to assess the feasibility of using UAS to improve monitoring of waterfowl populations and wetland habitat conditions, developing efficient, precise, consistent, and safe survey alternatives to the traditional methods. This project will increase the capabilities of waterfowl and wetland biologists to employ adaptive approaches to management in real time, using up-to-date current information collected through a systematic process that allows for collaborative learning and constant improvement of management actions to achieve desired outcomes across the state and region. Project products will allow for increased operational excellence by developing monitoring techniques that are less invasive, more efficient, cost effective, safer (for both wildlife and people), and provide more accurate population estimates on a smaller temporal scale than current approaches.

Our goal is to evaluate the capabilities of artificial intelligence, deep learning, and small unmanned aerial systems (sUAS) to estimate waterfowl abundance. A pilot season was conducting in fall/winter of 2020-2021 to collect images of waterfowl in Missouri to begin training algorithms to classify ducks and geese by species and sex. Waterfowl response to the sUAS was also observed to be minimal at all heights flown, with geese being more responsive to the flights than ducks.

## META-ANALYSIS AND SYNTHESIS OF SECRETIVE MARSHBIRD HABITAT REQUIREMENTS ACROSS THE FULL ANNUAL CYCLE

### Investigators

Dr. Kristen Malone, Post doc, MU  
Dr. Elisabeth Webb, MU  
Doreen Mengel, MDC

### Project Supervisor

Dr. Elisabeth Webb, MU

### Funding

USFWS, Region 3, Migratory Birds

### Cooperators

Members of the Mississippi Flyway  
Nongame Technical Section  
Midwest Marshbird Working Group

### Objectives

Quantitatively synthesize existing SMB literature to assess the influence of wetland habitat characteristics on SMB species presence and abundance.

Conduct a systematic review on how wetland management practices targeted for other wetland-dependent species could influence habitat conditions identified as important for SMB species.

Identify information gaps that could serve as the foundation for developing collaborative flyway-wide research objectives that address potential limiting factors of SMB populations, as well as identify other critical research needs and management uncertainties.

### Location

The Mississippi Flyway

### Expected Completion

March 2022

### Status

In progress

### Progress and Results

The group of birds known, collectively, as secretive marshbirds (SMB) includes some hunted species as well as species of greatest conservation need, within the Midwest region and the Mississippi Flyway. However, there is limited basic ecological information that evaluates whether wetland habitats available on public lands, and management actions directed toward other wetland-dependent taxa within the Mississippi Flyway, are meeting annual life cycle needs for this diverse suite of birds. The overall goal of this project is to better understand habitat requirements of SMB across their full annual cycle (i.e., migration, breeding and wintering periods) throughout the Midwest and the Mississippi Flyway and evaluate how wetland management practices on public lands have potential to influence SMB distribution and habitat use. We performed a meta-analysis and incorporated results from 40 studies that quantitatively assessed habitat associations of American Bittern, Least Bittern, King Rail, Sora, Virginia Rail, and Yellow Rail. Most studies examined breeding season habitat, whereas only 13% reported on habitat use during migration, and none during winter. At landscape scales, breeding marsh birds were positively associated with amount of wetlands, especially in the Great Lakes region, and negatively associated with amount of urban landcover, particularly for American Bittern. At the local scale, breeding marsh birds were positively associated with cattail coverage (*Typha spp*) and other robust emergent vegetation. Marsh birds were negatively associated with woody wetland vegetation, although effects were weaker in the Prairie Pothole region. During autumn migration, moist-soil vegetation coverage was important for rails in the lower Midwest. The habitat use trends we identified across studies provide a general characterization of marsh bird breeding habitat to aid in landscape-level multi-species conservation efforts. Our study also highlights the immediate research needs for full annual cycle conservation of secretive marsh bird habitat in North America: specifically, information during winter and migration.

# EVALUATING THE BIOTIC COMMUNITIES OF WETLANDS RESTORED UNDER THE WETLANDS RESERVE PROGRAM.

## Investigators

David Hicks, M.S. student, MU  
Dr. Elisabeth Webb, MU  
Jon Podoliak, PhD student MU

## Project Supervisors

Dr. Elisabeth Webb, MU

## Funding

USDA NRCS

## Cooperators

Natural Resources Conservation Service  
The Nature Conservancy  
Murray State University  
Tennessee Tech University

## Objectives

Evaluate the interaction of habitat variability and bird usage on WRP easements.

Assess the aquatic macroinvertebrate communities present on WRP easements and their relation to study site habitat variables.

Determine the economic return on investment of different restoration strategies used on WRP easements.

## Location

36 WRP Easements in Western Kentucky and Tennessee

## Expected Completion

August 2022

## Status

In progress

## 13Progress and Results

The Wetlands Reserve Program (WRP) seeks to restore wetlands by enrolling private land in conservation easements. However, WRP easements suffer from a lack of post-restoration monitoring. We are evaluating 36 WRP easements across Western Kentucky and Tennessee to determine the effectiveness of restoration activities at creating habitat for avian, vegetation, and aquatic macroinvertebrate communities. WRP restorations in the region typically include hydrologic modification and vegetation re-establishment that lead to a mosaic of habitat types. Typical habitat types include created shallow water areas, remnant forests, new tree plantings, and natural woody regeneration. The composition of these habitat types may influence bird usage and macroinvertebrate assemblages on WRP sites. Our objectives are to explore the association between bird usage and vegetation communities present on study sites, investigate the invertebrate community present and its association with restored habitat, and calculate the ecological return on investment of restored WRP sites.

We are currently processing invertebrate samples from previous sampling rounds in the laboratory and gathering economic data on purchase, management, and restoration costs. There are two more field sampling rounds planned in February and May 2021.

Preliminary data analyses indicate that more diverse WRP sites (those with a higher number of habitat types present) have higher bird species richness. Additionally, higher tree species richness on easements is correlated with higher bird species richness.



# EVALUATING THE ROLE OF WETLAND RESERVE PROGRAM EASEMENTS IN PROVIDING MULTIPLE ECOLOGICAL FUNCTIONS

## Investigators

Jon Podoliak Ph.D. student, MU  
Dr. Elisabeth Webb, MU  
David Hicks M.S. student MU

## Project Supervisors

Dr. Elisabeth Webb, MU

## Funding

USDA NRCS

## Cooperators

The Nature Conservancy  
NRCS  
Tennessee Technological  
University  
Murray State University

## Objectives

Survey biotic communities including avian, amphibian, plant and macroinvertebrates on restored Wetland Reserve Program easements

Evaluate the wildlife habitat and biotic communities present to determine the effectiveness of restorations

Evaluate and determine if WRP easements can provide multiple ecosystem functions concurrently

## Location

36 WRP easements in Western Tennessee and Kentucky

## Expected Completion

December 2022

## Status

In progress

## Progress and Results

The Wetland Reserve Program (WRP) is part of the federal Farm Bill and aims to restore marginal agricultural land to wetlands. The NRCS works with private citizens to restore agricultural land they are no longer farming to wetlands. Since inception the WRP has created over 1 million acres of wetland. Goals of WRP restorations include improving water quality and increasing wildlife habitat. There have been studies which evaluated wildlife habitat or water quality improvements however, few studies have monitored these restorations to determine the quality of wildlife habitat and water quality improvements concurrently. Specifically, in the Mississippi Alluvial Valley WRP easements focusing on restoring bottomland hardwood forests (BLH) which was once the dominant ecosystem. These BLH provided important habitat for wintering and migratory waterfowl, breeding and migratory habitat for neotropical passerine migrants, and breeding habitat for amphibian species. Additionally, BLH aided in filtering nutrients from runoff due to surrounding land use. Denitrification is an important wetland function which transforms nitrogen within wetlands and reduces nutrient loads that may reach downstream waters. Our main goal is to determine whether WRP easements can provide multiple ecosystem functions and to determine the quality of wildlife habitat on easements. Our objectives are to determine whether restored BLH can provide quality wildlife habitat while improving denitrification capabilities at the same time. Additionally, we aim to determine factors of restorations that affect avian use of the site across multiple seasons. Factors being evaluated that may affect avian use of sites include different habitat types, structure, hydrology and basal area of trees. In addition, we are using eDNA to sample for amphibian communities present on easements to determine whether WRP easements can provide quality amphibian habitat. We are sampling 36 WRP easements three times annually in late summer, winter, and spring over the course of two years. Invertebrate samples from Fall 2019 have been processed and samples from additional rounds are currently being processed. Preliminary results show that increased habitat diversity on sites increases avian species richness. Additionally, data from our first sampling year indicate that avian communities respond to different habitat variables and conditions across seasons, which may indicate that having diverse habitat types across the landscape will lead to increased avian use of habitats.

# QUANTIFYING BLUE-WINGED TEAL MIGRATION ROUTES, PHENOLOGY, AND HABITAT SELECTION PATTERNS THROUGHOUT THE NON-BREEDING PERIOD.

## Investigators

Brett Leach, M.S. student, MU  
Dr. Elisabeth Webb, MU  
Dr. William Beatty, USGS  
Paul Link, LDWF

## Project Supervisors

Dr. Elisabeth Webb, MU  
Dr. William Beatty, USGS

## Funding

Louisiana Wildlife and Fisheries  
Foundation, Ducks Unlimited

## Cooperators

Louisiana Department of  
Wildlife and Fisheries  
Ducks Unlimited  
Ducks Unlimited Canada

## Objectives

Quantify habitat selection during  
the non-breeding period at  
multiple spatial scales.

Quantify spring and fall  
migration phenology.

Quantify survival and  
reproductive effort due to  
individual behavior during the  
non-breeding season.

## Location

Krotz Springs, LA  
Sand Lake NWR, SD

## Expected Completion

August 2022

## Status

In progress

## Progress and Results

Blue-winged teal (*Spatula discors*) are an important species for many waterfowl hunters. Early September teal hunting seasons have been around for decades with recent expansions into production states, despite many uncertainties which remain given their long-distance migration and substantial harvest south of the United States border. Blue-winged teal primarily winter in Neotropical countries where band reporting rates are low. Currently, there is a lack of information regarding their timing of migrations, distribution, and use of habitats. Among other waterfowl species, significant carry-over effects have been documented from the non-breeding to the breeding season, and understanding the timing of migration, distribution and habitat selection throughout the non-breeding period offers insights into the drivers of population dynamics.

Utilizing newly released Orni-Track 10 GPS/GSM transmitters, we will be able to collect higher quality and quantitatively more data on a long-distant migrant than previously possible to help address the existing knowledge gaps for blue-winged teal. Since beginning our pilot season in 2019 we have deployed 91 transmitters on adult female blue-winged teal with plans to deploy an additional 60 transmitters by the end of September 2021. Birds will be captured both in the spring in Louisiana and again in South Dakota during preseason banding operations late summer. Transmitters are expected to last 2-3 years, allowing us to track an individual across multiple years from the breeding grounds in Prairie Canada to their wintering grounds as far south as South America.



## AGENT-BASED MODELING OF MOVEMENTS AND HABITAT SELECTION OF MID-CONTINENT MALLARDS

### Investigators

Florian Weller Post doc, MU  
Dr. Elisabeth Webb, MU  
William Beatty, USGS  
Dylan Kesler, Institute for Bird Populations

### Project Supervisors

Dr. Elisabeth Webb, MU

### Funding

USDA NRCS

### Cooperators

NRCS  
University of California - Davis

### Objectives

Develop an agent-based simulation tool to investigate scenarios of habitat use by mallards wintering in the MAV

Identify the relative impacts on mallard population development of the allocation of different wetland conservation acreages, configurations, and compositions

### Location

Mississippi Alluvial Valley

### Expected Completion

September 2021

### Status

In progress

### Progress and Results

Landscape management for waterfowl conservation depends on the evaluation of waterfowl responses to habitat conditions, which may be based on complex and emergent interactions between behavioral, environmental and anthropogenic factors. Agent-based models (ABMs) simulate the movement and actions of thousands of individuals at the same time and thus offer a spatially and temporally explicit approach to evaluating the response of waterfowl populations to conservation scenarios.

We are developing an ABM of mallards (*Anas platyrhynchos*) wintering in the Mississippi Alluvial Valley that is based on the energetics-based SWAMP framework developed for the Central Valley of California. The model simulates food depletion and decay, changes in inundation, and human disturbance, and is extensible to cover the full non-breeding period by integrating weather-driven relocation and migration movements. The model allows for tracking mallards' physiological and behavioural response to changing habitat conditions as well as emergent behaviours of landscape-scale populations. It is intended as a tool for the evaluation of scenarios of wetland conservation allotments under a range of management and future environmental conditions.

We are cooperating with the Eadie lab at the Department of Wildlife, Fish & Conservation Biology at UC Davis in adopting the SWAMP framework for the required scale and location-specific behavioural processes. We are also using two existing databases of location records from radio-tracked mallards to investigate the environmental drivers of large-scale migration movements, with the aim of informing simulated migration initiation in the model. The model is nearing the stage where it can be used for the qualitative analysis of conservation scenarios. We have developed a large library of map-based scenarios for a representative region (~29,000 km<sup>2</sup>) in east-central Arkansas that will be used to explore different habitat management approaches and derive recommendations for management actions under various future climatic circumstances.

# PROJECTS THROUGH THE UNIT

**DR. TOM BONNOT**

## DEVELOPMENT OF LANDSCAPE HEALTH INDEX (LHI) FOR MISSOURI PRIORITY GEOGRAPHIES

### **Investigators**

Dr. Rich Stanton, Post doc, MU

### **Project Supervisors**

Dr. Tom Bonnot, MU

### **Funding**

U.S. Fish and Wildlife Service  
RWO 139

### **Cooperators**

Missouri Department of Conservation

### **Objectives**

Facilitate objective setting for priority geographies

Develop sampling designs (landscape metrics; bird, herp, and fish occupancy and diversity)

Data synthesis of existing sampling designs (aquatics, private lands, etc.)

Develop LHI and dashboard (integration analytics & visualization)

### **Location**

North America

### **Completion**

July 2021

### **Status**

Ongoing

### **Progress and Results**

The Missouri Department of Conservation (MDC) has identified a set of Priority Geographies in which conservation partners are working to support and conserve viable populations of all wildlife and the habitats on which they depend. Now that work is occurring in these geographies, there is a need to assess whether conservation management actions are successfully creating ecologically resilient landscapes. Therefore, in cooperation with the U.S. Fish and Wildlife Service and MDC, we are developing a pilot Landscape Health Index (LHI) to measure progress towards landscape conservation goals by characterizing the status of habitats and species in the geographies. We have rooted the LHI in conservation biology, conservation planning, adaptive management and structured decision making that 1) names and quantifies the key facets of landscape health, 2) summarizes landscape health as a single number based on a value function, and 3) provides a flexible, modular framework for selecting suitable data and analyses to compute the index. The elements of the value function are biotic integrity, landscape condition, social condition, and expected future conditions, which contribute to the landscape health index via a weighting system reflecting the department's priorities. We are integrating modeling approaches across disciplines to quantify salient indicators of landscape health that include 1) associations between stream nutrient dynamics and land use, 2) community-level measures of metapopulation capacity based on habitat mapping, 3) abundance modeling for multiple wildlife species, and 4) human dimensions research.

## 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

December 2020

#### Status

Completed

#### 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**

May 2019

**Status**

Completed

**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.

## DR. MITCH WEEGMAN

### QUANTIFYING INDIVIDUAL DECISION-MAKING IN SPACE AND TIME TO LINK HABITAT CONSERVATION AND MANAGEMENT AT THE CONTINENT-SCALE FOR MIGRATORY SHOREBIRDS

#### Investigators

Dr. Mitch Weegman, MU  
Sarah Clements, Ph.D. student, MU  
Dr. Bart Ballard, Texas A&M-Kingsville  
Jason Loghry, M.S. student, Texas A&M-Kingsville  
Dr. Robert Clark, Environment & Climate Change Canada/U. of Saskatchewan  
Dr. Lisa Webb, MU

#### Project Supervisor

Dr. Mitch Weegman, MU

#### Funding

U.S. Fish and Wildlife Service,  
RWO 133

#### Objectives

- (1) Quantify the fitness implications of within-Prairie Pothole Joint Venture (PPJV) and Upper Mississippi River and Great Lakes Region (UMRGLRJV) decision-making in shorebirds, in terms of their survival and productivity as a function of habitat use, behavior and migration stopover duration.
- (2) Link habitat use and environmental conditions on breeding, staging and wintering areas to understand the relative importance of these areas to survival and productivity, as well as migration duration and stopover behavior.
- (3) Predict bird responses to future climate and landscape scenarios in PPJV and UMRGLRJV areas, and elsewhere, using relationships between decision-making, habitat, survival, and productivity quantified within objectives 1 and 2.

#### Location

North & South America

#### Completion

May 2022

#### Status

In Progress

#### Progress and Results

Wetland-dependent migratory shorebirds are in decline worldwide and are particularly sensitive to landscape and climate change. When studying migratory birds, researchers are often only able to briefly observe habitat use and assume it is linked with habitat quality, which risks incorrectly ascribing conservation plans and overlooks potential carry-over effects of individual decision-making. The focus of this study is on quantifying the causes and consequences of individual decision-making throughout the annual cycle in three wetland-dependent migratory shorebirds with contrasting migration strategies: the American avocet, black-bellied plover, and Hudsonian godwit, which undertake short-, medium-, and long-distance migrations, respectively. Data collection is in progress. Thus far we have captured and GPS-tagged 29 American avocets and 29 black-bellied plovers in Louisiana and Texas, and, working with collaborators in Chile, 38 Hudsonian godwits. We plan to deploy about 20 additional devices per species during spring 2021. Preliminary results show variable migration strategies within and among species. Black-bellied plovers migrated through and stopped over in PPJV and UMRGLRJV areas during spring; we anticipate that further analyses will inform habitat-specific management strategies for these and similar species. Black-bellied plovers also make few stops during their migrations, so stopover habitat choice and timing of stops could be critical in the annual cycle for this species. Further analyses will help us understand the importance of stopover decisions relative to other points in the annual cycle. Additionally, full-annual cycle information for all three species will be useful for continent-scale conservation planning for shorebirds using the Central and Mississippi Flyways. We will complete project objectives by spring 2022.



## PUBLICATIONS BY UNIT SCIENTISTS AND STUDENTS

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11. Fowler, D.N., E.B. Webb, and M.P. Vrtiska. 2020. Condition Bias of Hunter Harvested Birds: Heterogeneity in Body Condition of Long-Lived Waterfowl Species under Spring Harvest. *The Journal of Wildlife Management* 84:33-44.

12. Fowler, D.N., E.B. Webb, M.P. Vrtiska and K. A. Hobson. 2020. Winter carry over effects on spring body condition driven by agricultural subsidies to lesser snow geese (*Anser caerulescens caerulescens*). *Avian Conservation and Ecology*.
13. Guo, C., Y. Chen, R. Gozlen, Z. Li, T. Mehner, S. Lek, X. Ke, and C. Paukert. 2019. Biogeographic freshwater fish pattern legacy revealed despite rapid socio-economic change in developing countries. *Fish and Fisheries* 20:857-869. DOI: 10.1111/faf.12380.
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15. Kesler, D.C., E.B. Webb and J.R. Walters. *In press*. *Conservation Tools and Strategies in Ornithology: Foundation, Critique and Application* (M. Morrison, A. Rodewald, G. Voelker, J. Prather, and M. Colón, eds.). Johns Hopkins University Press.
16. Krabbenhoft, T., Myers, B., Wong, J., Chu, C., Tingley, R., Falke, J., Kwak, T., Paukert, C., and A. Lynch. 2020. Fish and Climate Change (FiCli) Database: Informing management actions for responding to climate change effects in fishes. *Scientific Data*. 7:124. doi.org/10.1038/s41597-020-0465-z.
17. Kuechle, K.J., E.B. Webb, D. Mengel and A.R. Main. 2019. Factors influencing neonicotinoid insecticide occurrence and concentration in floodplain wetlands sediments across Missouri. *Environmental Science & Technology* 53: 10591-10600.
18. LaRose, J., E.B. Webb, and D. Finke. 2019. Comparing grasshopper communities on tallgrass prairie reconstructions and remnants in Missouri. *Insect Conservation and Diversity* 13:23-35.
19. LaRose, J., E.B. Webb, and D. Finke. 2020. Comparing native bee communities on reconstructed and remnant prairie in Missouri. *The Prairie Naturalist* 52:33-44.
20. Lennox, R. J. C. P. Paukert and 28 coauthors. 2019. Hundred pressing questions on the future of global fish migration science, conservation, and policy. *Frontiers in Ecology and Evolution* 7:286. DOI: 10.3389/fevo.2019.00286.
21. Liu, H., C. Gou, X. Qu, F. Xiong, C. P. Paukert, Y. Chen, and W. Su. 2020. Fish diversity, endemism, threats, and conservation in the Jinsha River basin (upper Yangtze), China. *North American Journal of Fisheries Management*. doi.org/10.1002/nafm.10441.
22. Lynch, A. J., D. M. Bartley, T. D. Beard, Jr., D. B. Bunnell, S. J. Cooke, I. G. Cowx, S. Funge-Smith, C. P. Paukert, M. W. Rogers, and W. W. Taylor. 2020. InFish: A research network to promote global conservation and responsible use of inland fish. *Fisheries* <https://doi.org/10.1002/fsh.10419>.
23. Main, A.R., E.B. Webb, K.W. Goynes and D. Mengel. 2019. Field-level characteristics influence wild bee functional guilds on public lands managed for conservation. *Global Ecology and Conservation* 17:e00598.

24. Main, A.R., E.B. Webb, K.W. Goyne and D. Mengel. 2020. Seed treatment pesticides reduce abundance and richness of native bee communities in Missouri agricultural margins. *Agriculture, Ecosystems & Environment* 287:106693.
25. Main, A.R., M.L. Hladik, E.B. Webb, K.W. Goyne and D. Mengel. 2020. Beyond pesticides - wild pollinators are exposed to a range of pesticides while foraging in agroecosystems. *Science of the Total Environment* 742:140436.
26. Moore, M., C. Paukert, and T. Moore. 2020. Effects of latitude, season and temperature on Lake Sturgeon movement. *North American Journal of Fisheries Management* doi.org/10.1002/nafm.10416.
27. Owen, R.K., E.B. Webb, D.A. Haukos, F.B. Fritschi and K.W. Goyne. 2020. Projected climate and land use changes drive plant community composition in agricultural wetlands. *Environmental and Experimental Botany* 175:104039.
28. Owen, R.K., E.B. Webb, D.A. Haukos, F.B. Fritschi and K.W. Goyne. 2020. Barnyardgrass (*Echinochloa crusgalli*) emergence and growth in a changing climate in Great Plains wetlands. *Wetlands Ecology and Management* 28:35-50.
29. Owen, R.K., E.B. Webb, K.W. Goyne, B.M. Svoma and S. Guatam. 2019. Using climate model output data in ecological experiments: a Great Plains case study. *Ecosphere* 10(9):e02857.
30. Paukert, C. P. 2020. Don't Worry, Be Happy: Learning to Let Go. in: *Lessons in Leadership: Integrating Courage, Vision, and Innovation for the Future of Sustainable Fisheries*. American Fisheries Society.
31. Paukert, C., E. Kleekamp, and R. Tingley. 2020. Identifying Candidate Reference Reaches to Assess the Physical and Biological Integrity of Wadeable Streams in Different Ecoregions and Stream Sizes. *Ecological Indicators* 111. doi.org/10.1016/j.ecolind.2019.105966.
32. Paukert, C., E. Webb, D. Fowler, and C. Hilling. In press. Harvest as a Tool to Manage Populations of Undesirable or Overabundant Fish and Wildlife Species. Pages XX to XX in: L. Powell and K. Pope, editors. *Harvest of Fish and Wildlife: New Paradigms for Sustainable Management*. CRC Press.
33. Schepker, T.J., E.B. Webb and T.G. LaGrange. 2019. Are waterfowl food resources limited during spring migration? An energetic assessment of playas in Nebraska's Rainwater Basin. *Wetlands* DOI [10.1007/s13157-018-1047-0](https://doi.org/10.1007/s13157-018-1047-0).
34. Schepker, T.J., E.B. Webb, D. Tillitt and T. LaGrange. 2020. Neonicotinoid insecticides in agricultural wetlands: detection frequency, concentrations and associations with aquatic invertebrate communities. *Agriculture, Ecosystems & Environment* 287:106678.
35. Schultz, J.H., S.A. Wilhelm Stanis, D.M. Hall and E.B. Webb. 2021. Until it's a regulation, it's just not my fight: Complexities of a voluntary nonlead hunting ammunition program. *Journal of Environmental Management* 277:111438.
36. Schulz, J.H., S.A. Wilhelm Stanis, E.B. Webb, C.J. Li, and D.M. Hall. 2021. Attitudes of natural resource professionals about voluntary use of nonlead hunting ammunition. *Journal of Outdoor Recreation and Tourism* 33.

37. Schulz, J.H., S.A. Wilhelm Stanis, E.B. Webb, C.J. Li, and D.M. Hall. 2019. Communication strategies for reducing lead poisoning in wildlife and human health risks. *Wildlife Society Bulletin* 43:131-140.
38. Sievert, N. A., C. P. Paukert, and J. B. Whittier. 2020. A Framework to Incorporate Established Conservation Networks into Freshwater Conservation Planning. *Frontiers in Environmental Science*: doi.org/10.3389/fenvs.2020.515081.
39. Sievert, N.S., J.B. Whittier, and C. P. Paukert. 2019. Influence of Conservation Planning Methodology on Species Representation and Spatial Distribution of Priority Areas. Pages 85 to 108 in D. Dauwalter, editor. *Multispecies and Watershed Approaches to Freshwater Fish Conservation*. American Fisheries Society Symposium.
40. Tingley III, R. W., C. Paukert, G. G. Sass, P. C. Jacobson, G. J. A. Hansen, and A. J. Lynch. 2019. Adapting to climate change: Guidance for the management of inland glacial lake fisheries. *Lake and Reservoir Management* 35: 435-452. doi.org/10.1080/10402381.2019.1678535.
41. Tingley, R. W., Hansen, J. F., Isermann, D. A., Fulton, D. C., Musch, A. and Paukert, C. P. 2019. Characterizing Angler Preferences for Largemouth Bass, Bluegill, and Walleye Fisheries in Wisconsin. *North Am J Fish Manage* 39:676-692. doi:10.1002/nafm.10301.
42. Whittier, J., J. Westhoff, C. Paukert, and R. Rotman. 2020. Use of multiple temperature logger models can alter conclusions. *Water*2(3), 668; doi.org/10.3390/w12030668.
43. Wineland, S. M., R. Fovargue, B. York, A. J. Lynch, C. P. Paukert, and T. M. Neeson. 2020. Is there enough water? How bearish and bullish outlooks shape decision-maker perspectives on environmental flows. *Journal of Environmental Management*. doi.org/10.1016/j.jenvman.2020.111694.

## ORAL AND POSTER PRESENTATIONS

2019-2020

### Invited Presentations

1. Dunn, C.G. 2019. Carps, suckers, carp-suckers, and non-suckers: what fish live in Missouri's large rivers? Invited by organizers of Big Muddy Speaker Series. Rocheport, MO.
2. Dunn, C.G. 2019. Navigating the continuum: regional influences on fish populations and diversity in southeastern river networks. Invited by Aquatic Ecology Group at Oak Ridge National Laboratory. Oak Ridge, TN.
3. Dunn, C.G., and C.P. Paukert. 2020. Casting a wider net: efficacy of a multi-gear survey design for detecting Missouri's imperiled riverine fishes. Invited contribution to Endangered Species Research and Management symposium, Midwest Fish and Wildlife Natural Resources Conference. Springfield, IL.
4. Kuechle, K., E.B. Webb, D. Mengel, and A. Main. 2020. Agricultural seed treatments reduce aquatic insect abundance in managed floodplain wetlands. Southeastern Association of Fish and Wildlife Associations Annual Conference (virtual).
5. Lindner, G., J. Remo, E. Bulliner, R. Jacobson, and C. Paukert. 2020. Spatiotemporal inundation modeling of the middle Mississippi River Floodplain: insights into nutrient processing and other ecosystem services. 5th Annual West Tennessee Water Resources Symposium. Jackson, TN.
6. Main, A.R., E.B. Webb, K.W. Goyne, R. Abney and D. Mengel. 2020. Impacts of neonicotinoid seed-treatment use on native bee abundance and diversity in Midwest agroecosystems. Southeastern Association of Fish and Wildlife Associations Annual Conference (virtual).
7. Moorman, T., M. Brasher, M. Heitmeyer, H. Hagy, D. Humburg, A. Raedeke, J. Davis, J. Feddersen, D. Graber, L. Naylor, D. Osbourne, L. Reynolds and E. Webb. 2019. Non-breeding distribution dynamics of waterfowl: are patterns changing in the 21<sup>st</sup> century? 8<sup>th</sup> North American Duck Symposium, Winnipeg, Manitoba.
8. Paukert, C. 2020. Prioritizing and Implementing Climate Adaptation Strategies for Inland Fish and Fisheries. 2020. Keynoter Speaker, American Fisheries Society Annual Meeting, (virtual).
9. Paukert, C. E. Kleekamp, and N. Sievert. 2019. Linking Local to Landscape Drivers to Aquatic Biodiversity to Prioritize Streams in a Diverse Landscape. International Society for River Science Annual Meeting, Vienna, Austria. .
10. Paukert, C. P. and E. B. Webb. 2019. Harvest as a tool to manage undesirable or overabundant species. American Fisheries Society/The Wildlife Society Joint Annual Meeting, Reno, NV.
11. Paukert, C. P. 2020. Don't Worry, Be Happy: Learning to Let Go. American Fisheries Society Meeting, (virtual).

12. Paukert, C., and M. Moore. 2020. Dispersal and Survival Estimates of Juvenile Lake Sturgeon Stocked in Multiple Locations in the Osage and Gasconade rivers, Missouri Southern Division of the AFS Annual Meeting, Little Rock, AR..
13. Thomas, M. Z. Morris, Z. Ford, A. Turner, J. Dean, and C. Paukert. 2020. Evaluating factors influencing the electrofishing catchability of Blue Catfish and Flathead Catfish. Catfish 2020, Little Rock, AR.
14. Webb, E.B., A. Main, K. Kuechle, D. Mengel and K.W. Goyne. 2019. Distribution of neonicotinoid insecticides in Missouri wetland and agroecosystems. Missouri Natural Resources Conference, Osage Beach, MO.
15. Webb, E.B., D. Mengel, F. Nelson, A. Raedeke, M. MacPherson and E. Hill. 2019. Incorporating avian species of conservation concern in to wetland management practices: tradeoffs and opportunities. Society of Wetland Scientists Annual Conference, Baltimore, Maryland.
16. Webb, E.B., K. Kemink and B. Ross. 2019. Why we need more women in STEM leadership roles: innovations to overcome obstacles and identify solutions. 8<sup>th</sup> North American Duck Symposium, Winnipeg, Manitoba.

#### **PRESENTATIONS AT PROFESSIONAL SOCIETIES, WORKSHOPS, AND CONFERENCES**

1. Abney, R., E.B. Webb, D. Mengel, and A. Main. 2020. Impacts of Neonicotinoids on native bees: evaluating cavity-nesting wild bee reproduction in field-margins surrounding Imidacloprid-treated soybean fields. 80<sup>th</sup> Midwest Fish and Wildlife Conference, Springfield, IL.
2. Abney, R., E.B. Webb, D. Mengel, and A. Main. 2020. Sub-lethal Effects of Neonicotinoids on Native Bees: Evaluating Cavity-nesting Wild Bee Reproduction in Missouri Agroecosystems. Missouri Natural Resources Conference, Osage Beach, Missouri.
3. Baebler, E., and C. Paukert. 2019. The influence of season and streamflow on habitat selection of Spotted Bass and Shorthead Redhorse downstream of a hydropeaking dam in central Missouri, USA. Midwest Fish and Wildlife Conference, Cleveland, OH.
4. Boehm, H., A. Turner, and C. Paukert. 2019. Evaluation of the bonus fishery created by the low-density stocking of Striped Bass in Bull Shoals Lake. Poster. University of Missouri, School of Natural Resources Research Day, Columbia, MO.
5. Boehm, H., A. Turner, C. Paukert. 2020. Dispersal and movement patterns of stocked Striped Bass in Bull Shoals Lake. Poster Presentation. Annual Meeting of the Southern Division of the American Fisheries Society, Little Rock, AR.
6. Boehm, H., A. Turner, C. Paukert. 2020. Dispersal and movement patterns of stocked Striped Bass in Bull Shoals Lake. Poster Presentation. Missouri Natural Resources Conference. Osage Beach, MO.

7. Boehm, H., M. Luehring, J. D. Rose, R. Andersen, M. McGeshick, M. Preul, G. Madison, P. Hanchin, and S. Gilbert. 2019. Lessons learned during a cooperative management plan to restore a naturally-reproducing Walleye population in a Northern Wisconsin lake. The American Fisheries Society and the Wildlife Society Joint Annual Conference, Reno, NV.
8. Brant, J.D., C.P. Paukert. 2019. Hornyhead Chub Spawning Habitat in the East Fork Black River. Oral Presentation. Missouri Natural Resources Conference, Osage Beach, MO.
9. Brooke, B., M. Moore, and C. P. Paukert. 2019. Lake Sturgeon passage of Osage River Lock and Dam #1. Poster Presentation. Missouri Natural Resources Conference, Osage Beach, MO.
10. Dunn, C.G., & C.P. Paukert. 2019. A structured approach for incorporating manager feedback into the survey design of a standardized riverine fish sampling protocol. Missouri Natural Resources Conference. Osage Beach, MO.
11. Hicks, D., J. Podoliak, and E. Webb. 2020. How do wetland birds respond to habitat variables associated with wetland restoration? An evaluation of Wetland Reserve Program easements in western Kentucky and Tennessee. Southeastern Association of Fish and Wildlife Associations Annual Conference (virtual).
12. Kuechle, K, E.B. Webb, D. Mengel and A. Main. 2019. Impacts of neonicotinoids on aquatic invertebrates. Missouri Natural Resources Conference, Osage Beach, MO.
13. Kuechle, K., E.B. Webb, D. Mengel, and A. Main. 2019. A field study assessing effects of neonicotinoid insecticides to aquatic invertebrates: implications for wetland-dependent taxa. 79<sup>th</sup> Midwest Fish and Wildlife Conference, Cleveland, OH.
14. Kuechle, K., E.B. Webb, D. Mengel, and A. Main. 2019. Assessing the relationship between neonicotinoid insecticides and aquatic invertebrates in Missouri wetlands. Society of Wetland Scientists Central Chapter meeting, Booneville, MO.
15. Kuechle, K., E.B. Webb, D. Mengel, and A. Main. 2020. Seed treatments containing neonicotinoids reduce aquatic insect abundance in managed floodplain wetlands. 85<sup>th</sup> North American Wildlife and Natural Resources Conference, Omaha, NE.
16. Lindner, G., E. Bulliner, K. Bouska, C. Paukert, and R. Jacobson. 2019. Mapping flood patterns to address current and future management needs on the Lower Missouri River. Missouri Natural Resources Conference, Osage Beach, MO.
17. MacPherson, M., E. Webb, A. Raedeke, D. Mengel and F. Nelson. 2019. Linking life-history needs of wetland-dependent species with habitat conditions and associated ecological processes to implement the Wetland Planning Initiative. Missouri Natural Resources Conference, Osage Beach, MO.
18. Main, A.R., E.B. Webb, K.W. Goyne, and D. Mengel. 2019. Impacts of neonicotinoid seed-treatment use on native pollinator abundance and diversity in Missouri agroecosystems. Missouri Natural Resources Conference, Osage Beach, MO.

19. Main, A.R., E.B. Webb, K.W. Goyne, R. Abney and D. Mengel. 2020. A multi-year field experiment testing effects of imidacloprid-seed treatment use on wild bee functional guilds of Midwestern agroecosystems. American Chemical Society Conference, San Francisco, CA.
20. Main, A.R., E.B. Webb, K.W. Goyne, R. Abney, and D. Mengel. 2019. Impacts of neonicotinoid seed treatment use on native bee abundance and diversity in Midwest agroecosystems. 85<sup>th</sup> North American Wildlife and Natural Resources Conference, Omaha, NE.
21. Main, A.R., E.B. Webb, K.W. Goyne, R. Abney, and D. Mengel. 2019. Impacts of neonicotinoids on native pollinators: evaluating wild bee guilds in field-margins surrounding imidacloprid-treated soybean fields. 79<sup>th</sup> Midwest Fish and Wildlife Conference, Cleveland, OH.
22. Malone, K.M., E.B. Webb and D. Mengel. 2020. A meta-analysis to quantify secretive marshbird habitat use across the full annual cycle in the Mississippi Flyway. Southeastern Association of Fish and Wildlife Associations Annual Conference (virtual).
23. Malone, K.M., E.B. Webb and D. Mengel. 2020. Quantifying secretive marshbird habitat use across the full annual cycle in the Mississippi Flyway: a meta-analysis. The Wildlife Society Annual Conference (virtual).
24. Mengel, D., E.B. Webb, A. Main, K. Kuechle, K.W. Goyne, L. Satowski and C. Beringer. 2019. Management practices for reducing neonicotinoids in non-target ecosystems. Missouri Natural Resources Conference, Osage Beach, MO.
25. Moore, M. J., and C. P. Paukert. 2019. Lake Sturgeon Movements in the Missouri River Basin Call Attention to the Importance of Tributaries in Large River Fish Conservation. Oral Presentation. Midwest Fish and Wildlife Conference, Cleveland OH.
26. Moore, M. J., C. P. Paukert, T. Moore. 2019. Factors explaining spatiotemporal variation in movement patterns for a coolwater fish, the Lake Sturgeon. Oral Presentation. The American Fisheries Society and the Wildlife Society Joint Annual Conference, Reno, NV.
27. Moore, M. J., C. P. Paukert. 2019. Dispersal and Overwinter Survival of Stocked Age-0 Lake Sturgeon in Two Missouri River Tributaries. Oral Presentation. The North American Sturgeon and Paddlefish Annual Meeting, Gull Harbor, MAN.
28. Moore, M. J., C. P. Paukert. 2020. Investigating the Role of Stocking Location and Tracking Methods on Dispersal and Survival of Lake Sturgeon in the Osage and Gasconade rivers. Missouri Natural Resources Conference, Osage Beach, MO.
29. Moore, M., and C. Paukert. 2019. The Role of Tributary Habitats in the Recovery of the Lake Sturgeon, a Missouri Endangered Species. Missouri Natural Resources Conference, Osage Beach, MO.
30. Owens, S., M. Moore, C. Paukert. 2020. Using side scan sonar mapping to compare fluvial habitats in two large Ozark tributaries to the lower Missouri River. Poster Presentation. Missouri Natural Resources Conference, Osage Beach, MO.

31. Paukert, C., N. Sievert, J. Whittier, E. Tracy Smith, E. Kleekamp, and J. Rogosch. 2020. Aquatic landscape conservation tools: helping manage Missouri's aquatic systems. Missouri Natural Resources Conference, Osage Beach, MO.
32. Podoliak, J., D. Hicks and E. Webb. 2020. The role of habitat diversity in structuring avian communities on Wetland Reserve Program Easements in the Mississippi Alluvial Valley. The Wildlife Society Annual Conference (virtual).
33. Podoliak, J., D. Hicks, and E. Webb. 2020. Habitat diversity on Wetland Reserve Program easements can increase avian species richness. Southeastern Association of Fish and Wildlife Associations Annual Conference (virtual).
34. Rogosch, J. R., J. Brant, S. Abel, H. Boehm, C. Paukert. 2020. Population Size Structure of Stocked Channel Catfish on Fort Leonard Wood. Missouri Natural Resources Conference (virtual).
35. Rogosch, J. S., H. I. A. Boehm, R. W. Tingley, III, and C. P. Paukert. 2020. Is river restoration meeting the biggest challenges to global inland fish and fisheries? The American Fisheries Society Annual Conference, (virtual).
36. Schooley, J.D., A. Nealis, J.M. Long, and C.P. Paukert. 2020. World Record Paddlefish in Keystone Lake, Oklahoma – Hypothetical Causes, New Technologies, and Management Response. North American Sturgeon and Paddlefish Society Meeting, (virtual).
37. Schultz, J.H., S.A. Wilhelm Stanis, M. Morgan, C.J. Lie, D.M. Hall and E.B. Webb. 2020. Attitudes of natural resource professionals about voluntary use of nonlead hunting ammunition. 80<sup>th</sup> Midwest Fish and Wildlife Conference, Springfield, IL.
38. Sievert, N. and C. Paukert. 2020. Examining the Influence of Altered Stream Flow on the composition of Headwater Fish Communities. Missouri Natural Resources Conference, Osage Beach, MO.
39. Sievert, N., and C. Paukert. 2019. Investigating the Role of Stream Flow in the Structuring of Headwater Stream Fish Communities. Missouri Natural Resources Conference, Osage Beach, MO.
40. Smith, D., E.B. Webb, S. Amelon, and S. Marquardt. 2019. Indiana bat (*Myotis sodalis*) maternity roost site selection at National Wildlife Refuges in northern Missouri. Missouri Natural Resources Conference, Osage Beach, MO.
41. Thomas, M. Z. Ford, A. Turner, J. Dean, and C. Paukert. 2019. Mapping the Effective Field of an Electrofishing Boat to Inform Evaluations of Catchability. The American Fisheries Society and the Wildlife Society Joint Annual Conference, Reno, NV.
42. Thomas, M. Z. Morris, Z. Ford, A. Turner, J. Dean, and C. Paukert. 2020. Effects of waveform, power, and water temperature affect Blue Catfish and Flathead Catfish electrofishing catchability. Missouri Natural Resources Conference, Osage Beach, MO.
43. Thomas, M., A. Turner, Z. Ford, J. Dean, and C. Paukert. 2020. Evaluating factors influencing the electrofishing catchability of Smallmouth Bass in Missouri Ozark Rivers. Midwest Fish and Wildlife Conference, Springfield, IL.

44. Thomas, M., A. Turner, Z. Ford, J. Dean, and C. Paukert. 2020. How does electrofishing power and environmental conditions affect Smallmouth Bass catchability in Ozark rivers? Missouri Natural Resources Conference, Osage Beach, MO.
45. Thomas, M., Z. Ford, A. Turner, and C. Paukert. 2019. Mapping the Effective Field of an Electrofishing Boat to Inform Evaluations of Catchability. Missouri Natural Resources Conference, Osage Beach, MO.
46. Tingley III, R. W., J. Hansen, D. Isermann, D. Fulton, A. Musch, and C. Paukert. 2019. It's complicated: Characterizing Wisconsin angler preferences for largemouth bass, bluegill, and walleye fisheries in inland lakes. 79th Annual Midwest Fish & Wildlife Conference, Cleveland, OH.
47. Tingley RW III, Paukert CP, Sass GG, Jacobson PC, Hansen GJA, Lynch AJ, Shannon PD. 2019. Considerations on Adapting Inland Glacial Lake Fisheries Management to Climate Change. The American Fisheries Society and the Wildlife Society Joint Annual Conference, Reno, NV.
48. Tracy-Smith, E., C. Paukert, N. Sievert, P. Blanchard, M. Combes, B. Landwer, and J. Persinger. 2020. Evaluating fish community changes to stream flow alterations. Missouri Natural Resources Conference, Osage Beach, MO.
49. Webb, E.B., A. Main, K. Kuechle, D. Mengel and K.W. Goyne. 2020. Distribution of neonicotinoid insecticides in midwestern wetland and agroecosystems. 85<sup>th</sup> North American Wildlife and Natural Resources Conference, Omaha, NE.
50. Webb, E.B., K.W. Goyne, A. Main, K. Kuechle, L. Satowski, C. Beringer and D. Mengel. 2020. Management practices for reducing neonicotinoids in non-target ecosystems. 85<sup>th</sup> North American Wildlife and Natural Resources Conference, Omaha, NE.
51. Weller, F., E.B. Webb, W. Beatty, D. Kesler, M. Miller, K. Ringelman, R. Blenk, S. Fogenburg and J. Eadie. 2020. Agent based modeling of waterfowl in the Mississippi Alluvial Valley. 80<sup>th</sup> Midwest Fish and Wildlife Conference, Springfield, IL.
52. Weller, F., E.B. Webb, W. Beatty, D. Kesler, M. Miller, K. Ringelman, R. Blenk, S. Fogenburg and J. Eadie. 2020. Using an agent based model to understand the role of landscape composition on wintering mallard body condition, movements and survival. The Wildlife Society Conference (virtual).

## THESES AND DISSERTATIONS

2019-2020

- Brant, J. 2020. Habitat use and distribution of lithophilic spawning and riffle fishes in the east Fork of the Black River. M. S. Thesis, University of Missouri-Columbia. C. Paukert, advisor.
- Chilton, T.J. 2019. Habitat associations and distributions of endemic crayfish in the Meramec River Drainage. M.S. Thesis, University of Missouri Columbia. A. Rosenberger, advisor.
- Dunn, C. G. 2020. Assessment and diversity of fish communities in non-wadable tributaries of the Missouri and Mississippi river. Ph.D. Dissertation, University of Missouri-Columbia. C. Paukert, advisor.
- Owen, R. 2019. Playa wetland plant and soil response to predicted climate and land use change in the southern Great Plains. Ph.D. Dissertation, University of Missouri-Columbia. E. Webb and K. Goyne, advisors.
- Pherigo, E. 2019. Seasonal fish community and reproductive biology of fishes in two tributaries of the lower Missouri River, USA. M. S. Thesis, University of Missouri-Columbia. C. Paukert, advisor.
- Pierce, L. 2019. Conservation biogeography of lotic fishes in the Missouri and Colorado River Basins. Ph.D. Dissertation, University of Missouri-Columbia. C. Paukert, advisor.
- Smith, D. 2020. Occupancy modeling of bat species on national wildlife refuges along a latitudinal gradient in Northern Missouri. M.S. thesis. University of Missouri-Columbia. E. Webb, advisor.
- Thomas, M. 2020. Evaluation of the factors influencing electrofishing capture probability of Smallmouth Bass, Blue Catfish, and Flathead catfish. M. S. Thesis, University of Missouri. C. Paukert, advisor.

## COMMITTEES AND OTHER PROFESSIONAL SERVICE

2019-2020

### **Craig Paukert**

- Chair, American Fisheries Society Committee on Climate Change, 2018-present
- Member, Education Committee 2021 World Fisheries Congress in Adelaide, Australia, World Fisheries Congress, 2018 - Present
- Invited member, Scoping Document, assessment of the interlinkages among biodiversity, water, food and health (nexus assessment). Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2020-present
- Invited Member, Science Committee, National Fish Habitat Initiative, 2005-present
- Invited member, 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 Member, AFS Committee to review possible World Fisheries Congress bid for the 2024 meeting, 2018-2020
- Member, International Fisheries Section of AFS Student Exchange Program Committee, 2019-2020
- Chair, International Rivers Symposium, American Fisheries Society and International Society of River Science., American Fisheries Society, 2019 - 2020
- Chair, Mississippi River Yangtze River Symposium, American Fisheries Society and Chinese Academy of Sciences, American Fisheries Society, 2019 – 2020
- External PhD Reviewer, University of New England, Australia, 2020

### **Lisa Webb**

- USGS Representative to the Mississippi Flyway Technical Council, 2018-present
- Member, Director's Faculty Advisory Council, School of Natural Resources, University of Missouri (2017-2020)
- Organized and moderated special session on 'Impacts of neonicotinoids to non-target ecosystems and specie' at 85<sup>th</sup> North American Wildlife and Natural Resources Conference, March 2020
- Organized and moderated special session on 'Women in Waterfowl' 8<sup>th</sup> North American Duck Symposium, Winnipeg, Manitoba, August 2019
- Science Program Committee member, 8<sup>th</sup> North American Duck Symposium (2018-2019)
- Organized and moderated symposium on 'Current Use Pesticides: Exposure and Effects on non-target organisms and ecosystems' at 39<sup>th</sup> Annual Meeting SETAC North America, Sacramento, CA, November 2018.

### **Robert Abney, M.S. Student Advised by Webb**

- Vice President, Wildlife and Fisheries Graduate Student Organization (WAFSGSO), University of Missouri School of Natural Resources, 2019–2020
- Member, Boone Regional Beekeepers Association, 2019-present
- Member, The Wildlife Society, 2019-present

**Hadley Boehm, Ph.D. Student Advised by Paukert**

- Member, American Fisheries Society, 2013-present
- Member, American Fisheries Society Missouri Chapter, 2019-present
- Member, American Fisheries Society Wisconsin Chapter, 2012-18
- Member, Wildlife and Fisheries Graduate Student Organization (WAFSGSO), University of Missouri School of Natural Resources, 2018-present
- Treasurer, MU/SNR WAFSGSO, University of Missouri, 2019-present
- Coordinator of MU/SNR WAFSGSO invited speaker seminar series, 2019-present
- Mentor, MU/SNR WAFSGSO graduate student-undergraduate mentor program, 2019-present.
- Reviewed Midwest F&W Conference student/young professional scholarship applications on behalf of AFS-North Central Division, 2020
- Webinar Committee Co-Chair, American Fisheries Society Education Section, 2018-20
- MU College of Veterinary Medicine Pet Assisted Love and Support & MU Hospital WAGS Therapy Dog Programs, 2018-20
- Reviewer, *North American Journal of Fisheries Management*, 2020
- Reviewer, *The Prairie Naturalist*, 2019
- Co-leader of *GIS Techniques for Natural Resources Management* workshop, SD-AFS annual meeting, Little Rock, AR, 2020

**David Hicks, M.S. Student Advised by Webb**

- Member, Wildlife and Fisheries Sciences Graduate Student Organization (WAFSGSO), University of Missouri School of Natural Resources, 2019-present
- Vice President, WAFSGSO, University of Missouri School of Natural Resources, 2020-present
- Member, Conservation Federation of Missouri, 2020-present
- Member, The Wildlife Society, 2019-present

**Brett Leach, M.S. Student Advised by Webb**

- Member, The Wildlife Society, 2011 – present
- Member, Ducks Unlimited - Mizzou Chapter, 2020 – present

**Michael Moore, Ph.D. Student Advised by Paukert**

- 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 - 2020
- Instructor Beginning and Intermediate GIS Workshops, AFS Annual Meeting, 2017, 2018, and 2019
- Served as Ashley Hrdina's mentor for the American Fisheries Society Hutton Junior Fish Biologist Program, 2019.
- HHMI Thrive Undergraduate Student Community of Practice Graduate Mentor at the University of Missouri in 2019.
- Conservation Federation of Missouri and Rivers and Streams Committee member (2018–present).

- Co-Chair “Confronting present and emerging stressors in rivers for global fisheries conservation.” Symposium National American Fisheries Society Meeting 2020, (virtual).

**Gabrielle Ruso, Ph.D. Student Advised by Webb and Paukert**

- Member, The Wildlife Society, October 2020 – present
- Member, Society of Environmental Toxicology and Chemistry, July 2020 – present

**Nick Sievert, Ph.D. Student Advised by Paukert**

- Newsletter Co-Editor, Missouri Chapter of the American Fisheries Society, 2016 – present
- Co-Chair, Rivers, Streams, and Fisheries Committee, Conservation Federation of Missouri, 2016-present
- Reviewer, *North American Journal of Fisheries Management*, 2019
- Member, American Fisheries Society, 2011-present
- Member, American Fisheries Society Missouri Chapter, 2011-present
- Member, Conservation Federation of Missouri, 2016-present

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

- Board Member, Advocacy Advisor, Stream Teams United, 2019 – present
- Member, School of Natural Resources Director’s Staff Advisory Team, 2017 – present
- 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, Presentation Committee for the Big Muddy Speaker Series, Missouri River Relief, 2018-present
- Reviewer, *River Research and Applications*, 2019-2020

**Reid Viegut, M.S. Student Advised by Webb**

- Member, The Wildlife Society Missouri Chapter, 2020 – present
- Member, Ducks Unlimited Mizzou Chapter, 2020 – present
- Member, Society of American Foresters, 2017 – present
- Member, The Wildlife Society, 2016 – present

## AWARDS AND RECOGNITION

2019-2020

### **Craig Paukert**

- Drive to Distinction Award, MU College and Agriculture Food and Natural Resources top 10 research dollars, 2020
- USGS STAR Award for outstanding performance, 2019-2020
- Promoted to GS-15 through USGS Research Grade Evaluation Process
- Top 10% Most Downloaded Papers from North American Journal of Fisheries Management, 2018-2019

### **Lisa Webb**

- USGS Cooperative Research Unit Scientific Excellence Award, 2019
- USGS STAR Award for outstanding performance, 2019-2020
- Promoted to GS-14 through USGS Research Grade Evaluation Process

### **Robert Abney, M.S. Student Advised by Webb**

- Student Travel Award, Ozark-Prairie SETAC meeting, 2019
- Transworld Airlines Scholarship, University of Missouri, 2019
- Janice Lee Fenske Memorial Award finalist, 2019

### **Elisa Baebler, M.S. Student Advised by Paukert**

- Joan Duffy Travel Grant Award Winner, Missouri Chapter of the AFS, 2019

### **Hadley Boehm, Ph.D. Student Advised by Paukert**

- Trans World Airlines Scholarship, only 5 non law school awards given each year in the University of Missouri system, 2020
- Noreen Clough Memorial Scholarship for Females in Fisheries, (B.A.S.S. and Southern Division of AFS, 2020
- Robert Jenkins Memorial Reservoir Scholarship Southern Division of the AFS, 2020

### **John Brant, M.S. Student Advised by Paukert**

- Charles P. Bell Graduate Scholarship, Conservation Federation of Missouri Charitable Trust, 2019

### **David Hicks, M.S. Student Advised by Webb**

- Janice Lee Fenske Memorial Award finalist, 2020
- Carl Morrow Graduate Scholarship in Wildlife, Conservation Federation of Missouri, 2020
- Chambers Family Memorial Scholarship, Conservation Federation of Missouri, 2020

### **Michael Moore, Ph.D. Student Advised by Paukert**

- Outstanding Graduate Student in the MU School of Natural Resources, 2020

- Diana Hallett Fellowship 2020
- Charles P. Bell Graduate Scholarship- Conservation Federation of Missouri, 2020
- Carl Morrow Graduate Scholarship in Fisheries-Conservation Federation of Missouri, 2020
- Best Student Aquatics Presentation, Missouri Natural Resources Conference, 2020
- Travel Award, North American Sturgeon and Paddlefish Society, 2019
- Student Travel Award North American Sturgeon and Paddlefish Society Annual Conference, 2019

**Rachel Owen, Ph.D. Student Advised by Webb**

- Mizzou 18 Award, University of Missouri Alumni Association, 2019
- D.L. Hallett Fellowship, School of Natural Resources, MU, 2019

**Drew Self, Undergraduate Honors Student Advised by Webb**

- Outstanding Discovery Fellow, University of Missouri Honors College, 2019

**Mike Thomas, M.S. Student Advised by Paukert**

- Best Student Aquatics Poster, Missouri Natural Resources Conference, 2020
- Janice Lee Fenske Memorial Award finalist, 2020
- Joan Duffy Travel Grant Winner, Missouri Chapter of the AFS, 2020
- Best Student Aquatics Poster, Missouri Natural Resources Conference, 2019

**Ralph Tingley, Post-Doctoral Researcher Advised by Paukert**

- Top 10% Most Downloaded Papers from North American Journal of Fisheries Management, 2018-2019

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

- TIGER Award, Mizzou School of Natural Resources, 2020
- Missouri Stream Team Advocacy Award, 2019
- Best PhD Graduate Student Poster Award 2019, University of Missouri School of Natural Resources Research Day



Lisa Webb receiving the 2019 Cooperative Research Units Scientific Excellence Award, which is given to one Cooperative Research Unit Scientist annually. Lisa is shown with her Missouri Department of Conservation collaborators (left to right) Frank Nelson, Andy Raedeke, Lisa, Doreen Mengel, and Craig Paukert.

## SCIENCE IN THE NEWS AND OUTREACH

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

2019 TO 2020



Craig Paukert at Grand Lake, Oklahoma being interviewed about Paddlefish and other unique fishes  
for a new Discovery Channel Show called Planet Snoop

### **Craig Paukert**

- A recent dataset and paper in Nature: Scientific data on projected and documented effect of climate change on fish has been highlighted with [USGS](#), [Wildlife Management Institute](#), [University of Missouri](#), and 7 news outlets and is **considered** in the top 5% of papers published according to its Almetric score. : <https://www.altmetric.com/details/80227719/news>, 2020.
- A paper co-authored by Paukert on the value on inland fish globally was highlighted by the [US Geological Survey](#), 2020.
- Paukert was interviewed by [Outdoor Oklahoma](#) and the [Tulsa World](#) related to the World Record Paddlefish that was caught in summer 2020. The paddlefish was tagged by Paukert during his MS work in 1997 when he was a graduate student with the Oklahoma Cooperative Fish and Wildlife Research Unit at Oklahoma State University.
- Host Global Inland Fisheries Biodiversity and Sustainability Workshop to about 50 scientists from four countries at the United Nations, 2019.
- Gave public seminar on Fish Migration at the Missouri River Relief Big Muddy Seminar series, 2020.
- Gave an overview of Missouri fish and fish conservation to Gary White, CEO of water.org as part of SNR-hosted event, 2019.
- A new Discovery Channel Documentary on the wonders of the natural world will highlight Paukert as he (and colleagues from the Oklahoma Department of Wildlife Conservation) discussed conservation and management of Paddlefish and other unique freshwater fishes. The new show is tentatively titled Planet Snoop because it will be hosted by Snoop Dogg, 2020.

### **Lisa Webb**

- Presentation on ‘Neonicotinoids in Missouri: occurrence, impacts and implications’ to the Missouri Department of Conservation Wildlife Division Conference. Jefferson City, MO September 2019.
- Presentation on ‘Neonicotinoids in Missouri agro-ecosystems and impacts to ono-native pollinators’ at the Monarch Butterfly and Native Pollinator Habitat Workshop sponsored by Missouri Department of Conservation. 19-20 June 2019.
- Public seminar on ‘Neonicotinoids in Missouri Aquatic Ecosystems’ at the Missouri River Relief Big Muddy Seminar series, 2019.
- Webinar on ‘Ecological Implications of Neonicotinoids on Public Lands’ for USFWS Refuge Biologists, Region 4. (virtual), April 2019.
- Workshop on ‘Neonicotinoids in Missouri: Prevalence and Threats to Non-target Ecosystems’ for Missouri Corn Growers and Soybean Growers Association. Jefferson City MO, March 2019.

### **Robert Abney, M.S. Student advised by Webb**

- Volunteer, Designed and built an educational pollinator garden at Fairview Elementary School in Columbia, MO and provided educational materials to science staff at the school.



Recently established pollinator garden at Fairview Elementary in Columbia, MO. Built by graduate students with funds from a grant by the Conservation Federation of Missouri.

### **Hadley Boehm, Ph.D. Student Advised by Paukert**

- Volunteer, Pet Assisted Love and Support (PALS) to visit around 20 rooms at the Oncology Floor of the MU Hospital with her dog.

### **Corey Dunn, Ph.D. Student Advised by Paukert**

- Gave public seminar on Fishes of Missouri at the Missouri River Relief Big Muddy Seminar series, 2019.

### **Michael Moore, Ph.D. Student Advised by Paukert**

- Organized a virtual four-part series of academic enrichment activities titled “Fun in Science” for the Grade A+ program Summer STEM program, a local non-profit providing after school tutoring for low-income and minority students, 2020.
- Led station on native fishes for 180 8<sup>th</sup> grade students at Missouri River Relief’s “Investigating the Missouri River,” event, 2019.
- Presented “River monsters in training: movement and survival of juvenile Lake Sturgeon,” for the Personal Greening Speaker Series at Olivet Christian Church, 2019.
- Presented “Lake Sturgeon, Missouri rivers: tracking migrations for the recovery of a prehistoric giant.” at Science on Tap COMO, 2019.
- Organized a four-part series of academic enrichment activities titled “Backyard Biodiversity” for the Grade A+ program Summer STEM program, Students made their own nature journals and took photos to create backyard field guides from trips to local creek and parks, 2019.

### **Nick Sievert, Ph.D. Student Advised by Paukert**

- Volunteer, Missouri River Days Education Program for 4<sup>th</sup> grade students, Missouri River Relief, 2019.

### **Mike Thomas, M. S. Student Advised by Paukert**

- Volunteer, Missouri River Days Education Program for 4<sup>th</sup> grade students, Missouri River Relief, 2019.

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

- Volunteer, Missouri River Days Education Program for 4<sup>th</sup> grade students, Missouri River Relief, 2019.



Missouri Coop Unit students, staff, and friends gather for the 2019, 3rd annual Wylde Games, an Olympic-style event with activities and games based on student research. Missouri Unit students and post docs have organized the games, created a flag, and run the games. We could not have the Games in 2020 due to Covid but hope we can get back to the events soon.