PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM (PRRIP or Program)
Memorandum

TO: Governance Committee (GC)
FROM: Executive Director's Office (EDO)
RE: Peer Review Panel for Forage Fish Synthesis Document Peer Review
DATE: September 1, 2015

Request for GC Action

The EDO requests a motion from the GC to appoint these three peer review candidates and approve the associated peer review scope of work.

Background

Louis Berger submitted a report (**Attachment A**) in response to the Program's request for potential peer review panel members for the forage fish synthesis document. The EDO requested Louis Berger look for candidates, where possible, with cross-cutting expertise in least tern ecology, small riverine fish ecology, and ecological statistics particularly when those areas of expertise were applied in the context of a large-scale species recovery program. Louis Berger considered a list of twenty (20) peer review candidates. Several declined due to previous commitments, perceived there were conflicts of interest, or failed to respond to a request for information regarding their background, interest, and availability, leaving a final pool of nine (9) potential peer review panel members. The EDO reviewed this information to develop a list of three recommended panelists.

These peer review candidates and the Scope of Work are currently being reviewed by the Technical Advisory Committee (TAC). Any input or concerns raised by the TAC during the week of August 31, 2015 will be discussed with the GC during the September 8-9, 2015 GC meeting.

Peer Review Panel

The EDO recommends appointment of this peer review panel:

Name	Affiliation	Area of Expertise	Reasoning
Brian Gray, Ph.D.	USGS Upper Mississippi Ecological Sciences Center	Ecological statistics	Expertise with non-experimental (observational) data; experience with monitoring data involving river processes and related species; background with data analyses for large-scale river management programs.
Christopher Hoagstrom, Ph.D.	Weber State University	Small riverine fish ecology	Extensive experience with the ecology of Great Plains minnows; familiarity with small fishes in the Missouri River basin and experience with small fish ecology in managed river systems.
Sara Schweitzer, Ph.D.	North Carolina Wildlife Resources Commission	Least tern ecology	Experience with terns in the Central Flyway; expertise with tern monitoring for abundance, distribution, and site selection.

Louis Berger's summary memo and CVs for all peer review panel candidates are included in **Attachment A** for further reference.

Scope of Work and Schedule

The EDO drafted the Scope of Work (**Attachment B**) for this peer review based on Program need and the scopes for previous Program peer reviews. The EDO intends to follow the schedule below for completing peer review of the forage fish synthesis document:

Task/Deliverable	Completion Date
Task 1: Governance Committee (GC) approval of peer review scope of work and appointment of peer review panel.	September 8, 2015
Task 2: Executive Director's Office (EDO) secures signed contracts with all peer reviewers.	September 30, 2015
Task 3: Louis Berger and EDO provide access to all materials needed for review to each peer reviewer.	October 2, 2015
Task 4: Reviewers conduct a thorough, objective peer review of the forage fish synthesis document. Louis Berger and EDO answer clarifying questions as necessary. Peer reviewers provide written reviews to Louis Berger.	November 13, 2015
Task 6: Louis Berger summarizes individual peer reviews in a summary report and provides report to EDO.	December 18, 2015
Task 7: EDO provides written response to each peer review comment and proposes changes/edits to forage fish synthesis document, as necessary.	January 15, 2016
Task 8: TAC meeting to discuss results of peer review and EDO responses.	February, 2016
Task 9: EDO makes final edits to forage fish synthesis document.	February, 2016
Task 10: EDO seeks GC approval of final peer review package.	March 2015 (specific date TBD)

ATTACHMENT A

LOUIS BERGER REPORT – RECOMMENDED PEER REVIEW PANELISTS FOR FORAGE FISH SYNTHESIS DOCUMENT PEER REVIEW

Platte River Recovery Implementation Program

INDEPENDENT SCIENCE REVIEW
CONTRACT SERVICES REPORT

Submitted by

Louis Berger

August 2015

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1.0 Introduction and Background

The Platte River Recovery Implementation Program (Program) is intended to address issues related to endangered species and the loss of critical seasonal habitat in the Platte River in central Nebraska by managing land and water resources using the principles of adaptive management (AM). The application of AM to the Platte River will provide benefits for four protected species (i.e., Whooping Crane, Interior Least Tern, Piping Plover, and Pallid Sturgeon). One of the Program's management objectives is to increase production of interior least tern from the Associated Habitat Reach (AHR) along the central Platte River in Nebraska. Over the past eight years, the Program has implemented management actions through an AM program to reduce uncertainties about proposed management strategies and learn about species responses to management actions. This has resulted in a large body of species response data and the development of modeling and analysis tools for data interpretation and synthesis.

The Program is conducting a peer review of a data synthesis compilation document titled "Weight of Evidence Approach to Assessing Relationships between Flow and Interior Least Tern Forage Fish Abundance, Foraging Behavior, Productivity, and Dietary Requirements." The document, prepared by the Executive Director's Office, has six sections, each of which has unique objectives and analyses that generally represent separate and distinct lines of evidence for testing Program hypotheses and answering the associated "Big Question." The purpose of the review is to provide a formal, independent, external scientific peer review of the information presented in the data synthesis compilation.

This report was prepared to assist with the identification of prospective candidates for three peer review panel member positions. Louis Berger was asked to identify two to three candidates for each position. This report describes the process Louis Berger used to identify potential candidates and includes short biographical sketch forms, curricula vitae (CV) and signed no-conflict-of-interest statements for each candidate.

2.0 Selection of Potential Peer Review Panel Members

2.1 Background

The Program requested peer review panel member candidates that comprised the following areas of expertise: tern ecology (e.g., tern life history, bioenergetics); small fish ecology (e.g., Cyprinids or semi-arid river small fish); and ecological statistics. In its search, Louis Berger gave preference to individuals with experience in the Great Plains.

2.2 Identification of Potential Peer Review Panel Members by Louis Berger

The following is a brief summary of the process Louis Berger used to identify potential peer review panel members.

Step 1: Develop clear understanding of the required expertise of each position. This included a discussion with the Director of Natural Resources to obtain specific information on desired qualifications and experience.

Step 2: Conduct a search for potential candidates. Prospective candidates were identified from the subject-matter expertise network, as well as internet searches (e.g., Google Scholar) and reviews of relevant scientific journals, conference proceedings, and other publications. The subject-matter expertise network includes, but is not limited to, personal contacts, individuals previously considered for other peer reviews, and recommendations from other subject-matter experts with similar expertise.

Step 3: Contact prospective candidates to screen for criteria and conflict of interest. Prospective members were contacted to determine their interest, availability, and willingness to serve. Time commitments, experience, and potential conflicts of interest were also discussed.

Step 4: Obtain CVs, biographical sketch forms and signed "no conflict of interest" statements from all candidates. Each candidate was asked to provide their CV (Appendix A) and fill out a short biographical sketch highlighting their education, skills and experience. Each candidate was also asked to sign a "no conflict of interest" form (Appendix B).

3.0 Potential Peer Review Panel Members

Listed below are the 10 potential peer review panel members identified by Louis Berger, along with their affiliations and proposed positions on the panel (Table 3-1). These candidates have been critically reviewed to avoid conflicts of interests and ensure availability to serve. Following Table 3-1 are one-page biographical sketches for each proposed peer review panel member. For additional information about each candidate, please refer to their CVs in Appendix A.

Table 3-1: Potential Peer Review Panel Members

Name	Affiliation	Proposed Position on Peer Review Panel
Ali Arab, Ph.D.	Georgetown University	Ecological Statistics
Timothy Bonner, Ph.D.	Texas State University	Small Fish Ecology
Brian Cade, Ph.D.	USGS Fort Collins Science Center	Ecological Statistics
Priscilla Crawford, Ph.D.	University of Oklahoma	Tern Ecology
Brian Gray, Ph.D.	USGS Upper Mississippi Environmental Sciences Center	Ecological Statistics
Christopher Hoagstrom, Ph.D.	Weber State University	Small Fish Ecology
Eileen Kirsch, Ph.D.	USGS Upper Mississippi Environmental Sciences Center	Tern Ecology
Sara Schweitzer, Ph.D.	North Carolina Wildlife Resources Commission	Tern Ecology
Gene Wilde, Ph.D.	Texas Tech University	Small Fish Ecology

In addition to the above candidates, Louis Berger contacted 10 other individuals for this peer review who were either unavailable to participate or did not respond (Table 3-2).

Table 3-2: Other Individuals Contacted for this Peer Review

Name and Affiliation	Area of Expertise	Reason for Not Participating
Kevin Bestgen, Colorado State University	Small Fish Ecology	Did not reply to email responding to his questions
Roger Boyd, Baker University	Tern Ecology	Over committed during timeframe
Robert Dorazio, USGS Southeast Ecological Science Center / University of Florida	Ecological Statistics	Over committed during timeframe
Keith Gido, Kansas State University	Small Fish Ecology	Unavailable until November
Mevin Hooten, Colorado State University	Ecological Statistics	Over committed during timeframe
Andrew Kasner, Wayland Baptist University	Tern Ecology	Willing, but unable to return forms in time
David Leslie, Oklahoma State University	Tern Ecology	No longer working in this area
Casey Lott, American Bird Conservancy	Tern Ecology	Disagrees with need for future research on topic, as well as implementation
Joshuah Perkin, Tennessee Technological University	Small Fish Ecology	N/A (no response)
Joanna Whittier, University of Missouri	Tern Ecology	No reason provided
Chris Wikle, University of Missouri	Ecological Statistics	Willing, but not focused on ecological problems

Proposed Peer Review Panel Members

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Ali Arab, Georgetown University

Proposed Peer Review Panel Member for
Platte River Recovery Implementation Program

Name	Ali Arab
Title	Associate Professor of Statistics
Affiliation	Georgetown University, Department of Mathematics and Statistics
Address	305 St. Mary's Hall, 3700 O St NW, Washington, DC 20057
Phone #	(202) 687-1878
E-mail	ali.arab@georgetown.edu

Education	PhD (Statistics)

Unique Qualifications

Professor Arab's expertise includes metholodogical work in statistics with focus on applications to problems in ecology, fisheries, environmental studies, and epidemiology. He has worked in both classical and Bayesian inference. His research expertise include Bayesian hierarchical models, spatial and spatio-temporal analysis, and trend and pattern analysis of climate related response in environmental, ecological, and epidemiological phenomena.

Short Biography of Proposed Peer Review Panelist

Ali Arab is an Associate Professor of Statistics in the Department of Mathematics and Statistics at Georgetown University. He received a BS in Applied Mathematics at the Iran University of Science and Technology (Tehran, Iran; 1999) and an MS in Applied Mathematics and Statistics at Southern Illinois University Edwardsville (2002) and PhD in Statistics at University of Missouri-Columbia (2007). He joined Georgetown University in 2007. His methodological research is in spatio-temporal and spatial statistics, and hierarchical Bayesian modeling. He is interested in applications of statistics in the environment and climate change, ecology and marine ecology, epidemiology, science and human rights, and risk and reliability analysis. He has published in peer-reviewed journals in both statistics andsubject matter including ecology and fisheries. He has past and ongoing collaborations with fisheries ecologists, ecologists, and health professionals.

Timothy Bonner, Texas State University

Proposed Peer Review Panelist for
Platte River Recovery Implementation Program

Name	Timothy H. Bonner
Title	Professor of Biology
Affiliation	Texas State University, Department of Biology/Aquatic Station
Address	601 University Drive, San Marcos TX 78666
Phone #	512-245-2284
E-mail	Tbonner@txstate.edu

Education	BS Texas A&M, MS Texas State, PHD Texas Tech

Unique Qualifications

Aquatic ecologist with emphasis on the ecology and biology of fluvial fish communities. Research experience with reproductive biology and ecology, trophic ecology, historical ecology, and quantitative habitat analyses. Majority of research is concentrated within western gulf slope drainages of Louisiana, Texas, and New Mexico, which include prairie and desert streams.

Short Biography of Proposed Peer Review Panelist

I was hired as an assistant professor by the Department of Biology (Texas State University) in 2001. I received tenure and was promoted to associate professor in 2006 and promoted to full professor in 2012. To date, I've authored or co-authored about 70 peer-reviewed publications, including one book (Freshwater Fishes of Texas), graduated 33 MS and 3 PHD students, served on several science and advisory panels, served as reviewer of numerous journal manuscripts, and am actively involved in several professional societies. I've authored or co-authored funded research and teaching proposals totaling over $9 million, including funds from the National Science Foundation (NSF), US Army, and US Fish and Wildlife Service (USFWS). Many aspects of my research involves federally and state listed threatened and endangered fishes. I've been involved with development, review, and research associated with the Edwards Aquifer Recovery Implementation Program (RIP) and later Habitat Conservation Plan (HCP).

Brian Cade, USGS Fort Collins Science Center

Proposed Peer Review Panel Member for
Platte River Recovery Implementation Program

Name	Brian S. Cade
Title	Research statistician (biology)
Affiliation	U. S. Geological Survey
Address	Fort Collins Science Center, Bldg C, 2150 Centre Ave., Fort Collins, CO 8(
Phone #	970 226-9326
E-mail	cadeb@usgs.gov

Education	B.S. Wildlife Biology 1977, M.S. Wildlife Biology 1985, PhD. Ecology

Unique Qualifications

I have a mix of biological field research expertise, numerical modeling expertise for environmental impact assessments and for evaluating habitat management alternatives to implement conservation policies, statistical expertise in advanced linear modeling procedures for estimating intervals of response variables associated with heterogeneous and skewed outcomes typical of ecological data, and expertise in permutation theory and procedures for statistical inferences with minimal assumptions.

Short Biography of Proposed Peer Review Panelist

1978 - 1979: Wildlife technician, Univ. Idaho.
1980 - 1983: Graduate Research Assistant, Colorado Division of Wildlife and Colorado State Univ.
1984 - 1989: Wildlife Biologist, U. S. Fish and Wildlife Service, Fort Collins, CO.
1989 - present: Research statistician (biology), U. S. Geological Survey, Fort Collins, CO.

In my present position, I provide statistical consultation and research in support of programs investigating and predicting organism responses to their environment, especially as related to making environmental impact assessments or evaluating habitat management and conservation alterntatives. Because of the inherent heterogeneity in organism responses associated with biological systems, my statistical research has focused on the enhance information provided by quantile regression and various permutation procedures. I emphasize the utility of prediction and tolerance intervals and equivalence testing for improved frequentist inferences for scientific investigations.

Priscilla Crawford, University of Oklahoma

Proposed Peer Review Panel Member for
Platte River Recovery Implementation Program

Name	Priscilla H. C. Crawford
Title	Conservation Specialist
Affiliation	Oklahoma Biological Survey, University of Oklahoma
Address	111 E. Chesapeake St., Norman, OK 73019
Phone #	405-255-8106
E-mail	prill@ou.edu

Education	Ph.D. University of Oklahoma 2009; M.S. University of Oklahoma 2002; B.A. Marlboro College 1995

Unique Qualifications

I have been working on the Canadian River in central Oklahoma for the past 9 years. While my original focus has been monitoring and protecting the Interior Least Tern colonies, I have expanded my conservation efforts to include the Snowy Plover, Bell's Vireo, and Bald Eagles. I have also begun researching the dynamic nature of sandy prairie river systems by analyzing the vegetation change over time and its correlation to precipitation and hydrological changes.

Short Biography of Proposed Peer Review Panelist

I grew up on the edge of cornfields in Indiana, knowing I wanted to be a scientist since I was about 5 years old. I went to southern Vermont for college, studying biology and botany at Marlboro College, a very small liberal arts school that focused on clear writing, self guided study, and independent research. After graduating, I was employed at non-profits in Washington, D.C., conducted botanical inventories for the US Forest Service in Colorado, and worked at the National Wildlife Federation. During my time at NWF, they were building a program to draw attention to conservation issues in prairies. Grasslands intrigued me with their need for disturbance and biological diversity. I choose the University of Oklahoma to study grassland dynamics, concentrating on exotic species invasion and native woody plant encroachment. As a Ph.D. student, I continued my biogeographic exploration with herbarium and inventory data and species distribution models for a variety of invasive and rare species in Oklahoma. I was hired as a research scientist at the Oklahoma Biological Survey to work on conservation issues with private landowners across the state. I incorporated my research interests to help us focus rare species conservation work within the state. A major project I picked up after several years of inactivity was the protection of the Interior Least Tern colonies within central Oklahoma. For the past 9 years, I have worked with private landowners to monitor and protect the nesting sites of Least Terns. I am currently working with a citizens group to establish permanant protection of and public access to over 500 acres of river habitat in central Oklahoma, which includes a Least Tern colony site, wetlands, and additional rare bird habitat.

Brian Gray, USGS Upper Mississippi Ecological Sciences Center

Proposed Peer Review Panel Member for
Platte River Recovery Implementation Program

Name	Brian Gray
Title	Statistician
Affiliation	US Geological Survey
Address	2630 Fanta Reed Rd, La Crosse, WI 54603
Phone #	608-781-6234
E-mail	brgray@usgs.gov

Education	BSc (Botany), 1980; MS (Biology), 1993; PhD (Biostatistics), 2001

Unique Qualifications

- Research and consulting statistician for the USACEs' Long Term Resource Monitoring Program (LTRMP) on the Upper Mississippi and Illinois Rivers
- Currently overseeing efforts to estimate temporal trends in ~200 fish, vegetation and water quality variables for the LTRMP
- A statistician who is familiar with avian, and river and stream studies: contributing statistician to 12 peer-reviewed avian publications, and author or coauthor of a further 20 (of 47) peer-reviewed publications that address river or stream issues
- Specialties: analysis of clustered and of observational (nonexperimental) data

Short Biography of Proposed Peer Review Panelist

Brian worked in part as a de facto statistician in a sediment toxicology laboratory in the mid-1990s. That work led to enrollment in a PhD in biostatistics program--during which time he acted as consulting statistician for a marine field station and a hospital. He currently works as a research and consulting statistician at the USGS' Upper Midwest Environmental Science Center, a position he has held since 2001. The USGS position includes a half-time appointment as the statistician for a USACE river monitoring program, a program that oversees the collection and analysis of ecological and environmental data from the Upper Mississippi and Illinois Rivers. Brian's background in the biological and environmental sciences allows him to better understand scientific aspects of studies on which he is asked to contribute statistical expertise.

Brian's work for the USGS has largely focused on methods of making inferences from non-experimental data, such as are typically collected by ecological monitoring programs. Such data may be unbalanced, derive from complex sampling designs, and be collected in ways that risk attributing causation to non-causal variables. He has especially focused on methods of analyzing data that are correlated within groups, such as typically occurs when multiple measurements are obtained from each of multiple years, lakes or other groups. His experience includes the evaluation of hypotheses, the reasonableness of research designs (given objectives), data collection procedures, sampling methods, and methods to analyze data and report statistics. Brian has worked and published with data from invertebrate, plant, fish, bird, water and sediment studies; the context for most of his work has been that of rivers, streams and lakes.

Christopher Hoagstrom, Weber State University

Proposed Peer Review Panel Member for
Platte River Recovery Implementation Program

Name	Christopher Hoagstrom
Title	Associate Professor
Affiliation	Weber State University, Department of Zoology
Address	1415 Edvalson Street, Dept. 2505
Phone #	801-626-7486
E-mail	christopherhoagstrom@weber.edu

Education	PhD

Unique Qualifications

Extensive experience dealing with conservation ecology of minnows in rivers on the Great Plains. Detailed understanding of hydrology and reservoir operations in relation to river ecology on the Great Plains.

Short Biography of Proposed Peer Review Panelist

I received a BS in Biology from Ohio Northern University in 1992 and an MS in 1994 from Sul Ross State University. After that I was employed by the U.S. Fish & Wildlife Service from 1993 through 2002 within the New Mexico Fishery Resources Office. While there I worked my way up from a biological technician to a fishery biologist. During this entire time I was intimately involved in and often helped develop and lead detailed field studies. I was also responsible for reporting and presenting research findings. My main responsibilities during that time were field research on the Pecos River and Rio Grande aimed at documenting the status of declining species of minnows and providing recommendations for their conservation.

In 2003 I returned to school at South Dakota State University to pursue a PhD. My dissertation research had to do with relations between fish assemblages and environmental conditions within the Missouri River drainage. Part of this research included detailed studies of fish distributions in the Cheyenne River drainage.

In 2006 I accepted a position as an assistant professor in the Department of Zoology at Weber State University. I have remained there and have been promoted to associate professor and am presently department chair. While here I have continued active research on Great Plains rivers including field work in New Mexico (Pecos River) and continuing work on long-term data bases.

Eileen Kirsch, USGS Upper Mississippi Ecological Sciences Center

Proposed Peer Review Panel Member for
Platte River Recovery Implementation Program

Name	Eileen M. Kirsch
Title	research wildlife biologist
Affiliation	U.S. Geological Survey
Address	2630 Fanta Reed Rd.
Phone #	608 781 6226
E-mail	ekirsch@usgs.gov

Education	Ph.D. 1992 Zoology, University of Montana, M.A. (1986) B.Sci. (1984) Biology, University of Nebraska - Omaha

Unique Qualifications

-Nationally recognized expert on Least Tern and Piping Plover biology and ecology
-27 years of research experience working with various bird species and their habitat associations on midwestern river systems
-Adjunct Professor Biology Department, University of Wisconsin - La Crosse
-Author of over 21 peer-reviewed publications, and author or co-author on numerous technical reports, abstracts, and presentations.

Short Biography of Proposed Peer Review Panelist

Dr. Kirsch has been working on bird biology and ecology on midwestern river systems since 1986. She did her Ph.D. research on habitat selection and productivity of least terns and piping plovers on the lower Platte River. Since then her experience with terns and plovers has included: working with the Nebraska Game and Parks Commission to analyze more recent tern and plover data for the entire state, serving as the Executive Committee Chair of the Interior Least Tern Working Group (sponsored by American Bird Conservancy), providing scientific review for several Biological Opinions and related documents for the USFWS, and reviewing study plans and journal manuscripts dealing with least tern and piping plover conservation on interior rivers. She was also an ISAC Member that helped review the PRRIP plan in 2008.

Dr. Kirsch has training in decisions analysis, modeling, and adaptive mangement. She worked with the US Army Corps of Engineers to develop a Forest Management Plan for the Upper Mississippi River that includes modeling and adaptive management components. Her current research follows several lines related to bird movement and habitat use including work on habitat and invasive plant species effects on birds of conservation need on the Upper Mississippi River during migration and breeding seasons; sandhill crane landscape and airspace use in relation to a wind power facility near Horicon NWR; and using marine radar to assess airspace use of night migrating songbirds along the south sore of lake Erie during spring and fall migration.

Sara Schweitzer, North Carolina Wildlife Resources Commission

Proposed Peer Review Panel Member for
Platte River Recovery Implementation Program

Name	Sara Schweitzer
Title	Waterbird Investigations & Management Project Leader, Wildlife Diversity Biologist
Affiliation	North Carolina Wildlife Resources Commission
Address	106 Ferret Run Ln., New Bern, NC 28562
Phone #	252-639-8435
E-mail	sara.schweitzer@ncwildlife.org
Education	Ph.D., Oklahoma State University, Wildlife & Fisheries Ecology; M.S., Texas Tech University, Wildlife Science; B.S., University of North Carolina, Biology/Chemistry

Unique Qualifications

One part of Schweitzer's dissertation pertained to foraging ecology of Least Terns in the Central Flyway (Salt Plains NWR), and her work has included additional studies of Least Terns in Georgia and North Carolina. Specifically, her work includes surveys of abundance and distribution, monitoring for nesting success, and research relative to site selection, threat factors to nesting colonies and means of alleviating them, as well as impacts of toxicants in the environment to eggs, chicks, and adults.

Short Biography of Proposed Peer Review Panelist

Sara Schweitzer received her Ph.D. at Oklahoma State University through the USGS Cooperative Fish and Wildlife Research Unit, Department of Zoology. Her dissertation was titled, "Abundance and conservation of endangered Least Terns nesting on salt flat habitat." After completing her doctoral program at OSU, she joined the faculty in the Warnell School of Forestry and Natural Resources, University of Georgia. In the Warnell School, she taught graduate and undergraduate classes in wildlife ecology and wetland habitats, she established a research lab with her research associates and graduate students, and she became Director of the Bulgaria Study Abroad program upon returning to UGA from a Senior Fulbright Scholarship program in Sofia, Bulgaria. At UGA, Schweitzer served on numerous committees at the university and school level, contributed greatly to professional societies, and mentored 100s of students, both graduates and undergraduates. In 2010, Schweitzer accepted the opportunity to lead the Waterbirds Investigations and Management Project for NCWRC's Wildlife Diversity Program. In this position, she coordinates waterbird surveys, monitoring, and research by members of the N.C. Waterbird Management Committee (federal and state agencies, and NGOs), and conducts independent research on coastal waterbird species and their habitats. She continues to mentor students as an adjunct Professor and Graduate Faculty member for the Warnell School, serve professional societies, contribute to the scientific literature, conduct reviews for journals and grant organizations, and lead working groups and committees for the Association of Fish and Wildlife Agencies.

Gene Wilde, Texas Tech University

Proposed Peer Review Panelist for
Platte River Recovery Implementation Program

Name	Gene R. Wilde
Title	Professor of Fish Ecology
Affiliation	Department of Biology, Texas Tech University
Address	Lubbock, TX 79409
Phone #	806-834-0265
E-mail	gene.wilde@ttu.edu

Education	BS & MS Biological Sciences; PhD Zoology, Statistics minor

Unique Qualifications

20+ years experience with studies of Great Plains rivers and fishes and water quality; Expert on biology and, especially reproductive ecology, of Great Plains fishes; Five years experience as a biostatistician (Texas Parks and Wildlife Department) + graduate minor in statistics (Oklahoma State University); Experienced with Endangered Species Act; Experienced in modeling fish and wildlife populations

Short Biography of Proposed Peer Review Panelist

Dr. Gene Wilde has BS and MS degrees from the University of Nevada, Las Vegas, where he participated in numerous studies of endangered fish species and water quality (Colorado River and its reservoirs). He also has a PhD, with a Statistics minor, from Oklahoma State University. Dr. Wilde is a nationally and internationally recognized expert in the reproductive ecology, feeding habits and life history requirements of cyprinids (minnows), particularly those native to Great Plains rivers. He has been employed 20 years as a Professor of Fish Ecology at Texas Tech University and is a Certified Fishery Profession by the American Fisheries Society. Dr. Wilde has presented results of his research in several foriegn countries and has published over 80 scientific papers, many of which document the life history requirements, reproductive ecology, and migrations of several imperiled Great Plains fishes. He has worked closely with personnel from numerous development and management agencies, non-governmental organizations (NGOs), and with members of public user groups to incorporate sound science into applied conservation management of a variety of fish species.

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Appendix A – Curricula Vitae

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Ali Arab

Contact Information

305 St. Mary's Hall
Department of Mathematics & Statistics
Georgetown University
Washington, DC 20057

Phone: (202) 687-1878
Fax: (202) 687-6067
E-mail: ali.arab@georgetown.edu
Homepage: www.aliarab.com

Academic Appointments

Georgetown University, Washington, DC

- Associate Professor of Statistics, August 2014-Present
- Assistant Professor of Statistics, August 2007-July 2014
- Department of Mathematics & Statistics
- Environmental Initiative
- Center for the Environment

Clemson University, Clemson, SC

- Adjunct Assistant Professor, January 2011-Present
- Department of Forestry & Natural Resources

Education

University of Missouri, Columbia, Missouri

- Ph.D., Statistics, August 2007
- Advisor: Christopher K. Wikle
- Dissertation Topic: "Hierarchical Bayesian Spatio-Temporal Models for Environmental Processes"

Southern Illinois University, Edwardsville, Illinois

- M.S., Mathematics and Statistics, May 2002
- Advisor: Steven E. Rigdon
- Thesis Topic: "Piecewise Exponential Model for the Reliability of k Repairable Systems"

Iran University of Science and Technology, Tehran, Iran

- B.S., Applied Mathematics and Operations Research, February, 1999

Honors and Awards

- National Science Foundation/American Statistical Association Conference Travel Award (August 2011), Awarded funds: $2,275.

- University of Missouri Outstanding Ph.D. Dissertation Award (April 2008)
- University of Missouri, Department of Statistics Katti Fund Graduate Student Travel Award (2005-2007; Awarded funds: $1,500)
- Southern Illinois University, College of Arts and Sciences Certificate of Honor (April 2002)
- Southern Illinois University Outstanding Achievement Recognition Program- Student Leadership (April 2002)

Publications

Peer-Reviewd Articles and Book Chapters

1. Wildhaber M. L., Yang W.-H. and A. Arab (2015). Population Trends, Bend Use Relative To Available Habitat And Within-River-Bend Habitat Use Of Eight Indicator Species Of Missouri And Lower Kansas River Benthic Fishes: 15 Years After Baseline Assessment. *River Research and Applications*. In Print. DOI: 10.1002/rra.2846

2. Zhang Y., Arab A., Cowling B. J., and M. A. Stoto (2014). Characterizing Influenza surveillance systems performance: Application of a Bayesian hierarchical statistical model to Hong Kong surveillance data. *BMC Public Health*. 14(1), 850. doi:10.1186/1471-2458-14-850.

3. Arab, A., Jackson, M. and C. Kongoli (2014). Spatio-Temporal Analysis of Malaria Trends and Weather Effects in Western Africa. *Malaria Journal*.

4. Arab, A. and J. R. Courter (2014). Spatio-Temporal Trend Analysis of Historic Records of Spring Bird Arrival. *Communications in Statistics: Simulation and Computation*.

5. Arab, A. and G. Wimp (2013). Plant Production and Alternate Prey Channels Impact the Abundance of Top Predators. *Oecologia*, Volume 173, Issue 2, pages 331-341.

6. Zelt, J., Courter, J., Arab, A., Johnson R. and S. Droege (2012). Reviving a Legacy Citizen Science Project to Illuminate Shifting Migratory Bird Patterns. *The International Journal of Zoology*. Accepted (DOI:10.1155/2012/710710).

7. Arab A., Holan S., Wikle C. K. and M. L. Wildhaber (2012). Semiparametric Bivariate Zero-Inflated Poisson Models with Application to Studies of Abundance for Multiple Species. *Environmetrics*. Volume 23, Issue 2, pages 183-196.

8. Arab A., Rigdon S. E. and A. P. Basu (2012). Bayesian Inference for Piecewise Exponential Model for the Reliability of Multiple Repairable Systems. *Journal of Quality Technology*. Volume 44, Issue 1, pages 28-38.

9. Wildhaber M. L., Gladish D. and A. Arab (2012). Distribution and Habitat Use of the Missouri River and Lower Yellowstone River Benthic Fishes from 1996 To 1998: A Baseline for Fish Community Recovery. *River Research and Applications*. Volume 28, Issue 10, pages

1780-1803.

10. Witte C. C., Wildhaber M. L., Arab A. and D. B. Noltie (2009). Substrate Preference of Territorial Male Topeka Shiners (Notropis topeka) in the Absence of Sunfish (Lepomis sp.). *Ecology of Freshwater Fish*. Volume 18 Issue 3, pages 350-359.

11. Holan S., Wang S., Arab A., Sadler J. and K. Stone (2008). Semiparametric Geographically Weighted Response Curves with Application to Site-Specific Agriculture. *Journal of Agricultural, Biological, and Environmental Statistics*. Volume 13, Issue 4, pages 424-439.

12. Arab A., Wildhaber M. L., Wikle C. K. and C. N. Gentry (2008). Zero-inflated Modeling of Fish Catch Per Unit Area Resulting from Multiple Gears: Application to Channel Catfish and Shovelnose Sturgeon in the Missouri River. *North American Journal of Fisheries Management*. Volume 28, Issue 4, pages 1044-1058.

13. Arab A., Hooten M. B. and C. K. Wikle (2008). Hierarchical Spatial Models. In *Encyclopedia of Geographical Information Science*. Editors: Shashi Shekhar and Hui Xiong. pages 425-431. Springer: New York.

External Grants

- U.S. Geological Survey: Statistical Modeling of the Missouri River Pallid Sturgeon Monitoring Program: A 3-year subaward to conduct statistical analysis of data obtained from monitoring programs of Pallid Sturgeon in the Missouri River with possibility of renewal of the subaward contingent on funds availability (Summer 2012- Summer 2014). Awarded funds: $58,256.

- DC Water Resources Research Institute (DCWRRI) Seed Grant (January 2011), PI: Arash Massoudieh, Co-PI: Tolessa Dekisissa, UDC, Ali Arab (Collaborator), Awarded funds: $14,983.

- DC Water Resources Research Institute (DCWRRI) Seed Grant (January 2010), PI: Ali Arab, Co-PI: Tolessa Dekisissa, UDC, Awarded funds: $14,996.

- U.S. Geological Survey: Statistical Modeling of Benthic Fish Species Abundance Data: A 3-year subaward for statistical analysis of data on endangered and imperiled species of fish in the Missouri River (Summer 2008- Summer 2010). Awarded funds: $49,023.

Internal Grants & Fellowships

- Georgetown University, Medical Center, Department of Biostatistics, Bioinformatics, and Biomathematics: Flexible Statistical Models for the Analysis of Zero-Inflated Biological Data (February 2012, PIs: George Luta and Ali Arab), Awarded funds: $3,200 (summer support for 12 weeks, 20 hours per week for a graduate student researcher).

- Georgetown University Environmental Initiative: Partnership with USGS/NABPP (February 2012, PI: Ali Arab). Awarded funds: $18,000.

- Georgetown University Environmental Initiative: Bivariate Ecological Community Model (February 2012, PIs: Gina Wimp and Ali Arab). Awarded funds: $11,000.

- Georgetown University Junior Faculty Research Fellowship (Spring 2011): Fellowship provided release from teaching and service for one semester at full pay.

- Georgetown University Spring 2011 Grant-in-Aid Program (March 2011, PI: Ali Arab), Awarded funds: $1,250.

- Georgetown University Research Infrastructure Grant (2009): Advanced Computing Infrastructure (Co-PIs: Kim Sellers and Mahlet Tadesse), Awarded funds: $25,000.

- Georgetown University Summer Research Grant: a competitive research grant awarded by the Graduate School (Summer 2008), Awarded funds: $9,500.

Conference & Seminar Presentations

Presentations at International Conferences

- European Meeting of Statisticians (EMS 2013), Budapest, Hungary, July 2013 (*Invited Speaker*)
- Joint Meeting of International Young Business and Industrial Statisticians & Young Portuguese Statisticians (yBIS/jSPE 2012): Lisbon, Portugal; July 2012.
- The 58th World Statistics Congress, the International Statistical Institute (ISI 0211): Dublin, Ireland; August 2011.

Invited Presentations

- Joint Statistical Meetings (JSM 2014): Boston, MA, August 2014
- The International Association for Great Lakes Research, Hamilton, Ontario, Canada, May 26-30, 2014
- Millersville University, Department of Earth Sciences, Millersville, PA, March 13, 2014
- American University, Department of Mathematics and Statistics, Washington, DC, January 2014
- University of Missouri, Department of Statistics, September 2013. *Frontiers in Methodological and Applied Statistics: A Celebration of 50 Years*, Columbia, MO, 19-21 September 2013
- Joint Statistical Meetings (JSM 2013): Montreal, Canada; August 2013
- Medstar Health Research Institute, Hyattsville, MD, March 2013
- Colorado State University, Department of Statistics, November 2012
- Clemson University, Department Forestry and Natural Resources, March 2012
- Joint Statistical Meetings (JSM 2011): Miami, FL; August 2011
- Virginia Tech University, Department of Computer Science, April 2011
- American University, Department of Mathematics and Statistics, March 2011
- Joint Statistical Meetings (JSM 2009): Washington, DC; August 2009
- National Institute of Standards and Technology (NIST), Statistical Engineering Division, Gaithersburg, MD, June 2009
- Joint Statistical Meetings (JSM 2008): Denver, CO; August 2008 (*Invited Poster*)
- University of Maryland- Baltimore County, Department of Mathematics and Statistics, November 2008
- University of Maryland-College Park, Department of Mathematics and Statistics, October 2008
- George Washington University, Department of Statistics, September 2008
- American Fisheries Society 137th Annual Meeting, San Francisco, California; September 2007

- Virginia Commonwealth University, Department of Statistical Sciences and Operations Research, Richmond, Virginia, February 2007
- RAND Corporation, Statistics Group, Santa Monica, California, February 2007
- Georgetown University, Department of Mathematics, Washington, D.C., February 2007

Contributed Presentations

- ISBA- George Box Research Workshop at George Washington University; May 2014 (*poster*)
- Georgetown University Medical Center, The 2nd Annual Biomedical Informatics Symposium; October 2013 (*poster*)
- Joint Statistical Meetings (JSM 2012): San Diego, CA; August 2012
- Joint Statistical Meetings (JSM 2010): Vancouver, Canada; August 2010
- The 8th Annual Hawaii International Conference on Statistics, Mathematics and Related Fields: Honolulu, HI; January 2009 (*poster*)
- Joint Statistical Meetings (JSM 2007): Salt Lake City, Utah; 2007
- 32nd Spring Lecture Series, University of Arkansas, Spatial and Spatio-Temporal Statistics; April 2007
- 67th Annual Midwest Fish and Wildlife Conference, Omaha, Nebraska; December 2006
- Joint Statistical Meetings (JSM 2006): Seattle, WA; August 2006
- Joint Statistical Meetings (JSM 2005): Minneapolis, MN; August 2005
- International Biometric Society ENAR: Austin, TX; March 2005
- ASA Environmetrics Conference, Chicago, IL; October 2004

Workshops Attended

- AAAS Program Evaluation Workshop (June, 2013)
- Georgetown University, Teaching, Learning, and Innovation Summer Institute (TLISI) Workshops (2008-2012)
- AAAS Science & Human Rights Coalition Meeting, Washington, DC (2011-2013)
- Info-Metrics Institute, American University, Information and Econometrics of Networks, Washington, DC(March 2012)
- Georgetown University, Faculty Workshop on the Environmental Project Invited by President DeGioia (January 2010)
- Georgetown University, Initiating and Conducting Externally Sponsored Research (January 2010)
- Georgetown University, Environmental Studies Meeting with President DeGioia (July 2009)
- Georgetown University, Effective Classroom Interaction Faculty Workshop (November 2008)
- Georgetown University New Faculty Orientation (Fall 2007)
- SAMSI, Workshop on the NSF program Cyber-enabled and Discovery Initiative, SAMSI, Research Triangle, NC (Fall 2007)
- MD/DC/VA Section NExT workshops (Fall 2007, Spring 2008, Fall 2008)
- National Center for Atmospheric Research (NCAR), Fusing Geophysical Models with Data, Boulder, CO (June 2005)
- National Center for Atmospheric Research (NCAR), Spatio-Temporal Modeling Workshop, Boulder, CO (June 2003)
- University of Missouri, Program for Excellence in Teaching, Columbia, MO (August 2002)

Teaching Experience

Georgetown University

- **MATH-006 Statistics with Exploratory Data Analysis** (Fall 2008; Summer 2009-2010; Spring 2013)
- **MATH-140 Introduction to Mathematical Statistics** (Spring 2009)
- **MATH-234 Mathematical Statistics II** (Spring 2008)–No longer offered.
- **MATH-240 Applied Statistical Methods I** (Spring 2009; Fall 2009-2012)
- **MATH-405 Applied Time Series Analysis** (Spring 2013, Fall 2013)
- **MATH-503 Mathematical Statistics** (Spring 2010, 2012, 2014)
- **MATH-651 Regression Methods/Generalized Linear Models** (Fall 2007-2014)
- **MATH-701 Statistical Consulting Practicum** (Spring 2008)–No longer offered.
- **MATH-301/302 Tutorial (independent study)** (Spring 2008; Fall 2012-2014)
- **MATH-703 Internship** (Spring 2008)

Other Institutions

University of Missouri

- Introduction to Statistics and Probability: Instructor (Fall 2005 - Spring 2006)
- Statistical Reasoning: Recitation Instructor (Fall 2002)

Southern Illinois University-Edwardsville

- College Algebra: Instructor (Spring 2002)
- Introduction to Statistics and Probability: Teaching Assistant (Summer 2000)
- Multivariable Calculus: Teaching Assistant (Spring 2000 and Fall 2001)

Research Mentoring

Doctoral Students

- **Jason Courter (Ph.D. Wildlife and Conservation Ecology, Clemson University-Graduated July 2012):** I worked with Jason on his Ph.D. dissertation on spring arrival of birds in North America and provided help on statistical modeling. Jason is currently a visiting faculty at Taylor University and we are collaborating on projects related to the NABPP data.
- **Ying Zhang (Ph.D. Candidate, Global Health, Georgetown University–Graduated in May 2013)**: I co-advised Ying's dissertation work jointly with Professor Mike Stoto from the School of Nursing and Health Studies of Georgetown University. Ying's doctoral research included developing hierarchical Bayesian models to characterize influenza epidemics based on multiple data streams from Hong Kong.

Undergraduate & Masters Students

- **Christianne (Christie) Greer (M.S. Applied Mathematics and Statistics–Graduated December 2011):** Christie worked with me during Spring, Summer and Fall 2011 on a funded research project to analyze monthly precipitation data for the DC area. She is currently working as a statistical analyst at a consulting firm in Washington, DC. Christie presented the results of her research to a panel at the University of the District of Columbia in 2011.

- **Julie Menken (B.S. Mathematics, Graduated May 2012):** Julie worked with me during Spring 2011 on data analysis for a funded research project to analyze monthly precipitation data for the DC area.

- **Ben Feng (B.S. Mathematics, Graduated May 2012):** Ben worked with me during Spring 2012 on statistical analysis for Ultimate Frisbee. We have submitted an article on this project to *CHANCE* which is currently under review. Ben is currently teaching high school mathematics.

- **Joshua Chang (M.S. Applied Mathematics and Statistics, Graduated May 2012):** Josh worked with me during Fall 2011 on data visualization for spring arrival records from the NABPP database. Josh wrote Python scripts for efficient mapping of these data. Currently, Josh is working as a data analyst in a consulting firm in the DC area.

- **Xiaojing (Erin) Hu (M.S. Applied Mathematics and Statistics, Expected May 2013):** Erin has been working with me on a hierarchical Bayesian model for fisheries data since Spring 2012.

- **Yayun Xie (M.S. Applied Mathematics and Statistics, May 2013):** Yayun has been working on a funded research project on hierarchical models for ecological community data since July 2012. Currently, Yayun works as a full-time data analyst at a DC based company, SATMAP.

- **Xi Cheng (M.S. Applied Mathematics and Statistics, May 2013):** Xi has been working on a funded research project on hierarchical models for ecological community data since July 2012. Currently, Xi works as a full-time data analyst at a DC based company, SATMAP.

- **Yun Ling (B.S. Mathematics–May 2013):** Yun is currently working on her Honors Thesis under my guidance. She is working on statistical modeling of a game theory problem based on the "hot hand effect" in tennis using a large data set of 60,000 observations from several recent tournaments.

- **Danielle Swanson (B.S. Mathematics–Expected May 2015):** Danielle works with me on two different projects since May 2013. One of the projects involves statistical modeling of historic spring arrival data. This project is a partnership program between Georgetown University, the North American Bird Phenology Program, and the U.S. Geological Survey. The second project is part of the collaboration with the AAAS Human Rights Coalition, in particular, the Service to the Human Rights Community which involves developing an indicator for science human rights for different countries based on statistical data.

- **Alex Luta (B.S. Government–Expected May 2016):** Alex works with me on quantitative analysis of human rights related data. In particular, Alex works on using geospatial technologies for human rights projects.

- **Nazanin Dameshghi (M.S. Mathematics and Statistics-Expected May 2014):** Nazanin is a graduate student in statistics at American University. Nazanin is working on hierarchical spatial models for ecological count data with application to fisheries data.

- **Mingye May Cai (B.S. Statistics):** Mingye May worked with me during Summer 2013 on Bayesian and classical estimation for modeling precipitation time series data for the DC area. Mingye May is currently an undergraduate in statistics at University of California-Davis.

Academic Advising & Mentoring

Undergraduate

- Jonathan Balloch (Graduated May 2011)
- Jamara Clark (Graduated May 2012)
- Andrew Herren (Graduated May 2012)
- Alexander Clark (Graduated May 2012)
- Connor Brogan (In Progress)
- Drew Renzi (In Progress)
- Hamza Husain (In Progress)

Graduate (Masters)

- Erin Vickery (Graduated May 2011)
- John Matson (Graduated May 2011)
- Christianne Greer (Graduated December 2011)
- Jacob Enriquez (In Progress)
- Lauren Smith (In Progress)

Consulting & Professional Experience

- Consultant (*Pro Bono*): Casey Trees (DC based non-profit organization Urban)
- Consultant: Deartment of Transplant Surgery, Georgetown University Hospital (2009-Present)
- Consultant (*Pro Bono*): U.S. Geological Survey, Beltsville, MD (2010 -2012)
- Consultant: U.S. Geological Survey, Columbia, MO (May 2005 -Present)
- Research Assistant: U.S. Geological Survey, Columbia, MO (May 2005 -July 2007)
- Actuarial Science Intern (paid position): Buck Consultants (May 2001 -August 2002)

Professional Service

Department of Mathematics & Statistics

- Departmental Self-Study (Fall 2012)
- Merit Review Committee (Fall 2012-Spring 2013)
- Graduate Admission Committee (Fall 2009-Spring 2010-Fall 2010)
- Graduate Steering Committee (Spring 2012)
- Curriculum Committee (Fall 2007 -Fall 2011)
- Library Committee (Fall 2007-Spring 2010; Fall 2011-Present)
- Statistics Sub-Committee (Fall 2007 -Present)

- Teaching Merit Review Committee (Spring 2009-Fall 2009)

Georgetown University

- Georgetown College Goldwater Fellowship Committee (Fall 2007)
- Center for the Environment (Fall 2007-Present)
- Executive Faculty Committee (Spring 2009)
- Faculty Meeting on Environmental Research, Invited by President DeGioia (July 2009)
- Advanced Research Computing (Fall 2011-Present)
- G-QUADS (Georgetown Quantitative Analysis and Data Science) (Spring 2013)

National Service

- Expert Witness for the United States Government, Department of Justice (April 2012-Present)
- Representative of the American Statistical Association (ASA) to the AAAS Science and Human Rights Coalition (May 15, 2014-Present)
- Organizer and host of a discussion panel on "Repression of Students and Academics in Iran" at Georgetown University (November 16, 2013) jointly with Amnesty International and the Committee of Concerned Scientists; The event highlights the case of Omid Kokabee, a nuclear physicist imprisoned by the Iranian regime due to his refusal to participate in the regime's nuclear program.

Organizer and Chair of Conference Sessions

- Contributed Session Chair: "Space-Time Modeling II" (JSM 2012, San Diego, CA)
- Contributed Session Chair: "Methods for Ecological Data" (JSM 2011, Miami Beach, FL)
- Invited Session Chair: "New Developments for the Analysis of Spatial and Temporal Systems in Ecology" (JSM 2009, Washington, DC)
- Invited Session Organizer: "Model Specification and Uncertainty in Ecological Analyses" (ENAR 09, March 15-18, 2009, San Antonio, TX)

Other

- ASA's Transportation Statistics Interest Group-Member (2011-Present)
- ASA's Section on Statistics & the Environment (ENVR)-Member (2006-Present)
- ASA's Committee on Scientific Freedom and Human Rights- Friend (2012-Present)
- AAAS Science and Human Rights Coalition Membership & Outreach Committee-Member (2012-Present)
- AAAS Science and Human Rights Coalition Membership & Outreach Committee-Co-Chair (2013-Present)
- AAAS Science and Human Rights Coalition Service to the Human Rights Community Committee-Member (2011-Present)
- *Pro-Bono* statistical consulting for Casey Trees, and the USGS (October 2010-Present)
- Undergraduate Studies Committee, University of Missouri, Statistics Department (2004 -2007)
- Website Committee, University of Missouri, Statistics Department (2004 -2005)

Professional Organizations & Associations

- American Association for the Advancement of Science (AAAS) Science and Human Rights Coalition (2011-Present)

- Washington D.C. ASA Chapter- Washington Statistical Society (Since 2008)
- American Statistical Association Section on Environment (ENVR), member (Since 2006)
- American Statistical Association, member (Since 2003)
- Institute of Mathematical Statistics, member (Since 2004)
- University of Missouri, Statistics Graduate Students Association (SGSA), member (2002 -2007)
- University of Missouri, Statistics Graduate Students Association, Secretary (2003 -2004)
- American Mathematical Society, member (2000-2002)

Referee/Editor Experience

- Environmental and Ecological Statistics (EES)
- Environmetrics
- Ecological Applications (Subject-Matter Editor)
- Ecological Modelling
- Ecological Monographs
- Journal of Animal Ecology
- Stochastic Environmental Research & Risk Assessment (SERRA)
- Geoderma
- Biological Conservation
- IEEE Transactions on Reliability
- Journal of the American Statistical Association (JASA)-Applications and Case Studies
- Journal of Agricultural, Biological, and Environmental Statistics (JABES)
- Proceedings of the Royal Society-Proceedings A
- Served as reviewer for the Internal Review process required by the USGS (one research paper, and two abstracts)
- WIREs Computational Statistics
- The 32nd Int'l Conference on Information Technology Interfaces (Reviewer; June 2010, Croatia)
- College Mathematics Journal
- Springer (Book chapter review)
- Pearson Education (Textbook review: Statistics)
- Pearson Education (Textbook review: Stats, Data and Models)
- Chapman & Hall/CRC (Book proposal review)
- W.H. Freeman (Textbook review: Introduction to the Practice of Statistics)

In the News

- "Has a New Era of Academic Warfare Arrived?" by Ali Arab and Jeffery Toney. *Huffington Post*, June 12, 2013. The article discusses the impacts of academic sanctions and boycotts. In particular, the authors examine the adverse effects of boycotts of Israeli scientists and scholars, as well as the indirect impacts of sanctions on Iranian scholars and students. The authors discuss the academic boycotts and sanctions in light of the principles of science and human rights as described in the Article 15 of the International Covenant on Economic, Social and Cultural Rights (ICESCR).
- Report on ASA-AAAS focus group on human rights and statistics. *Amstat News*, November 2012 issue. To Appear.
- "Are U.S. Iranian Sanctions Self-Defeating?" by Natasha Bahrami, Ali Arab, and Jeffery Toney. *Huffington Post*, July 26, 2012. The article discusses the negative by-products of the economic sanctions of Iran on information exchange and scientific activities.
- Interviewed by the Associated Press on the probabilities related to winning the MegaMillion lottery; Broadcasted by the National Public Radio (NPR). March 30, 2012.

- Featured in "Meet ENVR Members" American Statistical Association's Section on Statistics & the Environment (ENVR) Newsletter, Summer 2012.
- Research profile featured in "Modeling the Environment" *Georgetown College Newsletter*, March 1, 2012.

Computer Skills

- Statistical softwares and programming: MATLAB, R/S-plus, WinBUGS & OpenBUGS, SAS, Stata, Minitab, FORTRAN, C++.
- Platforms: Unix/Linux, Mac OS and Windows.

Timothy H. Bonner

Mailing Address:
Department of Biology/ Aquatic Station
601 University Drive
Texas State University
San Marcos, Texas 78666

Revised: July 2015
Phone: (512) 245-2284
E-mail: TBonner@txstate.edu

Website: http://www.bio.txstate.edu/contacts/faculty/timothy-bonner.html

EDUCATION:

Texas Tech University -- May 2000
Doctor of Philosophy, Fisheries Science
Secondary emphasis: Statistics
Major Advisor: Dr. Gene R. Wilde
Dissertation Title: Habitat use and reproductive ecology of the Arkansas River shiner and peppered chub in the Canadian River, New Mexico and Texas.

Texas State University- San Marcos -- August 1996
Master of Science, Biology
Minor: Aquatic Biology
Major Advisors: Drs. Thomas M. Brandt and Bobby G. Whiteside
Thesis Title: The effects of temperature on egg production and early life stages of the endangered fountain darter.

Texas A&M University -- May 1992
Bachelor of Science, Wildlife and Fisheries Science
Option: Fisheries Science

PROFESSIONAL EXPERIENCE

Professor, Department of Biology, Texas State University (2012 – present)

Director, Aquatic Station, Department of Biology, Texas State University (2007 – 2012)

Associate Professor, Department of Biology, Texas State University (2007 – 2012)

Assistant Professor, Department of Biology, Texas State University (2001 – 2007)

Assistant Professor, Department of Biology, Northwestern State University (2000 – 2001)

Other:
Postdoctoral Research Associate, Texas Tech University (2000)
Research and Teaching Assistant, Texas Tech University (1996-2000)
Research and Teaching Assistant, Texas State University (1994-1996)
Experimental Biological Aide, Oregon Department of Fish and Wildlife (1992-1993)

PUBLICATIONS

Ruppel, D. S., C. R. Vaugh, H. T. Nichols, and T. H. Bonner. In review. Validating an instream flow recommendation using larval fish diets. Environmental Management.

Runyan, D. T., D. S. Ruppel, and T. H. Bonner. In review. Distribution and diet of larval and juvenile fishes in a Chihuahua Desert river. Journal of Freshwater Ecology.

Cook-Hildreth, C., T. H. Bonner, D. G. Huffman. Accepted pending revisions. Reproductive biology of an exotic suckermouth armored catfish (Loricariidae) in the San Marcos River, Hays Co., Texas, with observations on environmental triggers. Bioinvasion Records.

69. Craig, C.A., K. A. Kollaus, K. P. K. Behen, and T.H. Bonner. Accepted. Relationships among spring flow, habitats, and fishes within evolutionary refugia of the Edwards Plateau. Ecosphere.

68. McDonald, D. L., T. H. Bonner, P. D. Cason, B. W. Bumguardner, and S. Bonnot. Accepted. Cold weather simulation on hatchery propagated premetamorphic larvae and postmetamorphic juvenile Southern Flounder. Journal of Applied Aquaculture.

67. Robertson, S. M, J. N. Fries, and T. H. Bonner. Accepted pending revisions. Effects of habitat utilization on the reproductive of two imperiled, sympatric *Dionda* (Cyprinidae) in the Rio Grande Basin, Texas. American Midland Naturalists.

66. Phillips, M. B. and T.H. Bonner. Accepted pending revisions. Occurrence and amount of microplastic ingested by fishes in watersheds of the Gulf of Mexico. Marine Pollution Bulletin.

65. Labay, B. J., D. A. Hendrickson, A. E. Cohen, T. H. Bonner, R. S. King, L. Kleinsasser, G. Linam, and K. W. Winemiller. In press. Can species distribution models aid bioassessment when reference sites are lacking? Tests based on freshwater fishes. Environmental Management.

64. Craig, C. A., C. R. Vaughn, D. S. Ruppel, and T. H. Bonner. 2015. Occurrence of Brown Bullhead in Texas. Southeastern Naturalist 14:35-37.

63. Diaz, P, J. N. Fries, T. H. Bonner, M. Alexander, W. H. Nowlin. 2015. Mesohabitat associations of the threatened San Marcos salamander (*Eurycea nana*) across its geographic range. Aquatic Conservation: Marine and Freshwater Ecosystems 25:307-321

62. Perkin, J. S. and T. H. Bonner. In press. Historical changes in fish assemblage composition following water quality improvement in the mainstem Trinity River of Texas. Rivers Research and Application.

61. Curtis, S. G., J. S. Perkin, P. T. Bean, M. S. Sullivan, and T. H. Bonner. 2015. Guadalupe bass *Micropterus treculii* (Valliant & Boucourt, 1874). Pages 55-60 *in* M. D. Tringali, J. M. Long, T. W. Birdsong, and M. S. Allen, editors. Black bass diversity: multidisciplinary science for conservation. American Fisheries Society, Symposium 82, Bethesda, Maryland.

60. Kollaus, K. A., K. P. K. Behen, T. C. Heard, T. B. Hardy, and T. H. Bonner. 2015. Influence of urbanization on a karst terrain stream and fish community. Urban Ecosystem 18:293-320.

59. Nichols, H. T. and T. H. Bonner. 2014. First record and habitat associations of *Spongilla cenota* (Class Demospongiae) within streams of the Edwards Plateau. Southwestern Naturalist 59: 465-470.

58. Becker, J. C., K. J. Rodibaugh, B. J. Labay, T. H. Bonner, Y. Zhang, and W. H. Nowlin. 2014. Influence of land use and physiographic gradients on nutrients in a Gulf Slope (USA) river system. Freshwater Science 33:731-744.

57. Henn, M., H. T. Nichols, Y. Zhang, and T. H. Bonner. 2014. Effect of artificial light on the drift of aquatic insects in urban central Texas streams. Journal of Freshwater Ecology 29:307-318. Editor's Choice Article

56. Sullivan, M. L., Y. Zhang, T. H. Bonner. 2014. Carbon and nitrogen ratios of aquatic and terrestrial prey for freshwater fishes. Journal of Freshwater Ecology 29:259-266.

55. Bonner, T. H. 2014. Silverband Shiner, *Notropis shumardi* (Girard 1856). Pages 220-221. *In* Kansas Fishes Committee. Kansas Fishes. University Press of Kansas, Lawrence.

54. Bonner, T. H. 2014. River Darter, *Percina shumardi* (Girard 1859). Pages 430-431. *In* Kansas Fishes Committee. Kansas Fishes. University Press of Kansas, Lawrence.

53. Ryan, T. A., A. N. Kohl, D. J. Soucek, T. S. Smith, T. M. Brandt, T. H. Bonner, and D. M. Cropek. 2013. Short term effects of military fog oil on the fountain darter (*Etheostoma fonticola*). Archives of Environmental Contamination and Toxicology 65:790-797.

52. Perkin, J. S., Z. R. Shattuck, J. E. Gerken, and T. H. Bonner. 2013. Fragmentation and drought legacy correlated with distribution of Burrhead Chub in subtropical streams of North America. Transactions of the American Fisheries Society 142:1287-1298.

51. Sha, Q, M. R. J. Forstner, T. H. Bonner, D. Hahn. 2013. Salmonellae in fish feces analyzed by in situ hybridization and quantitative polymerase chain reaction. Journal of Aquatic Animal Health 25:184-190.

50. Dammeyer, N. T., C. T. Phillips, and T. H. Bonner. 2013. Site fidelity and movement of the smallest etheostomine darter with implications for endangered species management. Transactions of the American Fisheries Society 142:1049-1057.

49. Sullivan, M. L., Y. Zhang, T. H. Bonner, and J. Tomasso. 2013. Temperature modulation of growth and physiology of juvenile Guadalupe bass. North American Journal of Aquaculture 75:373-376.

48. Bean, P. T., D. J. Lutz-Carrillo, and T. H. Bonner. 2013. Range-wide survey of the introgressive status of Guadalupe bass *Micropterus treculii*: implications for conservation and management. Transactions of the American Fisheries Society 142:681-689.

47. Bonner, T. H. 2013. Book review: *Fishes of Central US* by J. R. Tomelleri and M. E. Eberle. Great Plains Research 23:81.

46. Gaertner, J., D. Brown, M. R. J. Forstner, T. H. Bonner, D. Hahn. 2012. Geographic variation in *Batrachochytrium dendrobatidis* occurrence among populations of *Acris crepitans blanchardi* in Texas, USA. Herpetological Review 43:150-159.

45. Sullivan, M. L., Y. Zhang, and T. H. Bonner. 2012. Terrestrial subsidies in the diets of stream fishes of the USA: comparisons among taxa and morphology. Marine and Freshwater Research 63:409-414.

44. Perkin, J. S, Z. R. Shattuck, and T. H. Bonner. 2012. Reproductive ecology of a relict ironcolor shiner (*Notropis chalybaeus*) population in the headwaters of the San Marcos River. American Currents 37:11–21.

43. Heard, T. C., J. S. Perkin, and T. H. Bonner. 2012. Intra-annual variation in fish communities and habitat associations in a Chihuahua Desert reach of the Rio Grande/Rio Bravo Del Norte. Western North American Naturalist 72:1-15.

42. Perkin, J. S., Z. R. Shattuck, and T. H. Bonner. 2012. Life history aspects of a relic ironcolor shiner *Notropis chalybaeus* population in a novel spring environment. American Midland Naturalist 167:111-126.

41. Kollaus, K. A., and T. H. Bonner. 2012. Habitat associations of a semi-arid fish community in a karst spring-fed stream. Journal of Arid Environments 76:72-79.

40. Fleming, B. P., D. G. Huffman, T. H. Bonner, and T. M. Brandt. 2011. Metacercarial distribution of *Centrocestus formosanus* (Dignea: Heterophyidae) among fish hosts in the Guadalupe River drainage of Texas. Journal of Aquatic Animal Health 23:117-124.

39. Bean, P. T., J. T. Jackson, D. J. McHenry, T. H. Bonner, M. R. J. Forstner. 2011. Rediscovery of headwater catfish, *Ictalurus lupus* (Ictaluridae) in a western gulf slope drainage. Southwestern Naturalist 56:285-289.

38. Perkin, J. S. and T. H. Bonner. 2011. Long-term changes in flow regime and fish assemblage composition in the Guadalupe and San Marcos rivers of Texas. Rivers Research and Application 27:566-579.

37. Pound, K. L., W. H. Nowlin, D. G. Huffman, and T. H. Bonner. 2011. Trophic ecology of a nonnative population of suckermouth catfishes (*Hypostomus plecostomus*) in a central Texas spring-fed stream. Environmental Biology of Fishes 90:277-285.

36. Bean, P. T., C. S. Williams, P. H. Diaz, and T. H. Bonner. 2010. Habitat associations, life history, and diet of the blackspot shiner, *Notropis atrocaudalis*. Southeastern Naturalist 9:673-686.

35. Smith, A., M. Chumchal, T. H. Bonner, and W. H. Nowlin. 2010. Mercury contamination of the Rio Grande/Rio Bravo Del Norte fish community: spatial variation and influence of environmental gradients. Environmental Toxicology and Chemistry 29:1762-1772.

34. Bean, M.G. and T. H. Bonner. 2010. Spatial and temporal distribution of *Bothriocephalus acheilognathi* (Cestoda: Bothriocephalidea) in the Rio Grande (Río Bravo del Norte). Journal of Aquatic Animal Health 22:182-189.

33. Perkin, J. S., Z. R. Shattuck, P. T. Bean, T. H. Bonner, E. Saraeva, and T. B. Hardy. 2010. Movement and microhabitat associations of Guadalupe bass in two Texas rivers. North American Journal of Fisheries Management 30:33 – 46.

32. Watson, J. M., C. Sykes, T. H. Bonner. 2009. Gut contents of age-0 Rio Grande silvery minnow *Hybognathus amarus* reared in hatchery ponds. Southwestern Naturalist 54:475-479.

31. Bean, M. G., and T. H. Bonner. 2009. Impact of *Bothriocephalus acheilognathi* (Cestoda: Pseudophyllidea) on *Cyprinella lutrensis* condition and reproduction. Journal of Freshwater Ecology 24:283-291

30. Perkin, J. S., C. S. Williams, and T. H. Bonner. 2009. Aspects of chub shiner *Notropis potteri* life history with comments on native distribution and conservation status. American Midland Naturalist 162:276-288.

29. Bean, P. T., M. G. Bean, and T. H. Bonner. 2009. Threatened fishes of the world: *Moxostoma congestum* (Catostomidae). Environmental Biology of Fishes 85:173-174.

28. Leavy, T. R. and T. H. Bonner. 2009. Relationships among swimming ability, current velocity associations, and morphology for freshwater lotic fishes. North American Journal of Fisheries Management 29:72-83.

27. Small, M. F., T. H. Bonner, and J. T. Baccus. 2009. Hydrologic alteration of the lower Rio Grande terminus: a quantitative assessment. River Research and Application 25:241-252.

26. Bonner, T. H. and P. T. Bean. 2008. Threatened fishes of the world: *Micropterus treculii* (Centrarchidae). Environmental Biology of Fishes 83:367-368

25. Gaertner, J., P. E. Wheeler, S. Obafemi, J. Valdez, M. R. J. Forstner, T. H. Bonner, D. Hahn. 2008. Detection of salmonellae from fish in a natural river system. Journal of Aquatic Animal Health 20:150-157.

24. Bean, P. T. and T. H. Bonner. 2008. Reproductive ecology and diet of the gray redhorse (Catostomidae) in a Hill Country stream and reservoir. Journal of Freshwater Ecology 23:397-404.

23. Bonner, T. H., J. M. Watson, and C. S. Williams. 2008. Threatened fishes of the world: *Cyprinella proserpina* (Cyprinidae). Environmental Biology of Fishes 81:365-366.

22. Bean, P. T., T. H. Bonner, and B. M. Littrell. 2007. Spatial and temporal patterns in the fish assemblage of the Blanco River, Texas. Texas Journal of Science 59:179-200.

21. Hulbert, J., T. H. Bonner, J. N. Fries, G. P. Garrett, and D. R. Pendergrass. 2007. Early development of *Dionda diaboli* (Cyprinidae). Southwestern Naturalist 52:378-385.

20. Littrell, B. M., D. Lutz-Carrillo, T. H. Bonner, and L. T. Fries. 2007. Status of an introgressed Guadalupe bass population in a central Texas stream. North American Journal of Fisheries Management 27:785-791.

19. Bean, M. G., A. Škeříková, T. H. Bonner, T. Scholz, and D. Huffman. 2007. First record of *Bothriocephalus acheilognathi* (Cestoda: Pseudophyllidea) in the Rio Grande with comparative ITS2 and V4-18S rDNA sequencing. Journal of Aquatic Animal Health 19:71-76.

18. McDonald, D. L., T. H. Bonner, E. L. Oborny, Jr. and T. M. Brandt. 2007. Effects of fluctuating temperatures and gill parasites on reproduction of the fountain darter, *Etheostoma fonticola*. Journal of Freshwater Ecology 22:311-318.

17. Williams, L.R., M.G. Williams, J.D. Hudson III, V. Campbell-Arvai, and T. H. Bonner. 2007. Evaluation of a stream system after clearcut logging disturbance in the Gulf coastal plain. Journal of Freshwater Ecology 22:119-133.

16. Thomas, C., T. H. Bonner, and B. G. Whiteside. 2007. Freshwater Fishes of Texas: A Field Guide. Texas A&M University Press. 216 pp.

15. Williams, C. S, and T. H. Bonner. 2006. Threatened fishes of the world: *Notropis sabinae* (Cyprinidae). Environmental Biology of Fishes 80:7-8.

14. Lutz-Carrillo, D. J., C. C. Nice, T. H. Bonner, M. R. J. Forstner, and L. T. Fries. 2006. Admixture analysis of Florida largemouth bass and northern largemouth bass using microsatellite loci. Transactions of the American Fisheries Society 135:779-791.

13. McDonald, D. L., T. H. Bonner, T. M. Brandt, and G. H. Trevino. 2006. Size susceptibility to trematode-induced mortality in the endangered fountain darter (*Etheostoma fonticola*). Journal of Freshwater Ecology 21:293-299.

12. Williams, C. S. and T. H. Bonner. 2006. Habitat associations, life history, and diet of the Sabine shiner *Notropis sabinae* in an east Texas drainage. American Midland Naturalist 155:84-102.

11. Patrikeev, M., T. H. Bonner, and G. M. Trujillo. 2005. Occurrence of the river shiner *Notropis blennius* in Lake Meredith, Texas. Southwestern Naturalist 50:488-490.

10. Bonner, T. H. and D. L. McDonald. 2005. Threatened fishes of the world: *Etheostoma fonticola* (Percidae). Environmental Biology of Fishes 73:333-334.

9. Williams, L. R., T. H. Bonner, J. D. Hudson, M. G. Williams, T. R. Leavy, and C. S. Williams. 2005. Interactive effects of environmental variability and military training on stream biota of three headwater drainages in Western Louisiana. Transactions of the American Fisheries Society 134:192-206.

8. Bonner, T. H., C. Thomas, C. S. Williams, and J. P. Karges. 2005. Temporal assessment of a west Texas stream fish assemblage. Southwestern Naturalist 50:74-78.

7. Littrell, B. M., C. Thomas, C. S. Williams, and T. H. Bonner. 2003. Gut contents of the headwater catfish *Ictalurus lupus* from two West Texas streams. Texas Journal of Science 55:323-328.

6. Bonner, T. H., and G. R. Wilde. 2002. The effect of turbidity on prey consumption by prairie stream fishes. Transactions of the American Fisheries Society 131:1203-1208.

5. Durham, B. W., T. H. Bonner, and G. R. Wilde. 2002. Occurrence of *Lernaea cyprinacea* on Arkansas River shiners and peppered chubs in the Canadian River, New Mexico and Texas. Southwestern Naturalist 47:95-98.

4. Wilde, G. R., T. H. Bonner, and P. J. Zwank. 2001. Diets of the Arkansas River shiner and peppered chub in the Canadian River, New Mexico and Texas. Journal of Freshwater Ecology 16:403-410.

3. Bonner, T. H., and G. R. Wilde. 2000. Changes in the fish assemblage of the Canadian River, Texas, associated with reservoir construction. Journal of Freshwater Ecology 15:189-198.

2. Wilde, G. R., and T. H. Bonner. 2000. First records of the suckermouth minnow *Phenacobius mirabilis* in Canadian River, Texas. Texas Journal of Science 52:71-74.

1. Bonner, T. H., T. M. Brandt, J. N. Fries, and B. G. Whiteside. 1998. Temperature effects on egg production and early life stages of the fountain darter. Transactions of the American Fisheries Society 127:971-978.

ONLINE PUBLICATIONS:

Hassan-Williams, C., C. L. Thomas, and T. H. Bonner. 2008. Identification and information for Texas fishes. (http://txstate.fishesoftexas.org/)

PROFESSIONAL PRESENTATIONS (last two years)

Phillips, M. B. and T. H. Bonner. 2015. The occurrence and amount of microplastics ingested by fishes in watersheds of the Gulf of Mexico. American Fisheries Society-Portland OR (oral presentation)

Nichols, H., K. Ostrand, and T. Bonner. 2015. Discharge and habitat mediated effects on Fountain Darter reproduction. American Fisheries Society-Portland OR (oral presentation)

Ruppel, D, E. Cowles, B. Littrell, and T. H. Bonner. 2015. Validation of environmental flow regimes in Brazos, Guadalupe, and San Antonio rivers. American Fisheries Society-Portland OR (oral presentation)

Clark, M. K. and T. H. Bonner. 2015. Effects of predation on Fountain Darters under low flow conditions. American Fisheries Society-Portland OR (oral presentation)

Ruppel, D., C. Vaughn, H. Nichols, and T. Bonner. 2015. Validation of an instream flow recommendation using larval fish diets. American Fisheries Society-Portland OR (oral presentation)

Scanes, C., Ruppel, B. Littrell, and T. Bonner. 2015. Fish community and habitat assessments within an urbanzied spring-fed stream of the Edwards Plateau. American Fisheries Society-Portland OR (poster presentation)

Craig, C.A., K. A. Kollaus, K. P. K. Behen, and T.H. Bonner. 2015. Relationships among spring flow, habitats, and fishes within evolutionary refugia of the Edwards Plateau. American Fisheries Society-Portland OR (oral presentation)

McDonald, D. L., T. H. Bonner, P. D. Cason, B. W. Bumguardner, and S. Bonnot. 2015. Cold weather simulation on hatchery propagated premetamorphic larvae and postmetamorphic juvenile Southern Flounder. American Fisheries Society-Portland OR (oral presentation)

Scanes, C. M., D. Ruppel, B. Littrell, and T. H. Bonner. 2015. Fish community and habitat assessments within an urbanized spring-fed stream. Southwestern Association of Naturalists. San Diego, CA (poster presentation)

Cowles, E. S., D. S. Ruppel, B. Littrell, and T. H. Bonner. 2015. Validation of environmental flow regimes in Brazos, Guadalupe, and San Antonio rivers. Southwestern Association of Naturalists. San Diego, CA (poster presentation)

Clark, M. K. and T. H. Bonner. 2015. Effects of predation on Fountain Darters under low flow conditions. Southwestern Association of Naturalists. San Diego, CA (oral presentation)

Craig C., T.H. Bonner, K. Kollaus, K Behen. 2015. Relationship Between Spring Flow and Spring Fish Communities. Southwestern Association of Naturalists. San Diego, California. (Oral presentation)

Ruppel, D., C. Vaughn, H. Nichols, and T. Bonner. 2015. Validation of an instream flow recommendation using larval fish diets. Southwestern Association of Naturalists. San Diego, California. (Oral presentation)

Craig C., T.H. Bonner. 2015. Impacts of Urbanization on Spring Fish Communities. Southwestern Association of Naturalists. San Diego, California. (Oral presentation)

Phillips, M. B. and T. H. Bonner. 2015. The occurrence and amount of microplastics ingested by fishes in watersheds of the Gulf of Mexico. Southwestern Association of Naturalists. San Diego, CA (oral presentation)

Nichols, H., K. Ostrand, and T. Bonner. 2015. Discharge and habitat mediated effects on Fountain Darter reproduction. Southwestern Association of Naturalists. San Diego, California. (Oral presentation)

Craig, C. A.,S, K. A. Kollaus, K. P. K. Behen, and T. H. Bonner. 2014. Relationships Between Spring Run Discharge and Spring-associated Fishes in the Karst Edwards Plateau Region. Texas Chapter of the American Fisheries Society. Pottsboro (oral presentation)

Phillips, M. B., and T. H. Bonner. 2014. The Occurrence and Amount of Microplastics Ingested by Fish in the Watersheds of the Gulf of Mexico. Texas Chapter of the American Fisheries Society. Pottsboro (oral presentation)

Ruppel, D. S., C. Vaughn, A. Grubh, S. McMillan, G. Linam, and T. H. Bonner. 2014. Diets of Larval Fishes Between Slack Water Habitats During the Day and Swift Water Habitats at Night. Texas Chapter of the American Fisheries Society. Pottsboro (oral presentation)

Sullivan, M. L., Y. Zhang, and T. H. Bonner. 2014. An Investigation into the Nutritional Value of Aquatic versus Terrestrial Prey for Freshwater Fishes. Texas Chapter of the American Fisheries Society. Pottsboro (oral presentation)

Vaughn, C., D. Ruppel, A. Grubh, S. McMillan, G. Linam, and T. H. Bonner. 2014. Validating Environmental Flow Recommendations with Regards to CPOM, Macroinvertebrates, and Larval Fish Drift in the Lower Guadalupe and San Antonio Rivers. Texas Chapter of the American Fisheries Society. Pottsboro (oral presentation)

Henn, M., H. Nichols, Y. Zhang, and T. H. Bonner. 2014. Effect of Artificial Light on the Drift of Aquatic Insects in Urban Central Texas Streams. Texas Chapter of the American Fisheries Society. Pottsboro (oral presentation)

Nichols, H. T., and T. H. Bonner. 2014. First Record and Habitat Associations of *Spongilla cenota* (Class Demospongiae) within Streams of the Edwards Plateau, Texas, USA. Texas Chapter of the American Fisheries Society. Pottsboro (poster presentation)

Labay, B. J., D. A. Hendrickson, A. E. Cohen, T. H. Bonner, R. King, L. Kleinsasser, G. Linam, K. Winemiller. 2013. Toward bioassessment without reference sites using species distribution modeling. Southwestern Association of Naturalists. McNeese State University (poster presentation)

Linam, G. W., S. Magnelia, T. H. Bonner, S. McMillan, C. A. Craig, E. Moran, S. Lusk, and R. Ranft. 2013. Re-establishment of Guadalupe bass in two central Texas rivers. Southern Division of the American Fisheries Society. Nashville (oral presentation)

Curtis, S. G., K. P. Behen, and T. H. Bonner. 2013. Effects of a declining hydrograph on instream habitats and fish communities in a semi-arid karstic stream. Southern Division of the American Fisheries Society. Nashville (oral presentation)

Vaughn, C., D. Ruppel, A. Grubh, S. McMillan, G. Linam, and T. H. Bonner. 2013. Effects of base flow and high flow pulses on drifting CPOM, macroinvertebrates, and larval fishes. Southern Division of the American Fisheries Society. Nashville (poster presentation)

Eaton, V., S. Curtis, and T. H. Bonner. 2013. Assessment of wildfire effects on fishes of the Texas gulf slope drainages using a conceptual framework. Southern Division of the American Fisheries Society. Nashville (poster presentation)

Kollaus, K. A., K. P. K. Behen, T. B. Hardy, T. C. Heard, and T. H. Bonner. 2013. Influence of water temperature on fish distributions within a Texas spring-fed stream. Texas Chapter of the American Fisheries Society. Lake Conroe (oral presentation)

Eaton, V., K. Ridenour, S. Curtis, and T. H. Bonner. 2013. Conceptual framework to assess the effects of wildland fire on fishes of the Texas Gulf Slope Drainages. Texas Chapter of the American Fisheries Society. Lake Conroe (oral presentation)

Curtis, S. G., K. P. Behen, and T. H. Bonner. 2013. Instream habitat and biological responses to low flow conditions in a semi-arid karstic stream. Texas Chapter of the American Fisheries Society. Lake Conroe (oral presentation)

Perkin, J. S., Z. R. Shattuck, J. E. Gerkin, and T. H. Bonner. 2013. Stream fragmentation and drought legacy determine distribution of Burrhead Chub in subtropical streams. Texas Chapter of the American Fisheries Society. Lake Conroe (oral presentation)

Vaughn, C., D. Ruppel, A. Grubh, S. McMillan, G. Linam, and T. H. Bonner. 2013. Effects of base flow and high flow pulses on drifting CPOM, macroinvertebrates, and larval fishes. Texas Chapter of the American Fisheries Society. Lake Conroe (poster presentation)

STUDENT SUPERVISION (Major advisor):

Cody A. Craig (BS Texas Tech University). 2014. Relationship between base flow magnitude and spring fish communities. M. S. Thesis
- current position: Ph.D. – Aquatic Resources Program, Texas State University

Melissa B. Phillips (BA University of Leeds). 2014. Occurrence and amount of microplastics ingested by fishes in watersheds of the Gulf of Mexico. M. S. Thesis

Christopher R. Vaughn (BS Texas A&M University). 2014. Validating environmental flow recommendations: drifting coarse particulate matter, macroinvertebrates, and larval fishes. M. S. Thesis.
- current position: Aquatic Biologist. San Antonio River Authority.

David S. Ruppel (BS Northern Michigan University). 2014. Flow and current velocity mediated diets of larval fishes. M. S. Thesis.
- current position: Ph.D. – Aquatic Resources Program, Texas State University

Virginia E. Dautreuil (BS Virginia Tech University). 2013. Conceptual framework to assess the effects of wildfire on aquatic systems of the semi- arid and arid regions of the western gulf slope drainages. M. S. Thesis.
- current position: Forest Supervisor; Martha's Vineyard and Nantucket, Massachusetts Department of Conservation and Recreation

Kenneth P. K. Behen (BS University of Washington). 2013. Influence of connectivity and habitat on fishes of the upper San Marcos River. M.S. Thesis.
-current position: Fisheries Biologist, Washington Department of Fish and Wildlife

Monika J. Henn (BS University of Virginia). 2013. Effects of artificial light on the drift of macroinvertebrates in urban central Texas streams. M.S. Thesis (Co-advisor with Dr. Y. Zhang).
-current position: Analyst, Urban Land Institute. New York, New York.

Mario L. Sullivan (BS Colorado State, MS Western Kentucky State). 2013. The role of terrestrial subsidies in fish communities with a particular focus upon cyprinids. Ph.D. Dissertation (Co-advisor with Dr. Y. Zhang).
- current position: Central Arizona College

Preston T. Bean (BS Texas Tech University; MS Texas State University). 2012. Introgressive status, population genetic structure, phylogeographic history and individual-level resource specialization of the Guadalupe bass *Micropterus treculii*. Ph.D. Dissertation.
- current position: Research Biologist, Texas Parks and Wildlife

Robert J. Maxwell (BS Texas State University). 2012. Patterns of endemism and species richness of fishes of the western gulf slope. M.S. Thesis.
- current position: Fisheries Biologist, Louisiana Department of Wildlife and Fisheries

Stephen Curtis (BS Texas A&M University). 2012. Effects of dry baseflow conditions in a declining hydrograph on instream habitats and fish communities in a semi-arid karstic stream. M.S. Thesis.
- current position: Fisheries Biologist, University of Houston-Clear Lake; Environmental Institute of Houston

Sarah McMillan (BS Texas State University). 2011. Reproductive and feeding ecology of two sympatric *Dionda* (Cyprinidae) in the Rio Grande basin, Texas. M.S. Thesis.
- current position: Fisheries Biologist, Texas Parks and Wildlife-Inland Fisheries, San Marcos

Tom Ryan (BS Texas A&M University). 2011. Short term effects of military fog oil on fish. M.S. Thesis
- current position: River Systems Institute, Texas State University and USFWS-San Marcos Aquatic Research Center

Casey S. Williams (BS Northwestern State University; MS Texas State University). 2011. Life history characteristics and larval drift patterns of obligate riverine species in the Lower Brazos River, Texas. Ph.D. Dissertation.
- current position: Assistant Professor, Valley City State University, North Dakota

Nathan Dammeyer (BS Purdue University). 2010. Movement patterns of *Etheostoma fonticola* in a headwater stream. M.S. Thesis
- current position: National Park Service, Virginia

Benjamin Labay (BS University of Texas). 2010. The influence of land use, zoogeographic history, and physical habitat on fish community diversity in the lower Brazos watershed. M.S. Thesis
- current position: UT Memorial Museum Ichthyology Collection

Zachary Shattuck (BS Colorado State University). 2010. Spatiotemporal patterns of fish and aquatic insects in an urbanized watershed of Central Texas. M.S. Thesis
- positions: BioWest, Logan, Utah, Native Species Coordinator, Montana Fish, Wildlife, and Parks.

Clara Folb (BS Ohio State University). 2010. Reproductive seasons and life histories of three Texas *Percina* (Actinopterygii). M.S. Thesis
- positions: Pennsylvania Nature Conservancy and other various agencies

Kristy Kollaus (BS Texas State University). 2009. Fish assemblage structure and habitat associations in a Texas spring-fed river. M.S. Thesis
- current position: Fisheries Biologist, Meadows Center, Texas State University

Josh Perkin (BS Texas State University). 2009. Historical composition and long-term trends of fish assemblages in two Texas rivers and microhabitat associations and movement of Guadalupe bass *Micropterus treculii* in the Pedernales and South Llano rivers. M.S. Thesis.
- current position: Assistant Professor, Tennessee Tech University

Tom Heard (BS Texas State University). 2008. Spatial and temporal patterns in a Chihuahua Desert fish assemblage. M.S. Thesis.
- current position: Fisheries Biologist, Meadows Center, Texas State University

Megan Bean (BS Texas State University). 2008. Occurrence and impact of the giant Asian tapeworm in the Rio Grande drainage. M. S. Thesis
- current position: Texas Parks and Wildlife-Inland Fisheries, Mountain Home

Katrina Cohen (BS University of Texas). 2008. Gut content and stable isotope analysis of exotic suckermouth catfishes (*Hypostomus*) in the San Marcos River, Texas: A concern for spring endemics? M. S. Thesis
- Former position: Ph.D., University of Texas-Arlington

Becca Marfurt Fordham (BS Southwestern University). 2008. Habitat associations of macroinvertebrates in the Big Bend Reach of the Rio Grande. M. S. Thesis
- Current position: Oklahoma Department of Environmental Quality

Dennis Runyan (BS Texas A&M University). 2007. Fish assemblage changes in Gulf Slope drainages; an historical perspective. M. S. Thesis
- Current position: Fish Biologist, Alan Plummer Associates, Austin.

Rex Tyrone (BS University of Washington-Wilmington). 2007. Effects of upland timber harvest and road construction on headwater stream fish assemblages in a southeastern forest. M. S. Thesis
- Former position: Fish Biologist, US Geological Survey, Washington.

Preston Bean (BS Texas Tech University). 2007. Spatial and temporal patterns in the fish assemblage of the Blanco River, Texas *and* Reproductive ecology and diet of the gray redhorse. M. S. Thesis.
- Current position. Research Biologist, Texas Parks and Wildlife.

Dave Pendergrass (BA Covenant College). 2006. Macroinvertebrate assemblage in the Blanco River basin. M. S. Thesis.
- Current position: Research Scientist: Texas Institute for Applied Environmental Research; Tarleton State University.

Jackie Watson (BS Texas State University). 2006. Patterns and habitat associations of a desert spring fish assemblage and responses to a large-scale flood. M. S. Thesis
- Current position: June Sucker Biologist, Utah Division of Wildlife Resources, Provo.

Brad Littrell (BS Texas State University). 2006. Can invasiveness of native cyprinids be predicted from life history traits? *and* Status of an introgressed Guadalupe bass population in a central Texas stream. M.S. Thesis.
- Current position: Fisheries Biologist, Bio-West, Inc., Austin, Texas

Julie Hulbert (BS Trinity University). 2005. Morphology, meristic counts, and melanophore description for *Dionda diaboli* (Cyprinidae) during development. M.S. Thesis.
- Former position: Director, Education Center, City of San Marcos.

Tracy R. Leavy (BS Long Island University). 2004. Relationships among swimming ability, habitat use, and morphology of freshwater fishes in Texas and Louisiana. M.S. Thesis.
- Former position: Fish and habitat biologist, US Fish and Wildlife Service, Washington State

Dijar Lutz-Carrillo (BS University of Texas). 2004. The use of microsatellite DNA to identify largemouth bass subspecies. M.S. Thesis, Co-advisor with C. Nice.
- Current position: Geneticist, Texas Parks and Wildlife Department, San Marcos

Dusty McDonald (BS Schreiner College). 2003. Effects of fluctuating temperatures on egg production of the endangered fountain darter. M.S. Thesis.
- Current position: Fisheries Biologist, Texas Parks and Wildlife Department, Perry R. Bass Marine Fisheries Research Station, Palacios

Casey S. Williams (BS Northwestern State University). 2003. Cyprinid assemblage structure along physical, longitudinal, and seasonal gradients and life history and reproductive ecology of the sabine shiner. M.S. Thesis.
- Current position: Assistant Professor, Valley City State University, North Dakota

Chad Thomas (BS Texas State University). 2001. Effects of smallmouth bass on habitat associations of selected preys species of the Devils River (TX). M.S. Thesis.
- Current position: Risk Management; Texas State University

In progress:
- Myranda Clark (BS Missouri State University) Predation of fountain darters
- Cody Craig (BS Texas Tech University, MS Texas State) TBD
- Nicky Hahn (BS Louisiana Tech University) TBD
- Harlan Nichols (BS Texas State University) Habitat-mediated effects on fountain darter reproduction
- Dave Ruppel (BS Northern Michigan, MS Texas State U.) Validating instream flow recommendations
- Cory Scanes (BS Texas State University) Historical and contemporary community structure of Comal River fish community

HONORS/AWARDS/SERVICE (2002 – 2015):

Reviewer: Aquatic Ecology, BioScience, Biological Invasions, Fisheries, Canadian Journal of Fisheries and Aquatic Sciences, Fishery Bulletin, Southeastern Naturalist, North American Journal of Fisheries Management, Transactions of the American Fisheries Society, Ecology of Freshwater Fishes, American Midland Naturalist, Southwestern Naturalist, North American Journal of Aquaculture, Hydrobiologia, Copeia, Texas Journal of Science, Lakes and Reservoirs, Desert Fishes Council Symposium, Southeastern Fish and Wildlife Agencies, Journal of the Arkansas Academy of Science, Environmental Biology of Fishes, Great Plains Research

Favorite Professor. 2014, 2015 Texas State University. Alpha Chi National Honor Scholarship Society

Advisor: TxState Aquatic Biology Society (2006 – current)

Organizer and weighmaster: Port Mansfield Chamber of Commerce Fishing Tournament (2003 – current). Tournament to generate college scholarships for Port Mansfield and area students.

Advisor: TxState BassCats--Tournament Fishing club (2009 – 2012)

Inland Fisheries Advisory Board. Texas Parks and Wildlife (2009 – 2014)

Brazos River Bays Basin Expert Science Team (2011 – 2012)

Guadalupe River Bays Basin Expert Science Team (2010 – 2011)

Chair, Awards Committee, Southern Division of the American Fisheries Society (2008- 2013)

Editorial Committee. Southeastern Fish and Wildlife Agencies (2008)

President. Texas Chapter of the American Fisheries Society (2008)

Presidential Award for Scholarly Activity. Texas State University (2007)

Texas State University Foundations of Excellence Award (2006)

Board of Directors, San Marcos River Foundation (2004 - 2006)

Co-Chair, Program Committee. 2006 Southern Division of the American Fisheries Society meeting

Editorial Committee Chair. Texas Chapter of the American Fisheries Society (2002 – 2005)

Outstanding Fisheries Worker of 2004 in Education. Texas Chapter of the American Fisheries Society

Favorite Professor. 2002, Texas State. Alpha Chi National Honor Scholarship Society

Curriculum Vitae

Name: Brian S. Cade

Position:
Research Biological Statistician (GS-14), Fort Collins Science Center
U.S. Geological Survey
2150 Centre Ave., Bldg. C
Fort Collins, CO 80526-8118
Email: cadeb@usgs.gov

I provide statistical consultation and research in support of programs trying to predict and understand organism responses to their environment, especially as related to making environmental impact assessments or evaluating habitat management alternatives. Because of the inherent heterogeneity in responses associated with biological systems, my statistical research has focused on the enhanced information provided by quantile regression and various permutation procedures. I emphasize the utility of prediction and tolerance intervals and equivalence testing for improved frequentist inferences for scientific investigations.

Education:
B.S. 1977. Wildlife Biology, Colorado State Univ., Fort Collins, CO.
M.S. 1985. Wildlife Biology, Colorado State Univ., Fort Collins, CO.
PhD. 2003. Ecology, Colorado State Univ., Fort Collins, CO.

Research and Professional Experience:
1978 – 1979: Wildlife technician, Univ. Idaho.
1980 – 1983: Graduate Research Assistant, Colorado Div. Wildlife and Colorado State Univ.
1984 – 1989: Wildlife Biologist, U.S. Fish and Wildlife Service, Fort Collins, CO.
1989 – present: Research Biological Statistician, U. S. Geological Survey, Fort Collins, CO.

Publications:
Cade, B. S. 2015. Model averaging and muddled multimodel inferences. Ecology 96: 2370-2382.

Bowen, Z. H., G. P. Oelsner, B. S. Cade, T. J. Gallegos, A. M. Farag, D. N. Mott, C. J. Potter, P. J. Cinotto, M. L. Clark, W. M. Kappel, T. M. Kresse, C. P. Melcher, S. S. Paschke, D. D. Susong, and B. A. Varela. 2015. Assessment of surface water chloride and conductivity trends in areas of unconventional oil and gas development – Why existing national data sets cannot tell us what we would like to know. Water Resources Research 51: 704-715.

Talbert, M. K., and B. S. Cade. 2013. User manual for Blossom statistical package for R. U. S. Geological Survey Open-File Report 2005-1353. 81pp.

Blum, M. J., M. J. Bagley, D. M. Walters, S. A. Jackson, F. B. Daniel, D. J. Chaloud, and B. S. Cade. 2012. Genetic diversity and species diversity of stream fishes covary across a land use gradient. Oecologia 168: 83-95.

Schmidt, T. S., W. H. Clements, and B. S. Cade. 2012. Estimating risks to aquatic life using quantile regression. Freshwater Science 31: 709-723.

Ransom, J. I., J. E. Roelle, B. S. Cade, L. Coates-Merkle, and A. J. Kane. 2011. Foaling rates in feral horses treated with the immunocontraceptive Porcine Zona Pellucida. Wildlife Society Bulletin 35: 343-352.

Cade, B. S., J. W. Terrell, and B. E. Neely. 2011. Estimating geographic variation in allometric growth and body condition of blue suckers with quantile regression. Transactions of the American Fisheries Society 140: 1657-1669.

Cade, B. S., and P. R. Johnson. 2011. Quantile equivalence to evaluate compliance with habitat management objectives. Journal of Fish and Wildlife Management 2(2):169-182.

Leu, M., S.E. Hanser, C.L. Aldridge, S. E. Nielsen, B.S. Cade, and S.T. Knick. 2011. A sampling and analytical approach to develop spatial distribution models for sagebrush-

associated species. Pp 88-111 in Hanser, S.E., M. Leu, S.T. Knick, and C.L. Aldridge (editors). Sagebrush ecosystem conservation and management: Ecoregional assessment tools and models for the Wyoming Basins. Allen Press, Lawrence, KS.

Aldridge, C.L., S.E. Hanser, S.E. Nielsen, M. Leu, B.S. Cade, D.J. Saher, and S.T. Knick. 2011. Detectability adjusted count models of songbird abundance. Pp 141-220 in Hanser, S.E., M. Leu, S.T. Knick, and C.L. Aldridge (editors). Sagebrush ecosystem conservation and management: Ecoregional assessment tools and models for the Wyoming Basins. Allen Press, Lawrence, KS.

Friedman, J., J. E. Roelle, and B. S. Cade. 2011. Genetic and environmental influences on leaf phenology and cold hardiness of native and introduced riparian trees. International Journal of Biometerology 55:775-787.

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Ransom, J. I., B. S. Cade, and N. T. Hobbs. 2010. Influences of immunocontraception on time budgets, social behavior, and body condition of feral horses. Applied Animal Behaviour Science 124(1-2): 51-60.

Kennen, J. G., J. A. Henriksen, J. Heasley, B. S. Cade, and J. W. Terrell. 2009. Application of the hydroecological integrity assessment process for Missouri streams. U. S. Geological Survey Open-File Report 2009-1138. 57pp.

Rochinni, D., H. Nagendra, R. Gate, and B. S. Cade. 2009. Spectral distance decay: Assessing species beta-diversity by quantile regression. Photogrammetric Engineering & Remote Sensing 75: 1225-1230.

Ransom, J.I. and B. S. Cade. 2009. Quantifying equid behavior--A research ethogram for free-roaming feral horses. Techniques and Methods Report 2-A9. : U.S. Geological Survey. 23p.

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Cade, B. S., J. W. Terrell, and Mark T. Porath. 2008. Estimating fish body condition with quantile regression. North American Journal of Fisheries Management 28: 349-359.

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Zoellick, B. W., and B. S. Cade. 2006. Evaluating redband trout habitat in sagebrush desert basins in southwestern Idaho. North American Journal of Fisheries Management 26: 268-281.

Cade, B. S., and J. D. Richards. 2006. A permutation test for quantile regression. Journal of Agricultural, Biological, and Environmental Statistics 11:106-126.

Cade, B. S., J. D. Richards, and P. W. Mielke, Jr. 2006. Rank score and permutation testing alternatives for regression quantile estimates. Journal of Statistical Computation and

Simulation 76:331-355.
Sankaran, M., N. P. Hanan, R. J. Scholes, J. Ratnam, D. J. Augustine, B. S. Cade, J. Gignoux, S. I. Higgins, X. Le Roux, F. Ludwig, J. Ardo, F. Banyikwa, A. Bronn, G. Bucini, K. K. Caylor,M. B. Coughenour, A. Diouf, W. Ekaya, C. J. Feral, E. C. February, P. G. H. Frost, P. Hiernaux, H. Hrabar, K. L. Metzger, H. H. T. Prins, S. Ringrose, W. Sea, J. Tews, J. Worden, and N. Zambatis. 2005. Determinants of woody cover in African savannas. Nature 438(8): 846-849.
Farmer, A. H., B. S. Cade, J. W. Terrell, J. H. Henriksen, and J. T. Runge. 2005. Evaluation of models and data for assessing whooping crane (*Grus americana*) habitat in the central Platte River, Nebraska. U. S. Geological Survey, Biological Resources Discipline, Scientific Investigations Report 2005-5123, 64pp.
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Cade, B. S. 2005. Linear models: Permutation methods. Pages 1049 - 1054 *in* D. Howell and B. Everitt, eds., Encyclopedia of Statistics in Behavioral Science, Volume 2, John Wiley & Sons, Ltd, Chichester, UK.
Zoellick, B. W., H. M. Ulmschneider, B. S. Cade, and A. W. Stanley. 2004. Isolation of Snake River islands and mammalian predation of waterfowl nests. Journal of Wildlife Management 68: 650-662.
Cade, B. S., and B. R. Noon. 2003. A gentle introduction to quantile regression for ecologists. Frontiers in Ecology and the Environment 1: 412-420.
Cade, B. S. 2003. Quantile regression models of animal habitat relationships. Ph.D dissertation, Colorado State University, Fort Collins, CO. 186pp. (Barry R. Noon advisor)
Prose, B. L., B. S. Cade, and D. Hein. 2002. Nesting habitat of sharp-tailed grouse in the Nebraska Sandhills. The Prairie Naturalist 34(3/4): 85-105.
Dunham, J. B., B. S. Cade, and J. W. Terrell. 2002. Influences of spatial and temporal variation on fish-habitat relationships defined by regression quantiles. Transactions of the American Fisheries Society 131: 86-98.
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Allen, A. W., B. S. Cade, and M. W. Vandever. 2001. Effects of emergency haying on vegetative characteristics within selected conservation reserve program fields in the northern Great Plains. Journal of Soil and Water Conservation 56: 120-125.
Roelle, J. E., D. N. Gladwin, and B. S. Cade. 2001. Establishment, growth, and early survival of woody riparian species at a Colorado gravel pit. Western North American Naturalist 61: 182-194.
Cade, B. S., and Q. Guo. 2000. Estimating effects of constraints on plant performance with regression quantiles. Oikos 91: 245-254.
Huston, M. A., L. W. Aarssen, M. P. Austin, B. S. Cade, J. D. Fridley, E. Garnier, J. P. Grime, J. Hodgson, W. K. Lauenroth, K. Thompson, J. H. Vandermeer, and D. A. Wardle. 2000. Technical comment: No consistent effect of plant diversity on productivity. Science 289 25 August 2000: 1255. (Science Online)
Haire, S. L., C. E. Bock, B. S. Cade, and B. C. Bennett. 2000. The role of landscape and habitat characteristics in limiting abundance of grassland nesting songbirds in an urban open space. Landscape and Urban Planning 48: 65-82.
Haire, S. L., C. E. Bock, and B. S. Cade. 2000. Paradigm shifts in theory and methods: regression quantile analysis enables new insights for ecology. *In*: Proceedings of the 4th International Conference on Integrating GIS and Environmental Modeling (GISEM4):Problems, Prospect and Research Needs for Research, September 2-8, 2000, Banff, Alberta, Canada. Boulder, CO: University of Colorado, Cooperative Institute for Research in

Environmental Sciences. p.1-10 CD-ROM.
Cade, B. S., J. W. Terrell, and R. L. Schroeder. 1999. Estimating effects of limiting factors with regression quantiles. Ecology 80: 311-323.
Dodd, C. K., Jr., and B. S. Cade. 1998. Movement patterns and the conservation of amphibians breeding in small, temporary wetlands. Conservation Biology 12: 331-339.
Cade, B. S. 1997. Comparison of tree basal area and canopy cover in habitat models: Subalpine forest. Journal of Wildlife Management 61: 326-335.
Cade, B. S., and J. W. Terrell. 1997. Comment: Cautions on forcing regression equations through the origin. North American Journal of Fisheries Management 27: 225-227.
Cade, B. S., and J. D. Richards. 1996. Permutation tests for least absolute deviation regression. Biometrics 52: 886-902.
Kennedy, P. E., and B. S. Cade. 1996. Randomization testing in multiple regression. Communications in Statistics - Computation and Simulation 25: 923-936.
Terrell, J. W., B. S. Cade, J. Carpenter, and J. M. Thompson. 1996. Modeling stream fish habitat limitations from wedged-shaped patterns of variation in standing stock. Transactions of the American Fisheries Society 125: 104-117.
Baker, B. W., and B. S. Cade. 1995. Predicting biomass of beaver food from willow stem diameters. Journal of Range Management 48: 322-326.
Baker, B. W., B. S. Cade, W. L. Mangus, and J. McMillen. 1995. Spatial analysis of sandhill crane nesting habitat. Journal of Wildlife Management 59: 752-758.
Cade, B. S., and R. W. Hoffman. 1993. Differential migration of blue grouse in Colorado. Auk 110: 70-77.
Skagen, S. K., F. L. Knopf, and B. S. Cade. 1993. Estimation of lipids and lean mass of migrating sandpipers. Condor 95: 944-956.
Stauffer, D. F., A. H. Farmer, and B. S. Cade. 1992. Use of wildlife habitat models for habitat management planning. Pages 609-616 *in* Proceedings Resource Technology 90. American Society of Photogrammetry and Remote Sensing, Bethesda, MD.
Cade, B. S., and R. W. Hoffman. 1990. Winter use of Douglas-fir forests by blue grouse in Colorado. Journal of Wildlife Management 54: 471-479.
Cade, B. S. 1988. Least absolute deviation regression is a robust alternative to least squares regression. U. S. Dep. Int., Fish Wildlife Service, Research Information Bulletin 88-32.
Cade, B. S. 1986. Habitat suitability index models: Brown thrasher. U.S. Fish Wildlife Service Biological Report 82(10.118). 14pp.
Cade, B. S. 1985. Habitat suitability index models: American woodcock (wintering). U. S. Fish Wildlife Service Biological Report 82(10.105). 23pp.
Cade, B. S., and P. J. Sousa. 1985. Habitat suitability index models: Ruffed grouse. U. S. Fish Wildlife Service Biological Report 82(10.86). 31 pp.
Cade, B. S. 1985. Winter habitat preferences and migration patterns of blue grouse in Middle Park, Colorado. M.S. thesis, Colorado State University, Fort Collins. 101 pp.
Hoffman, R. W., and B. S. Cade. 1982. Occurrence of sage grouse above treeline. Colorado Field Ornithology Journal 16: 22-31.

Priscilla H. C. Crawford
Conservation Specialist
Oklahoma Biological Survey
University of Oklahoma

EDUCATION

PhD in Ecology and Biogeography, May 2009 — University of Oklahoma, Norman, Oklahoma
Dissertation: Using a Natural History Collection and Inventory Data to Create Spatial and Ecological Models of Species Distributions.

MS in Ecology and Biogeography, May 2002 — University of Oklahoma, Norman, Oklahoma
Thesis: Progress from Grassland to Shrubland: the Effect of Woody Plant Encroachment on Plant Community Diversity.

BA with Honors in Biology and Botany, May 1995 — Marlboro College, Marlboro, Vermont
Senior Research Project: Seed Dormancy and the Role of Soil Seed Banks in Forest Dynamics.

PROFESSIONAL EXPERIENCE

Conservation Specialist — Jan. 2006 - present
Oklahoma Biological Survey, University of Oklahoma — Norman, OK
Conduct research projects on public and private lands concerning state rare and endangered species. Encourages landowners to conserve Oklahoma's biological diversity by becoming members of a voluntary land preservation association. Coordinate annual BioBlitz! event that brings together field biologists and citizen scientists to inventory a natural area in 24 hours.

Adjunct Professor — Jan. 2008 - present
Dept. of Microbiology & Plant Biology, University of Oklahoma — Norman, OK
Teach upper division Internship in Conservation Biology.

Graduate Research Assistant — Jan. 2003-Dec 2005
Oklahoma Biological Survey, University of Oklahoma — Norman, OK
Manage the Oklahoma Vascular Plant Database. Supervise data entry employees. Investigate problems in the database and implement procedures to correct current and future problems.

Graduate Research Assistant — Jan. 2002-July 2002
Bebb Herbarium, University of Oklahoma — Norman, OK
Assisted in the maintenance of the plant collection. Assisted in faculty sponsored research projects. Collected and identified plants for permanent herbarium collection.

Lecturer and Teaching Assistant — Aug. 1998-Dec. 2002
Department of Botany and Microbiology, University of Oklahoma — Norman, OK
Taught: Introductory Botany with Lab; Economic Botany; Methods in Plant Ecology; Flowering Plants Lab; and Ecology and Environmental Quality Lab.

Community-Based Programs Assistant and Intern — Jan. 1997-Aug. 1998
National Wildlife Federation Educational Outreach Department — Vienna, VA
Maintained internet site and created promotional materials for nature education programs. Presented educational programs. Created and maintained a database of inquiries and contacts.

Field Botanist — May 1996-Oct. 1996
San Juan National Forest — Dolores, CO
Conducted vegetation surveys over a wide variety of terrain, from sagebrush to subalpine conifer forests. Learned all prevalent species in each habitat.

Research & Horticulture Internship - Howard Hughes Foundation funded — May 1994-Aug. 1994
Henry Doubleday Research Association — Ryton-On-Dunsmore, UK
Maintained research garden plots and greenhouses. Designed and conducted laboratory research on seed germination. Classified 50+ legume varieties deposited in germplasm library.

PUBLICATIONS

Smith-Patten BD, Bridge ES, Crawford PHC, Hough DJ, Kelly JF, Patten MA. 2015. Is extinction forever? Public Understanding of Science. 24:481-495.

Caire W, Ganow KB, Matlack RS, Caddell GM, Crawford PHC. 2014. Loss of a significant Maternity Population of Brazilian Free-Tailed Bat (*Tadarida barasiliensis*) in Oklahoma. Southwestern Naturalist 59:274-277.

Crawford PHC, Hoagland BW 2010. Using species distribution models to guide conservation at the state level: the endangered American burying beetle (*Nicrophorus americanus*) in Oklahoma. Journal of Insect Conservation. 14:511-521.

Bridge ES, Kelly JF, Bjornen PE, Curry CM, Crawford PHC, Parritte JM. 2010. Effects of nutritional condition on spring migration: do migrants use resource availability to keep pace with a changing world? Journal of Experimental Biology 213:2424-2429.

Crawford PHC, Hoagland BW. 2009. Can herbarium records be used to map alien species invasion and native species expansion over the past 100 years? Journal of Biogeography 36:651-661.

Crawford PHC, Crawford PT. 2005. Additions to the flora of Garvin County, Oklahoma: including a complete vascular plant checklist. Oklahoma Native Plant Record 5:77-102.

Elisens WE, Buthod AK, Crawford PHC. 2005. The vascular plant type specimens in the Robert Bebb Herbarium of the University of Oklahoma (OKL). Publications of the Oklahoma Biological Survey, 2nd series 6:1-14.

Hoagland BW, Buthod AK, Butler IH, Crawford PHC, Elisens WJ, Tyrl RJ. 2004. Oklahoma Vascular Plants Database (http://www.oklahomaplantdatabase.org/), Oklahoma Biological Survey, University of Oklahoma, Norman, OK, USA.

Hoagland BW, Crawford PHC, Crawford PT, Johnson F. 2004. Vascular flora of Hackberry Flat, Frederick Lake, and Suttle Creek, Tillman County, Oklahoma. Sida 21:429-445.

PRESENTATIONS

Crawford PHC. Inconsistent recovery: the local decline of Least Tern colonies and nesting habitat and in central Oklahoma. AOU/COS, Annual Meeting, University of Oklahoma, July 2015.

Crawford PHC, Stancampiano AM. Productivity of Interior Least Terns in Central Oklahoma: Past Habitat Dynamics, Current Pressures, and Future Management Considerations. Conference on Ecological Restoration in the Southwest, a joint meeting of the Society for Ecological Restoration, Texas & Southwest Chapters, Sul Ross University, Texas, October 2014.

Crawford PHC. Documenting Invasives Across Oklahoma. Oklahoma Invasive Plant Council, Annual Meeting, July 2013.

Crawford PHC. Teaching about biodiversity using Oklahoma's ecoregions. STEM Teacher Workshop, Oklahoma State University, June 2013.

Crawford PHC. Monitoring and protecting the interior least tern in Oklahoma. SW Region of AAAS annual meeting, Tulsa, OK, March 31-April 4, 2012.

Crawford PHC, Clopton E. The 100 year decline of tallgrass prairie in Oklahoma: What is the future of the remaining prairie fragments? America's Grasslands Conference: Status, Threats and Opportunities, Sioux Falls, SD, August 15-17, 2011.

Crawford PHC. BioBlitz! Oklahoma as a citizen science activity. Oklahoma Environmental Education Association Annual Meeting, Oklahoma City, OK, February 11, 2011.

Crawford PHC. Working with Diverse Stakeholders in the Oklahoma Invasive Plant Council. Presented at the annual meeting of the Texas Chapter of the Society for Ecological Restoration, November 2010.

Crawford PHC, Tucker J. Fighting an invasive iris in spring fed wetlands and river corridor. Presented at the annual meeting of the Texas Chapter of the Society for Ecological Restoration, November 2009.

Crawford PHC, Hoagland BW. Predicting the distribution of invasive species using native range information: can local conservation benefit from global models? Presented at the annual meeting of the Southwestern Association of Naturalists, April 2009.

Crawford PHC. Fagin TD, Hoagland BW. Modeling the potential geographic distribution of species in Oklahoma. Annual Meeting of the Oklahoma Chapter of the SouthCentral Arc Users Group, Moore Norman Technology Center, October 2007.

GRANTS

Interior Least Tern Protection and Monitoring, ESA Section 6, USFWS, 2012, $52,500.
Advancing Environmental Literacy, EPA Small Grants Program, 2013, $4,800.
Shortleaf Pine Forest Poster, educational material development, ODAFF and USDA FS, 2015, $2,840
Cross Timbers Poster, educational material development, ODAFF and USDA FS, 2014, $
BioBlitz! environmental outreach, Oklahoma Dept. of Wildlife Conservation, 2010 & 2009, $600.
Seaside Alder Distribution and Field Germination Study, The Nature Conservancy, 2009, $3,600.
Canadian River Landowner Conservation Cooperative, ESA Section 6, USFWS, 2009, $52,500.
University of Oklahoma Staff Senate Grant for Professional Development, 2008, $400.
BioBlitz! Improvement Grant, OU College of Arts and Sciences, 2008, $500.
IT Grant for Wireless Network Access at OBS, OU College of Arts and Sciences, 2007, $2000.
University of Oklahoma Graduate Student Senate Grant for Research, 1999, 2000, 2004.
University of Oklahoma Graduate Student Senate Grant for Conference Travel, 1999, 2001, 2005.

AWARDS

In-Plant Printing and Mailing Association's, honorable mention for design of educational poster, 2015
OU Regents Award for Superior Staff, nominated, 2012
Loren G. Hill University of Oklahoma Biological Station Scholarship, 2003.
Best Student Poster, Botanical Society of America, Ecology Section, Annual Meeting, 2001.
Cullowhee Landscaping with Native Plants Conference Scholarship, 1997.
Warren Sesson Scholarship for Academic Achievement and Community Service, 1994.

PROFESSIONAL MEMBERSHIPS AND SERVICE

Canadian River Conservancy, Board Member
Oklahoma Invasive Plant Council, President Elect
Oklahoma Natural Resources Conference, Annual Meeting Committee
Oklahoma Ornithological Society
Society for Conservation Biology
Society for Ecological Restoration and regional chapter
Southwestern Association of Naturalists, Secretary 2008 to 2011

University of Oklahoma Informational Staff Association, President 2011 to 2012
University of Oklahoma Staff Senate, Elected Member 2014 to 2016

REVIEWER

The Condor
Diversity and Distributions
Journal of Biogeography
Oklahoma Comprehensive Wildlife Conservation Strategy
The Southwestern Naturalist

TEACHING

Master's Committee Member, 4 students
Internship in Conservation Biology, 6 students
Summer Session Short Course: Field Studies in Conservation Biology, Oklahoma Biological Station

OUTREACH MATERIALS

Developed and Written:
Life Along a Prairie River – poster, brochure, and educator's guide
Cross Timbers: Gateway From Forest to Prairie – poster and brochure
Short Leaf Pine: Our Heritage, Our Resource, Our Legacy – poster

SPECIAL SKILLS

Permitted by USFWS to conduct research on the endangered interior least tern.
Certified Pesticide Applicator, Oklahoma
Wilderness and Remote Areas First Aid certified

Curriculum vitae
Brian R. Gray
August 2015

Upper Mississippi Environmental Sciences Center, US Geological Survey, La Crosse, WI 54603
Phone: 608-781-6234, fax: 608-783-6066, email: brgray@usgs.gov,
web: http://www.umesc.usgs.gov/staff/bios/brg0.html.

Education

Ph.D., Biostatistics, University of South Carolina, Columbia, SC, 2001
Dissertation: Modeling nonstationary and spatially-correlated oyster infection prevalence data
M.S., Biology, University of Kentucky, Lexington, KY, 1993
Thesis: Heavy metal sorption by stream periphytic surfaces
Diploma in Natural Resources, Lincoln College, New Zealand, 1982
B.Sc., Botany, University of Auckland, Auckland, New Zealand, 1981

Positions

2001-present: Statistician, Upper Midwest Environmental Sciences Center, US Geological Survey, 2001-present. Develop and publish methods for analysis of ecological and environmental data; consult on study design and analytical questions; statistician for US Army Corps of Engineers' Long Term Resource Monitoring Program (for the Upper Mississippi and Illinois Rivers).

1997-2001 (part time). Biostatistician, Schools of Medicine and Public Health, and Baruch Institute for Marine Biology and Coastal Ecology, University of South Carolina, 1997-2001 (part-time). Modeled spatially- and spatiotemporally-correlated ecological outcomes as functions of land use and environmental variables; statistical consultant for students and staff.

1993-1997: Sediment toxicologist, AScI Corporation, U.S. Army Corps of Engineers' Waterways Experiment Station, Vicksburg, MS. Primary technical writer and data analyst for sediment toxicity group; led acute, sub-chronic and chronic tests with freshwater, estuarine and marine macroinvertebrates; supervised technical work of up to eight staff.

1981-1990. Magazine circulation analyst, Plain Truth magazine, Pasadena, CA 1987-1990; B.A., Theology, Ambassador University, Pasadena, CA, 1987; Assistant data processing manager, Auckland, New Zealand, 1985-1986; A.A., Theology, Ambassador University, Big Sandy, TX, 1984; Land planning assistant, Department of Lands and Survey, Christchurch, NZ (authored environmental assessment of recreation effects on an 800-acre national wetland; coauthored land management plan for national recreation reserve), 1981-82 (as student).

Peer reviewed papers

Gray BR, V Lyubchich, YR Gel, JT Rogala, DM Robertson and X Wei. Accepted. Estimation of river and stream temperature trends from irregular time series. Statistical Methods & Applications.

Kenow KP, MW Meyer, R Rossmann, BR Gray and MT Arts. 2015. Influence of in ovo mercury exposure, lake acidity, and other factors on common loon egg and chick quality in Wisconsin. Environmental Toxicology and Chemistry 34:1870-1880.

King RS, PC McKann, BR Gray, PH Adler and MS Putnam. 2015. Host-parasite behavioral interactions in a recently introduced, whooping crane population. J Fish and Wildlife Management 6:220-226.

Newton TJ, SJ Zigler and BR Gray. 2014. Mortality, movement, and behavior of native mussels during a planned water level drawdown in the Upper Mississippi River. Freshwater Biology. doi:10.1111/fwb.12461.

Larson JH, RP Maki, BC Knights and BR Gray. 2014. Mercury accumulation in young-of-the-year yellow perch in Rainy Lake and Namakan Reservoir: effects of water level fluctuations. Ecotoxicology 23:1555-1563. DOI 10.1007/s10646-014-1296-5.

Russell M and BR Gray. 2013. Markov chains and zeros in my data: Bayesian approaches in SAS® that address zero-inflation in count data. In Proceedings of the SAS Global Forum 2013 Conference, paper 450-2013, SAS Institute, Cary, NC. Accessible at http://support.sas.com/resources/papers/proceedings13/450-2013.pdf.

Houser JN, SM Giblin, WF James, HA Langrehr, JT Rogala, JF Sullivan and BR Gray. 2013. Nutrient cycling and the abundance of duckweed and filamentous algae in backwater lakes of the Upper Mississippi River. River Systems 21:71–89.

Gray BR, JT Rogala, JN Houser. 2013. Treating floodplain lakes of large rivers as study units for variables that vary within lakes; an evaluation using chlorophyll *a* and inorganic suspended solids data from floodplain lakes of the Upper Mississippi River. River Research and Applications 29:330–342.

Gray BR, MD Holland, F Yi, LAH Starcevich. 2013. Influences of availability on parameter estimates from site occupancy models, with application to submersed aquatic vegetation. Natural Resource Modeling (http://onlinelibrary.wiley.com/doi/10.1111/nrm.12012/pdf).

Kirsch EM, PJ Heglund, BR Gray, P McKann. 2013. Songbird use of floodplain and upland forests along the upper Mississippi River corridor during spring migration. Condor 115:115-130.

McKann PC, BR Gray, WE Thogmartin. 2013. Small sample bias of dynamic occupancy models. J Wildlife Management and Wildlife Monographs 77:172-180.

BR Gray, AM Ray, JT Rogala, MD Holland, JD Houser. 2012. Spatial and temporal variation in duckweed and filamentous algal levels in contiguous floodplain lakes of the Upper Mississippi River. J Aquatic Plant Management 50:91-100.

Smith DR, JT Rogala, BR Gray, S Zigler, TJ Newton. 2011. Evaluation of sampling designs for estimation of density and abundance of freshwater mussels in the Upper Mississippi River.

River Research and Applications 27:122–133.

Newton TJ, SJ Zigler, JT Rogala, BR Gray, M Davis. 2011. Population assessment and potential functional roles of native mussels in the Upper Mississippi River. Aquatic Conservation:Marine and Freshwater Ecosystems 21:122–131.

Nielson RM, BR Gray, LL McDonald, PJ Heglund. 2011. Estimating site occupancy rates for aquatic plants using spatial sub-sampling designs when detection probabilities are less than one. Aquatic Botany 95:221– 225.

Kenow KP, MW Meyer, R Rossmann, A Gendron-Fitzpatrick, BR Gray. 2011. Effects of injected methylmercury on hatch success of common loon (*Gavia immer*) eggs. Ecotoxicology 20:1684-1693.

Toribio SG, BR Gray, S Liang. 2011. An evaluation of the Bayesian approach for fitting the N-mixture model for use with pseudo-replicated count data. J Statistical Computation and Simulation 82:1135-1143.

Gray, BR, RJ Haro, JT Rogala. 2010. Addressing among-group variation in covariate effects using multilevel models. Environmental and Ecological Statistics 17:573–591.

Custer, TW, CM Custer, BR Gray. 2010. Polychlorinated biphenyls, dioxins, furans, and organochlorine pesticides in belted kingfisher eggs from the upper Hudson River basin, New York. Environmental Toxicology and Chemistry 29:99-110.

Custer TW, CM Custer, BR Gray. 2010. Polychlorinated biphenyls, dioxins, furans, and organochlorine pesticides in spotted sandpiper eggs from the upper Hudson River basin, New York. Ecotoxicology 19:391-404.

Custer CM, BR Gray, TW Custer. 2010. Effects of egg order on organic and inorganic element concentrations and egg characteristics in tree swallows, *Tachycineta bicolor*. Environmental Toxicology and Chemistry 29:909–921.

Holland MD, BR Gray. 2011. Multinomial mixture model with heterogeneous classification probabilities. Environmental and Ecological Statistics 18:257–270.

Gray BR, W Shi, JN Houser, JT Rogala, Z Guan, JL Cochran. 2011. Cumulative effects of restoration efforts on ecological characteristics of an open water area within the Upper Mississippi River. River Research and Applications 27:537-549.

Holland MD, G Meeden, BR Gray. 2010. A finite population Bayes procedure for censored categorical abundance data. J Indian Society of Agricultural Statistics 64:171-175.

Kenow KP, RK Hines, MW Meyer, SA Suarez, BR Gray. 2010. Effects of methylmercury exposure on the behavior of captive-reared common loon (*Gavia immer*) chicks. Ecotoxicology 19:933-944.

Smith DR, BR Gray, TJ Newton, D Nichols. 2009. Effect of imperfect detectability on adaptive

and conventional sampling:simulated sampling of freshwater mussels in the Upper Mississippi River. Environmental Monitoring and Assessment 170:499-507.

Gray BR, D Bushek, JW Drane, D Porter. 2009. Associations between land use and *Perkinsus marinus* infection of eastern oysters in a high salinity, partially urbanized estuary. Ecotoxicology 18:259-269.

McCain KNS, RA Hrabik, VA Barko, BR Gray, JR Bidwell. 2009. An evaluation of invertebrate sampling methods for use in the Open River reach of the Upper Mississippi River. MDC Resource Science 4:1-3.

Li J, BR Gray, DM Bates. 2008. An empirical study of statistical properties of variance partition coefficients for multi-level logistic regression models. Communications in Statistics – Simulation and Computation 37:2010-2026.

Kenow KP, KA Grasman, RK Hines, MW Meyer, A Gendron-Fitzpatrick, MG Spalding, BR Gray. 2007. Effects of methylmercury exposure on the immune function of juvenile common loons. Environmental Toxicology and Chemistry 26:1460-1469.

Langrehr HA, BR Gray, JA Janvrin. 2007. Evaluation of aquatic macrophyte community response to island construction in the Upper Mississippi River. Lake and Reservoir Management 23:313-320.

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Thogmartin, WE, BR Gray, M Gallagher, N Young, JJ Rohweder, MG Knutson. 2007. Power to detect trend in short-term time series of bird abundance. Condor 109:943–948.

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Gray BR. 2005. Selecting a distributional assumption for modelling relative abundances of benthic macroinvertebrates. Ecological Modelling 185:1-12.

Gray BR, RJ Haro, JT Rogala, JS Sauer. 2005. Modeling fingernail clam (Family:Sphaeriidae) abundance-habitat associations at two spatial scales using hierarchical count models. J Freshwater Biology 50:715-729.

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Minnesota, USA. Science of the Total Environment 330:81-87.

Knutson MG, WB Richardson, DM Reineke, BR Gray, JR Parmelee, SE Weick. 2004. Agricultural ponds support amphibian populations. Ecological Applications 14:669-684.

Gray BR, WR Hill, AJ Stewart. 2001. Effects of development time, biomass and ferromanganese oxides on nickel sorption by stream periphyton. Environmental Pollution 112:61-71.

Gray BR, S McDermott, S Butkus. 2000. Effect of job coaches on employment likelihood for individuals with mental retardation in South Carolina. J Vocational Research 14:5-11.

Gray BR, VL Emery, DL Brandon and others. 1998. Selection of optimal measures of growth and reproduction for the sublethal *Leptocheirus plumulosus* sediment bioassay. Environmental Toxicology and Chemistry 17:2288-2297.

Emery VL, DW Moore, BR Gray, BM Duke, AB Gibson, RW Wright, JD Farrar. 1997. Development of a chronic sublethal sediment bioassay using the estuarine amphipod *Leptocheirus plumulosus* (Shoemaker). Environmental Toxicology and Chemistry 16:1912-1920.

Moore DW, TS Bridges, BR Gray, BM Duke. 1997. Risk of ammonia toxicity during sediment bioassays with the estuarine amphipod *Leptocheirus plumulosus*. Environmental Toxicology and Chemistry 16:1020-1027.

Bridges TS, RB Wright, BR Gray, AB Gibson, TM Dillon. 1996. Chronic toxicity of Great Lakes sediments to *Daphnia magna*:elutriate effects on survival, reproduction, and population growth. Ecotoxicology 5:83-102.

Gray BR, WR Hill. 1995. Nickel sorption by periphyton exposed to different light intensities. J North American Benthological Society 14:299-305.

Book chapters

Lyubchich V, BR Gray and YR Gel. 2015. Multilevel random slope approach and nonparametric inference for river temperature, under haphazard sampling. In V Lakshmanan, E Gilleland, A McGovern and M Tingley, eds., Machine learning and data mining approaches to climate science, Springer, Cham, Switzerland, pp. 137-145. IP-059442.

Gray BR. 2011. Variance components estimation for continuous and discrete data, with emphasis on cross-classified sampling designs. In Gitzen RA, JJ Millspaugh, AB Cooper, DS Licht (eds.), Design and analysis of long-term ecological monitoring studies, Cambridge, Cambridge, UK, pp. 200-227.

Reports

Reports to US Army Corps of Engineers on environmental and/or ecological issues (and mostly subsumed in subsequent publications): approximately 10.

Russell M, BR Gray. 2013. Markov chains and zeros in my data: Bayesian approaches in SAS® that address zero-inflation in count data. In Proceedings of the SAS Global Forum 2013 Conference, paper 450-2013, SAS Institute, Cary, NC. Accessible at http://support.sas.com/resources/papers/proceedings13/450-2013.pdf.

Kenow KP, BR Gray, PJ Boma, SC Houdek, L Fara, M Suarez. 2012. Annual Report: Boater Compliance With The Lake Onalaska Voluntary Waterfowl Avoidance Area - Fall 2011. Submitted in fulfillment of the Scope of Work entitled "Boater Compliance with the Lake Onalaska Voluntary Waterfowl Avoidance Area - Fall 2011"; U.S. Fish and Wildlife Service, Upper Mississippi River National Wildlife and Fish Refuge – La Crosse District (Agreement No. F11RG00339; 29 June 2011), 12 September 2012.

Kenow KP, BR Gray, P Boma. 2010. Letter Report: Human disturbance and biotic response to island restoration in the Wisconsin Islands closed area on the Upper Mississippi River, Fall 2009. Letter report TS-08-B2K5C (DMM4K) to US Fish and Wildlife Service.

King R, P Adler, S Converse, BR Gray, K Maguire, M Meier, M Putnam. 2010. Whooping crane site selection and factors limiting whooping crane nest success in central Wisconsin. US Fish and Wildlife Service.

Kenow KP, L Robinson, BR Gray, P Boma. 2009. Human disturbance and biotic response to island restoration in the Wisconsin Islands closed area on the Upper Mississippi River. Briefing report TS-08-B2K5C (DMM4E) to US Fish and Wildlife Service.

Kenow KP, L Robinson, BR Gray, P Boma. 2008. Human disturbance and biotic response to island restoration in the Wisconsin Islands closed area on the Upper Mississippi River - pilot study. Draft briefing report TS-08-B2K5C to US Fish and Wildlife Service.

Knutson MG, N Danz, T Sutherland, BR Gray. 2008. Landbird monitoring protocol for the U.S. Fish and Wildlife Service, Midwest and Northeast Regions, Version 1. Biological Monitoring Team Technical Report BMT-2008-01. U.S. Fish and Wildlife Service, La Crosse, WI.

Thogmartin WE, MG Knutson, JJ Rohweder, BR Gray. 2006. Bird habitat associations on the lower Missouri River floodplain: A report to the U.S. Fish and Wildlife Service Big Muddy National Wildlife and Fish Refuge: La Crosse, WI, Upper Midwest Environmental Sciences Center, 123 pages.

Rogala JT, PJ Boma, BR Gray. 2003. Rates and patterns of net sedimentation in backwaters of Pools 4, 8, and 13 of the Upper Mississippi River. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin. An LTRMP Web-based report available online at www.umesc.usgs.gov/data_library/sedimentation/documents/ rates_patterns/.

Moore DW, AB Gibson, TM Dillon, TS Bridges, EW Gamble, BR Gray, RB Wright, LH Baggett. 1994. Evaluation of proposed U. S. Environmental Protection Agency dredged material bioassays using Great Lakes sediments. Misc. paper EL-94-11, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Commissioner of Crown Lands. 1986. Akaroa Head Reserve management plan. Department of Lands and Survey, Private Bag, Christchurch, New Zealand.

Presentations at professional meetings: approx. 80

Editorial board membership
Environmental Toxicology and Chemistry, 2002-2004.

Manuscript refereeing
Auk; Canadian J Zoology; Diseases of Aquatic Organisms; Ecology; Ecosphere; Ecotoxicology; Environmental and Ecological Statistics; Environmental Toxicology and Chemistry; Environmetrics; Frontiers in Ecology; Freshwater Biology; J Agricultural, Environmental and Agricultural Statistics; Freshwater Biology; J Animal Ecology; J Agricultural, Biological, and Environmental Statistics; J Applied Ecology; J Wildlife Management; Methods Ecology Evolution; River Research and Applications; Sustainability; Wildlife Society Bulletin; Wilson Journal of Ornithology.

Proposal reviewer
National Science Foundation, 2006; National Wildlife Health Center, 2005; Patuxent Wildlife Center, 2005; USEPA Environmental Monitoring and Assessment Program, 2003.

Expert consultant
Region 3, US Fish and Wildlife Service, 2007 – 2013; occasional, for editor of *Ecotoxicology*; Oregon Water Science Center, 2007; Hudson River Natural Resource Damage Assessment, US Fish & Wildlife Service, 2004, 2005.

Service
Secretary, Section on Environment and Statistics, American Statistical Association, 2011-2014
North American representative, The International Environmetrics Society (TIES), 2009-2013
Organizer, North American regional meeting, TIES, La Crosse, WI, 2009
Lead and principal author, LTRMP sampling design and statistics web pages, http://www.umesc.usgs.gov/ltrmp/stats/statistics.html
UMESC representative, USFWS Great Lakes Basin Ecosystem Team, 2002-2005.

Grants and awards
Erickson RA and BR Gray (PI). Estimating trends in UMRR fish and vegetation levels using state-space models. Long Term Resource Monitoring Program, US Army Corps of Engineers. $44,430. 2015-16.

Haro R [co-PI], B Bennie [co-PI], JP Pierce [co-PI], GJ Sandland [co-PI], BR Gray, WB Richardson and WT Thogmartin. 2009. UBM-Group: Collaborations on Riverine Ecology (CORE), National Science Foundation – Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences. Collaboration between University of Wisconsin – La Crosse Departments of Biology and Mathematics, the University of Wisconsin – La Crosse River Studies Center, and Upper Midwest Environmental Sciences Center, USGS. $234,547.

Gray BR. 2009. Estimating submersed aquatic vegetation levels in rivers, lakes and estuaries of the United States using rake data. USGS burden dollars. $15,000.

The effects of river nutrient concentrations on metaphyton, submersed aquatic vegetation and dissolved oxygen across a connectivity gradient. 2008. Additional Program Elements, Long Term Resource Monitoring Program, US Army Corps of Engineers. $19,960. Gray BR (JD Houser PI).

Rogala J, T Newton, BR Gray, S Zigler, D Smith, M Davis. 2008. Development of survey methods to spatially map mussel assemblages in the UMRS. US Army Corps of Engineers. $46,766.

Sauer JS, R Cole, G Sandland, RJ Haro, BR Gray, S Westenbroek. 2008. Understanding mortality of waterbirds caused by the dynamics of disease-carrying exotic snails in the Upper Mississippi River. US Geological Survey Midwest Area Science Funds. $60,000.

Zigler S, T Newton, BR Gray, J Rogala. 2008. Statistical and geospatial analyses of mussel communities in the UMR. US Army Corps of Engineers. $57,633.

Newton TN, BR Gray, D Smith, S Zigler. 2007. Development of sampling designs for estimating mussel abundances associated with HREPs. US Army Corps of Engineers. $101,000.

Gray BR. 2007. Cumulative HREP effects on ecological characteristics of impounded regions of the Upper Mississippi River. US Army Corps of Engineers. $38,117.

Gray BR, T Newton. 2006. Comparison of clustered and adaptive sampling designs for estimating abundance of freshwater macroinvertebrates (native mussels, zebra mussels and soft-sediment macroinvertebrates). UMESC Director's Funds. $19,206.

Gray BR. 2006. Model chlorophyll *a* and suspended solids levels in backwater lakes of the UMRS, Part II: Importance of backwater lakes, backwater lake-covariate associations, and long-term trends in backwater variability. Additional Program Elements, Long Term Resource Monitoring Program, US Army Corps of Engineers. $26,123.

Deppa B, BR Gray, PH Heglund. 2006. Assessment of the rake method for the estimation of submersed aquatic vegetation levels. Additional Program Elements, Long Term Resource Monitoring Program, US Army Corps of Engineers. $43,221.

Gray BR. 2005. Develop control charts for selected water quality constituents. Additional Program Elements, Long Term Resource Monitoring Program, US Army Corps of Engineers.

$19,294.

Gray BR. 2005. Model chlorophyll *a* and suspended solids levels in backwater lakes of the UMRS. Additional Program Elements, Long Term Resource Monitoring Program, US Army Corps of Engineers. $26,469.

Knutson MG, TJ Fox, EM Kirsch, BR Gray and others. 2001. Science Support for Regional and Refuge Bird Conservation Planning. $70,000.

Travel awards, Graduate School and School of Public Health, USC, 1999 and 2000. $650.

Grants-in-Aid of Research award, Sigma Xi Scientific Research Society, 1992. $375.

Oak Ridge Associated Universities Graduate Student Research Participation Program fellowship (full stipend) award, 1992-1993.

'A' bursary award (stipend and tuition waiver at NZ university), NZ government, 1977-1980.

Curriculum Vitae

Christopher W. Hoagstrom

Residence: 1030 East Country Hills Drive
Ogden, Utah 84403

(801) 388-6226 cell
pecospupfish@hotmail.com

Office: Weber State University
Department of Zoology
2505 University Circle
Ogden, Utah 84405-2505
Phone: (801) 626-7486
FAX: (801) 626-7445
ChristopherHoagstrom@weber.edu

Present Position: Associate Professor, Zoology, Weber State University

Education:

South Dakota State University	Biology	PhD	2006
Sul Ross State University	Biology	MS	1994
Ohio Northern University	Biology	BS	1992

Academic experience:

Weber State University	Associate Professor & Department Chair	2012-present
Weber State University	Assistant Professor	2006 – 2012
South Dakota State University	Graduate Research Assistant	2003 – 2006
Sul Ross State University	Graduate Research Assistant	1992 – 1994
Ohio Northern University	Undergraduate Teaching Assistant	1991

Relevant employment (non-academic):

U.S. Fish & Wildlife Service, New Mexico Fishery Resources Office	Biological Technician - Fishery Biologist	1993 – 2002
U.S. Geological Survey, Water Resources Division, Columbus, Ohio	Biological Technician	1992
U.S. Department of Agriculture, Animal Plant Health Inspection Service, Plant Protection and Quarantine, Toledo, Ohio	Technician	1991
U.S. National Park Service, Theodore Roosevelt National Park	Student Conservation Association Volunteer	1990

Honors

- Gwen Williams Prize, awarded by the Hemingway Faculty Development Trust for extraordinary work by faculty receiving Hemingway Vitality Grants (2012)

- John R. Morgart Science Award, U.S. Fish and Wildlife Service, Southwest Region, best published paper (2010)
- Jerome Norgren Endowment at South Dakota State University, Fisheries Ph.D. graduate student of the year (2005)
- U.S. Department of the Interior Star Award (2001, September 1999, January 1999)
- U.S. Department of the Interior On-the-Spot Award (1994, 1996)
- U.S. Department of Agriculture Certificate of Merit (1992)
- Dean's List (spring 1989-1990, fall 1990-1991, winter 1991-1992, spring 1991-1992)
- Beta Beta Beta Biological Honor Society (1990)

RESEARCH
Publications

REFEREED ARTICLES

Osborne MJ, Diver TA, Hoagstrom CW, Turner TF. In Press. Biogeography of "*Cyprinella lutrensis*": intensive genetic sampling from the Pecos River 'melting pot' reveals a dynamic history and phylogenetic complexity. Biological Journal of the Linnean Society.

Matamoros WA, Hoagstrom CW, Schaefer JF, Kreiser BR In Press. Fish faunal provinces of the conterminous United States of America reflect historical geography and familial composition. Biological Reviews.

Collyer ML, Hall MD, Smith MD, Hoagstrom CW. 2015. Habitat-morphotype associations of Pecos pupfish (*Cyprinodon pecosensis*) in isolated habitat complexes. Copeia 103:181-199.

Hoagstrom CW, Archdeacon TP, Davenport SR, Propst DL, Brooks JE 2015. Intrafragment riverscape conservation for an imperiled, small-bodied, pelagic-broadcast spawning minnow: speckled chub (*Macrhybopsis aestivalis*). Canadian Journal of Fisheries and Aquatic Sciences 72:527-537.

Hoagstrom, CW, and TF Turner 2015. Recruitment ecology of pelagic-broadcast spawning minnows: paradigms from the ocean advance science and conservation of an imperilled freshwater fauna. Fish and Fisheries 16:282-299.

Echelle AA, Schwemm MR, Lang NJ, Nagle BC, Simons AM, Unmack PJ, Fisher WL, Hoagstrom CW 2014. Molecular systematics and historical biogeography of the *Nocomis biguttatus* species group (Teleostei: Cyprinidae): Nuclear and mitochondrial introgression and a cryptic Ozark species. Molecular phylogenetics and evolution 81:109-119.

Hoagstrom CW. 2014. Drift versus retention: an alternative perspective to Wilde and Urbanczyk's 'relationship between river fragment length and persistence of two imperiled great plains cyprinids'. Journal of Freshwater Ecology. 29:449-452.

Hoagstrom CW. 2014. Habitat loss and subdivision are additive mechanisms of fish extinction in fragmented rivers. Global Change Biology. In Press.

Hoagstrom CW, V Ung, and K Taylor. 2014. Miocene rivers and taxon cycles clarify the comparative biogeography of North American highland fishes. Journal of Biogeography 41:644-658.

Davenport SR, JF Mull, and CW Hoagstrom. 2013. Attempted consumption of a dangerous, riparian ant (*Camponotus vicinus*) by a threatened, fluvial minnow (*Notropis simus pecosensis*). Southwestern Naturalist 58:126-128.

Hoagstrom CW, JE Brooks, and SR Davenport. 2011. A large-scale conservation perspective considering endemic fishes of the North American plains. Biological Conservation 144:21-34.

Osborne MJ, SR Davenport, CW Hoagstrom, and TF Turner. 2010. Genetic effective size, N_e, tracks density in a small freshwater cyprinid, Pecos bluntnose shiner (*Notropis simus pecosensis*). Molecular Ecology 19:2832-2844.

Hoagstrom, CW, and CR Berry Jr. 2010. The native range of walleye in the Missouri River drainage. North American Journal of Fisheries Management 30:642-654.

Hoagstrom CW, ND Zymonas, SR Davenport, DL Propst, and JE Brooks. 2010. Rapid species replacements between fishes of the North American plains: a case history from the Pecos River. Aquatic Invasions 5:141-153.

Hoagstrom CW, WJ Remshardt, JR Smith, and JE Brooks. 2010. Changing fish faunas in two reaches of the Rio Grande in the Albuquerque Basin. Southwestern Naturalist 55:78-88.

Hoagstrom CW. 2009. Causes and impacts of salinization in the Lower Pecos River. Great Plains Research 19:27-44.

Hoagstrom CW, CA Hayer, and CR Berry Jr. 2009. Criteria for determining native distributions of poorly-studied taxa: the case of the northern plains killifish in the Cheyenne River drainage, North America. Aquatic Conservation: Marine and Freshwater Ecosystems 19:88-95.

Hoagstrom CW, JE Brooks, and SR Davenport. 2008. Recent habitat association and the historical decline of *Notropis simus pecosensis*. River Research and Applications 24:789-803.

Hoagstrom CW, JE Brooks, and SR Davenport. 2008. Spatiotemporal population trends of *Notropis simus pecosensis*, 1992-2005, in relation to habitat conditions and the annual flow regime. Copeia 2008:5-15.

Hoagstrom CW, and CR Berry Jr. 2008. Morphological diversity among fishes in a Great Plains river drainage. Hydrobiologia 596:367-386.

Hoagstrom CW, NJC Gosch, AC DeWitte, CR Berry Jr, and JP Duehr. 2007. Biodiversity, biogeography, and longitudinal fish faunal structure among perennial, warmwater streams of the Cheyenne River drainage. Prairie Naturalist 39:117-144.

Selch TM, CW Hoagstrom, EJ Weimer, JP Duehr, and SR Chipps. 2007. Influence of fluctuating water levels on mercury concentrations in adult walleye. Bulletin of Environmental Contamination and Toxicology 79:36-40.

Hoagstrom CW, AC DeWitte, NJC Gosch, and CR Berry Jr. 2007. Historical fish assemblage flux in the Cheyenne River below Angostura Dam. Journal of Freshwater Ecology 22:219-229.

Kaemingk MA, BDS Graeb, CW Hoagstrom, and DW Willis. 2007. Patterns of Fish Diversity in a mainstem Missouri River Reservoir and Associated Delta. River Research and Applications 23:786-791.

Hoagstrom CW, SS Wall, JG Kral., BG Blackwell, and CR Berry Jr. 2007. Zoogeographic patterns and faunal change of South Dakota Fishes. Western North American Naturalist 67:161-184.

Hoagstrom CW, SS Wall, CR Berry Jr, and JP Duehr. 2006. River size and fish assemblages in southwestern South Dakota. Great Plains Research 16:117-126.

Hoagstrom CW, and CR Berry Jr. 2006. Island biogeography of native fish faunas among Great Plains drainage basins: basin scale features influence composition. American Fisheries Society Symposium 48:221-264.

Hoagstrom CW, and JE Brooks. 2005. Distribution and status of Arkansas River shiner *Notropis girardi* and Rio Grande shiner *Notropis jemezanus*, Pecos River, New Mexico. Texas Journal of Science 57:35-58.

Hoagstrom CW. 2003. Historical and recent fish fauna of the Lower Pecos River. Pages 91-110 *in* G. P. Garrett and N. L. Allan (editors). Aquatic fauna of the northern Chihuahuan Desert. Special Publications of the Museum of Texas Tech University 46.

Hoagstrom CW, and JE Brooks. 1999. Distribution, status, and conservation of the Pecos pupfish, *Cyprinodon pecosensis*. Technical Report No. 2, New Mexico Department of Game and Fish, Santa Fe.

Echelle AA, CW Hoagstrom, AF Echelle, and JE Brooks. 1997. Expanded occurrence of genetically introgressed pupfish (Cyprinodontidae: *Cyprinodon pecosensis* x *variegatus*) in New Mexico. Southwestern Naturalist 42:336-339.

OTHER PUBLICATIONS (NOT PEER-REVIEWED)

Hoagstrom CW, WE Adams Jr, RM Neumann, and DW Willis. 2011. Guide to the fishes of South Dakota. Department of Wildlife and Fisheries Sciences, South Dakota State University, Brookings, SD.

Hoagstrom CW, SS Wall, JG Kral, and BG Blackwell. 2007. Recent zoogeography of South Dakota fishes. Pages 37-89 *in* CR Berry Jr, KF Higgins, DW Willis, and SR Chipps (editors). History of fisheries and fishing in South Dakota. South Dakota Department of Game, Fish and Parks, Pierre.

Hoagstrom CW, AC DeWitte, NJC Gosch, and CR Berry Jr. 2006. Perennial-Warmwater Fish Communities of the Cheyenne River Drainage: a seasonal assessment. Proceedings of the South Dakota Academy of Science 85:213-245.

Hoagstrom CW, CA Hayer, JG Kral, SS Wall, and CR Berry Jr. 2006. Rare & Declining Fishes of South Dakota: a river drainage scale perspective. Proceedings of the South Dakota Academy of Science 85:171-211.

Berry CR Jr, and CW Hoagstrom. 2003. Bioethics in a changing world: fisheries issues. Fisheries 28(9):30-31.

Agency Reports

Hoagstrom CW. 2003. Pecos bluntnose shiner population dynamics, Pecos River, New Mexico, February 1992 through August 2002. Final Report to the U.S. Bureau of Reclamation, Albuquerque Area Office, Albuquerque, NM.

Hoagstrom CW. 2003. Pecos bluntnose shiner habitat suitability, Pecos River, New Mexico, 1992 through 1999. Revised Final Report to the U.S. Bureau of Reclamation, Albuquerque Area Office, Albuquerque, NM.

Davenport SR, CW Hoagstrom, and JR Smith. 2003. Fish community and physical habitat associated with habitat enhancement structures. Final Report to the U.S. Section, International Boundary and Water Commission, El Paso, TX.

Remshardt WJ, JR Smith, and CW Hoagstrom. 2003. Fishes of the mainstem Rio Grande; Bernalillo to Fort Craig, New Mexico. June 1999 through June 2001. With an emphasis on Rio Grande silvery minnow, *Hybognathus amarus* (Girard). Report to U.S. Army Corps of Engineers, Albuquerque District, Albuquerque, New Mexico and the City of Albuquerque, Water Resources Division, Public Works Department, Albuquerque, NM.

Watts HE, CW Hoagstrom, and JR Smith. 2002. Observations on habitat associated with Rio Grande silvery minnow, *Hybognathus amarus* (Girard). Report to U.S. Army Corps of Engineers, Albuquerque District, Albuquerque, NM.

Hoagstrom CW. 2000. Fish collections from the lower Rio Jemez. Report to the Pueblo of Santa Ana, NM.

Hoagstrom CW. 1997. Pecos River fishery investigations: fish habitat availability and use; fish community structure in relation to reservoir operation. 1995 Annual Report to U.S. Bureau of Reclamation, Albuquerque Area Office, Albuquerque, NM.

Smith JR, and CW Hoagstrom. 1997. Fishery investigations on the Low Flow Conveyance Channel Temporary Outfall Project and on intermittency in the Rio Grande. Progress Report and Scope of Work to U.S. Bureau of Reclamation, Albuquerque, NM.

Hoagstrom CW, NL Allan, and JE Brooks. 1995. Pecos River fishery investigations: fish community structure and habitat use and availability as a response to reservoir operations. 1994 Annual Report to U.S. Bureau of Reclamation, Albuquerque Area Office, Albuquerque, NM.

Presentations

ORAL PRESENTATIONS

Hoagstrom CW, and K Taylor. 2015. Deep Endemism of Fishes in the Ozarks and Pre-Pleistocene Highland Vicariance. Joint Meeting of Ichthyologists and Herpetologists, Reno, NV.

Mecham, DJ, Hoagstrom CW, and Graeb, BDS. 2014. The effects of river channel restoration on early juvenile fishes and meiofauna of the Pecos River, New Mexico. Desert Fishes Council Annual Symposium, Los Cabos, BCS.

Hoagstrom CW, TP Archdeacon, SR Davenport, DL Propst, and JE Brooks. 2014. Last-stand population ecology in fragmented rivers and conservation in de-facto refugia. Desert Fishes Council Annual Symposium, Los Cabos, BCS.

Hoagstrom CW, and K Taylor. 2014. Evidence that a Centrifugal-Speciation/Taxon-Cycle Process Produced Endemism in the Ouachita Mountains via Peripheral Isolation. Joint Meeting of Ichthyologists and Herpetologists, Chattanooga, TN.

Hoagstrom CW, TP Archdeacon, SR Davenport, DL Propst, and JE Brooks. 2013. Population regulation and conservation of speckled chub *Macrhybopsis aestivalis*. Desert Fishes Council Annual Symposium, Flagstaff, AZ.

Hoagstrom, CW, V Riviere-Ung, and K Taylor. 2013. Tertiary Origins of Fish Endemism in North American Highlands: Parallel Evolution, Taxon Cycles, and Human Intrusions. Joint Meeting of Ichthyologists and Herpetologists, Albuquerque, NM. Fish out of Water:

evolutionary and ecological issues in the conservation of fishes in water-altered environments special symposium [**invited presentation**].

Collyer ML, and CW Hoagstrom. 2013. Examining the association between ecology and morphology in the Pecos pupfish (*Cyprinodon pecosensis*) in an altered and ecologically diverse landscape. American Society of Ichthyologists and Herpetologists, Albuquerque, NM. Fish out of Water: evolutionary and ecological issues in the conservation of fishes in water-altered environments special symposium [**invited presentation**].

Hoagstrom CW, and TF Turner. 2012. The recruitment sequence, fish community assembly, & conservation ecology in arid-land rivers. Desert Fishes Council Annual Symposium, Death Valley, CA. Evolutionary Ecology of Refuge Populations of Protected Fishes special symposium [**invited presentation**].

Hoagstrom CW, SR Davenport, JE Brooks, and DL Propst. 2012. Complex life history, ecology, and conservation of speckled chub (*Macrhybopsis aestivalis*), a benthic, opportunistic, pelagic-broadcast spawning minnow. Annual meeting of the Society for Freshwater Science, Louisville, KT.

Hoagstrom CW. 2011. Fish endemism and conservation in the plains, North America. Science Conversations presented by the Weber State University Chapter of Sigma Xi. Ogden, UT.

Hoagstrom CW. 2011. Biological homogenization by rapid species replacement. Seminar speaker. Utah State University, College of Natural Resources [**invited presentation**], Logan, UT.

Hoagstrom CW. 2010. Challenges ahead and research needs. Break-out period presenter. Restoring Rivers in the Southwestern U.S. and Northern Mexico, a Bi-National Conference On Learning From the Past To Benefit the Future [**invited presentation**]. Tucson, AZ.

Hoagstrom CW, ND Zymonas, SR Davenport, DL Propst, and JE Brooks. 2010. Ecology of rapid replacement – Rio Grande silvery minnow vs. plains minnow – middle Pecos River, New Mexico. Desert Fishes Council Annual Symposium, Moab, UT.

Osborne MJ, SR Davenport, CW Hoagstrom, and TF Turner. 2010. Genetic effective size, N_e, tracks density in a small freshwater cyprinid, Pecos bluntnose shiner (*Notropis simus pecosensis*). Desert Fishes Council Annual Symposium, Moab, UT.

Hoagstrom CW. 2010. Benthic fish assemblages in northern Utah. Western Division of the American Fisheries Society Annual Meeting, Salt Lake City, UT.

Hoagstrom CW. 2009. Benthic fish assemblages in northern Utah. 6th Annual Faculty Forum, WSU, Ogden, UT.

Hoagstrom CW, SR Davenport, and JE Brooks. 2009. Biogeography and long-term conservation of fishes and aquatic habitats of the Pecos River drainage. Western Division of the American Fisheries Society Annual Meeting, Albuquerque, NM.

Davenport SR, CW Hoagstrom, T Archdeacon. 2009. Response of Pecos River fish community to surface flow intermittence. Western Division of the American Fisheries Society Annual Meeting, Albuquerque, NM.

Kodric-Brown A, CW Hoagstrom, JE Brooks. 2009. Fish assemblages of sinkholes in the lower Pecos River Basin of New Mexico. Western Division of the American Fisheries Society Annual Meeting, Albuquerque, NM.

Holmes NV and CW Hoagstrom. 2009. Ecomorphology of sculpin in northeastern Utah. Western Division of the American Fisheries Society Annual Meeting, Albuquerque, NM.

Holmes NV and CW Hoagstrom. 2009. Ecomorphology of sculpin in northeastern Utah. Weber State University Undergraduate Research Symposium, Ogden, UT.

Holmes NV, and CW Hoagstrom. 2009. Ecomorphology of sculpin, a native fish of northeastern Utah. Utah Conference on Undergraduate Research, Salt Lake City, UT.

Hoagstrom CW. 2009. Preliminary data on the distribution, habitat association, and population structure of Paiute sculpin *Cottus beldingii* in northeastern Utah. Utah Chapter of the American Fisheries Society Annual Meeting, Moab, UT.

Holmes NV and CW Hoagstrom. 2009. Ecomorphology of sculpin in northeastern Utah. Utah Chapter of the American Fisheries Society Annual Meeting, Moab, UT.

Hoagstrom CW, and NV Holmes. 2008. Ecomorphological relations between *Cottus* species and their environment in northeastern Utah. Desert Fishes Council Annual Symposium, Cuatro Ciénegas, Coahuila.

Hoagstrom CW, and NV Holmes. 2008. How does the environmental variation among streams affect morphological variation of individual fish? 5th Annual Faculty Forum, WSU, Ogden, UT.

Hoagstrom CW. 2008. Hydrological causes and ecological impacts of salinization in the Lower Pecos River. Annual meeting of the North American Benthological Society, Salt Lake City, UT.

Hoagstrom CW, JE Brooks, and SR Davenport. 2007. Recent habitat association and the historical decline of *Notropis simus pecosensis*. Desert Fishes Council Annual Symposium, Ventura, CA.

Hoagstrom CW, JE Brooks, and SR Davenport. 2006. Spatiotemporal population patterns of the Pecos bluntnose shiner, 1992-2005. Desert Fishes Council Annual Symposium, Furnace Creek, CA.

Davenport SR, CW Hoagstrom, and JE Brooks. 2006. Effects of surface flow intermittence on a Great Plain's fish community, Pecos River, New Mexico. Desert Fishes Council Annual Symposium, Furnace Creek, CA.

Kaemingk MA, BDS Graeb, CW Hoagstrom, and DW Willis. 2006. Patterns of fish diversity within the Lewis and Clark Reservoir and delta. 67th Midwest Fish and Wildlife Conference, Omaha, NE.

Berry CR, and CW Hoagstrom. 2006. Status of fishes in South Dakota with emphasis on declining species in eastern rivers. Eastern South Dakota Water Conference, Brookings, SD.

Hoagstrom CW, CR Berry, NJC Gosch, and AC DeWitte. 2006. Fish assemblage structure in the North American Great Plains: a case history. Annual Meeting of the North American Benthological Society, Anchorage, AK.

Hoagstrom CW, AC DeWitte, NJC Gosch, and CR Berry Jr. 2006. Perennial-Warmwater Fish Communities of the Cheyenne River Drainage: a seasonal assessment. South Dakota Academy of Science Meeting, Chamberlain, SD.

Hoagstrom CW, CA Hayer, JG Kral, SS Wall, and CR Berry Jr. 2006. Rare & Declining Fishes of South Dakota: a river drainage scale perspective. South Dakota Academy of Science Meeting, Chamberlain, SD.

Hoagstrom CW, SS Wall, JG Kral, BG Blackwell, and CR Berry Jr. 2006. Distributional trends of South Dakota Fishes among river drainages and over time. Dakota Chapter American Fisheries Society Meeting, Chamberlain, SD.

Hoagstrom CW, and CR Berry Jr. 2006. South Dakota's river fish inventory and habitat analysis: 15-year summary of fish ecology discoveries, Part II. Dakota Chapter American Fisheries Society Meeting, Chamberlain, SD.

Berry CR Jr. and CW Hoagstrom. 2006. South Dakota's river fish inventory and habitat analysis: 15-year summary of fish ecology discoveries, Part I. Dakota Chapter American Fisheries Society Meeting, Chamberlain, SD.

Kaemingk MA, BDS Graeb, CW Hoagstrom, and DW Willis. 2006. Patterns of Juvenile Fish Diversity within the Lewis and Clark Reservoir System. Dakota Chapter American Fisheries Society Meeting, Chamberlain, SD.

Hoagstrom CW, CR Berry Jr, NJC Gosch, and AC DeWitte. 2005. Is it "normal" for smallmouth bass to dominate the Cheyenne River below Angostura Dam during drought periods? Midwest Fish & Wildlife Conference, Grand Rapids, MI.

Selch TM, SR Chipps, CW Hoagstrom, JP Duehr, and EJ Weimer. 2005. Predictive models relating mercury concentrations in top-level piscivores to water level fluctuations and physicochemical properties. Midwest Fish & Wildlife Conference, Grand Rapids, MI.

Duehr JP, CW Hoagstrom, and CR Berry Jr. 2005. Segment and reach scale geomorphology and associated fish assemblages in the Cheyenne River Basin. Joint Assembly of the American Geophysical Union, North American Benthological Society, Society of Exploration Geophysicists, and the Solar Physics Division of the American Astronomical Society, New Orleans, LA.

Hoagstrom CW, and CR Berry Jr. 2004. Fluviogeomorphical Continua And Fish Communities In Western South Dakota Rivers. Midwest Fish & Wildlife Conference, Indianapolis, IN.

Hoagstrom CW, and CR Berry Jr. 2004. Zoogeography of native fishes in western Missouri River tributary watersheds from the Yellowstone to the Platte. Annual Meeting of the American Fisheries Society, Madison, WI.

Hoagstrom CW. 2004. Downstream reduction of fish species richness in the Cheyenne River, South Dakota, U.S.A. Annual Meeting of the North American Benthological Society, Vancouver, BC.

Hoagstrom CW. 2004. Pelagic, broadcast spawning minnows in South Dakota? Dakota Chapter American Fisheries Society Meeting, Pierre, South Dakota.

Hoagstrom CW, and CR Berry Jr. 2003. Channel Catfish Distribution in Western South Dakota. Midwest Fish & Wildlife Conference, Kansas City, MO.

Berry CR Jr., NM Morey, and CW Hoagstrom. 2003. Recreational Catfishing, Status of Channel and Flathead Catfish Populations, and Proposed Flood Control Measures in Eastern South Dakota. Midwest Fish & Wildlife Conference, Kansas City, MO.

Hoagstrom CW, and JE Brooks. 2003. Pecos bluntnose shiner conservation status. Society for Conservation Biology Annual Meeting, Duluth, MN.

Hoagstrom CW. 2002. Length structure of the Pecos bluntnose shiner population at two temporal scales. Joint Meeting of the Ichthyologists and Herpetologists, Kansas City, MO.

Hoagstrom CW. 2002. Pecos bluntnose shiner: size-related habitat use. Annual Symposium of the Desert Fishes Council, Hotel Fiesta Inn, San Luis Potosi.

Brooks JE, DL Propst, RK Dudley, CW Hoagstrom, SP Platania, and TF Turner. 2002. Native fish research and management in the upper/middle Rio Grande basin, 2002. Annual Symposium of the Desert Fishes Council, Hotel Fiesta Inn, San Luis Potosi.

Hoagstrom CW. 2001. Habitat preference of Rio Pecos fluvial cyprinids. Meeting of the North American Benthological Society, LaCrosse, WI.

Hoagstrom CW. 2001. Historical and recent distributions of lower Pecos River fishes. Annual Symposium of the Desert Fishes Council, Alpine, TX.

Brooks JE, DL Propst, CW Hoagstrom, SP Platania, TF Turner, and BG Wiley. 2001. Native fish research and management in the upper/middle Rio Grande basin during 2001. Annual Symposium of the Desert Fishes Council, Alpine, TX.

Tashjian PL, and CW Hoagstrom. 2001. The Physical In-Channel Habitat of the Middle Pecos River, New Mexico: Geomorphic Control on Native Fish Community. American Water Resources Association National Conference, Albuquerque, NM.

Hoagstrom CW. 2000. Significance of fluvial, sand-bed habitat to desert river minnow conservation. Annual Symposium of the Desert Fishes Council, Death Valley, CA.

Brooks JE, DL Propst, RK Dudley, CW Hoagstrom, J Monzingo, SP Platania, and JR Smith. 2000. Native fish research and management in New Mexico during 2000. Annual Symposium of the Desert Fishes Council, Death Valley, CA.

Hoagstrom CW. 1999. Native fishes in the Pecos River, New Mexico. Annual Symposium of the Desert Fishes Council, Ciudad Victoria, Tamaulipas.

Hoagstrom CW. 1999. Fate of native Pecos River fishes: Red Bluff Dam to Sheffield, Texas. Symposium on the Resources of the Chihuahuan Desert Region: U.S. and Mexico, Alpine, TX.

Hoagstrom CW. 1998. Pelagic spawning cyprinids and reservoir operation, Pecos River, NM. Southwestern Association of Naturalists Annual Meeting, Albuquerque, NM.

Hoagstrom CW. 1998. Endemic Pecos River minnows. Uniting the Basin Congress, El Paso, TX.

Hoagstrom CW., and JE Brooks. 1998. Distribution, status, and conservation of the Pecos pupfish, *Cyprinodon pecosensis*. Annual Symposium of the Desert Fishes Council, Wahweap Lodge, Page, AZ.

Hoagstrom CW. 1997. Reservoir operation, habitat, and cyprinid fishes in the middle Pecos River, NM. Annual Symposium of the Desert Fishes Council, Death Valley National Park, CA.

Hoagstrom CW. 1995. Fish population interactions in a southeast New Mexican sinkhole. Annual Symposium of the Desert Fishes Council, Peppermill Hotel Casino, Reno, NV.

Hoagstrom CW. 1994. Status of estuarine fishes inhabiting the Pecos River. Annual Symposium of the Desert Fishes Council, Death Valley National Park, Furnace Creek, CA.

External grants received

- POPULATION MANAGEMENT OF PRAIRIE-RIVER MINNOWS. 2013. Grant proposal funded by the Great Plains Landscape Conservation cooperative for **$33,381** in 2013-2014 (with potential for funding in a second year).
- SEASONAL ECOLOGY OF PECOS PUPFISH IN A DYNAMIC, REMNANT WETLAND. 2012. Grant proposal funded by U.S. Geological Survey for **$87,699**. *Dr. Colleen Caldwell*, U.S. Geological Survey, New Mexico Cooperative Fish and Wildlife Research Unit, Department of Fishery and Wildlife Sciences, New Mexico State University.

- CHANNEL RESTORATION AND PECOS BLUNTNOSE SHINER RECRUITMENT. 2011. Grant proposal funded by U.S. Bureau of Reclamation for **$203,860**. *Dr. Brian Graeb*, Department of Wildlife and Fisheries Sciences, South Dakota State University is co-principal investigator.
- FISH INVENTORIES IN AND FISH POPULATIONS AND ASSEMBLAGE COMPARISONS AMONG THREE TETLIN NWR STREAMS, Challenge Cost Share, U.S. Fish and Wildlife Service, Anchorage, Alaska for **$5000**.
- FISHES AND RIVERINE HABITAT OF BADLANDS NATIONAL PARK, WITH EMPHASIS ON THE STURGEON CHUB AND OTHER IMPERILED SPECIES. 2006. South Dakota State University, Brookings, SD. Grant proposal funded by the National Park Service and South Dakota State University (Park Oriented Biological Support Program) for **$76,833**. Grant in part supported an MS level research assistant for two years. Coauthored with *Dr. Charles R. Berry, Jr*.
- RIO GRANDE SILVERY MINNOW ECOLOGICAL INVESTIGATIONS, HABITAT UTILIZATION BY RIO GRANDE SILVERY MINNOW IN RELATION TO GEOMORPHIC REACH, DISCHARGE, AND POLLUTION, MAINSTEM RIO GRANDE, BERNALILLO TO SAN MARCIAL, NEW MEXICO. 2002-2003. U.S. Fish and Wildlife Service, New Mexico Fishery Resources Office, Albuquerque, NM. Grant proposal funded by the Endangered Species Act Work Group for the Middle Rio Grande, NM for **$107,400** in 2003 and **$213,240** in 2004. Coauthored with *Mr. Paul L. Tashjian*.

Curriculum Vitae

Eileen M. Kirsch

Home
204 N 23rd St.
La Crosse, WI
54601
Home and cell: (608) 785-1561
Email: eileen_ski@yahoo.com

Office
USGS, UMESC
2630 Fanta Reed Rd.
La Crosse, WI 54603
(608) 781-6226
e-mail: ekirsch@usgs.gov

U.S. Citizen: YES
Highest Previous Federal Position: GS-13/08, 0486 series, in grade December 2000 to present
Veteran's Preference: None

Education:

High School: Indio High School, Indio CA, graduated 1978
B.S. Biology 1984 University of Nebraska - Omaha
M.A. Biology 1986 University of Nebraska - Omaha
Ph.D. Zoology 1992 University of Montana

Experience:

1991-present: Research Wildlife Biologist, USGS-BRD, Upper Midwest Environmental Sciences Center, Section of Terrestrial Ecology. Responsibilities: Conducting and supervising research on wildlife, primarily birds in the Upper Midwest. Includes securing funding, coordinating with research partners and DOI and state resource managers, publishing in peer reviewed scientific journals, giving scientific presentations, maintaining research expertise in population and habitat selection studies, budgeting, hiring and training technicians, purchasing, and following safety regulations.

Currently studying foraging ecology of migrant songbirds during spring in floodplain forests along the Upper Mississippi River. The goal of this research is to provide forest managers information on trees that birds select during this critical stage of the annual cycle, and provide information relevant to possible phonological changes that may help understand possible effects of climate change. This project required coordination with the US Army Corps of Engineers. This project is in the manuscript preparation phase.

Currently conducting a study of airspace use by night migrating songbirds (spring and fall) along the southwestern shore of Lake Erie. Using portable marine radars, the goal of this research is to provide information on altitudes of level flight, ascent and descent and directional flight patterns related to the Lake Erie shoreline, and relative intensity of migration as related to banding data from Black Swamp Bird Observatory. This research required coordination with federal, state, private and NGO partners and landowners. This project is in the field work phase

Currently conducting a study of landscape and airspace use of the Horicon Marsh (WI) landscape by refuging Sandhill Cranes in the fall. The goal of this research is to determine how cranes use the landscape and airspace to evaluate possible impact of wind turbines in the area, and model movement and foraging site selection to help inform future wind turbine placement in similar areas with large concentrations of refuging waterbirds. This project was in partnership with the USFWS. This project is in the data analysis and manuscript preparation phases.

Completed – A multiyear study of spring songbird migration along the Upper Mississippi River. This multifaceted study included using NEXRAD images, line-transect bird surveys, bird banding observations, forest habitat characterization on the ground and using GIS, and analyses of plasma lipid metabolites of captured birds to evaluate the value of upland versus floodplain habitats for songbirds during migration. This work requires extensive contact with private land owners and collaboration with USFWS

Completed - Study of songbird use of interior, edge and random floodplain forest sites during spring migration and the breeding season. Also assessed the effect of the invasive grass, *Phalaris arundinacea*, on bird community composition. Collaborated with Minnesota DNR and US Army Corps of Engineers in analyses of forest structure and species composition.

Completed - Study of breeding bird use of wet meadows in the Upper Midwest. Of interest is the effect of invasive Reed Canarygrass, and management such as burning and mowing on bird species composition and bird abundance. Point count and call response bird survey techniques. Sweep net, Malaise trap and vacuum sampling for terrestrial invertebrates that birds potentially feed upon. Line intercept vegetation sampling and plant identification. Use of PLGRs to locate sample points. ArcView III to spatially reference data.

Completed - Study of breeding bird community structure and habitat relationships on the Upper Mississippi River from St. Louis, MO, to Red Wing, MN. Used GIS databases and ARC/INFO to develop random samples of survey points stratified by habitat in selected reaches of the Upper Mississippi River floodplain. Used point count and call response techniques to survey birds. Developed a modified releve' method to quantify vegetation characteristics. Used orienteering skills and Global Positioning Systems to locate survey points. Used several multivariate (maximum likelihood estimation modeling, stepwise regression, and cluster analyses and univariate (t-tests, mixed model ANOVA) techniques and SAS to summarize and analyze bird and vegetation data. Used EZ Barcode with Word Perfect for fast and accurate data entry. Trained and supervised up to 6 technicians for field work and data entry. Developed standard operating procedures for field methods, data entry, and quality control according to Center policy. Coordinated with state (WI, MN, IA, MO and IL), federal (U.S. Fish and Wildlife Service, U. S. Army Corps of Engineers), and private land managers to gain access to sites, obtain logistical support and unpublished relevant data. Applied principles of conservation biology and community ecology to analyze data and write up results.

Completed - research on Double-crested Cormorant (*Phalacrocorax auritus*) ecology. Developed methods to survey cormorants on a large riverine system, conducted aerial surveys, surveyed birds at colonies and night roosts from a boat, described diet of chicks based on samples of regurgitations and of adults based on stomach contents of cormorants shot at day roosts. Used GIS data bases and ARC/INFO to map cormorant roosts and colonies. Provided technical assistance to state and federal managers in the Midwest concerning cormorant abundance, distribution, effects to fisheries, and study designs for future research and monitoring. Used Harvard Graphics to create figures for reports and publications.

Completed – assessment of population status of the interior population of Least Tern (*Sterna antillarum*). This project included creating a database (dBASE III) which included number of terns and nests counted in discrete areas, years, timing and techniques of surveys, and productivity estimates and methods. Used route regression and a deterministic computer population model to assess status. Applied principles of conservation biology and metapopulation ecology to write up results, which was published in 1999. Provided technical assistance to U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and several state and university researchers concerning Least Tern and Piping Plover (*Charadrius melodus*) conservation and research needs.

Completed - research on habitat use of bitterns and rails on riverine wetlands, including development of sampling schemes, materials, and protocol, choosing study sites, and coordinating state, federal, and volunteer participation. Developed monitoring program for bitterns and rails used by USFWS Upper Mississippi National Wildlife and Fish Refuge.

Assisted in planning and writing the interagency proposal: "Strategy for Improving Management of Migratory Birds on the Upper Mississippi River." Provided technical assistance to USFWS refuge, enhancement, and law enforcement personnel as well as to state wildlife and fishery biologists by developing and reviewing monitoring plans, coordinating research efforts, organizing meetings, and facilitating transfer of information.

Performed extensive review of primary and grey literature concerning monitoring and sampling techniques for birds, mammals, amphibians, and reptiles. Developed a report suggesting protocols and sampling regimes suitable for monitoring representative species or guilds of birds, mammals, amphibians, and reptiles on the highly dynamic and fragmented habitats of the Upper Mississippi River.

Supervisor, currently, Dr. Kirk Lohman, you may contact him, phone 608-781-6341, email: klohman@usgs.gov. past: 1991-2000, Dr. Carl Korschgen, see references; 2002-2008, Dr. Patricia Heglund, see references; 2008-2010, Dr. Jack Waide 608-781-6269

1988-1991: Cooperative Education Student, U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center. Responsibilities: Conducted research on the ecology of Least Terns and Piping Plovers on the lower Platte River in Nebraska. Used aerial videography and MIPS Geographic Information System to

quantify and characterize nesting habitats. Conducted surveys and behavioral observations of terns and plovers. Captured and banded adults and chicks. Mapped colonies, sampled habitat characteristics and vegetation. Used discriminant function analysis, path analysis, MANOVA, ANOVA, and nonparametric techniques to analyze data with SYSTAT program. Developed deterministic and stochastic computer population models for Least Terns and Piping Plovers. Applied principles of population ecology, habitat selection, and conservation biology in writing reports, dissertation and publication and providing management suggestions. Coordinated with Nebraska Game and Parks Commission, USFWS, and private land owners. Used McIntosh graphics programs. Key witness in U.S. Fish and Wildlife Service Region 6 investigation of "take" of Least Tern and Piping Plover nests on a Platte River sandpit. The case resulted in an out of court settlement awarded to the Nebraska Game and Parks Commission for Least Tern and Piping Plover conservation and education of sandpit workers and owners and coordination of sandpit operations. Supervisor: Lee Metzgar, you may contact him, see references. He is now an emeritus professor so he may be difficult to reach.

1986-1990: Graduate Assistant (teaching and research), University of Montana. Courses Taught: Embryology, Mammalogy, Animal Behavior, Introductory Biology, Human Sexuality, Montana Wildlife. Research Project: Rodent control methods and efficacy in eastern Montana agriculture. Contacted and interviewed landowners. Conducted extensive literature review.

1986: Biological Technician, Nebraska Game and Parks Commission. Responsibilities: Census and monitor productivity of Least Terns and Piping Plovers. Conducted surveys, behavioral observations, and monitored colonies. Extensive landowner contact. Supervisor: John Dinan, deceased.

1984-1986: Graduate Teaching Assistant, University of Nebraska - Omaha. Courses Taught: Vertebrate Anatomy and Embryology, Ecology, Ichthyology, Vertebrate Zoology, Introductory Biology, General Zoology. Other Responsibilities: Maintained and catalogued fish and mammal specimens for the Biology Department's teaching collection. Thesis project: Roadside ditches as refugia for small mammals in highly agricultural areas. Designed small mammal and vegetation sampling schemes. Use live trapping methods for small mammals. Identified and humanely marked small mammals in the field. Use SAS for Chi-square analyses. Extensive land owner contact.

1984: Undergraduate Teaching Assistant, University of Nebraska - Omaha. Courses Taught: Introductory Biology.

Professional Writing, Publications, Theses:

Kirsch, E. M., Michael J. Wellik, Manuel Suarez, Robert H. Diehl, Jim Lutes, Wendy Woyczik, Jon Krapfl, and Richard Sojda. 2015. Observation of Sandhill Crane flight behavior in heavy fog. Wilson Journal of Ornithology 127: 281-288.

Kirsch, E. M., P. J. Heglund, B. Gray and P. McKann. 2013. Songbird use of floodplain and upland forests along the Upper Mississippi River corridor during spring migration. Condor 115:115-130.

Thomsen, M., K. Brownell, M. Groshek and E. Kirsch. 2012. Control of reed canarygrass promotes wetland herb and tree seedling establishment in an Upper Mississippi River floodplain forest. Wetlands 32:543-555.

Kirsch, E. M., R. S. Sojda, R. H. Diehl, and M. Suarez. 2010. A crane movement model parameterized using portable radar for evaluating response to wind energy development. Proceedings of iEMSS 5th Biennial meeting: International Congress on Environmental Modeling and Software Society, Ottawa, Canada, July 2010.

Annen, C. A, E. M. Kirsch, and R. W. Tyser. 2008. Reed canarygrass invasions alter succession patterns and may reduce habitat quality in wet meadows. Ecological Restoration 26:190-193.

Kirsch, E. M., B. Ickes, and D.Olson. 2008. Assessing habitat use by Great Blue Herons (*Ardea herodias*) on the

Upper Mississippi River, USA. Waterbirds 31:252-267.

Kirsch, E. M., B. R. Gray, T. S. Fox, and W. E. Thogmartin. 2007. Breeding bird territory placement in riparian wet meadows in relation to invasive reed canary grass, *Phalaris arundinacea*. Wetlands 27:644-655.

Annen, C. A., R. W. Tyser, and E. M. Kirsch. 2005. Effects of selective herbicide, sethoxydim, on reed canarygrass. Ecological Restoration 23:99-102.

Kirsch, E. M. 2004. Book Review: Mississippi River Blufflands and Bird Conservation. The Prairie Naturalist 35:295.

Boyce, M. S., E. M. Kirsch and C. Serveen. 2002. Bet-hedging applications for conservation. Biological Conservation 27 (Suppl.2):385-392.

Kirsch, E.M., and J.G. Sidle. 1999. Status of the interior population of least tern. Journal of Wildlife Management. 63:470-483.

Lingle, G.R., J.G. Sidle, A. Hecht, and E.M. Kirsch. 1999. Observations of banding-related leg injuries in the piping plover. Pages 118-123 in K.F. Higgins, M.R. Brashier, and C.D. Kruse, eds. Proceedings, piping plovers and least terns of the Great Plains and nearby. South Dakota State University, Brookings, South Dakota. (abstract)

Kirsch, E.M., and M.S. Boyce. 1999. Bet hedging for least tern conservation. Pages 42-43 in K.F. Higgins, M.R. Brashier, and C.D. Kruse, eds. Proceedings, piping plovers and least terns of the Great Plains and nearby. South Dakota State University, Brookings, South Dakota. (abstract)

Wiener, J.G., C.R. Fremling, C.E. Korschgen, K.P. Kenow, E.M. Kirsch, S.J. Rogers, Y. Yin, and J. S. Sauer. 1998. Mississippi River. in Mac, M.J., Opler, P.A., C.E. Puckett Haecker, and P.D. Doran, Editors. Status and Trends of the Nation's Biological Resources. Biological Resources Division, U.S. Geological Survey, Reston, Va.

Kirsch, E.M. 1997. Numbers and distribution of Double-crested Cormorants on the Upper Mississippi River. Colonial Waterbirds 20:177-184.

Kirsch, E.M. 1997. Small mammal community composition in cornfields, roadside ditches, and prairies in eastern Nebraska. Natural Areas Journal 17:204-211.

Thompson, B.C., J.J. Jackson, J, Burger, L.A. Hill, E.M. Kirsch, J.L. Atwood. 1997. Least Tern (*Sterna antillarum*). in The Birds of North America. No. 290 (A. Poole and F. Gill, eds.) The Academy of Natural Sciences, Philadelphia, PA, and the American Ornithologists Union, Washington, D.C..

Kirsch, E.M. 1996. Habitat selection and productivity of Least Terns on the lower Platte River, Nebraska. Wildlife Monographs 132:1-48.

Kirsch, E.M. 1995. Double-crested Cormorants on the Upper Mississippi River. Colonial Waterbirds 18 (Special Publication 1):131-136.

Kirsch, E.M. 1995. Book Review: Birds of the Platte. Prairie Naturalist 27:75.

Sidle, J.G., and E.M. Kirsch. 1993. Least Terns and Piping Plovers nesting at sand pits in Nebraska. Colonial Waterbirds 16:139-148.

Kirsch, E.M. 1993. Observations of aggression in Piping Plover adults on the lower Platte River, Nebraska. Prairie Naturalist 25:77-79.

Kirsch, E.M. 1993. Habitat selection of Least Terns on the lower Platte River, Nebraska. Page 108 in K.F. Higgins and M.R. Brashier eds, Proc. Missouri River ant its tributaries: Least Tern and Piping Plover Symp. South Dakota State University, Brookings. (abstract).

Kirsch, E.M. 1993. Productivity, causes of mortality, and projected population trends for Least Terns and Piping Plovers on the lower Platte River, Nebraska. Pages 137-138 in K.F. Higgins and M.R. Brashier eds, Proc. Missouri River and its tributaries: Least Tern and Piping Plover Symp. South Dakota State University, Brookings. (abstract).

Kirsch, E.M., and G.R. Lingle. 1993. Habitat use and nesting success Least Terns on the Platte River, Nebraska. Pages 73-74 in K.F. Higgins and M.R. Brashier eds, Proc. Missouri River and its tributaries: Least Tern and Piping Plover Symp. South Dakota State University, Brookings. (abstract).

Sidle, J.G., D.A. Carlson, E.M. Kirsch, J.J. Dinan. 1992. Flooding: mortality and habitat renewal for Least Terns and Piping Plovers. Colonial Waterbirds 15:132-136.

Kirsch, E.M. 1992. Habitat Selection and productivity of Least Terns (*Sterna antillarum*) on the lower Platte River, Nebraska. Ph.D. dissertation.University of Montana.

Kirsch, E.M. 1988. On the Edge - on the Platte. NEBRASKALAND 66(2):36-42.

Kirsch, E.M. 1986. Roadside ditches as refugia for small mammals in highly agricultural areas. M.A. thesis, University of Nebraska - Omaha.

Reports: 14 peer reviewed reports for agencies

Presentations at Professional Meetings: 57, 3 as co-author 54 as lead-author/presenter

Grants and Awards:

US Geological Survey $160,000 added to base, annually, beginning in 2010, USGS/BRD FY2010 Alternate Energy Request: Proposal for Increased Capacity (Wind Energy Theme)

Minnesota Department of Natural Resources $45,000 April 2008, Ecological survey of bird populations and floodplain forest in the Vermillion/Cannon River Bottoms Important Bird Area.

US Army Corps of Engineers $150,000, March 2007, Importance of the Upper Mississippi River Forest Corridor to Neotropical Migratory Birds, year 2

US Fish and Wildlife Service. Challenge Cost Share Program. $11,000. March 2006, Importance of the Upper Mississippi. River Forest Corridor to Neotropical Migratory Birds. In partnership with the Big Rivers National Wildlife Refuge (USFWS).

US Army Corps of Engineers $80,000, December 2005, Development of a floodplain forest restoration database for the UMRS: a tool for future coordinated forest management planning

US Army Corps of Engineers $150,000, December 2005, Importance of the Upper Mississippi River Forest Corridor to Neotropical Migratory Birds.

USGS Quick Response Program for FWS $15,000, October 2003, “Assessing habitat use by breeding Great blue Herons and Great Egrets on the Upper Mississippi River National Wildlife and Fish Refuge.”

USGS State Partnership: Ecological costs and benefits of restoring reed canary grass wetlands to native vegetation. $50,000 awarded April 2002, co-PIs Dr. Joy Zedler, University of Wisconsin, and P. Scott Hauseman Wisconsin Department of Natural Resources

USGS Species at Risk: Rail Survey for the Bi-County Area of Pike County in Missouri and Illinois. $18,000 awarded April 2002.

Nebraska Game and Parks Commission $9, 700 May ,2000,Analysis of interior least tern and piping plover habitat use and population data 1978-1999.

Star Award, U.S. Geological Survey, September, 1999

On the Spot Award, U.S. Geological Survey, March, 1998.

Special Service Award, U.S. Geological Survey, April, 1997.

Superior Accomplishment Award, National Biological Service, April, 1996.
Performance Award, National Biological Service, September, 1995.
Special Achievement Award, National Biological Service, September, 1994.
Special Achievement Award, U.S. Fish and Wildlife Service, September, 1993.
Population analysis and database compilation for the interior population of Least Tern. Funded $2,500, USFWS Region 3 Endangered Species Office. Twin Cities, MN, April 1992.
Habitat Use of Bitterns and Rails on pools 6-8 of the Upper Mississippi River. Funded $3,000 USFWS Region 3 Joint Ventures Office. Twin Cities, MN, April 1992
$1,000 Wisconsin Dept. Natural Resources (in kind)
$1,000 Minnesota Dept. of Natural Resources (in kind) April 1992.
Second year: $2,000 USFWS Region 3 Nongame Bird Program
$2,000 USFWS Region 3 Joint Ventures Office
$1,000 Wisconsin Dept. of Natural Resources (in kind)
$1,000 Minnesota Dept. of Natural Resources (in kind) March 1993
Special Appreciation Award, USFWS Region 6 Law Enforcement. February 1992.
Ecology of Least Terns on the lower Platte River. Funded $400 Sigma Xi. April 1990.
Bertha Morton Fellowship for outstanding graduate student achievement. University of Montana Graduate School. $ 4,000, May 1988.
Ecology of Least Terns and Piping Plovers on the lower Platte River, Nebraska. Funded $15,000 Nebraska Game and Parks Commission. June 1987.
Funded $45,000 USFWS - Northern Prairie Wildlife Research Center 1988-1991.

Manuscript Reviews: Over 40 peer reviews for scientific journals:

Journal of Wildlife Management, Waterbirds, Journal of Applied Ecology, Landscape Ecology, Journal of Field Ornithology, Restoration Ecology, American Midland Naturalist, Ecological Restoration , Wilson Bulletin, The Auk, Wetlands Ecology and Management, The Condor, Conservation Biology, Wildlife Society Bulletin,

Membership in Professional Organizations:

Cooper Ornithological Society - Secretary 1997 – 2008, Board of Directors 2010-2012
Honorary Member 2006
Honorary Member Committee Chair 2013- present
Chair of the local committee for the annual meeting 2004
Student Paper Awards Chair, 1996
Student Participation Committee, 1996 -1997
Colonial Waterbird Society - Member of the Executive Council, 1993-1995
Student Paper Award Committee - Chairperson, 1993-1995
American Ornithologists Union – Elected Member 2000
Wilson Ornithological Society
Association of Field Ornithologists
Upper Mississippi Conservation Committee-Wildlife Technical Section

Other Pertinent Information:

Faculty Affiliate, Department of Biology, University of Wisconsin - La Crosse, 1992-present
**Courses taught: Graduate Level, Scientific Communication Spring 1994, 1996 (team taught), Graduate and Undergraduate Level, Conservation Biology Seminar (taught with Dr. M. Knutson) Fall 1996.
Graduate students: Craig Annen, complete program at UW-La Crosse Spring 2002, and Melissa Meier, completed program spring 2004, both were coadvised with Dr. Rob Tyser.

Served on USGS Research Grade Evaluation Panels 2008, 2005, 2003.

Training:
*Structured Decision Making 5 day workshop with Anthony Starfield, La Crosse, WI. 2006

*DOI Leadership Intensive, Madison, WI. 2005

Multiagency Working Groups:

Member and science leader for the Forest Management Project Delivery Team for the Navigation and Ecological Sustainability Program (US Army Corps on the Upper Mississippi River). 2005-present. Group formed the write a management plan and recommend research needs for Upper Mississippi River Floodplain forest.

Executive Chair person for the Interior Least Tern (*Sterna antillarum athalassos*) Working Group 2004-2006. Group formed to coordinate monitoring efforts for this (sub)species.

Upper Mississippi River Forest Partnership. 2005-present. A working group stemming from a program lead by USFS and State Foresters to coordinate monitoring and focus restoration to benefit water quality, bird habitat and landscape values.

SARA H. SCHWEITZER, PH.D.

North Carolina Wildlife Resources Commission
Division of Wildlife Management, Wildlife Diversity Program
106 Ferret Run Ln., New Bern, NC 28562
Phone: 252-639-8435; sara.schweitzer@ncwildlife.org

EDUCATION

Ph.D., December 1994. Oklahoma State University, Department of Zoology, Wildlife & Fisheries Ecology (Dissertation: Abundance and conservation of endangered interior least terns nesting on salt flat habitat; Advisor, Dr. David M. Leslie, Jr.)

M.S., August 1988. Texas Tech University, Department of Range & Wildlife Management, Wildlife Science (Thesis: Evaluation of forage species for improving deer habitat in the rolling plains; Advisor, Dr. Fred C. Bryant)

B.S., May 1985. University of North Carolina, Chapel Hill, Biology

PROFESSIONAL EXPERIENCE

Waterbird Investigations & Management Project Leader, Wildlife Diversity Program, North Carolina Wildlife Resources Commission, Division of Wildlife Management, New Bern, NC. (June 2010 –)

Adjunct Professor of Wildlife Ecology & Management, D. B. Warnell School of Forestry & Natural Resources; Graduate Faculty, University of Georgia, Athens. (July 2010 –)

Professor of Wildlife Ecology & Management, D. B. Warnell School of Forestry & Natural Resources, University of Georgia, Athens. (Assistant Professor, 1995-2000; Associate Professor, 2000-2006; Professor, 2007-2010, June).

Adjunct Professor, Georgia Agricultural Experiment Station, College of Agriculture & Environmental Sciences, University of Georgia, Athens, July 2007-2010. (Adjunct Assist. Prof., 1995-2000; Adjunct Assoc. Prof., 2000-2006)

Adjunct Associate Professor, Department of Forest & Natural Resources, College of Agriculture, Forestry, & Life Sciences, Clemson University, Clemson, SC, 2002-2008.

Research Associate, Oklahoma Cooperative Fish & Wildlife Research Unit, Department of Zoology, Oklahoma State University, Stillwater. September - December 1994.

Graduate Research Assistant, Oklahoma Cooperative Fish & Wildlife Research Unit, Department of Zoology, Oklahoma State University, Stillwater. December 1991 - August 1994.

Graduate Teaching Assistant, Department of Zoology, Oklahoma State University, Stillwater. August 1990 - December 1991.

Environmental Scientist, U.S. Army Corps of Engineers, Norfolk District, Construction & Operations Division, Regulatory Branch, Permits & Waterways Inspection Sections, Norfolk, Virginia. October 1988 - July 1990.

Research Technician, Applied Marine Research Laboratory, Old Dominion University, College of Sciences, Norfolk, Virginia. October 1988 - January 1989.

Graduate Research Assistant, Department of Range & Wildlife Management, Texas Tech University, Lubbock. July 1986 - October 1988.

AREAS OF RESEARCH & MANAGEMENT INTEREST

- Ecology, management, and conservation of wading birds, seabirds, and shorebirds, especially relative to human activities;
- Responses of avian communities to enhancement and restoration of coastal wetland habitats.

PUBLICATIONS

Selected Technical, Peer-refereed Publications (n = 50 total)

Nareff, G.E., S.H. Schweitzer, E.P. Wiggers, and W.E. Mills. *in press*. Time activity budgets of shorebirds in managed impoundments. Journal Southeastern Association of Fish & Wildlife Agencies

Wohner, P.N., R.J. Cooper, R. Greenberg, and S.H. Schweitzer. *in press*. Winter diet of rusty blackbirds in suburban landscapes and implications for management. Journal of Wildlife Management.

Hostetter, N.J., B. Gardner, S.H. Schweitzer, R. Boettcher, A.L. Wilke, L. Addison, W.R. Swilling, K.H. Pollock, and T.R. Simons. 2015. Repeated count surveys help standardize multi-agency estimates of American Oystercatcher (*Haematopus palliatus*) abundance. Condor 117:354-363.

Robinson, G.L., G.L. Mills, A.H. Lindell, S.H. Schweitzer, and S.M. Hernandez. 2015. Exposure to mercury and Aroclor 1268 congeners in least terns (*Sternula antillarum*) in coastal Georgia, USA. Environmental Science Processes and Impacts 17:1424-1432.

Homyack, J.A., S.H. Schweitzer, and T.Graves. 2014. Glass ceilings and institutional biases: a closer look at barriers facing women in science and technical fields. Wildlife Professional 48-52.

Schweitzer, S.H. 2011. Chapter on Appearance *in* Birds of North America – American Oystercatcher. American Oystercatcher Working Group (author) and T.R. Simons, E. Nol, and R. Boettcher (editors). Online series.

McGregor, S.P., S.H. Schweitzer, W.E. Mills, and E.P. Wiggers. 2009. Distribution of King and Clapper Rails in managed impoundments and tidal marshes of South Carolina. The Chat 73:139-148.

Sabine, J. B., J. M. Meyers, C. T. Moore, and S. H. Schweitzer. 2008. Effects of human activity of breeding American Oystercatchers, Cumberland Island National Seashore, Georgia, USA. Waterbirds 31:70-82.

Spear, K.A., S.H. Schweitzer, R. Goodloe, and D.C. Harris. 2007. Effects of management strategies on the nesting success of least terns on dredge spoil in Georgia. Southeastern Naturalist 6:27-34.

Sabine, J.B., S.H. Schweitzer, and J.M. Meyers. 2006. Nest fate and productivity of American Oystercatchers, Cumberland Island National Seashore, Georgia. Waterbirds 29:308-314.

Sabine, J.B., J.M. Meyers, and S.H. Schweitzer. 2005. A simple, inexpensive video camera setup for the study of avian nest activity. Journal of Field Ornithology 76:293-297.

George, R.C., S.H. Schweitzer, and B. Winn. 2004. Reproductive success of American Oystercatchers at managed sites in Georgia. The Oriole 69:51-67.

Moseley, K.R., S.B. Castleberry, and S.H. Schweitzer. 2003. Effects of prescribed fire on herpetofauna in bottomland hardwood forests. Southeastern Naturalist 2:475-486.

Schweitzer, S.H., J.T. Ayers, and P.E. Hale. 2003. Response of plant and invertebrate communities to pothole blasting in a giant cutgrass marsh. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 57:172-180.

Schweitzer, S.H., and D.M. Leslie, Jr. 2000. Stage-specific survival rates of the endangered least tern (*Sterna antillarum*) in northwestern Oklahoma. Proceedings of the Oklahoma Academy of Science 80:53-60.

Krogh, M.G., and S.H. Schweitzer. 1999. Least terns nesting on natural and artificial habitats in Georgia, USA. Waterbirds 22:301-307.

Schweitzer, S.H., and D.M. Leslie, Jr. 1999. Nesting habitat of least terns (*Sterna antillarum athalassos*) on an inland alkaline flat. American Midland Naturalist 142:173-180.

Schweitzer, S.H., and D.M. Leslie, Jr. 1996. Foraging patterns of the least tern (*Sterna antillarum*) in north-central Oklahoma. Southwestern Naturalist 41:307-314.

Krey, A., R.F. Krey, and S.H. Schweitzer. 1993. Interior least tern artificial nest and chick shelter temperature variations. Pages 181-187 *in* K. F. Higgins and M. R. Brashier, eds. Proceedings of the Missouri River & Its Tributaries; Piping Plover & Least Tern Symposium, Lincoln, Nebraska.

CONVENTION PAPERS

Recent Invited Presentations (n = 24 total)

Schweitzer, S.H. 2013. The Red Knot – A primer and what's next. Annual Conference of the North Carolina Beach, Inlet, and Waterway Association – Challenges of Our Coastal World. 18-19 November, Wrightsville Beach, NC.

Schweitzer, S.H. 2012. Conservation of waterbirds using dredged-material islands and protected beaches. Invited Seminar, 24 September. USGS, National Wetlands Research Center, Lafayette, LA.

Recent Voluntary Presentations (n = 164 total)

Addison, L.M., S.H. Schweitzer, S.E. Cameron, and M.L. Abraham. 2015. Abundance, distribution, and geographic origin of non-breeding American Oystercatchers (*Haematopus palliatus*) in North Carolina. 39th Annual Meeting of the Waterbird Society, 12-15 August, Bar Harbor, ME.

Schweitzer, S.H., L.M. Addision, S.E. Cameron, and M.L. Abraham. 2015. Abundance and distribution of American Oystercatchers during the Breeding Season in North Carolina. 39th Annual Meeting of the Waterbird Society, 12-15 August, Bar Harbor, ME.

Brzorad, J., A. Maccarone, R. Kays, and S.H. Schweitzer. 2014. Observations of movement patterns of Great Egrets tagged in 2013. Annual Meeting of the NC Waterbird Management Committee, 6 March, Hammocks Beach State Park, Swansboro, NC

Schweitzer, S.H. 2014. Unusual winter mortality events in multiple Atlantic seabird species. Annual Meeting N.C. Waterbird Management Committee, Swansboro, NC [state]

Schweitzer, S.H. 2014. The Red Knot – a primer and what's next. Annual Meeting N.C. Waterbird Management Committee, Swansboro, NC [state]

Schweitzer, S.H., and M.A. Abraham. 2014. Surveys and research focused on Piping Plovers in NC. Annual Meeting N.C. Waterbird Management Committee, Swansboro, NC [state]

Abraham, M.L., and S.H. Schweitzer. 2014. American Oystercatcher and Wilson's Plover breeding distribution and abundance, 2013 survey. Annual Meeting N.C. Waterbird Management Committee, Swansboro, NC [state]

Schweitzer, S.H. 2014. Long-standing cooperation between NCWRC and Corps of Engineers provides positive results for shorebirds and colonial waterbirds. NC TWS & NC PIF Meeting, Browns Summit, NC. [state]

Schweitzer, S.H. 2014. Population trends of the Wood Stork in North Carolina. Annual Meeting – Wood Stork Recovery Working Group, 19 February, Jacksonville, FL [regional] *via Skype*

Homyack, J.A., S.H. Schweitzer, and T. Graves. 2013. Institutional biases and barriers in the science and technical fields: What the research tells us. Annual Conference of The Wildlife Society, 7 October, Milwaukee, WI. [international]

Schweitzer, S.H., S. Courchesne, S. Jennings, M. Pokras, T. Diamond, D. McNair, J. Brown, J. Ballard, C. Harms, E. Christiansen, A. Ballman, D.E. Green, M. Hines, J. Okoniewski, M.P. Harris, D.M. Turner, J. Gallegos, J. Stanton, and J. Ellis. 2013. Unusual winter mortality events in multiple Atlantic seabird species. Wildlife Disease Association Annual Conference, 29 July, Knoxville, TN. [international]

Schweitzer, S.H. 2013. International Alliances Program – Full Life-cycle Conservation. Habitat and Nongame Species Committee of N.C. Wildlife Resources Commission, 12 March, Raleigh, NC. [local]

Schweitzer, S.H. 2013. 2012 breeding season results for North Carolina's Piping Plover population. Annual Meeting of the N.C. Waterbird Management Committee, 6 March, Hammocks Beach State Park, Swansboro, NC. [state]

Schweitzer, S.H., and M.L. Abraham. 2013. Coast-wide survey of shorebirds during migration – truly an ISS and plea for help. Annual Meeting of the N.C. Waterbird Management Committee, 6 March, Hammocks Beach State Park, Swansboro, NC. [state]

Schweitzer, S.H., and M.L. Abraham. 2013. Coast-wide survey of American Oystercatchers and Wilson's Plovers, pairs and singles, April-May 2013 – another plea for help. Annual Meeting of the N.C. Waterbird Management Committee, 6 March, Hammocks Beach State Park, Swansboro, NC. [state]

Schweitzer, S.H., M.L. Abraham, E. Gaydos, and T. Wilson. 2013. Great Black-backed and Herring Gulls as predators and habitat hogs. Annual Meeting of the N.C. Waterbird Management Committee, 6 March, Hammocks Beach State Park, Swansboro, NC. [state]

Schweitzer, S.H., J. Brzorad, R. Kays, M. Dowland, C. Goforth, and L. Baird. 2013. Great Egrets as feathered ambassadors and educators – a collaborative, fledgling project among Lenoir-Rhyne University, NCSU, N.C. Natural Science Museum, and NCWRC. Annual Meeting of the N.C. Waterbird Management Committee, 6 March, Hammocks Beach State Park, Swansboro, NC. [state]

Schweitzer, S.H. 2013. Conservation of colonial-nesting waterbirds in North Carolina. N.C. Chapter of The Wildlife Society Annual Meeting, 26 February, Columbia, NC. [state].

HONORS & AWARDS

2014. Selected to be a TWS Fellow for The Wildlife Society by TWS Council
2008. Certificate of Appreciation for service as member of the Georgia State Technical Committee, USDA, Natural Resources Conservation Service.
2006. Faculty Award for Outstanding Teaching, The University of Georgia, D.B. Warnell School of Forest Resources, Alumnae Association
2004. Granted membership, Fulbright Academy of Science & Technology by Secretary & Board of Directors
2002. Awarded J. William Fulbright Foreign Scholarship Lecture/Research Grant, Sofia, Bulgaria, 18 September 2002 - 28 February 2003
2001. International Fellow, University of Georgia's International Fellows Program, Office of Instructional Support & Development
2001. Inducted into Gamma Sigma Delta, Honor Society of Agriculture, University of Georgia Chapter, Athens
1997. Certificate of Appreciation for Contributions as Chair of Research Committee and member of Steering Committee, Georgia's PIF Migratory Bird Conservation Program
1994. Outstanding Ph.D. Student, Department Zoology, Oklahoma State University, Stillwater
1994. Byron B. Moser Memorial Award for Outstanding Professional Achievement, Oklahoma Chapter of The Wildlife Society
1994. Certificate of Professionalism for the Outstanding Presentation at the 1993 Annual Meeting of the Oklahoma Academy of Science. From the Oklahoma Academy of Science and Oklahoma Department of Wildlife Conservation
1990. Certificate of completion of Corps of Engineers Training Course Regulatory I, Arlington, Texas.
1989. Certificate of Promotion to GS-9, U.S. Department of the Army Corps of Engineers, Norfolk, VA
1988. Inducted into Phi Kappa Phi Scholastic Honor Society, Texas Tech University Chapter, Lubbock

PROFESSIONAL SERVICE TO FEDERAL AGENCIES

Review Panels

Member, Environmental Sciences Committee, Council for International Exchange of Scholars and Fulbright Scholar Awards Program, 2004-2006.

Member, Discipline Peer Review Committee, Council for International Exchange of Scholars and the Fulbright Senior Specialists Program, 2003-2006.

Panelist, 2004, 2005, 2006, 2007, 2009, 2010, 2011, 2013, 2014. National Science Foundation's Graduate Research Fellowship Program, Environmental Life Sciences and Ecology Panels.

Peer reviewer, competitive Graduate Environmental Study Fellowships submitted to the U.S. Environmental Protection Agency's Office of Research and Development in response to its 2001 Request for Applications, Science to Achieve Results grant program. 21-24 February 2001.

SERVICE – UNIVERSITY OF GEORGIA

D. B. Warnell School of Forestry and Natural Resources COMMITTEES

Business Manager Staff Search (2005)
Human Dimensions & Recreation Faculty Search (2005-2006)
Forest Lands, External Advisory Committee (2005 - 2010)
Post-tenure Review for S. Covert and R. Hendrick (2004)
Dean Search (2003)
Graduate Affairs (2003 - 2010)
Lands (2003-2004)
Graduate Student Recruitment (2000-2002)
Wildlife Extension Faculty Search (2000-2001)

Wildlife Vertebrate Ecologist Faculty Search (2000-2001)
Undergraduate Affairs (1996-1997, 2000-2001)
Curriculum (1996-2002)
Research Coordination and Review (1996-2003)
E. L. Cheatum Award (1995 - 2010)
Writing Instructor Search (2000)
Development, Master, Internat'l Forest Resour. Mgt. degree w/ U.S. Peace Corps Prgm. (1999-2000)
Associate Dean for Research and Service Search (1998-1999)
Dean's 5-year Review (1997)
GIS-Wetlands Inventory Faculty Search (1997)
Harvest Scheduling Faculty Search (1997)
Wildlife Biometrician Faculty Search (1996)
New Faculty and Staff Orientation Handbook (1995)
Forest Resources Economics Faculty Search (1995)

University of Georgia COMMITTEES

Professional & Applied Studies (B) Area Committee (2009-2010) – review and vote on promotion and tenure dossiers
Professional & Applied Studies (B) Area Committee (2008-2010) – review appointment and reappointment applications to the Graduate Faculty
Steering Committee, Ph.D. Program in Conservation, Odum School of Ecology (2008 – 2010)
University Council (2003-2004)
Executive, Educational Affairs, Faculty Benefits, and Strategic Planning Committees
Stoddard-Burleigh-Sutton Wildlife Conservation Awards (1995-2010)
Faculty Admissions (1999-2001)
Freshman Task Force Subcommittee of Faculty Admissions (2000-2001)

SERVICE – PROFESSIONAL SOCIETIES AND ACTIVITIES

The Wildlife Society (1986 - present)

National "Parent" Chapter

- Moderator, paper session, "Grassland Bird Species," 1999 TWS Annual Conference
- Reviewer, Contributed Papers Subcommittee, 1999 TWS Annual Conference
- Ad-hoc Membership Committee (2012-2014)
- Representative to AFWA Committees (2013-2015)
- Ethnic and Gender Diversity Working Group Member (2005 – present) (was committee until 2007)
  - Diversity Award, Committee Member (2005 – 2010, 2013), Chair (2010 – 2012)
  - President-Elect (2009 & 2010)
  - President (2011 & 2012)
  - Past-President (2013 & 2014)
  - Board Member (2015 & 2016)
  - Women-of-Wildlife receptions at Annual Conferences – assistance in organizing (2012, 2013)
  - 2016 Symposium Committee, TWS Conference, Manitoba, Canada
- International Wildlife & Habitat Management Working Group Member (2006 – 2010)
  - Web site manager (2007 – 2010)
- Restoration Working Group Member (1995 - 2010)
  - Symposium Organization Committee (1998)
  - Officer Nomination Committee (1999-2002)
  - Southeastern Representative (2000-2001)

Southeastern Section

- Elected Secretary & Treasurer (2006 & 2007)

Georgia Chapter

- President-Elect, President, Past-President (1997-2001)
- Member at Large (2005-2007)

Society for Range Management (1986 - 2010)
National and Southern Sections
o Farm Bill (1996) Conservation Reserve Program Committee Member
o Wildlife Habitat Management Committee (2004 - 2010)

Southeastern Quail Study Group (1996-2004)
o Research Committee Member

Southeast Deer Study Group (1996-2003)
o Invited moderator of paper session on Urban Deer Management, February 1997

American Ornithologists' Union (1992-1994)
Association of Field Ornithologists (1992 - present)
Waterbird Society (formerly, Colonial Waterbird Society) (1995 - present)
2016 Conference Local Committee Chair; Science Committee Member
Georgia Ornithological Society (1995 - present)
Carolina Bird Club (2014 – present)
American Oystercatcher Working Group member (2000 – present)
Piping Plover Technical Advisory Team (2010 – present)
American Wood Stork Recovery Working Group (2010 – present)
Atlantic Flyway Shorebird Business Plan for international conservation of shorebirds – contributor (2012, 2013, 2014, 2015)
Association of Fish and Wildlife Agencies
- Bird Conservation Committee, member (2012 – present)
- Partners in Flight / Shorebird / Waterbird Working Group, Chair (2012 – present)
- Southern Wings Program / International Committee, member (2013 – present)

Southeastern Association of Fish and Wildlife Agencies
- 2015 Conference. Student Affairs Committee, Co-Chair

North American Bird Conservation Initiative
- 2015 Winter Meeting Organizer

Partners in Flight Council & Steering Committee, member (2012 – present)
U.S. Shorebird Conservation Partnership Council, member (2014 – present)

SERVICE – JOURNAL EDITORSHIP

Co-Editor– The Oriole (journal for Georgia Ornithological Society), 2007 – 2010
Associate Editor– Wildlife Society Bulletin, 2004-2006
Guest Editor– Southeastern Naturalist, 2004-2005
Ad hoc Reviewer–

Auk (2008, 2010); American Midland Naturalist (2000); Biologica-Bratislava, Slovenia (2002, 2003); Condor (2014, 2015); Journal of Ecological Risk Assessment (2012); Journal of Field Ornithology (1999, 2000, 2004, 2008, 2009, 2010); Journal of Range Management (1993, 1994); Journal of Wildlife Management (1995, 1999, 2002, 2003, 2007, 2008, 2010, 2013, 2014); Journal Wildlife Diseases (2015); New Forests (2001); Northeastern Naturalist (2005); Southeastern Association of Fish and Wildlife Agencies Annual Conference Proceedings (1997, 2002, 2005, 2007, 2008); Southeastern Naturalist (2004, 2005, 2010, 2011, 2012); Waterbirds (2000, 2007, 2008, 2009, 2010, 2011, 2012, 2014); The Wildlife Society Bulletin (2011, 2012, 2013), The Wilson Bulletin (2001, 2006, 2008); Wildlife Monographs (2014)

SERVICE – UNIVERSITY OF GEORGIA STUDENT GROUPS AND ORGANIZATIONS

Judge, Annual Warnell School of Forestry & Natural Resources' Graduate Student Symposium (2005, 2007, 2008, 2009, 2010)
Judge, Quiz Bowl, Southeastern Conclave of Student Chapters of The Wildlife Society (2007)
Co-Faculty Advisor to the UGA Student Chapter of The Wildlife Society (1995-2001)

Gene R. Wilde

7 August 2015

Address

Department of Biological Sciences
Mail Stop 43131
Texas Tech University, Lubbock, TX 79409-3131
Phone: (806) 742-2710 ext 290
FAX: (806) 742-2963
Email: gene.wilde@ttu.edu
Personal Web Page: http://www.biol.ttu.edu/faculty/gwilde

Education

1994 Ph.D., Zoology, Statistics minor, Oklahoma State University
1984 M.S., Biological Sciences, University of Nevada, Las Vegas
1978 B.S., Biological Sciences, University of Nevada, Las Vegas

Professional Experience

2007 – Professor, Department of Biological Sciences, Texas Tech University
2001 – 2007 Associate Professor, Natural Resources Management, Texas Tech University
2006 Visiting Scientist, Infofish Services, Rockhampton, Australia
2003 Visiting Scientist, Infofish Services, Rockhampton, Australia
1995 – 2001 Assistant Professor, Natural Resources Management, Texas Tech University
1990 – 1995 Fishery Statistician, Texas Parks and Wildlife Department

Professional Affiliations

American Association for the Advancement of Science
American Fisheries Society
American Society of Ichthyologists and Herpetologists
Asian Fisheries Society
Australian Society for Fish Biology
Ecological Society of America
Southwestern Association of Naturalists
Texas Chapter American Fisheries Society

Research Interests

I am interested in all aspects of the ecology, conservation, and management of freshwater fishes. My current research includes studies of: (1) migration of Great Plains minnows; (2) propagation and repatriation of imperiled fishes; (3) development and application of population dynamics

models for imperiled fishes; (4) factors affecting reproductive success and survival of juvenile stages of Great Plains fishes; (5) development of individual-based models for fishery conservation and management.

Representative Refereed Publications (Total = 88)

1. Durham, B. W., and G. R. Wilde. 2014. Elasticity analysis of an age-structured population dynamics model for the Pecos bluntnose shiner. Pages 14-17 *in* C. A. Hoyt and J. Karges (editors). Proceedings of the Sixth Symposium on the Natural Resources of the Chihuahuan Desert Region. Chihuahua Desert Research Institute, Fort Davis, Texas.

2. Wilde, G. R., and A. C. Urbanczyk. 2014. Speculation but no data: A response to Hoastrom's drift versus retention perspective. Journal of Freshwater Ecology 29:453-455.

3. Durham, B. W., and G. R. Wilde. 2014. Understanding complex reproductive ecology in fishes: the importance of individual and population scale information. Aquatic Ecology 48:91-106. DOI: 10.1007/s10452-014-9469-0

4. Wilde, G. R., and B. W. Durham. 2013. Habitat associations of the sharpnose shiner *Notropis oxyrhynchus* in the upper Brazos River, Texas. Journal of Freshwater Ecology 28:453-461.

5. Wilde, G. R., and A. C. Urbanczyk. 2013. Relationship between river fragment length and persistence of two imperiled Great Plains cyprinids. Journal of Freshwater Ecology 28:445–451.

6. Durham, B. W., and G. R. Wilde. 2009. Population dynamics of smalleye shiner an imperiled cyprinid fish endemic to the Brazos River, Texas. Transactions of the American Fisheries Society 138:666–674.

7. Durham, B. W., and G. R. Wilde. 2009. Effects of streamflow and intermittency on the reproductive success of two broadcast-spawning cyprinid fishes. Copeia 2009:21–28.

8. Wilde, G. R., and B. W. Durham. 2008. A life-history model for peppered chub, a broadcast spawning cyprinid. Transactions of the American Fisheries Society 137:1657–1666.

9. Durham, B. W., and G. R. Wilde. 2008. Synchronous and asynchronous spawning in a Great Plains cyprinid fish. Ecology of Freshwater Fish 17:528–541.

10. Wilde, G. R., and B. W. Durham. 2008. Daily survival rates of larvae and juveniles of six species of Great Plains cyprinid fishes. Transactions of the American Fisheries Society 137:830–833.

11. Durham, B. W., and G. R. Wilde. 2008. Composition and abundance of drifting fish larvae in the Canadian River, Texas. Journal of Freshwater Ecology 23:273–280.

12. Durham, B. W., and G. R. Wilde. 2008. Validation of daily growth increment formation in the otoliths of juvenile cyprinid fishes from the Brazos River, Texas, USA. North American Journal of Fisheries Management 28:442–446.

13. Durham, B. W., G. R. Wilde, and K. L. Pope. 2006. Biodiversity implications of a temperature caused fish kill in a flowing prairie river. Southwestern Naturalist 51:397–401.

14. Durham, B. W., and G. R. Wilde. 2006. Influence of stream discharge on reproductive success of a prairie stream fish assemblage. Transactions of the American Fisheries Society 135:1644–1653.

15. Higgins, C. L., and G. R. Wilde. 2005. The role of salinity in structuring fish assemblages in a prairie stream system. Hydrobiologia 549:197–203.

16. Durham, B. W., and G. R. Wilde. 2005. Relationship between hatch date and first-summer growth of five species of prairie-stream cyprinids. Environmental Biology of Fishes 72:45–54.

17. Ostrand, K. G., and G. R. Wilde. 2004. Changes in prairie stream fish assemblages restricted to isolated streambed pools. Transactions of the American Fisheries Society 133:1329–1338.

18. Bonner, T. H., and G. R. Wilde. 2002. Effect of turbidity on feeding efficiency of prairie stream fishes: test of a hypothesis. Transactions of the American Fisheries Society 131:1203–1208.

19. Wilde, G. R. 2002. Threatened and endangered fishes of the world: *Notropis girardi* Hubbs and Ortenburger, 1929 (Cyprinidae). Environmental Biology of Fishes 65:98.

20. Ostrand, K. G., and G. R. Wilde. 2002. Seasonal and spatial variation in a prairie stream-fish assemblage. Ecology of Freshwater Fish 11:137–149.

21. Durham, B. W., T. H. Bonner, and G. R. Wilde. 2002. Occurrence of *Lernaea cyprinacea* on Arkansas River shiners and peppered chubs in the Canadian River, New Mexico and Texas. Southwestern Naturalist 47:95–98.

22. Bonner, T. H., and G. R. Wilde. 2000. Changes in the Canadian River fish assemblage associated with reservoir construction. Journal of Freshwater Ecology 15:189–198. ***(Identified by the publisher as among the most highly cited articles published in this journal.)***

23. Wilde, G. R., and K. G. Ostrand. 1999. Changes in the fish assemblage of an intermittent prairie stream upstream from a Texas impoundment. Texas Journal of Science 51:203–210.

24. Wilde, G. R., and A. A. Echelle. 1992. Genetic status of Pecos pupfish populations after establishment of a hybrid swarm involving an introduced congener. Transactions of the American Fisheries Society 121:277–286.

25. Bozek, M. A., L. J. Paulson, G. R. Wilde, and J. E. Deacon. 1991. Spawning season of the razorback sucker, *Xyrauchen texanus*, in Lake Mohave, Arizona and Nevada. Journal of Freshwater Ecology 6:61–73.

26. Bozek, M. A., L. J. Paulson, and G. R. Wilde. 1990. Effects of ambient Lake Mohave temperatures on development, oxygen consumption, and hatching success of the razorback sucker. Environmental Biology of Fishes 27:255–263.

27. Wilde, G. R. 1989. Foods and feeding periodicity of the White River springfish, *Crenichthys baileyi*. Great Basin Naturalist 49:249–251.

Recent Grants and Contracts (total = $2,427,893)

2014–2017 Conservation genetics of wild and propagated sharpnose shiner and smalleye shiner from the upper Brazos River. Texas Parks and Wildlife Department (Competitively Awarded, Section 6 Grant). Co-Principal Investigator (with Lou Densmore, Texas Tech University). $75,255.

2014–2016 Assessing dynamics of introgression and behavioral mechanisms of hybridization between the invasive *Cyprinodon variegatus* and the endemic *Cyprinodon rubrofluviatilis*. Texas Parks and Wildlife Department (Competitively Awarded, Section 6 Grant). Co-Principal Investigator (with Jenny Gumm, Stephen F. Austin University. $37,538.

2013–2016 Propagation and repatriation of native prairie stream minnows in the Middle Brazos River. Texas Parks and Wildlife Department (Competitively Awarded, Section 6 Grant). Principal Investigator. $62,944.

2010–2011 Monitoring of riparian and stream habitat and biotic communities in the Wichita River Basin, Texas in 2013-2014. US Army Corps of Engineers, Tulsa District (Oklahoma) by contract with Weston Solutions, Inc., Broken Bow, Oklahoma. Principal investigator. $211,651.

2012–2014 Population dynamics of fishes in the upper Brazos River. Texas Parks and Wildlife Department (Competitively Awarded, State Wildlife Grant). Principal Investigator. $30,000.

2010–2014 Migration of Arkansas River shiner and other broadcast spawning fishes in the Canadian River, New Mexico-Texas. Great Plains Landscape Conservation Cooperative (Competitively Awarded). Principal Investigator. $70,569.

2010–2011 Red River Chloride Control baseline inventory of aquatic resources and location of instream refugia and limnological survey of Lake Kemp. US Army Corps of Engineers, Tulsa District (Oklahoma) by contract with Weston Solutions, Inc., Broken Bow, Oklahoma. Principal investigator. $207,607.

2008–2009 Arkansas River shiner presence-absence survey on the Canadian River, Texas. National Park Service. Principal Investigator. $53,810.

2007–2012 Population dynamics of fishes in the upper Brazos River. Texas Parks and Wildlife Department (Competitively Awarded, State Wildlife Grant). Principal Investigator. $317,476.

2006–2007 Red River Chloride Control baseline inventory of aquatic resources and location of instream refugia. US Army Corps of Engineers, Tulsa District (Oklahoma) by contract with Weston Solutions, Inc., Broken Bow, Oklahoma. Principal investigator. $101,738.

2005–2006 Red River Chloride Control baseline inventory of aquatic resources and location of instream refugia. US Army Corps of Engineers, Tulsa District (Oklahoma) by contract with Weston Solutions, Inc., Broken Bow, Oklahoma. Principal investigator. $156,654.

2005–2006 Distribution, status, habitat preferences, and reproductive ecology of smalleye shiner and sharpnose shiner in the Brazos River. Texas Parks and Wildlife Department (Competitively Awarded, Section 6 Grant). Principal Investigator. $70,128.

2001 Habitat use and status of the Arkansas River shiner in the North Canadian River, Oklahoma: phase II. US Army Corps of Engineers, Tulsa District. Principal investigator. $25,135.

2000–2002 Habitat use and reproductive ecology of the Arkansas River shiner and speckled chub in the Canadian River, New Mexico and Texas. US Bureau of Reclamation. Principal investigator. $45,000.

Brief List of Awards, Certifications, and Honors

2016 Best Professional Poster for, "Size-selective predation by Gulf killifish on endangered sharpnose shiner." Texas Chapter American Fisheries Society.
2014 Certified Fisheries Professional, American Fisheries Society. Certification number 3416
2013 Certification of completion for (Texas) Mussel Identification and Sampling Workshop.
2012 Fisheries Worker of the Year: Special Recognition. Texas Chapter American Fisheries Society (for participation in the Great Shiner Roundup, in which two species of imperiled fishes were collected from the wild to safeguard against their possible extinction)
2003 Outstanding Achievement Award. Southern Division American Fisheries Society
2003 Certificate of Appreciation: for Service as Chapter President. Texas Chapter American Fisheries Society
2003 Fisheries Worker of the Year: Education. Texas Chapter American Fisheries Society
2002-2012 Certified Fisheries Professional, American Fisheries Society. Certification number 2447
2000 Fisheries Worker of the Year: Research. Texas Chapter American Fisheries

Professional Service

American Society of Ichthyologists and Herpetologists
2007 Session moderator at 88th Annual Meeting St. Louis, MO

European Inland Fisheries and Aquaculture Advisory Commission (FAO)
2015 Co-organizer of Symposium on "Use of data collected from anglers for management of recreational fisheries"

American Fisheries Society
2015 American Fisheries Society Endangered Species Committee
2014– American Fisheries Society Ethics and Professional Conduct Committee
2011–2014 Editorial Board, *Dataset Papers in Ecology*
2010–2012 Associate Editor, *North American Journal of Fisheries Management*, American Fisheries Society
2009–2011 American Fisheries Society Ethics and Professional Conduct Committee
2009–2012 American Fisheries Society Publications Overview Committee
2009 Session moderator at the Annual Meeting of the American Fisheries Society, Nashville, TN

2004 Co-organizer and moderator of "I survived: A fishes' eye view of black bass fishing tournaments," a symposium convened at the Annual Meeting of the American Fisheries Society, Madison, WI
1999–2001 Associate Editor, *North American Journal of Fisheries Management*, American Fisheries Society
1998 Judge, Student Paper competition, Annual Meeting of the American Fisheries Society, Dearborn, MI
1993–2004 Applied Human Dimensions in Fisheries Committee, Management Section
1993–1995 Continuing Education Committee

Southern Division American Fisheries Society
2013- Chairman, Awards Committee
2015- Chairman, Resolutions Committee
2006 Organizer and moderator of "The science of trophy fish management," a symposium convened at the Midyear Meeting of the Southern Division American Fisheries Society
2005 Co-organizer and moderator of "Developing conceptual models for catch and release fishing," a symposium convened at the Midyear Meeting of the Southern Division American Fisheries Society
2004–2005 Warmwater Streams Committee
2004 Judge, Student Paper and Student Poster Competition at Winter (Midyear) Meeting
2001–2002 Resolutions Committee
1991–1998 Reservoir Committee
1996–1998 Chairman, Continuing Education Committee
1996–1998 Nominating Committee
1994–1995 Nominating Committee
1992–1995 Finance Committee, National Symposium on Multidimensional Aspects of Reservoir Fisheries Management, Chattanooga, TN
1992 Co-chair, Poster Session Committee, Forty-sixth Annual Conference of the Southeastern Association of Fish and Wildlife Agencies, Corpus Christi, TX

Texas Chapter American Fisheries Society
2015 Co-Chair, Issues Committee
2015 Ad hoc Program Committee
2013-2015 Issues Committee
2005–2015 Clark Hubbs Research Award Committee
2000–2015 Founding Advisor- Texas Tech Student Subsection, Texas Chapter American Fisheries Society
2006–2009 Awards Committee
2004–2006 Continuing Education Committee
2003–2004 Past President
2002–2003 President

2001–2002 President Elect
1996–1999 Chair, Awards Committee
1994 Awards Committee
1994 Nominating Committee
1993–1994 Editorial Committee
1993–1994 Newsletter Committee

Chi Chapter of Phi Beta Delta, the Honor Society for International Scholars
2007–2008 President
2006–2007 Vice President

Southwestern Association of Naturalists
2004 Session moderator at Fifty-first Annual Meeting. San Antonio, TX.

Miscellaneous

2015 Invited Speaker and Participant at Great Plains Landscape Conservation Cooperative Science Meeting for Prairie Rivers and Streams
2015 Proposal Reviewer for Texas Comptroller of Public Accounts Endangered Species Research Projects
2014 Panelist. National Science Foundation Graduate Research Fellowship Program
2013 Panelist. National Science Foundation Graduate Research Fellowship Program
2011 Panelist. Great Plains Landscape Conservation Cooperative Science Workshop. Oklahoma City, OK
2009 Panelist. ARI-BIO General Lab Renovation Panel, National Science Foundation. Washington, D.C.
1998-2010 Advisor to the Science Spectrum, Lubbock, TX, for development, maintenance, and updating of *The Brazos Journey* exhibit
2006 Proposal reviewer for Australian National Released Fish Survival Program
2004–2005 Proposal reviewer for Ecosystem Restoration Program, CALFED (California Bay-Delta Authority)
2004–2005 Proposal Review Panel, Managed Ecosystems Program, US Department of Agriculture
2003 Proposal reviewer for Australian National Released Fish Survival Program
2001 Proposal reviewer for the National Sea Grant College Program- Aquatic Nuisance Species Program
2000 Protocol Evaluation Panel, Lee's Ferry Rainbow Trout Monitoring Program, Grand Canyon Monitoring and Research Center, Flagstaff, AZ
2000 Panelist. South Central Division Aquatic Experts Workshop. The Nature Conservancy of Texas, San Antonio, TX
1997 Organized and hosted Interstate and Interagency Meeting on Arkansas River Shiner Management, Lubbock, TX
1997 Proposal Review Panel, Risk Management Research of Ecosystem Restoration in Watersheds, US EPA

Journal Referee
African Journal of Aquatic Ecology, Canadian Journal of Fisheries and Aquatic Sciences, Conservation Genetics, Copeia, Ecology of Freshwater Fish, Fisheries, Fishery Bulletin, Fisheries Management and Ecology, Fisheries Research, Game and Wildlife Science, Hydrobiologia, Journal of Fish Biology, Journal of Mammalogy, Journal of Experimental Marine Biology And Ecology, Journal of Wildlife Management, Lakes & Reservoirs: Research and Management, Limnologia, Marine and Freshwater Research, Marine Biology, North American Journal of Fisheries Management, Proceedings of the Southeastern Association of Fish and Wildlife Agencies, Progressive Fish Culturist, Southwestern Naturalist, Texas Journal of Science, Transactions of the American Fisheries Society, Wildlife Society Bulletin

Representative Presentations at Professional Meetings (Total = 193)

1. Wilde, G. R., and K. B. Mayes. 2015. Longterm changes in the fish assemblage of the upper Brazos River, Texas. Midyear Meeting of the Southern Division American Fisheries Society. Savannah, GA.

2. Cross, W.L., and G. R. Wilde. 2015. A long-term study of the fish assemblages of the Wichita River, Texas. Midyear Meeting of the Southern Division American Fisheries Society. Savannah, GA.

3. Urbanczyk, A. A., G. R. Wilde, C. G. Coleman, and D. W. Knabe. 2015. Predation By juvenile longnose gar on Brazos River fishes. Midyear Meeting of the Southern Division American Fisheries Society. Savannah, GA.

4. Coleman, C. G., and G. R. Wilde. 2015. Specific gravity of ova and fry of broadcast-spawning cyprinids. Midyear Meeting of the Southern Division American Fisheries Society. Savannah, GA.

5. Knabe, D. W., G. R. Wilde, and K. B. Mayes. 2013. Effects of a drought of record on the fish assemblage of a prairie stream in Texas. Midyear Meeting of the Southern Division American Fisheries Society. Nashville, TN.

6. Knabe, D. W., and G. R. Wilde. 2012. Age and growth of young-of-the-year red shiner in the Brazos River, Texas. Annual Meeting of the Texas Chapter, American Fisheries Society. Galveston, TX.

7. Urbanczyk, A. C., and G. R. Wilde. 2012. Reproductive ecology of plains minnow *Hybognathus placitus* in the Brazos River, Texas. Annual Meeting of the Texas Chapter, American Fisheries Society. Galveston, TX.

8. Weissenfluh, D. S., G. R. Wilde, and C. R. Baldino. 2010. Evaluating methodology and habitat selection for the endangered warm springs pupfish (*Cyprinodon nevadensis*

pectoralis) in School Springs Refuge. 2010 Ash Meadows National Wildlife Refuge Symposium. Pahrump, NV.

9. Wilde, G. R. 2009. Development and assessment of population dynamics models for Ash Meadows fishes. 41st Annual Meeting of the Desert Fishes Council. Furnace Creek, CA.

10. Wilde, G. R., and B. W. Durham. 2008. Conservation implications of elasticity patterns in Great Plains cyprinids. Annual Meeting of the Texas Chapter, American Fisheries Society. Junction, TX.

11. Durham, B. W., and G. R. Wilde. 2008. Development of the Upper Brazos River Basin: effects of existing and proposed reservoirs on native fish abundance. Annual Meeting of the Texas Chapter, American Fisheries Society. Junction, TX.

12. Wilde, G. R., and B. W. Durham. 2007. Early survival estimates for six species of juvenile cyprinid fishes in two Great Plains rivers. Annual Meeting of the American Society of Ichthyologists and Herpetologists. St. Louis, MO.

13. Wilde, G. R., and B. W. Durham. 2007. Population dynamics models for imperiled stream-fish populations. Annual Meeting of the Arizona-New Mexico Chapter of the American Fisheries Society. Albuquerque, NM.

14. Durham, B. W., and G. R. Wilde. 2007. Reproductive failure as a mechanism for the decline of imperiled stream-fish populations. Annual Meeting of the Arizona-New Mexico Chapter of the American Fisheries Society. Albuquerque, NM. **(*Received "Best Student Presentation Award."*)**

15. Wilde, G. R., and B. W. Durham. 2006. Population dynamics models for broadcast spawning stream fishes. Ecology of Stream Fish: State of the Art and Future Prospects Symposium II. Leòn, Spain NE.

16. Wilde, G. R., and B. W. Durham. 2004. Development and sensitivity analysis of age-structured population dynamics models for prairie-stream fishes. Fifty-first Annual Meeting of Southwestern Association of Naturalists. San Antonio, TX.

17. Durham, B. W., and G. R. Wilde. 2002. Evaluation of alternative models for predicting reproductive success of prairie stream fishes. Annual Meeting of the American Fisheries Society, Baltimore, MD.

Appendix B – No Conflict-of-Interest Forms

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NO CONFLICT-OF-INTEREST FORM

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

Peer Review Panel

Forage Fish and Least Tern Data Synthesis Compilation

Guidance regarding avoiding conflicts-of-interest was developed in accordance with the Scientific Peer Review Guidelines contained in the Platte River Recovery Implementation Program's Adaptive Management (AM) Plan (Appendix A). Conflicts-of-interest include, but are not limited to:

- Financial interest in the product to be reviewed or the authors(s)
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- Bias, for personal reason for or against the author(s) of the document to be reviewed or institutions involved in the production of the document
- Professional connection (current or former; student or advisor, supervisor or supervised, employer, etc.) to the author(s) or the institutions of authoring and/or responsible for producing the document to be reviewed
- Organizational affiliation (same agency, department, organization, business, etc.)
- Impacts of lobbying or political pressure exerted by person(s) looking for a particular result or more work in the area of the product under review
- Advocacy related to the product under review

As a member selected for participation on one of the Program's Peer Review Panels, I hereby state that I ***do not*** have any conflicts-of-interest with the Platte River Recovery Implementation Program as outlined above. I can serve effectively as a peer review panelist without any financial, familial, personal, or professional bias in order to further the goals of developing innovative ways to better manage the Platte River for the health of the ecosystem and the people that depend on it.

Ali Arab 8/21/2015

Peer Review Panelist Signature Date

NO CONFLICT-OF-INTEREST FORM

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

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Peer Review Panelist Signature

08/09/2015

Date

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PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

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Brian S. Cade

Peer Review Panelist Signature

8/18/15

Date

NO CONFLICT-OF-INTEREST FORM

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Priscilla H Crawford

Peer Review Panelist Signature

27 August 2015

Date

NO CONFLICT-OF-INTEREST FORM

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

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Note that I am an employee of the U.S. Geological Survey, which is a bureau within the U.S. Department of the Interior (DOI); the U.S. Fish and Wildlife Service is also a bureau within DOI.

Peer Review Panelist Signature

8/19/15.

Date

NO CONFLICT-OF-INTEREST FORM

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

Peer Review Panel

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CL [illegible]

Peer Review Panelist Signature

8-25-15

Date

NO CONFLICT-OF-INTEREST FORM

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

Peer Review Panel

Forage Fish and Least Tern Data Synthesis Compilation

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Please note - I am an employee of the U.S. Geological Survey, which is a bureau within the U.S. Department of Interior (DOI); the U.S. Fish and Wildlife Service is also a bureau within DOI.

Eileen M. Kirsch 08/17/2015

Peer Review Panelist Signature Date

NO CONFLICT-OF-INTEREST FORM

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

Peer Review Panel

Forage Fish and Least Tern Data Synthesis Compilation

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__ ____ __8/24/2015_____

Peer Review Panelist Signature Date

NO CONFLICT-OF-INTEREST FORM

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

Peer Review Panel

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S R Wilde

Peer Review Panelist Signature

11 August 2015

Date

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ATTACHMENT B

PRRIP PEER REVIEW SCOPE OF WORK
FORAGE FISH SYNTHESIS DOCUMENT

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM (PRRIP or Program)
Peer Review Scope of Work for the PRRIP Document:
Weight of Evidence Approach to Assessing Relationships between Flow and Interior Least Tern Forage Fish Abundance, Foraging Behavior, Productivity, and Dietary Requirements

1) Document Introduction and Background

The Executive Director's Office (EDO) of the Platte River Recovery Implementation Program ("Program" or "PRRIP") prepared this synthesis document (hereafter referred to as the "forage fish synthesis document", included as **Attachment A**) related to relationship between forage fish abundance and least tern productivity. The information and analyses presented herein focus solely on informing the use of Program land, water, and fiscal resources to achieve one of the Program's management objectives: increasing production of the tern and plover from the Associated Habitat Reach (AHR) along the central Platte River (the Associated Habitat Reach consists of a 90-mile reach of the Platte River in central Nebraska from Lexington to Chapman). The Program spent the last eight years implementing an Adaptive Management Plan (AMP) to reduce uncertainties about proposed management strategies and learn about river and species responses to management actions. During that time, the Program implemented management actions, collected a large body of physical and species response data, and developed modeling and analysis tools to aid in data interpretation and synthesis.

The forage fish synthesis document is compilation of six sections with unique objectives and analyses for testing Program hypotheses and answering associated PRRIP "Big Question" #8 – Does forage availability limit tern and plover productivity on the central Platte River? The compiled document is organized as follows:

- Cover Page and Preface (3 pages)
- Section 1 – Forage Fish Uncertainties and Data Sources (11 pages)
- Section 2 – Relationship between Forage Fish Abundance and Flow (5 pages)
- Section 3 – Relationships between Flow, Forage Fish Abundance, and Interior Least Tern Foraging Behavior and Success (12 pages)
- Section 4 – Least Tern Productivity in the Central Platte River Valley (8 pages)
- Section 5 – A Bioenergetics Approach to Estimating Forage Fish Demand of Least Terns in the Central Platte River Valley (7 pages)
- Section 6 – Evaluation of a Program Priority Hypothesis, Sub-hypothesis, and Big Question that Relate Flow, and thus Forage Fish Abundance and Diversity, to Least Tern Productivity (2 pages)
- References (6 pages)

Section 1 was developed to provide background and context to the discussions in the subsequent sections and contains: 1) the means by which the Program addresses scientific uncertainties; 2) a brief summary of least tern life history and occurrence in the central Platte River; and 3) relevant data used to address Program uncertainties. Sections 2–4 of this document report analytical methods and results of using available forage fish sampling data, the Program's foraging ecology data, the Program's productivity data, and flow data collected at United States Geological Survey gaging stations to test three inferred relationships in the hypotheses including: 1) forage fish abundance is related to flow in open channel habitat; 2) foraging behavior and success in open channel habitat is related to forage fish abundance, flow, or both; and 3) given a relationship between forage fish abundance and flow, least tern productivity is related to flow and thus forage fish abundance. We also used forage fish data and a review of literature to develop a bioenergetics approach to estimate numbers of least tern family units the central Platte Associated Habitat Reach (AHR)

could support at various flows in section 5. Finally, in section 6 we summarize all findings related to our weight of evidence approach for testing a Program priority hypothesis and an associated sub-hypothesis.

After completion of the peer review, the forage fish synthesis document will be utilized by the Program as reference material for developing the annual State of the Platte Report which synthesizes information relative to 11 "Big Questions" that are the focus of investigation through implementation of the AMP. State of the Platte Reports are developed for the Program's Governance Committee and are the key annual summary of Program science used by the Governance Committee to inform Program decision-making. It is imperative that this forage fish synthesis document receives thorough review and related editing, if necessary, to ensure it is the best available science for Program decision-makers.

2) Description of Peer Review

The purpose of this review is to provide a formal, independent, external scientific peer review of the information presented in the forage fish synthesis document. The document represents a synthesis of Program-collected data, data collected by Program entities, Program analyses, and other lines of evidence. The document relies on peer-reviewed literature to help answer questions of science uncertainty when available but also incorporates selected cases of unpublished or grey literature that fill a significant data gap where peer-reviewed sources were not available. **Peer reviewers will review this approach and assess the sufficiency of the document's conclusions regarding outstanding questions of scientific uncertainty.**

NOTE: In all cases (including this scope of work), peer-reviewed and other documents cited in the chapters have been compiled into a zip file that will be made available to all peer reviewers for reference if necessary.

3) Methods and Scientific Standards

Factors to be addressed include the scientific merit of the chapters' technical analyses and conclusions. The peer reviewers must ensure any scientific uncertainties are clearly identified and characterized, and the potential implications of the uncertainties for the technical conclusions drawn are clear. Peer reviewers are advised they are not to provide advice on policy. Rather, they should focus their review on identifying and characterizing scientific and technical uncertainties.

4) Charge to the Panel

Each Peer Review Panel member will be tasked with reviewing the entirety of the forage fish synthesis document from their particular area of expertise following the PRRIP Peer Review Guidelines for Reports & Studies (attached) and the specific directions contained in this Scope of Work. Peer reviewers will be asked to submit all comments, questions, and other communication in writing to ensure an appropriate record is built, and generally all communication with peer reviewers will be conducted via e-mail during the course of the review. Peer reviewers must consider and respond to the questions listed below, at a minimum, in their reviews:

1. Does the forage fish synthesis document adequately address the overall objective of the document, which is to present lines of evidence for broader examination of the relationship between forage fish abundance, river flow, and tern productivity on the central Platte River?

2. Do the authors of the forage fish synthesis document draw reasonable and scientifically sound conclusions from the information presented? If not, please identify those that are not and the specifics of each situation.

3. Are the statistical methods used in each section appropriate?

4. Are potential biases, errors, or uncertainties appropriately considered within the methods sections of this document and then discussed in the results and conclusion sections?

5. Are the conclusions drawn supported by the synthesis of data reported in Sections 2 – 5?

6. Did we utilize the data we had as effectively as possible to address the hypotheses *"forage fish abundance below 800 cfs limits least tern productivity?"* and *"there is a direct relationship between flow and forage fish abundance and species diversity?"* and answer the Big Question *"Does forage availability limit tern productivity on the central Platte River"*? If not, what additional analyses do you recommend?

Reviewers must protect information and ensure that services consist of unbiased assessments. Until it is made public, no information from the forage fish synthesis document may be released without express written permission from the EDO. Additionally, all peer review-related inquiries from outside sources must be forwarded to the Louis Berger project manager; reviewers should not communicate with those inquiring about the review.

5) Peer Review Rating & Recommendation

In addition to providing written comments on the forage fish synthesis document, each reviewer will provide a comprehensive rating and recommendation for the overall document utilizing the following format:

RATING

Please score each aspect of this set of chapters using the following rating system:
1 = Excellent; 2 = Very Good; 3 = Good; 4 = Fair; 5 = Poor

Category	**Rating**
Scientific soundness	_____
Degree to which the monitoring approach addresses the project's objectives	_____
Organization and clarity	_____
Conciseness	_____
Important to objectives of the Program	_____

RECOMMENDATION	**(Check One)**
Accept	_____
Accept with revisions	_____
Unacceptable	_____

PLEASE NOTE: *The PRRIP peer review process differs from the process used for technical journals and other publications in one critical area. If a peer reviewer checks "Accept with revisions" or "Unacceptable", the peer reviewer* ***must explicitly state*** *which specific changes would be required for them to change their recommendation to "Accept" (i.e., the subset of comments that are most critical to address and the specific changes to address them). This critical step ensures the Program understands potential fatal flaws or major areas of revision that must be addressed before finalizing this document and moving it on to the Governance Committee for approval. The reviewer may choose to list these specific changes or to reference the question responses where the changes are described, but either way they must*

be explicitly identified. The PRRIP will respond to all peer review comments received in some fashion and identification of the most critical changes needing to be made for this document to be acceptable expedites this process.

6) Peer Review Schedule

The specific schedule for completing the peer review will be dictated by the final stages of the contracting process for each reviewer, but in general the schedule below provides guidance for conducting a 45-day peer review of the forage fish synthesis document:

Peer Review Process Step	Begin Date	End Date
Reviewer contracting	September 9, 2015	September 30, 2015
Conduct peer review	October 1, 2015	November 13, 2015
PRRIP Independent Science Review contractor summarizes peer review comments and provides report to PRRIP	November 16, 2015	December 18, 2015
PRRIP reviews peer review report and comments, develops responses to each peer review comment, and seeks clarification from peer reviewers if necessary	December 21, 2015	January 15, 2016

The extent and content of peer review comments may necessitate more time on the part of the Independent Science Review contractor or the Program in terms of fully addressing all peer review comments. The goal is to develop responses to all peer review comments by the end of January 2016, discuss those responses with the Program's Technical Advisory Committee in February 2015, and seek final approval of the revised forage fish synthesis document (with all peer review comments included) from the Program's Governance Committee in March 2016.

7) Available Documentation

Peer reviewers will be provided with the following information:

- This Scope of Work for the peer review, including PRRIP Peer Review Guidelines for Reports
- Forage fish synthesis document (including the Cover Page, Preface, and Summary of Key Findings)
- Access to all references cited in the synthesis chapters
- 2012, 2013, and 2014 State of the Platte Reports
- Adaptive Management Plan
- Additional information as requested by Peer Review Panel members – if a document is requested by one member, it will be transmitted to all members simultaneously.

ATTACHMENT A

PRRIP Review Draft

Weight of Evidence Approach to Assessing Relationships between Flow and Interior Least Tern Forage Fish Abundance, Foraging Behavior, Productivity, and Dietary Requirements

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

Data Synthesis Compilation

Weight of Evidence Approach to Assessing Relationships between Flow and Interior Least Tern Forage Fish Abundance, Foraging Behavior, Productivity, and Dietary Requirements

PLATTE RIVER
RECOVERY IMPLEMENTATION PROGRAM

Prepared by staff of the Executive Director's Office for the Governance Committee of the Platte River Recovery Implementation Program

September 01, 2015

PREFACE

This document was prepared by the Executive Director's Office (EDO) of the Platte River Recovery Implementation Program ("Program" or "PRRIP"). The information and analyses presented herein are focused solely on informing the use of Program water and fiscal resources to achieve one of the Program's management objectives: increasing production of interior least tern from the Associated Habitat Reach (AHR) along the central Platte River in Nebraska. The Program has invested eight years in implementation of an adaptive management program to reduce uncertainties about proposed management strategies and learn about species responses to management actions. During that time, the Program has implemented management actions, collected a large body of species response data, and developed modeling and analysis tools to aid in data interpretation and synthesis.

Implementation of the Program's AMP has proceeded with the understanding that management uncertainties, expressed as hypotheses, encompass complex ecological responses to limited treatments that occur within a larger ecosystem that cannot be controlled by the Program. The lack of experimental control and complexity of response precludes the sort of controlled experimental setting necessary to cleanly follow the strong inference path of testing alternative hypotheses by devising crucial experiments (Platt 1964). Instead, adaptive management in the Platte River ecosystem must rely on a combination of monitoring species response to management treatments, predictive modeling, and retrospective analyses (Walters 1997). The Program has pursued all three of these approaches, producing multiple lines of evidence across a range of spatial and temporal scales.

This document is compilation of six sections with unique objectives and analyses that generally are separate and distinct lines of evidence for testing Program hypotheses and answering the associated Big Question. Section 1 was developed to provide background and context to the discussions in the subsequent sections. Section 1 contains: 1) the means by which the Program addresses scientific uncertainties; 2) a

brief summary of least tern life history and occurrence in the central Platte River; and 3) relevant data used to address Program uncertainties herein.

Sections 2–4 of this document report analytical methods and results of using the Districts' forage fish sampling data, the Program's foraging ecology data, the Program's productivity data, and flow data collected at United States Geological Survey gaging stations to test three inferred relationships in the hypotheses including: 1) forage fish abundance is related to flow in open channel habitat; 2) foraging behavior and success in open channel habitat is related to forage fish abundance, flow, or both; and 3) given a relationship between forage fish abundance and flow, least tern productivity is related to flow and thus forage fish abundance. We also used the Districts' forage fish data and a review of literature to develop a bioenergetics approach to estimate numbers of least tern family units the AHR could support at various flows in section 5. Finally, in section 6 we summarize all findings related to our weight of evidence approach for testing a Program priority hypothesis and an associated sub-hypothesis.

SECTION 1 – Forage Fish Uncertainties and Data Sources

Approach to Addressing Program Uncertainties

The Platte River Recovery Implementation Program (Program) is responsible for implementing certain aspects of the endangered interior least tern (*Sternula antillarum athalassos*; hereafter, least tern) and threatened piping plover (*Charadrius melodus*) recovery plans. More specifically, one of the Program's Adaptive Management Plan (AMP) management objectives is to increase productivity of the least tern and piping plover from the Associated Habitat Reach (AHR) of the Platte River in central Nebraska. This ninety-mile reach extends from Lexington, NE downstream to Chapman, NE and includes the Platte River channel and off-channel habitats within three and one half miles of the river (Figure 1).

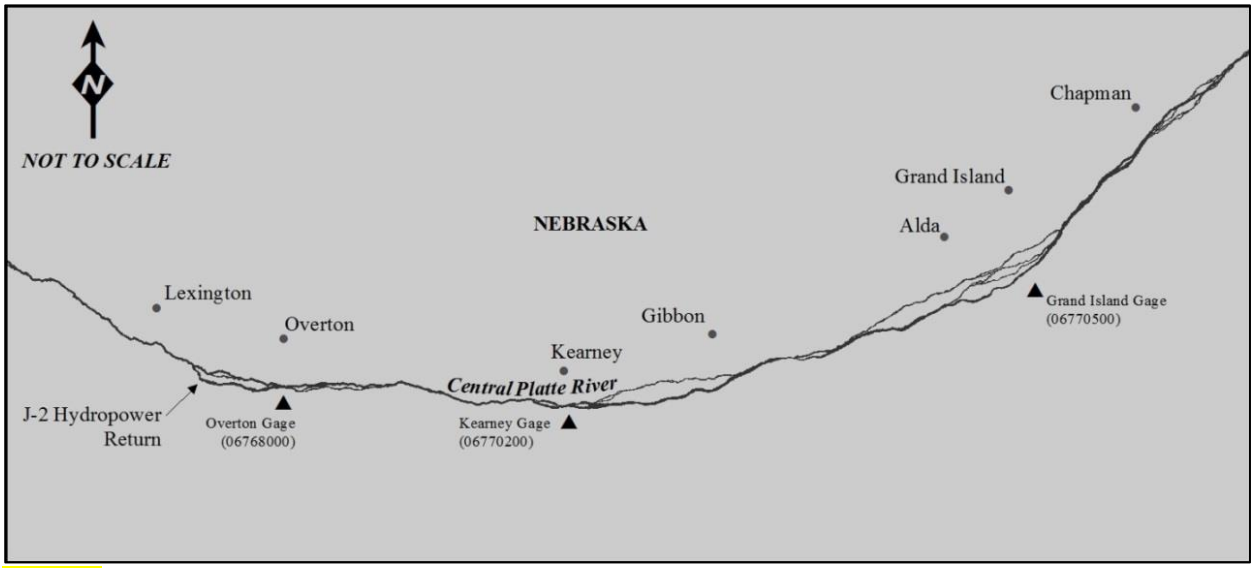


Figure 1. Associated Habitat Reach (AHR) of the central Platte River extending from Lexington downstream to Chapman, Nebraska.

The Program addresses key scientific and technical uncertainties through application of adaptive management. The Program's AMP provides a systematic process to test hypotheses and apply information learned to improve management (Smith 2011). The Program defines adaptive management as "a series of scientifically driven management actions (within policy and resource constraints) that use the monitoring and research results provided by the Integrated Monitoring and Research Plan to test priority hypotheses

related to management decisions and actions and apply the resulting information to improve management" (Program 2006). During the negotiation and development phases of the Program, Program participants developed conceptual models to provide a visual framework of the hypothesized understandings of central Platte River processes relative to the target species, including least tern (Smith 2011). A hierarchy of broad and priority hypotheses, management strategies and actions, implementation activities, monitoring protocol development, and data evaluation detailed in the AMP are an extension of the relationships identified in the conceptual models. Based on the objectives and intent of Program broad and priority hypotheses, the Program developed a set of 11 "Big Questions" to summarize a large amount of data into a straight-forward, well-focused, and easy to understand format to assist the Program's Governance Committee in decision making (Program 2013).

Several of the Program's priority hypotheses are focused on relationships between productivity of least terns on the central Platte River and management actions. Among other things, variation in productivity of least terns on the central Platte River has been attributed to several factors including predation events, changes in the amount of natural and manmade nesting habitat, alterations in flow patterns, and abundance of prey fish (Wilson et al. 1993, National Research Council 2004, U.S. Department of the Interior et al. 2006, Jenniges and Plettner 2008).

Within the Great Plains, abundance and diversity of fish occurring in streams has been shown to decrease with groundwater extractions and flow alterations especially when desiccation events occur due to prolonged periods of zero flow (Falke et al. 2011, Perkin et al. 2014). The Program's Biological Opinion includes a USFWS Target Flow of 800 – 1,200 cfs from 11 May – 15 September. One of several purposes for the flow target is to maintain flows in the central Platte River to increase forage fish abundance and diversity to increase productivity of least terns within the AHR (USFWS 2006). It is important to note, however, that this flow target was based on decreasing water temperatures and thus increasing the abundance and diversity of all guilds of fish within the central Platte River, not solely the guilds that include

forage fish species for least terns. The Biological Opinion states "no flow (i.e., a dry channel) or very low flow conditions would affect forage fish and, thus, least terns if such a flow event occurred during the nesting season." (USFWS 2006). This assertion is articulated in Priority Hypothesis T2 and sub-hypothesis T2a (Figure 2) in the Program's AMP (Program 2006) that state:

T2 – Tern productivity is related to the number of prey fish (<3 inches) and fish numbers limit tern production below 800 cfs from May–September.

T2a – Flow rates influence the number and species diversity in tern prey base (fish).

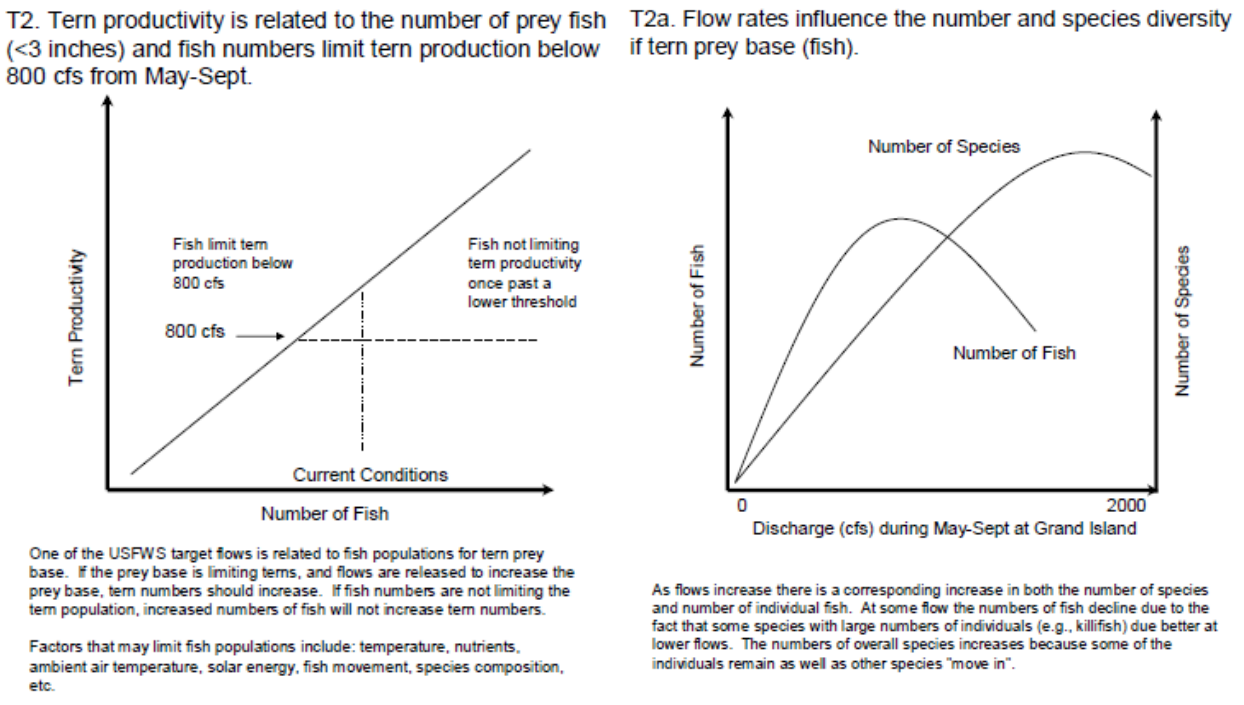


Figure 2. Hypothesized relationships between forage fish abundance and least tern productivity (T2; left) and flow and fish abundance and diversity (T2a; right).

The Big Question associated with these hypotheses states: "Does forage availability limit tern […] productivity on the central Platte River?" This question is used to direct a weight of evidence approach to synthesize multiple lines of evidence to assess what the Program has learned about the relationship between

forage fish abundance and least tern productivity. This synthesis document is the result of that approach and will be used by the Program to assess the Big Question and its impact on Program decision-making.

Least Tern Life History

The least tern was listed as endangered on June 27, 1985 (USFWS 1990); however, a recently completed five-year review recommends delisting least terns due to recovery (USFWS 2013). The USFWS is now in the process of putting in place the necessary monitoring plans, conservation agreements, and population models in hopes of moving forward with a proposed delisting in the near future. The breeding range for least terns spans from Montana to Texas and from Eastern New Mexico and Colorado to Indiana and Louisiana (USFWS 1990). Least terns are a colonial nesting bird that mobs predators or other intruders by dive-bombing and defecating on them. The species breeds and nests on barren to sparsely vegetated riverine sandbars, sand and gravel pits, lake and reservoir shorelines, rooftops, ash pits, and salt flats from late April to early August. The central Platte River Valley in Nebraska, USA supports a small population of least terns that typically utilize manmade river sandbars and off-channel habitats (i.e., sandpits) that are managed specifically for nesting; however, a small proportion (<10%) have nested on unmanaged sandbars and sandpit sites (Jenniges and Plettner 2008, Baasch 2014). Least terns usually lay two to three eggs in a shallow scrape and may renest if their nest is destroyed (USFWS 1990). The incubation and brood rearing period for nests and chicks generally lasts from 38 to 50 days. Although the persistence of least terns along the central Platte River has been dependent on manmade habitat for nesting, this piscivorous species relies heavily on the river for foraging (Wilson et al. 1993, Sherfy 2012).

During the nesting and brood rearing season, least tern forage on small fish (<7.6 cm; 3 in) they capture by diving into shallow riverine habitats and freshwater ponds. However, least terns forage most intensively and successfully in the river channel (Wilson et al. 1993, Sherfy et al. 2012). Least terns are a semi-altricial species and thus chicks are not capable of foraging on their own so only a single brood is

raised each year as adults must continue to feed offspring for several weeks after fledging. Based on sampling data, the predominant species of forage fish available for least terns included red shiner (*Cyprinella lutrensis*), sand shiner (*Notropis stramineus*), bigmouth shiner (*Notropis dorsalis*), brassy minnow (*Hybognathus hankinsoni*), mosquitofish (*Gambusia affinis*), plains killifish (*Fundulus zebrinus*) and unidentifiable young-of-the-year fish species (Program 2013). These six species and unidentifiable young-of-the-year fish accounted for >75% of all fish captured in each sample. Similarly, Wilson et al. (1993) reported 79% of identifiable fish that were captured and carried to a nest by least terns were cyprinid species. As such, we limited our definition of forage fish to these six species and unidentifiable young of the year fish.

Least tern observations in the AHR prior to systematic monitoring

Historical records of least tern occurrence in Nebraska were compiled by Ducey (1985, 2000) and Pitts (1988). The first recorded observation of least terns in what is now Nebraska was made near the mouth of the Platte River in 1804 by the Lewis and Clark expedition as they traveled up the Missouri River. The next recorded observations were made by Duke Paul Wilhelm at the mouth of the Platte River in 1823. Subsequent observations in the 19th century include the Loup River in 1857, the North Platte River in Keith County in 1859, and on the banks of a wetland basin near York, Nebraska in 1896 and 1897 (Ducey 2000, Pitts 1985). Least terns were next observed nesting on the South Platte River near the city of North Platte in 1926-1929 with 57 nests recorded as well as documentation of foraging movements to the North Platte River and sand pit lakes when the South Platte River went dry (Tout 1947).

The next recorded least tern observation on the Platte River occurred near Columbus in 1941, the same year that Lake McConaughy, the largest reservoir in the basin, was completed. Ten nests were observed on river sandbars (Shoemaker 1941). The first recorded least tern observations in the Program's AHR occurred in 1942 when a colony was discovered nesting on the river near Lexington, Nebraska by Dr.

Ray S. Wycoff. Dr. Wycoff studied the colony for 17 years and observed nesting on a low sandbar in the channel, high in-channel island created by sand mining, and at adjacent sandpits (Wycoff 1960). In 1943, a single nest was observed on a swimming lake beach near Plattsmouth (Heineman 1944). In 1948 and 1949 least tern were again observed nesting on the South Platte River (Benckeser 1948, Audubon Field Notes).

Pitts (1988) compiled records from the Proceedings of the Nebraska Ornithologists Union, Wilson Bulletin, and Nebraska Bird Review and other sources to identify annual adult and nest sightings by county for the period of 1804-1984. Records of adult and nest sightings in the AHR began with Dr. Wycoff's observations which account for the majority of AHR records. Other observations prior to the first systematic survey results for the AHR in 1979 include one mid-reach adult observation in 1960 and observations of adult birds in the downstream portion of the reach in 1953, 1954, 1957, 1959, and 1973.

Systematic monitoring of least tern in the AHR

Intermittent systematic monitoring of least tern occurrence and productivity has been conducted in the AHR since 1979 with variable degrees of monitoring effort expended every year after 1982 (Pitts 1988, Lingle 2004, Baasch 2010, 2012, 2014). Since 2001, efforts have included systematic monitoring of least tern habitat use and productivity within the AHR. Since 1979, a total of 1,946 least tern nests have been documented in the AHR (Table 1; Figure 3). Of all nests documented in the AHR, 89.1% of least tern nests occurred on off-channel sandpit habitat. Approximately 3.1% of least tern nests occurred on natural sandbars; the remaining in-channel nests were observed on islands that were mechanically created and maintained as nesting habitat.

Table 1. Central Platte River nest incidence by habitat type, 1979-2013.

Habitat Type	Interior Least Tern	
	Count	**Percent**
Sandpit	1,733	89.1%
Natural Sandbar	61	3.1%
Constructed or Managed Sandbars	152	7.8%
Total	**1,946**	**100.0%**

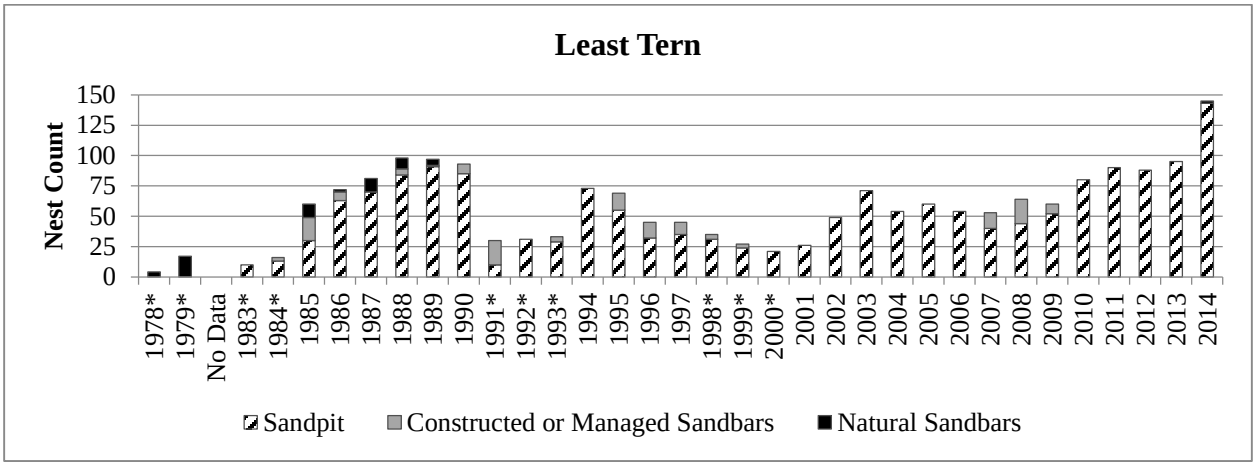


Figure 3. Central Plate River least tern nest incidence by year and habitat type, 1978-2013. Asterisks indicate periods when monitoring effort changed substantially.

Least tern productivity data

Least tern nests and broods were monitored at least twice weekly from 2001–2014 where nesting occurred within the AHR (Figure 4; Program 2011). These data contain, among many other variables, the number of eggs that hatched, date nests hatched, fate of broods (fledged, failed, unknown), date the brood's fate was determined, and the number of successful fledglings in each brood. The fate of the brood was recorded as "fledged" if one or more chicks from each brood were observed approximately 21 days after hatching or when sustained flight was observed if <21 days. A fate of "failed" was recorded if no chicks were observed as fledglings or if mortality was confirmed. A fate of "unknown" was assigned to broods when chicks were observed within a few days of the fledging age (i.e., 21 days after hatching), but no fledglings were actually observed.

Monitoring Forage Fish Abundance in the AHR

On January 25, 1999 the Central Nebraska Public Power and Irrigation District (CNPPID) and the Nebraska Public Power District (NPPD; known collectively as the Districts) filed a plan with the Federal Energy Regulatory Commission to, among other things, monitor least tern productivity and forage

availability for least terns at habitat areas managed by the Districts. The objective of the forage fish monitoring program was to monitor the abundance of forage fish for least terns and evaluate fish species diversity on or near areas owned or managed by the Districts. As such, forage fish abundance and diversity were sampled periodically from 1999–2014 using the Districts' forage fish monitoring protocol. Four sampling sites were established based on their close proximity to areas managed as least tern nesting habitat in 1999. A fifth sampling location near Alda, Nebraska was added in 2003 (Figure 4). Forage fish sampling generally occurred during the latter portion of the least tern nesting season in 1999, 2003, 2005, and 2007–2010. In any given year, data collection generally occurred over a few consecutive days (range of 2–7 days); however, the date sampling was initiated ranged from 23 June to 13 August.

Each area sampled included a 200 m (219 yd) reach of river with areas classified as open channel habitat which was defined as the flowing portion of the active channel area >23 m (25 yd) wide. Open channel areas were sampled using 0.3 cm (1/8-inch) mesh seines to enclose an area 7.5 m by 15 m (112.5 m^2; 8.2 yd by 16.4 yd; 134.5 yd^2). At each site, five to ten samples were obtained; total number of samples at each site depended on the available channel area. The location of sampling at each site was chosen to be representative of open channel areas. Sampling at a site did not occur if flows were too high or water was not present. A total of 237 samples were obtained to document fish abundance and diversity during the study period 1999–2010.

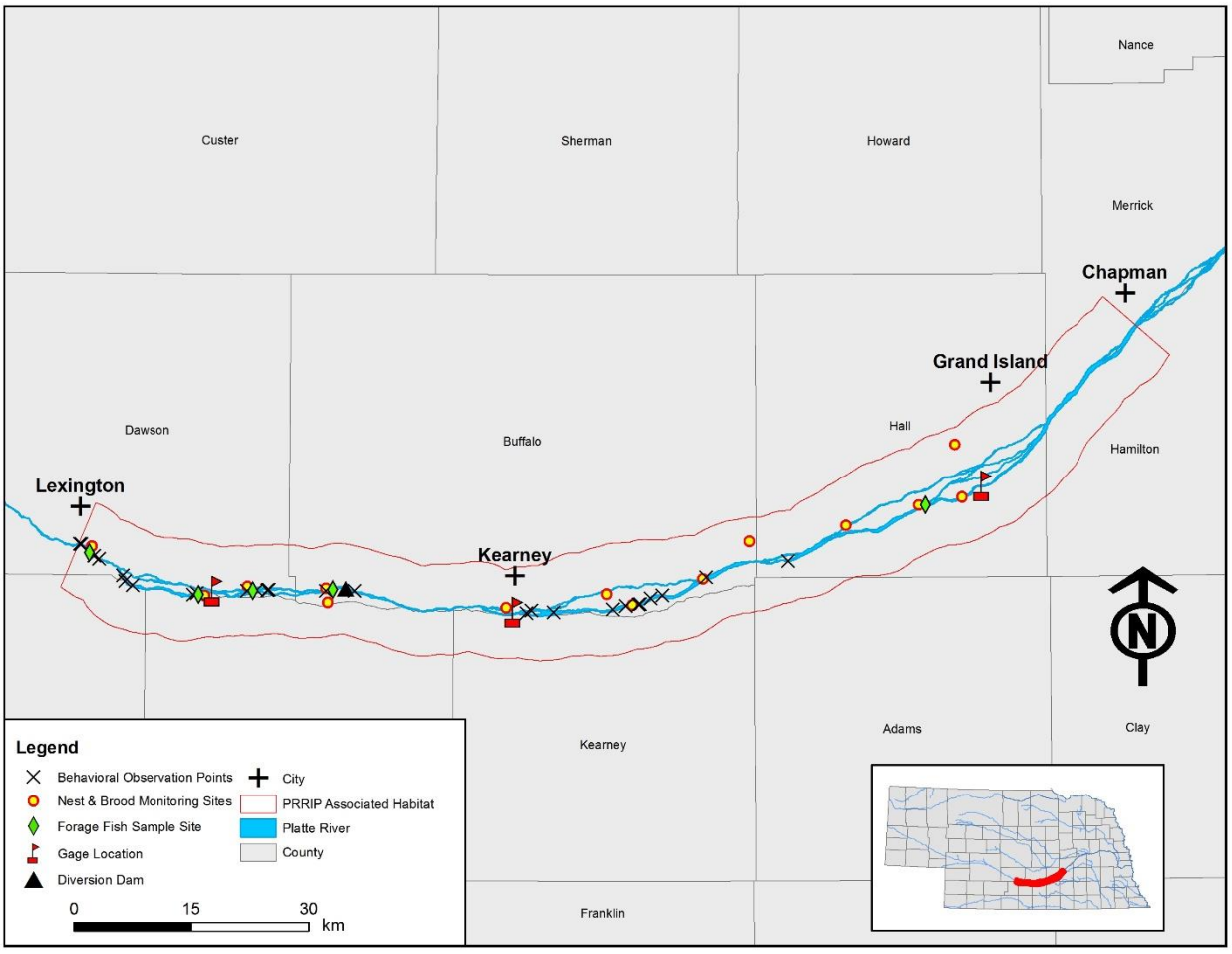


Figure 4. Study area (Associated Habitat Reach) showing data collection sites and other important features.

All captured fish were counted and identified to species or were classified as young-of-the-year if they were too small to identify. We limited our analysis to fish species and age classes generally of an appropriate size (<7.6 cm; 3 in) for least tern forage. The species included in our analysis were: red shiner (*Cyprinella lutrensis*), sand shiner (*Notropis stramineus*), bigmouth shiner (*Notropis dorsalis*), brassy minnow (*Hybognathus hankinsoni*), mosquitofish (*Gambusia affinis*), plains killifish (*Fundulus zebrinus*) and unidentifiable young-of-the-year fish species (Program 2013). These six species and unidentifiable young-of-the-year fish accounted for >75% of all fish captured in each sample.

Monitoring Foraging Habits of Least Terns in the AHR

In 2009 the Program implemented a foraging habits study to document foraging activity of least terns along the central Platte River valley (Sherfy et al. 2012). The purposes of the foraging habits study was to help determine if prey base availability limits reproductive success of least terns on the central Platte River and to attempt to isolate the effects of foraging habits on productivity from other influences such as predation and human disturbance. Sherfy et al. (2012) recorded behavioral observations of least terns at sandpits and riverine sites. During the months of June–August (2009–2010) least tern behavior was observed during 378 sessions (358 hours) conducted opportunistically or during three 4-hour periods between sunrise and sunset (0600–1000, 1200–1600, and 1700–2100 h). The majority of observation sessions (n=306) and time (310 hours) occurred at sandpits or at Nebraska Public Power District's Kearney Canal Diversion (Figure 1). The remainder of the sessions (n=72) and time (48 hours) focused on two sandbar colony sites and open river channel (hereafter, river channel sessions). We used only river channel sessions in our analysis because we were interested in how foraging behavior is influenced by flow and fish abundance in open river channel habitat and not at sandpits or a division structure. Behaviors were observed using binoculars or spotting scopes from ground blinds at sandpits, river banks and sandbars, canoes, and an airboat. Many behavioral types were reported including three directly related to least tern foraging: 1) successful plunges; 2) unsuccessful plunges (including dives that do not end in a plunge into the water) and; 3) plunges for which the capture success was unknown. From this we constructed a data set to record the date, location, length of the session (to the nearest minute), total number of successful plunges, unsuccessful plunges, and plunges with unknown success. See Sherfy et al. (2012) for more details.

It is important to note that data collected by Sherfy et al. (2012) was the result of two different study designs. The first design involved systematic observations taken by going to a location and making observations (e.g., observations from the blind) while the second design involved opportunistic observations (e.g., from an airboat after observing least terns in a given area). Clearly, the opportunistic

observations were likely to have higher rates of plunging because observations were conditional on least terns being present. Due to small sample size, we choose not to analyze both types separately, that is, we analyzed both types of observation as if they were interchangeable.

Central Platte River Flow Data

We obtained mean daily flow (m^3s^{-1} and ft^3s^{-1}) records from U.S. Geological Survey gaging stations on the Platte river near the cities of Overton (06768000), Kearney (06770200) and Grand Island, Nebraska (06770500) from May 1999 to August 2010. Our analyses of the forage fish data used mean daily flow records on the date of sampling from the nearest gaging station as a covariate.

Synthesizing Data

Subsequent sections of this document report the results of using the Districts' forage fish sampling data (CNPPID and NPPD 2013), the Program's foraging ecology data (Sherfy et. al. 2012), the Program's productivity data (Baasch 2014), and flow data collected at United States Geological Survey (USGS) gaging stations to test three inferred relationships in the hypotheses including: 1) forage fish abundance is related to flow in open channel habitat (Districts' forage sampling data and flow records); 2) foraging behavior and success in open channel habitat is related to forage fish abundance, flow, or both (Districts' forage sampling data, Program's foraging ecology data, and flow records); and 3) given a relationship between forage fish abundance and flow, least tern productivity is related to flow and thus forage fish abundance (Program's tern and plover monitoring data and flow records). We also used the Districts' forage fish data and a review of literature to develop a bioenergetics approach to estimate numbers of least tern family units (assuming 2 adults and 3 chicks) the AHR could support at various flows (forage fish data and literature review).

SECTION 2 – Relationship between Forage Fish Abundance and Flow

Priority hypothesis T2 in the Program's Adaptive Management Plan (AMP) deals with concerns over the relationship between least tern productivity on the central Platte River and the availability of forage fish in the river (Program 2006). A sub-hypothesis (T2a) postulates a non-linear relationship between the number and diversity of fish and river discharge (Program 2006). As such, the Big Question associated with this hypothesis states: "Does forage availability limit tern […] productivity on the central Platte River." To provide a line evidence for answering the Big Question and assessing this premise, we used forage fish sampling data collected by the Districts (CNPPID and NPPD 2013) and flow records from USGS gaging stations to determine impacts of river discharge and other factors on forage fish availability. We use these results to begin to build empirical evidence to test the forage fish-related hypotheses in the AMP.

Forage fish model

Our first assumption regarding the priority hypothesis was that flow was related to forage fish abundance in open channel habitat. Therefore we developed a regression model to establish a relationship between flows and forage fish abundance in open channel habitat as follows. Let x_i correspond to the observed catch in the i^{th} seine, for i = 1,2,…,237. We let this count have a negative binomial distribution with mean μ_i and dispersion ϕ:

$$x_i \sim Negative\ Binomial(\mu_i, \phi). \quad (3.1)$$

Under this parameterization, the expected value of x_i is μ_i and the variance of x_i is $\mu_i + \phi\mu_i^2$. We assumed the log of the expected catch per seine depends linearly on flow:

$$\log(\mu_i) = \beta_1 + \beta_2 f_i, \quad (3.2)$$

where β_1 is the log expected catch per seine at a flow of 0.0 m^3s^{-1} (0.0ft $^3s^{-1}$) and β_2 is the coefficient that determines how the expected catch per seine depends on the mean daily flow at the nearest gaging station

to site i on the day of seining (f_i). Since each seine sampled an area of 112.5 m^2 (134.5 yd^2) we reported quantities of interest per m^2 (e.g., $\mu_i/112.5\ m^2$).

To assess the fit of our model, we present posterior predictive model checks. Posterior predictive checks, show agreement (or discrepancy) between the fitted model and the observed data and can be used to asses model adequacy (Gelman *et al.* 2013).

Results

We found expected forage fish densities ($\mu_i/112.5\ m^2$) decreased as flow increased (Figure 5). The number of fish caught per seine was highly variable; however, the negative binomial distribution appears to capture this variability as the posterior median of ϕ was relatively large. Because of the variability in the seining data, our predicted fish densities were also highly variable (Figure 6). The posterior predictive distribution shows agreement between the fitted model and the observed data (Figure 6). This suggests our forage fish model with the single flow covariate is adequate.

Discussion

Previous investigations of tern foraging behavior, as well as observations of least terns foraging on the central Platte River, generally indicate a selection for foraging in open channel habitat provided by the river (Wilson *et al.* 1993; Tibbs & Galat 1998; Sherfy *et al.* 2012). Because of least tern foraging behavior and the proximity of our five sampled sites to areas with the highest nesting densities in the AHR, we expect the sampling design was representative of the open channel habitat readily available to least terns at areas managed as nesting habitat. We note, however, the sampling design was not a random set of sites (or similar design) within the AHR that would lead to broader inference.

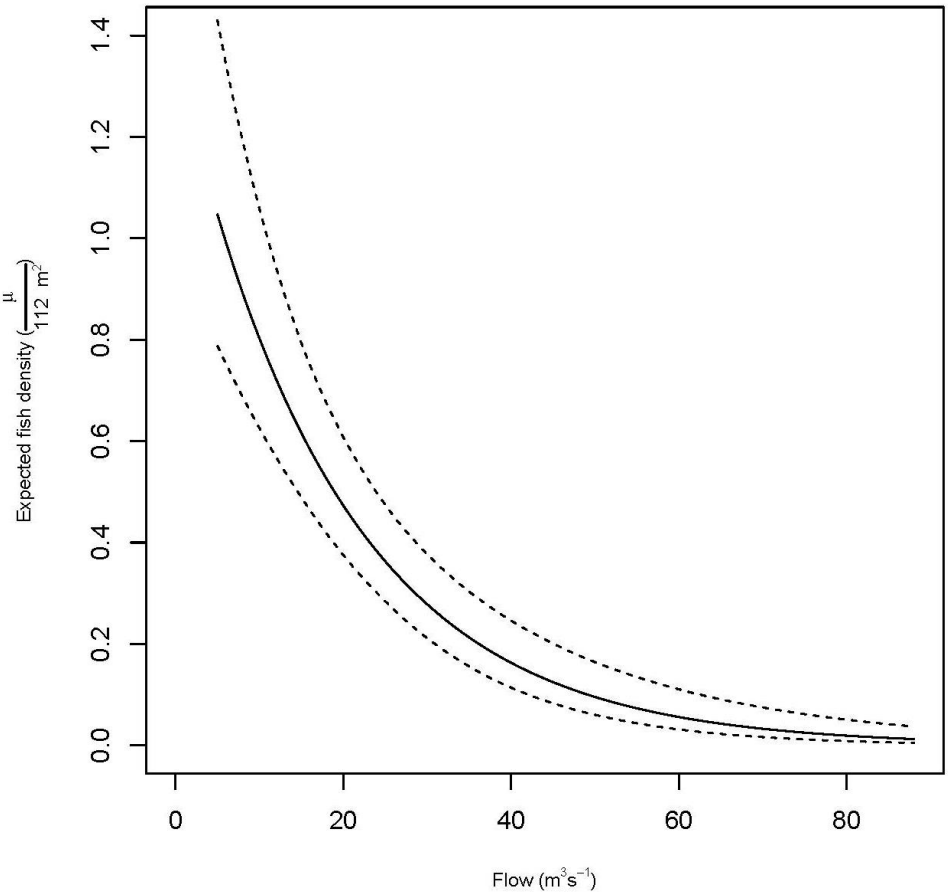


Figure 5. Regression model (Eq. 3.1–3.2) showing the relationship between expected forage fish density ($\mu/112.5\ m^2$) and average daily flow the day seining occurred (posterior median = solid black line; 95% CIs = dashed black lines).

We expected and found a nonlinear relationship between forage fish abundance and discharge metrics. Our results indicate expected forage fish abundance are highest at low mean daily flows on the day of sampling (hereafter referred to as flows) and declined as flow increases. For the forage fish abundance data, the effect is relatively small in comparison to the variability in the data (Figure 6). However, at very low flows we would expect seining to result in higher catches of forage fish and this results is corroborated by the observed data (Figure 6).

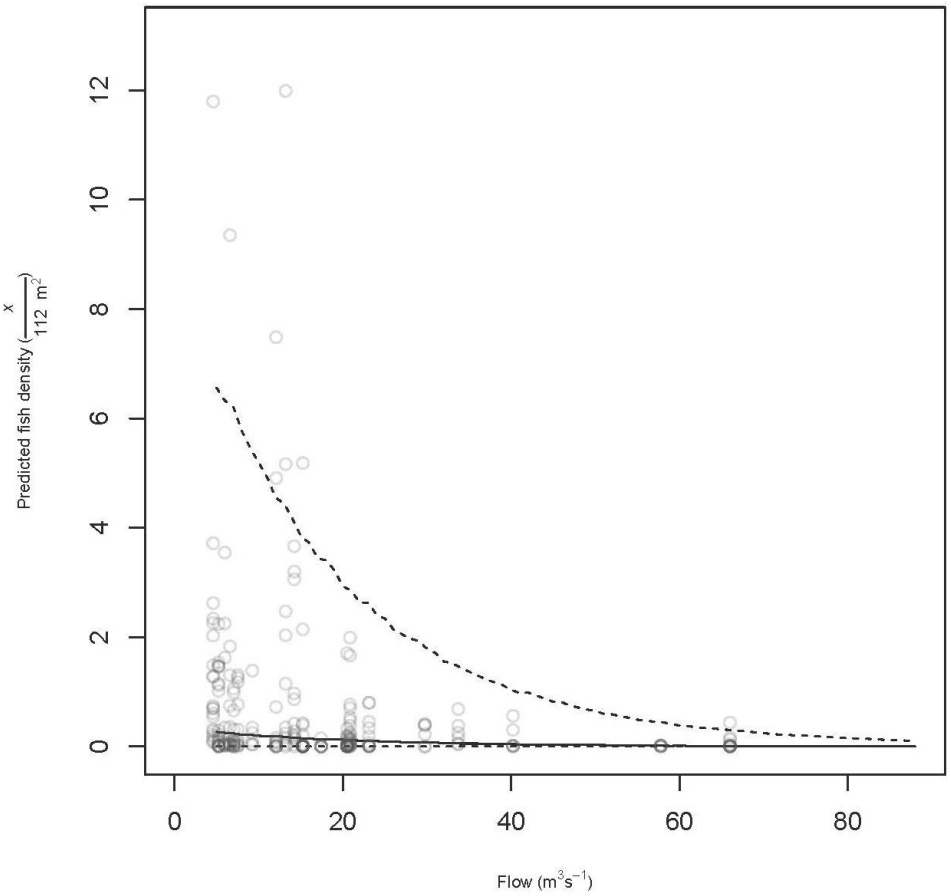


Figure 6. Regression model (Eq. 3.1–3.2) showing the relationship between predicted forage fish density ($x/112.5\ m^2$) and average daily flow the day seining occurred (posterior median = solid black line; 95% PIs = dashed black lines).The gray circles show the observed data (i.e., number of fish caught in each seine/112.5 m^2; 134.5 yd^2).

These results need to be interpreted with caution due to variable catchability. Variation in catchability occurs when the probability a fish is captured is less than one and variable from sample to sample. For detection of trends, variable catchability is a concern if the probability of catching an individual depends on the explanatory variables (e.g., flow) or other unmeasured variable that correlates with the predictors used in our analysis. Variable catchability, also known as non-detection, has the potential to be the sole driver of the trend in our analysis. However, given the data used in our analysis, we cannot confirm, nor refute, this claim.

Summary

Based on the Districts' forage fish sampling data and USGS flow records, we were able to establish a relationship between forage fish abundance and mean daily flows. This relationship was opposite of what was hypothesized as the abundance of forage fish caught in each sample, though variable, was higher during periods of low flow. However, the relationship we found was small as compared to variability in sampling data and potential differences in catchability under various flow conditions.

SECTION 3 – Relationships between Flow, Forage Fish Abundance, and Interior Least Tern Foraging Behavior and Success

We used data collected by the Districts and least tern foraging behavior data to provide another line evidence for answering the Big Question and assessing this premise. The objective of this evaluation was to determine impacts of flow and forage fish abundance on least tern foraging behavior and success in open channel habitat. Although indirect to productivity of least terns, we might expect flow and forage availability to influence foraging behavior and success of the birds. We use this indirect evidence to build empirical support to test the forage fish-related hypotheses in the Program's AMP (Program 2006).

Least tern foraging model

We constructed two models. We related the total number of plunges observed during each behavioral session to a set of covariates in model one. In model one, y_j corresponded to total number of plunges (successful, unsuccessful and unknown outcome) that occurred during the j^{th} behavioral observation session for j = 1,2,…72. We assumed y_j followed a negative binomial distribution with expected value λ_j and dispersion θ:

$$y_j \sim Negative\ Binomial(\lambda_j, \theta). \quad (4.1)$$

The log of the expected plunge rate (λ_j) depended on three covariates:

$$\log(\lambda_j) = \beta_3 + \beta_4 \frac{x_j}{112.5\ m^2} + \beta_5 f_j + \beta_6 {f_j}^2 + \beta_7 \log(h_j), \quad (4.2)$$

which are the predicted fish abundance per m^2 ($x_j/112.5\ m^2$), mean daily flow at the location on the day of the observation (f_j) and the session length in hours (h_j). The numerator in the predicted fish abundance per m^2 in eqn 3.2 (i.e., x_j) was predicted from the model described in eqn 3.1 and 3.2 in Section 3. We used the forage fish model to predict fish abundance for flow (f_j).

We related the number of fish captured during each behavioral session to a set of covariates in model two. The observed number of fish captured (z_j) in the j^{th} session followed a binomial distribution with total number of plunges (N_j) and probability of success (π_j):

$$z_j \sim Binomial(N_j, \pi_j), \quad (4.3)$$

where N_j is the observed sum of the number of successful and unsuccessful plunges. The logit of π_j depends on fish abundance per m^2 and mean daily flow at the location on the day of the observation:

$$\text{logit}(\pi_j) = \beta_8 + \beta_9 \frac{x_j}{112.5\ m^2} + \beta_{10} f_j + \beta_{11} {f_j}^2. \quad (4.4)$$

We were also interested in the expected catch rate (γ_j), which we define as the expected plunge rate multiplied by the probability a plunge results in a fish capture:

$$\gamma_j = \lambda_j \pi_j \, . \quad (4.5)$$

Biologically, we expected the plunge rate and probability of fish captured to depend on both flow and forage fish abundance. We expected plunge rates and capture success were higher at locations with greater fish densities. Likewise, because it seems there would be a minimum depth of water a least tern can plunge into without injury, we expected flow to influence the plunge rate (i.e., least terns would not plunge because the water is too shallow) or capture success (i.e., least terns dive but do not plunge into the water). We also expected plunge rate and probability of fish capture to decrease as flow increased because at higher flows the water in the channel is deeper, moves with greater velocity, and is more turbid. Under these conditions, forage fish may not be visible or catchable (i.e., forage fish may be located at depths greater than the maximum viewing or diving capabilities of least terns). Allowing for a quadratic effect of flow in eqn 3.2 and 3.4 captured this dynamic.

Use of forage fish model

The least tern foraging model required, as a covariate, the density of forage fish present at each plunge location. We did not have data pertaining to the density of forage fish present at each location during the time a plunge was observed. Furthermore, it is not clear how forage fish abundance could be measured instantaneously at each plunge location (although see Safina & Burger 1985). We have the required data at several locations and points in time, but not at the locations or time we need. This is a common problem in spatial statistics and is known as spatial misalignment (Carol & Young 2002). A solution to this problem is to make a prediction of the covariate at the location and time when and where it is needed. For example, it is common to use environmental data (e.g., average temperatures) collected at various locations (e.g., weather stations) to provide predictions across a spatial domain (e.g., the United States). The predicted covariates are then extracted, usually from geographic information systems, and treated as if they were actually measured at the location and time the biological data was collected. This process, however, can produce inference biases if uncertainty in predictions is not accounted for (Foster *et al.* 2012; Stoklosa *et al.* 2014).

We used the predicted abundance as a surrogate for measured fish abundance at each observation location in our analysis. We incorporated prediction error into our Bayesian hierarchal models (Cressie *et al.* 2009; Cressie & Wikle 2011). For the purposes of this study, we implemented the negative binomial regression model to: 1) make inference with regard to the relationship between forage fish abundance and flow, and 2) predict forage fish abundances for use as a covariate.

Model selection and inference

Model selection for our model could occur at many levels. For example, we could test if the negative binomial distribution fit the data better than a Poisson distribution. We could try to determine if the functional form, for example in eqn. 3.2, best fit the data. We could also try to determine which β's

should be included in the model. The first two examples involved checking model assumptions, which can also be accomplished by posterior predictive checks (Gelman *et al.* 1996, 2013). We performed posterior predictive checks on our model to assess model assumptions and show the results for the two best models. We then proceeded with model selection, where our goal was to determine which, if any, covariates—forage fish, abundance, or flow—effectively predicted tern forage rate and forage success.

We agree with Hooten & Hobbs (2014) that out-of-sample validation would be the gold standard for predictive model selection, however, we feel our datasets were too small to split into training and test sets. As such, we used K-fold cross validation which required K runs of the Markov Chain Monte Carlo (MCMC) algorithm as recommended by Hooten and Hobbs (2014). For our model, we defined the score function as:

$$-2\sum_{k=1}^{K}\log\left(\frac{\sum_{t=1}^{T} Negative\ Binomial(\boldsymbol{y}|\boldsymbol{\mu}(t),\phi(t)\cdot Binomial(\boldsymbol{z}|\boldsymbol{N},\pi(t))}{T}\right), \quad (3.6)$$

where K is the number of folds and T is the MCMC iteration in the K^{th} fold. We calculated the score for four different models where the plunge rate and fish capture rate depended on: 1) fish abundance and flow (M1); 2) flow only (M2); 3) fish abundance only (M3); and neither flow or fish abundance (M4). We assumed plunge rate depended on effort in all four models. We identified the best predictive model by finding the model with the smallest value of the score function using 10-fold cross validation (i.e., K=10 in Eq. 8).

Finally, we reported the median and 95% equal-tailed credible intervals (CIs) for the posterior distributions of the expected plunge rate, the probability of fish capture, and the expected capture rate for the model or models with the lowest score after model selection. We calculated the median and 95% CIs for all variables that depended on the covariate for a grid of values between the minimum and maximum observed from the data so that, when plotted against the covariate, the lines appeared continuous. We standardized all quantities that depended on survey effort (eqn 3.2 and 3.4) to an hourly rate (i.e., $h = 1$).

Results

Results of cross-validation indicate M4 (score = –9.5) had the highest predictive ability which suggests neither fish density nor flow influenced plunge and fish capture rates. The model that only allowed for an influence of flow (M2), however, had only slightly less predictive ability (score = –8.8). Both M1 (score = 20.0) and M3 (score = 11.5), which allowed for an influence of fish density on plunge and fish capture rates, had much lower scores indicating the predictive ability of those model was degraded. We present results for M4 and M2 since these models had the lowest, but nearly equal scores. We present results of M2 (second ranked model) in more detailed given M4 (top model) suggests neither flow nor fish density influenced plunge and fish capture rates, and thus a detailed presentation is not necessary (Figure 7–10).

Presented as an hourly rate (i.e., h = 1), M2 indicates the expected plunge rate increased from around 4 plunges per hour at the lowest observed flows (5 m^3s^{-1}; 177 ft^3s^{-1}) to a peak of 9 plunges per hour at flows of 45 m^3s^{-1} (1,589 ft^3s^{-1}). After the peak of 9 plunges per hour, the plunge rate decreased to around 3 plunges per hour at the highest observed flow (87 m^3s^{-1}; 3,072 ft^3s^{-1}). The probability of fish capture increased from approximately 0.10 at 5 m^3s^{-1} (177 ft^3s^{-1}) to around 0.30 at 87 m^3s^{-1} (3,072 ft^3s^{-1}). When the plunge rate and probability of fish capture were combined, the catch rate increased from 0.25 fish per hour at 5 m^3s^{-1} (177 ft^3s^{-1}) to about 2.00 fish per hour around 60 m^3s^{-1} (2,119 ft^3s^{-1}), but decreased at higher flows. Based on incidental field observations, we assume the variability in catch rates are more an artifact of changes in foraging strategy (skimming verses plunging to capture forage) than forage fish abundance. It is also important to note that 95% CIs for all relationships are wide, particularly at higher flows, which indicates there is a lot of uncertainty in the relationships at high flows.

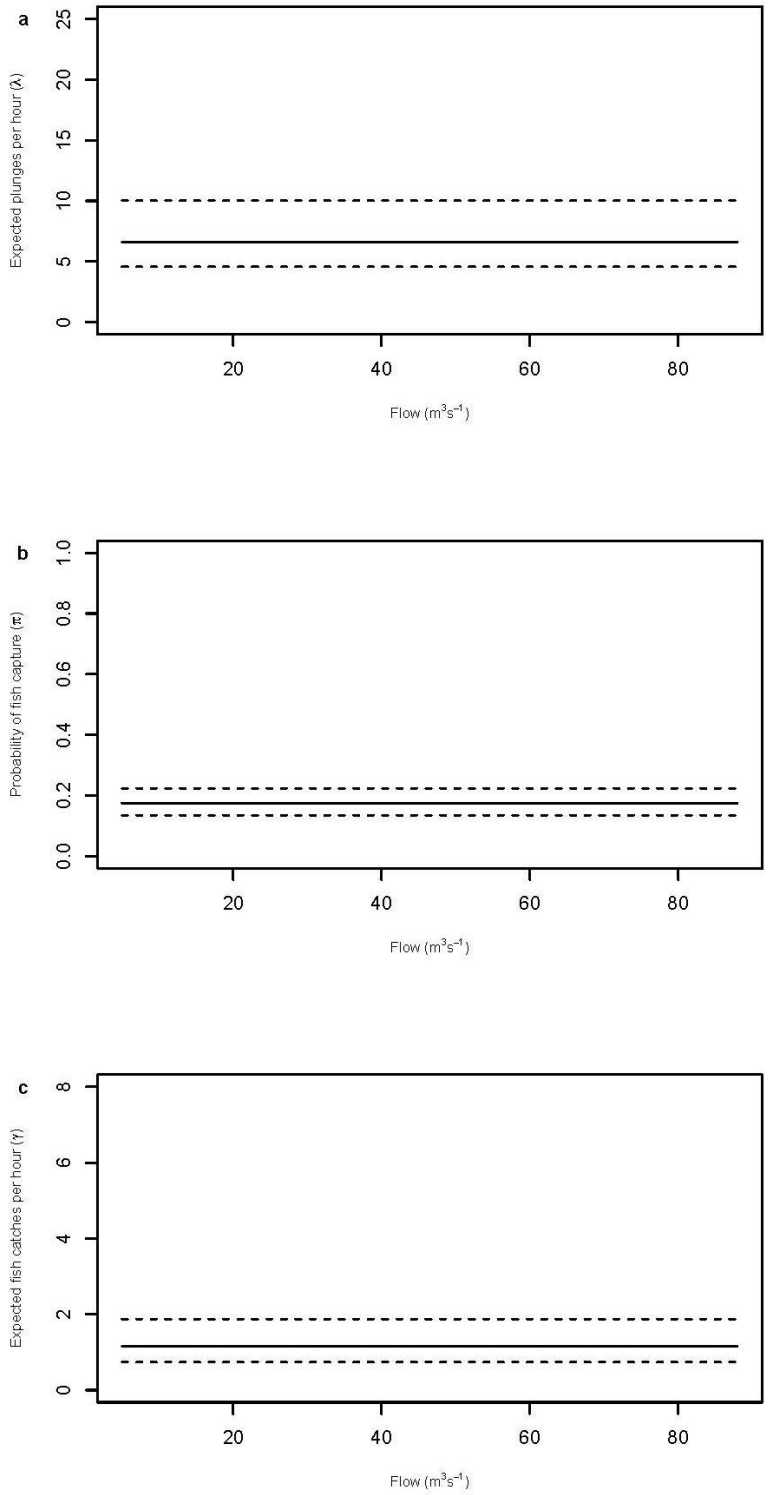
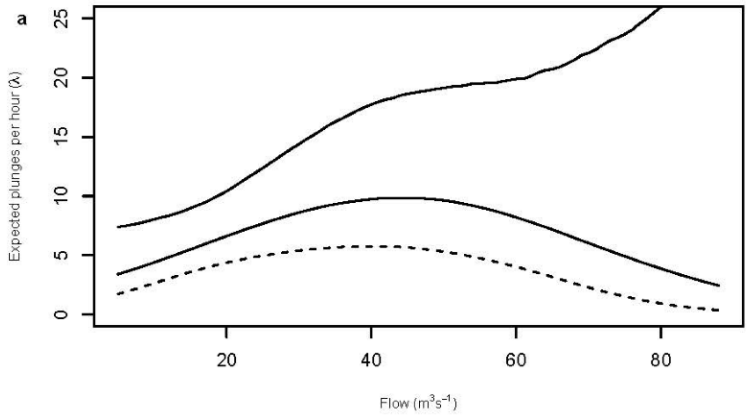
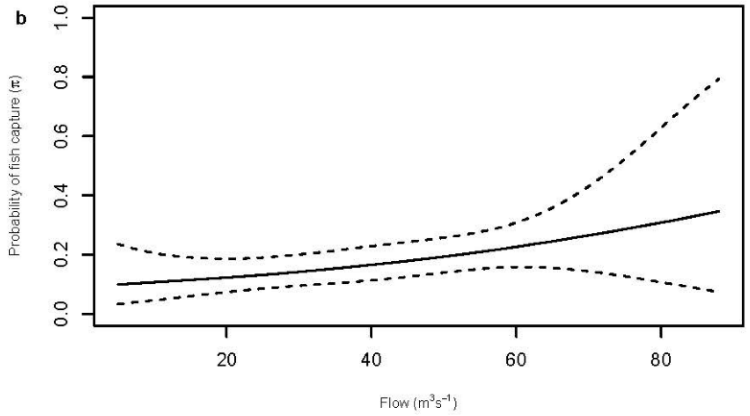


Figure 7. Hierarchal regression model (Eq. 4.1–4.5) showing the relationship between average daily flow on the day of the observation and expected plunge rate (λ; a), probability of fish capture (π; b) and expected fish capture rate (γ; c). Results shown are for model M4, which was the best predictive model. In each figure the posterior median (solid lines) and 95% CIs are shown (dashed lines).





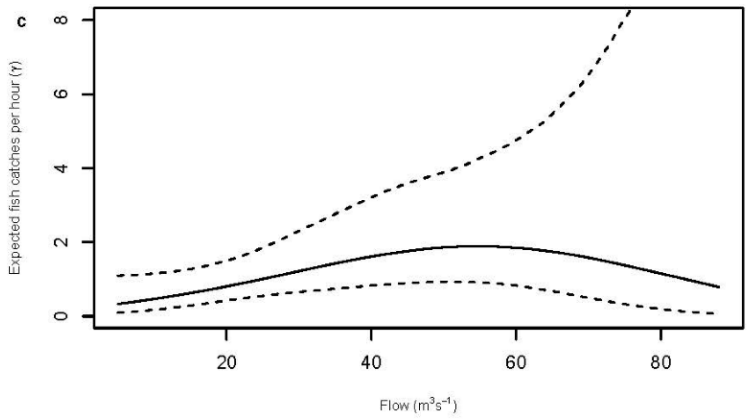


Figure 8. Hierarchal regression model (Eq. 4.1–4.5) showing the relationship between average daily flow on the day of the observation and expected plunge rate (λ; a), probability of fish capture (π; b) and expected fish capture rate (γ; c). Results shown are for model M2, which was the second best predictive model (see Fig. 3 for best model). In each figure the posterior median (solid lines) and 95% CIs are shown (dashed lines).

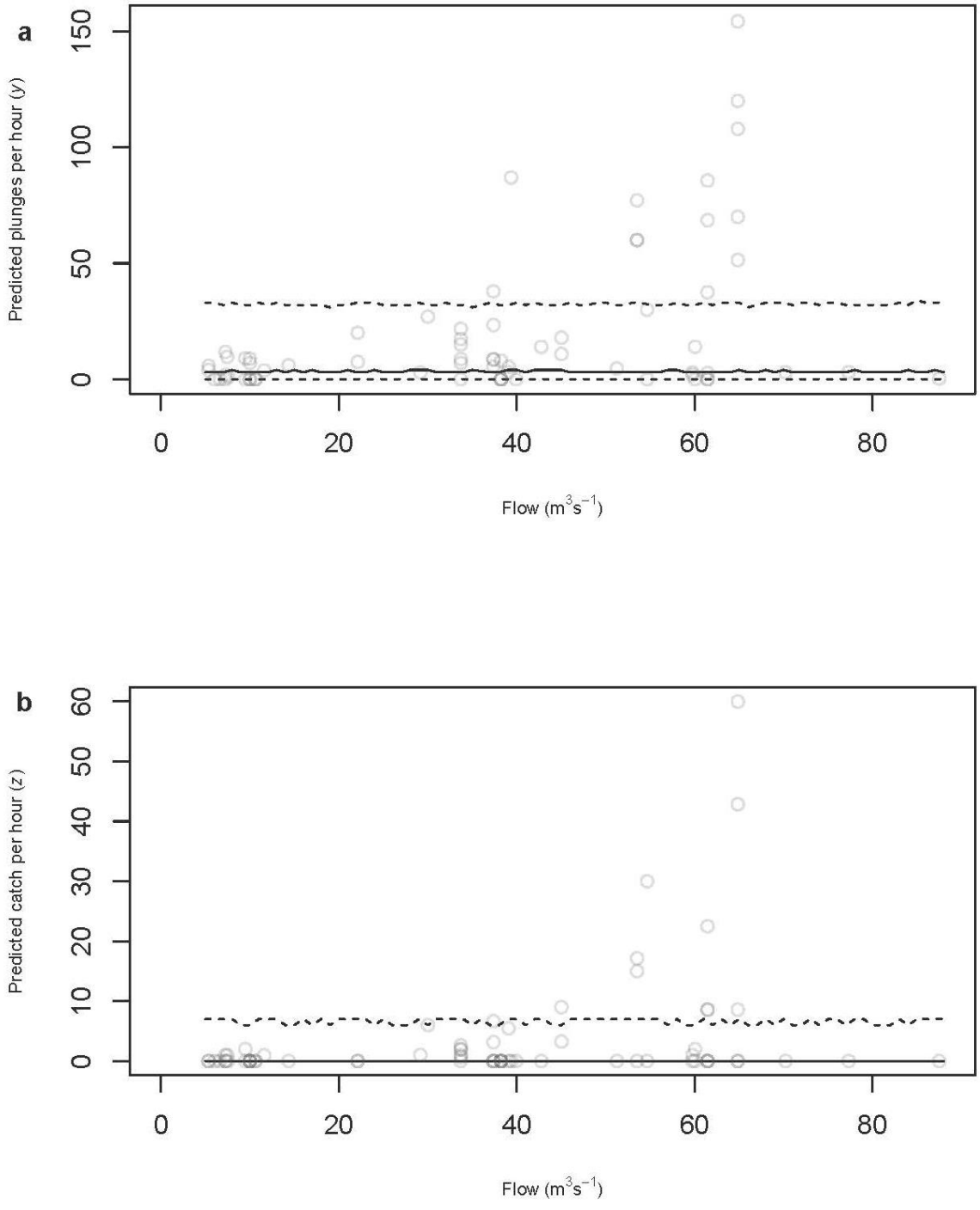


Figure 9. Posterior predictive plots from a hierarchal regression model (Eq. 4.1–4.5) showing how the observed plunge rate (*y*; **a**) and catch rate (*z*; **b**) is related to average daily flow on the day of observation (median and 95% CIs). Results are for model M4, which was the best predictive model. See Fig. S1 for alternative results which suggest flow may have a slight influence on *y* or *z*. Gray circles designate the raw data. Note both the observed *y* and *z* have been scaled to an hourly rate. Also note the high values for the observed plunge and catch rate are mostly due to opportunistic samples that were short in duration.

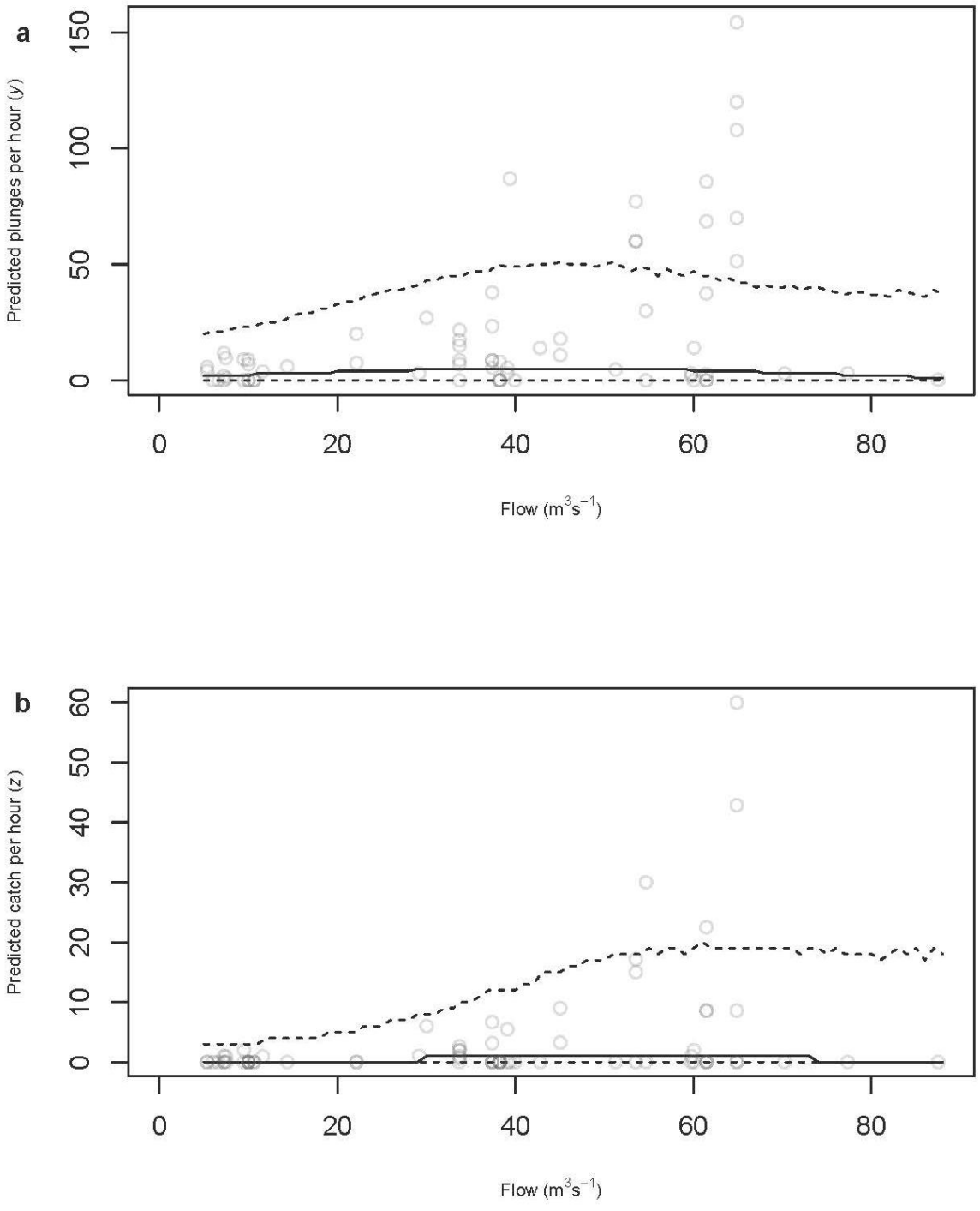


Figure 10. Posterior predictive plots from a hierarchal regression model (Eq. 4.1–4.5) showing how the observed plunge rate (*y*; **a**) and catch rate (*z*; **b**) is related to average daily flow on the day of observation (median and 95% CIs). Results are for model M2, which was not the best predictive model. See Fig. S1 for alternative results which suggest flow may have a slight influence on *y* or *z*. Gray circles designate the raw data. Note both the observed *y* and *z* have been scaled to an hourly rate. Also note the high values for the observed plunge and catch rate are mostly due to opportunistic samples that were short in duration.

Discussion

Numerical relationships between predators (least tern) and prey (fish) are often unknown, but can be approximated empirically (e.g., Cury et al. 2011) or indirectly (e.g., by observing foraging behavior). We assumed if forage fish abundance was limiting, least terns would develop compensatory strategies and mitigate relationships between prey availability and reproductive success by increasing foraging effort (Piatt et al. 2007). That is, even if there was no observable effect of forage fish densities on productivity, we might expect to observe a measurable effect on least tern foraging behavior.

Prey availability, as measured through forage fish density, did not appear to affect the plunge rate, the probability of fish capture, or the fish capture rate. This is substantiated by the scores for M1 and M3, which indicate predicted fish densities decreased the predictive ability of the models substantially. We suspect the reduced predictive performance of M1 and M3 could be caused by one or a combination of the two factors: 1) the predicted fish densities are too "noisy", and/or 2) tern foraging behavior is independent of fish densities over the ranges observed in this study. Predictions, and hence predicted fish densities, have error that reduces the predictive ability of the model when compared to analyses that have perfectly measured values of the covariates. We cannot confirm, nor refute, if this is the case in our analysis. In our study, it would be difficult or impossible to accurately measure fish densities at each plunge location during each observational session, therefore, predicted fish densities were required. Numerous studies have used predicted or estimated fish densities to explain variations in seabird productivity (Cury *et al.* 2011; Santora *et al.* 2014). These studies, however, did not propagate the error associated with the covariate through their analyses to the final result. Recently, multiple authors have recognized the importance of accounting for the uncertainty associated with covariates that are predicted in ecological models (Foster *et al.* 2012; Stoklosa *et al.* 2014). However, the loss of ability to detect significant effects when covariates are predicted is a needed area of research. Secondly, it could be the plunge rate, probability of fish capture, and fish

capture rate were independent over the range of flows observed during the foraging habits study (5–87 m^3s^{-1}; 177–3,072 ft^3s^{-1}).

Models M2 and M4 had the highest, but nearly equal predictive ability. The most parsimonious model and the one with the best predictive score, model M4, suggests neither fish density nor flow is related to the plunge rate or probability of fish capture (Figures 7 and 9). The result and interpretation of this model is fish capture rate is constant across all flows observed during our study. The model that only included an effect of flow (M2) suggests as flow increased, plunge rate, probability of fish capture, and fish catch rate increased. Although at higher flows (≥45 m^3s^{-1}; 1,589 ft^3s^{-1}) these rates decreased (Figure 8). Given the predictive performance of M2, there is a little evidence supporting this conclusion. Furthermore, the fact M4, which contained no effect of flow or fish density, outperformed M2 in terms of predicative accuracy would suggest the true effect of flow may be zero or relatively small compared to that estimated by M2 (Figures 7–10).

Spatial variability in landscape features can affect predator-prey interactions and responses (Hunsicker *et al.* 2011). For example, in marine environments water temperature can affect predatory swimming speed and encounter rates with prey (Sanford 1999). Turbulence has also been shown to affect encounter rates and prey pursuit probabilities (MacKenzie *et al.* 1994). Therefore, it seems reasonable that flow could influence least tern foraging behavior. For example, there has to be a minimum flow and channel topography that results in water depths too shallow for plunging. However, even at the lowest flows observed (5.0 m^3s^{-1}; 177 ft^3s^{-1}), plunge rates of 4 plunges per hour would be expected in open channel habitat (Figure 8). Empirically, in two session Sherfy et al. (2012) observed 12 plunges and 2 fish captures at a flow of 7.2 m^3s^{-1} (254 ft^3s^{-1}) and 7.4 m^3s^{-1} (261 ft^3s^{-1}), respectively. This suggests least terns are capable of plunging and capturing fish at flows much lower than 22.7 m^3s^{-1} (802 ft^3s^{-1}). However, we suspect the actual minimum amount of flow necessary for successful foraging would depend on channel morphology. Furthermore, M2 suggests higher flows (e.g., 80 m^3s^{-1}; 2,825 ft^3s^{-1}) may have similar effects on foraging

success for least terns as extremely low flows (Figure 8c). We believe there may be a small influence of flow on least tern foraging behavior in open channel habitat given the score of M2 and M4 were nearly equal. If the effect exists, we suspect the effect size is not very large and that higher flows have similar negative effects as low flows as measured by reduce plunging rate, probability of fish capture, and fish capture rate.

Summary

We were unable to establish a strong relationship between fish density and flow and plunge and fish capture rates. However, our second ranked model suggests expected plunge rates more than double from the lowest flows observed (5 m^3s^{-1}; 177 ft^3s^{-1}) until flows reach 45 m^3s^{-1} (1,589 ft^3s^{-1}) and then plunge rates decrease as flows continue to increase. Probabilities of fish captures increased linearly from the lowest to highest flows observed during our study. We believe there may be a slight influence of flow on least tern foraging behavior in open channel habitat. We suspect the effect size is not very large and that higher flows have similar negative effects as low flows. Based on confidence intervals, it appears there is a lot of uncertainty in the relationships at high flows. Furthermore, the fact best model contained no effect of flow or fish density would suggest the true effect of flow may be zero or relatively small compared to that estimated by the second best model.

SECTION 4 – Least Tern Productivity in the Central Platte River Valley

We used least tern productivity data collected via the Program's monitoring protocol (Program 2011) and USGS gaging station data collected on the Platte River to provide a line evidence for answering the Big Question and assessing this premise. The objective of this study was to determine impacts of flow on least tern productivity within the AHR. Although indirect, we might expect flow, and thus forage availability, to influence productivity of least terns within the AHR. We use this indirect evidence to build empirical support to test the forage fish-related hypotheses in the Program's AMP (Program 2006).

Sherfy et al. (2012) found least terns made longer distance movements during the nonbreeding and post fledging periods and shorter movement distances occurred during the incubation and brood rearing periods. This finding would suggest least terns are possibly constrained to foraging relatively close to nesting and brood rearing locations. Given foraging demands are presumably greatest and yet most constrained during the brood rearing period, we expected productivity to be most sensitive to flow, and thus prey availability, during the brood rearing period. Our analysis, therefore, is focused exclusively on the number of fledglings produced per hatched nest and river discharge data.

Flow measurements

Our analysis of the fledgling success data included average daily flow records for the date on which a brood's fate was determined as well as the previous 7 days. Initially we considered testing several different measures of flow as covariates. For example, we considered mean daily flow on all seven days before fate determination, the minimum mean daily flow seven days prior to the date the fate was determined, etc. We found, however, the flow covariates were highly correlated which would make comparisons of the covariates very difficult in our regression analysis (Dormann *et al.* 2013). Therefore, we used the minimum daily flow that occurred during the seven day period prior to date the fate of each brood was determined and recognized our results and interpretations could apply to several different measures of flow.

Least tern productivity model

We used logistic regression models to relate flow measurements to least tern productivity. An assumption of our logistic regression model is the numbers of fledglings from each brood (b_k) follow a binomial distribution:

$$b_k \sim Binomial\ (C_k, \eta_k), \tag{5.1}$$

where C_k is the number of chicks hatched from each nest and η_k is the probability a chick fledged from the k^{th} brood (k=1,2,…,486). We expected the probability of fledging to be related to the flow, and thus abundance of forage fish, near the location of the brood. Initially, it would seem we could use the relationship between flows and forage fish abundance developed in Chapter 2 to predict forage fish abundance near the location of the brood. Doing so presents at least two problems: 1) the probability of fledging likely depends on the cumulative effects of forage fish abundance some unknown time before the fate was determined, and 2) for a given flow, total forage fish catch most likely depends on the expected forage fish density ($\mu/112.5\ m^2$) and not predicted forage fish density ($x/112.5\ m^2$). For example, low forage fish abundance several days prior to chick mortality may be the cause of mortality. It was not exactly clear how to use the forage fish abundance model to incorporate this temporal dynamic. Secondly, although the plunge rate and probability of fish capture are likely to respond to small scale variability in forage fish abundance captured by the seining data, a larger area is available to each least tern for foraging. For example, Sherfy et al. (2012) reported least terns routinely traveled distances of 3 km (1.9 mi) while rearing broods. As a result, the probability of a chick fledging is likely not dependent on the small scale variability captured by the seining data, and hence predicted by the forage fish model, but rather the expected forage fish abundance. Because of the high correlation between flow and expected fish abundance, flow can be used as a surrogate covariate (Section 3). Given the two issues discussed above, we choose to model the probability of fledging using various measurements of flow. Although such an analysis is less mechanistic

as compared to the foraging model in Section 4, given the data limitations we believe this was the most appropriate approach to link flow to productivity.

We assumed the logit of η_k depended on f_k, the minimum flow within 7 days prior to the date of fate determination:

$$\text{logit}(\eta_k) = \alpha_1 + \alpha_2 f_k. \quad (5.2)$$

We also tested to see if minimum flows <22.7 m^3s^{-1} (802 ft^3s^{-1}) during the 7 days prior to the date of fate determination influenced η_k with the linear predictor:

$$\text{logit}(\eta_k) = \alpha_3 + \alpha_4 I(f_k < 22.7), \quad (5.3)$$

where $I(\min(f_k) < 22.7)$ takes on a value of zero when minimum flows were ≥22.7 m^3s^{-1} (802 ft^3s^{-1}) and one if the flow were <22.7 m^3s^{-1} (802 ft^3s^{-1}).

Sherfy et al. (2012) discovered high rates of foraging at the Kearney Canal Diversion structure (Figure 4) and that least terns occasionally made long distance movements. Based on observations by the authors, the diversion structure supported large abundances of fish and pools deep enough for plunging at low flows. Therefore, we suspected when flows were low, least terns may travel at an increased frequency to the diversion structure to forage. If this is true, we would expect the distance from the location of the brood to the diversion dam may influence least tern productivity. To test this relationship we included distance to the diversion structure as a covariate:

$$\text{logit}(\eta_k) = \alpha_5 + \alpha_6 d_k, \quad (5.4)$$

where d_k is the distance between the k^{th} brood and the Kearney Canal Diversion in km (Figure 4). We also included a two-way interaction with the covariates minimum flow and $I(\min(f_k) < 22.7)$, as we expected

the effect of d_k to depend on flow, that is, traveling to the diversion structure only when there is a flow that results in reduced fish capture success or a shortage of fish. We therefore used the linear predictors:

$$\text{logit}(\eta_k) = \alpha_7 + \alpha_6 d_k + \alpha_7 \min(f_k) + \alpha_8 d_k \min(f_k) \quad (5.5)$$

and

$$\text{logit}(\eta_k) = \alpha_9 + \alpha_{10} d_k + \alpha_{11} I(\min(f_k) < 22.7) + \alpha_{12} d_k \; I(\min(f_k) < 22.7). \quad (5.6)$$

Lastly, we included a model that did not include an influence of flow, which was:

$$\text{logit}(\eta_k) = \alpha_{13} \quad (4.7)$$

We randomly split the data into a training set with 241 observations and test set with 241 observations. We used a generalized linear model and maximum likelihood to obtain parameter estimates using the training data set (Stroup 2012). We calculated the predictive deviance (i.e., –2 times the predictive log likelihood) using the test data. Predictive deviance is a measure of the models predictive ability and has a similar interpretation as Akaike information criterion (AIC; Burnham & Anderson 2002; Hooten & Hobbs 2015). We also calculated and reported AIC scores for comparison.

Results

Of 551 broods monitored, 416 broods fledged at least one chick, 65 resulted in an unknown status and 70 failed. Of the 70 broods that failed, 43 had an unknown cause of failure, 8 failed due to weather, and 19 failed due to predation. Of the 486 broods that had a known fate (i.e., "fledged" or "failed"), 478 included records of the number of chicks that hatched and fledged. These 478 broods produced 1,092 chicks, of which 830 chicks fledged. Of these 478 broods, 378 had fates determined when the flow was <22.7 m^3s^{-1} (802 ft^3s^{-1}) and resulted in 648 fledged chicks (see raw data in Figure 11c).

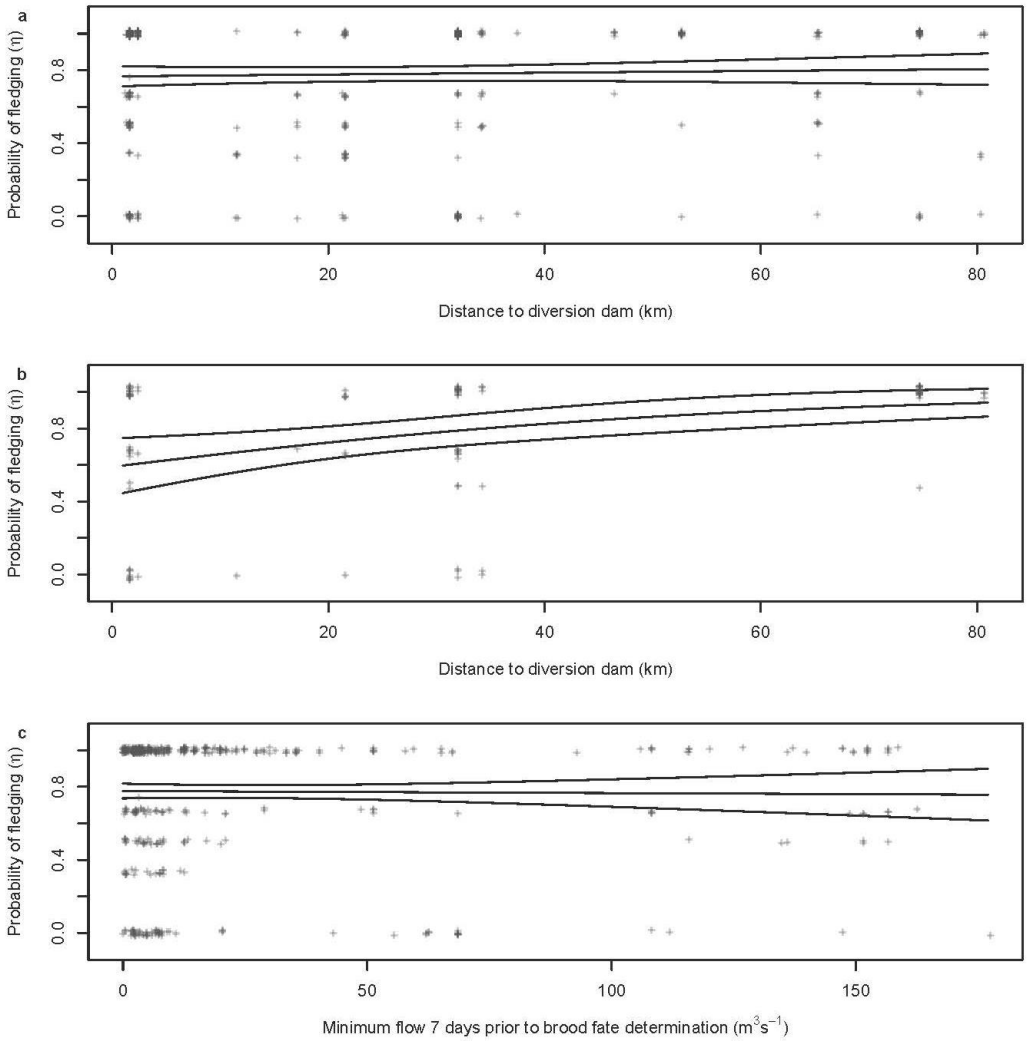


Figure 11. Logistic regression model (Eq. 5.5) showing the relationship between probability of a chick fledging (η) and the distance to the Kearney Canal Diversion when the minimum average daily flows were less than (a) and greater than (b) 22.7 m^3s^{-1} (802 ft^3s^{-1}) seven days before fate determination of the brood (estimate and 95% CIs). Logistic regression model (Eq. 5.2), showing how the probability of a chick fledging (η) is unrelated to minimum average daily flows on the seven days before fate determination (c; estimate and 95% CIs). Note model in Eq. 5.5 had the best predictive deviance and AIC score. The gray plus signs (+) show the empirical probabilities of fledging for each brood ($\frac{number\ of\ chicks\ fledged}{number\ of\ chicks\ hatched}$).

Analysis of brood data showed the best model (Eq. 4.6) had a predictive deviance of 476, an AIC score of 496, and included distance to the Kearney Canal Diversion and minimum flow <22.7 m^3s^{-1} (802 ft^3s^{-1}; Figure 11). For comparison, the model that included no covariates (Eq. 4.7) had a predictive deviance of 488 and an AIC of 500 and suggested the probability a chick fledged was 0.77 (0.73–0.81; 95%

confidence interval). The predictive performance of all other models was similar to the model with no covariates, with the exception of the models presented in Eq. 5.4 and 5.5, which slightly outperformed the model with no covariates (predictive deviance of 483 and 479 and AIC of 499 and 498, respectively).

Within the AHR, least terns forage at a variety of locations including open channels, sandpits and the Kearney Canal Diversion. Our data, and hence conclusions, are limited to open channel habitat. Although the Program's priority hypothesis is not limited to open channel habitat, species of fish captured by least tern are typically found in open channel habitat (Wilson *et al.* 1993; Stucker *et al.* 2012). Consequently, open channels were thought to be the most important foraging habitat for least terns and thus were the focus of our study. Sherfy et al. (2012) found least terns rarely foraged at sandpits and were quite unsuccessful when they did so within the AHR. Sherfy et al. (2012) observed plunge rates of 1.2 plunges per hour at sandpit sites, which was more than 7 times lower than what was observed at riverine sites (8.5 plunges per hour). Furthermore, during 230 behavioral observation sessions totaling 234 hours of observation at sandpit sites, only 7 successful plunges were observed. Given this information, it seems unlikely sandpits contributed greatly to least tern foraging within the AHR. Sherfy et al. (2012), however, did discover a high rate of foraging at the Kearney Canal Diversion. During 76 sessions, which totaled 77 hours of observation, 503 successful plunges were observed. For comparison, during 72 sessions totaling 48 hours of observation, 49 successful plunges were observed in open channel habitat (Sherfy et al. 2012).

Based on results of Sherfy et al. (2012), we suspected the Kearney Canal Diversion may be particularly important for providing least terns foraging opportunities during low flow events as we were unaware of any area where such high frequency of successful foraging regularly occurred. At flows <22.7 m^3s^{-1} (802 ft^3s^{-1}), it does not appear distance to the Kearney Canal Diversion had any influence on the probability of fledging (Figure 11a). Rather, our results indicate the distance to the Kearney Canal Diversion influenced the probability of fledging only when flows were >22.7 m^3s^{-1} (802 ft^3s^{-1}) and that the probability of fledging increased the further broods were from the Kearney Canal Diversion. Though this result is

counter to what we expected, further examination of the data resulted in a fairly logical explanation (Figure 11b). In 2010 and 2011 a site located approximately 75 km (46.6 mi) downstream from the Kearney Canal Diversion had exceptionally high productivity; 45 out of 46 chicks fledged. Flows were high during 2010 and 2011 and we have no reason to believe the high survival rate was the result of increased foraging success. Rather, we attribute the high success rate to good fortune in that adverse weather events and predation did not impact the site during either year. Furthermore, this site experienced exceptionally low flows during 2012 and 2013 when 77% (37 of 48) of the chicks observed fledged; the average flow for each brood 7 days prior to the date their fate was determined was 0.8 m^3s^{-1} (28 ft^3s^{-1}). Of the 11 chick mortalities recorded, 10 chicks were associated with four broods of which no chick fledged. In all cases, cause of mortality was undetermined. However, given the four broods were located on a site <0.5 ha (1.24 ac) in size and 38 eggs from 15 additional nests hatched and resulted in 37 fledged chicks, it seems highly unlikely the 4 broods failed due to a lack of forage.

Summary

From 2001–2014, we observed 478 broods with records of numbers of chicks that hatched and fledged within the AHR. These broods resulted in 1,092 chicks, of which 830 fledged. Of these broods, 79% had fates determined when the flow was <22.7 m^3s^{-1} (802 ft^3s^{-1}) and resulted in 78% of the fledged chicks observed. We only observed 43 broods that hatched and failed due to unknown causes. Thus, these are the only broods where starvation could have resulted in the loss of the entire brood. However, our analysis was conducted at the scale of the brood rather than individual chicks and we have no evidence of the cause of loss for partially fledged broods (i.e., broods where only 1 chick out of 3 fledged). Given a lack of information as to the cause of partial brood losses (>100 chicks lost when a sibling fledged), it is conceivable that a shortage of forage and thus sibling rivalry could have contributed to some of these losses. We found no evidenced least tern productivity was negatively influenced by low flow events. The best model indicated flows below 22.7 m^3s^{-1} (802 ft^3s^{-1}) had higher predicted probability of fledging than higher

667 flows. We also found least tern productivity was positively influenced by distance to the Kearney Canal
668 Diversion; a common foraging site for least terns (Sherfy et al. 2012). However, this relationship was likely
669 driven by one site that had exceptionally high reproductive success. In summary, we found nests that
670 hatched had an unusually high success rate (fledged ≥1 chick) even though nearly half of our study period
671 occurred during times of extreme drought.

SECTION 5 – A Bioenergetics Approach to Estimating Forage Fish Demand of Least Terns in the Central Platte River Valley

Our goal thus far has been to approach priority hypothesis T2 using multiple lines of evidence that are not direct links between flows, forage fish abundance, and least tern productivity. In the previous Sections, we relied on a "top down" approached to detect direct and indirect influences of forage fish availability on least tern productivity (see Sections 3, 4 and 5). An alternative "bottom up" approach, where one attempts to estimate the population size a prey base can support (hereafter referred to as a "bioenergetics approach"), is applied in this Section. We use this indirect evidence to build empirical support to test the forage fish-related hypotheses in the Program's AMP (Program 2006). The objective of this study was to utilize the Districts' existing central Platte River forage fish monitoring data and available references to determine the number of least terns the forage fish population in the AHR can support.

Channel area calculations

We used a HEC-RAS 1D hydraulic model to estimated average wetted channel width at 453 locations within the main channel of the AHR for flows ranging from 3–85 m^3s^{-1} (106–3,002 ft^3s^{-1}). The spacing between, and hence the location of, each wetted width measurement was generally determined so that the distance between successive measurements was approximately equal to the channel width measurement at the location. As a result, the average distance between wetted width measurements was 355.2 m (SD = 187.0 m; 388.5 yd; SE = 204.5 yd). Wetted widths were calculated for flows listed in Table 2. Next we calculated the area of open channel habitat as the wetted width measurement at the location multiplied by the sum of half the distances to the nearest wetted width measurements expressed as:

$$A_i = w_i \left(\frac{d_{i-1}+d_{i+1}}{2}\right) \quad (6.1)$$

where A_i is the channel area representative of the i^{th} wetted width measurement (i = 2,…452) and $d_{i-1}$is the distance between the location i and location $i-1$. Similarly, d_{i+1} is the distance between the location i and location $i+1$. Then the total channel area is the sum (Table 2):

$$open\ channel\ area = \sum_{i=2}^{452} A_i. \quad (6.2)$$

Table 2. Calculations used to determine the number of family units (defined as 2 adults + 3 chicks) the prey fish population in the AHR could potentially support.

Flow m^3s^{-1} (ft^3s^{-1})	Open channel area (km^2)	Expected fish catch per seine haul	Fish/m^2	Millions of fish in main channel habitat	Available forage (kg) wet weight	Available forage (kg) dry weight	Available energy (mj)	Total number of family units supported
2.83 (100)	8.02	131.62	1.17	9.38	3,003	901	61,853	825
5.66 (200)	10.20	113.28	1.01	10.27	3,287	986	67,703	903
8.50 (300)	11.63	97.49	0.87	10.08	3,225	968	66,437	886
11.33 (400)	12.87	83.90	0.75	9.60	3,072	921	63,275	844
14.16 (500)	14.19	72.21	0.64	9.11	2,915	874	60,042	801
21.24 (750)	16.65	49.62	0.44	7.34	2,350	705	48,411	646
28.32 (1000)	18.81	34.10	0.30	5.70	1,824	547	37,581	501
35.40 (1250)	20.78	23.43	0.21	4.33	1,385	415	28,528	380
42.48 (1500)	22.60	16.10	0.14	3.23	1,035	310	21,320	284
49.55 (1750)	24.38	11.06	0.10	2.40	767	230	15,804	211
56.63 (2000)	26.20	7.60	0.07	1.77	567	170	11,671	156
70.79 (2500)	29.62	3.59	0.03	0.95	302	91	6,230	83
84.95 (3000)	33.16	1.69	0.02	0.50	160	48	3,293	4

Forage fish abundance

The relationship between flow and forage fish abundance was estimated using the negative binomial regression model in Chapter 2. We showed that the expected number of forage fish caught in each seine haul was:

$$E(x) = e^{\beta_1 + \beta_2 f}. \quad (6.3)$$

We used the posterior median of β_1 and β_2 as point estimates for the following calculations, which resulted in $\hat{\beta}_1 = 5.03$ and $\hat{\beta}_2 = -0.053$. We used this relationship to calculate the expected fish catch per seine haul for flows ranging from 3–85 m^2s^{-1} (106–3,002 ft^3s^{-1}; Table 1). We also calculated the number of fish per m^2 (i.e., $E(x)/112.5\ m^2$) and multiplied this by the area of open channel habitat to estimate the how many millions of fish were predicted to be in main channel habitat (Table 2).

Energetic calculations

We assumed a breeding pair consists of two adult least terns and a successful brood consists of three chicks (hereafter, a breeding pair with three chicks is referred to as a "family unit") for the following calculations. We assumed each breeding pair produced one successful brood with three chicks (i.e., no chick mortality occurred and no double brooding). We also made the assumption that all species of forage fish available to be consumed by least terns are age-class 0 (young-of-year) red shiners (*Cyprinella lutrensis*; i.e., all species of forage fish in the river were treated as if they were red shiners). We made these assumptions because we were able to find the required information for our calculations for red shiners (e.g., energy content and body mass) and so that our estimates will be conservative as young-of-year fish were likely the smallest bodied forage collected in our forage fish sampling protocol (see Section 3). Yildirim & Peters (2006) reported average total weight for male and female red shiners of age class 0 had a total wet weight of 0.32 gram (SE = 0.03; 0.01 oz; SE = 0.001). We multiplied their estimated by the number of

738 forage fish estimated to be in open channel habitat by the lowest weight (0.32 grams; 0.01 oz) to obtain the
739 weight of available forage fish in main channel habitat (Table 2; "Available forage (kg) wet weight").
740 Franssen et al. (2006) reported red shiners averaged 4923.2 (SE = 522.1) calories per gram of dry mass
741 (20.60 kj per gram). Since the caloric value of red shiners is reported in dry weight, we converted the wet
742 weight of red shiners to dry weight assuming the dry weight was 30% of the wet weight (i.e., $0.32g \times$
743 $30\% = 0.096g$; Table 2; "Available forage (kg) dry weight"). We then multiplied the dry weight by the
744 energy content (20.60 kj per gram) to obtain the minimum amount of energy that may be available from
745 forage fish (Table 2; "Available energy").

746 Roby *et al.* (2003) reported that the daily energy expenditure of free-ranging breeding Caspian
747 terns was 1040 kj/day. Adult Caspian terns weigh 600–700 grams (21.16–24.69 oz; male) and 500–640
748 grams (17.64–21.16 oz; female), whereas adult least terns are reported to weight 30–45 grams (1.06–1.59
749 oz; Olsen & Larsson 1995; Roby *et al.* 2003). The empirical relationship estimated by Nagy (2005) was:

750 $$FMR = 2.25{M_b}^{0.808} \quad (6.4)$$

751 where FMR is the field metabolic rate (in kj metabolized per day), and M_b is the body mass (in grams). We
752 used equation 6.4 to estimate daily energy expenditure for adult least terns using what has been reported
753 for Caspian terns. Assuming Caspian terns weigh 600 grams (21.16 oz) and least terns weigh 45 grams
754 (1.59 oz), it could be estimated that a least tern will have a FMR that is 0.123 times less than a Caspian tern
755 $(\frac{2.25(45)^{0.808}}{2.25(600)^{0.808}} = 0.123)$. Using the reported energy expenditure of free-ranging breeding Caspian terns of
756 1040 kj/day, we estimate that an adult least tern requires 128.25 kj/day.

757 We estimate adult least terns are present and require 128 kj/day of forage for 60 days each nesting
758 season. Therefore, the total energy requirement for an adult least tern during the nesting season is 7,695 kj
759 $(\text{i.e.}, 60 \text{ days} \times 128.25\text{kj/day} = 7{,}695 \text{ kj})$. Roby et al. (2003) also reported that total metabolic energy

requirements for Caspian tern chicks (from hatch to fledgling) were 19,200 kj. If we assume the same allometric relationship as we did for adults, the seasonal energy requirement for a fledgling would be 2,368 kj (i.e.$19{,}200\ \text{kj} \times 0.123 = 2{,}368\ \text{kj}$). Therefore a breeding pair family unit that fledges 3 chicks would require 22,494 kj ($2 \times 7{,}695\ kj + 3 \times 2{,}368\ kj = 22{,}494\ kj$) per season. The energy requirement of $22{,}494\ kj$ can be divided by the amount of energy available from forage fish ("Available energy (mj) "; Table 2) to estimate the number of family units the forage fish population in AHR could potentially support.

Results

The number of family units the forage fish population in AHR could potentially support is maximized at 5.66 m^3s^{-1} (200 ft^3s^{-1}) with an estimated 903 family units supported. At flows <5.66 m^3s^{-1} (200 ft^3s^{-1}) the number of family units decreases due to a decrease in channel area, whereas at higher flows the decrease is a result of decrease in forage fish densities (Figure 12; Table 2).

Discussion

Our calculations indicate forage fish in main channel of the central Platte River within the AHR should be able to support >100 family units at flows between 2.83–56.63 m^3s^{-1} (100–2,000 ft^3s^{-1}; Table 2). In the nesting season of 2014 there was an estimated 98 breeding pairs. Our results suggest the abundance of forage fish within the AHR may be able support substantially more family units. Given relatively low flows (5.66 m^3s^{-1}; 200 ft^3s^{-1}), the maximum number of family units the AHR was estimated to be capable of supporting was 903 family units, which is >9 times the maximum number of pairs observed, 2001-2014. Although most of our calculations could be viewed as conservative (e.g., restricting our calculations of channel area to the main channel, using the smallest age and sex class of fish, etc.), there are at least four factors that should be considered: 1) study design; 2) forage fish availability; 3) forage fish population dynamics; and 4) estimation uncertainty. The forage fish sampling sites were established based on their close proximity to areas managed as least tern nesting habitat. Given the limited number of nesting sites

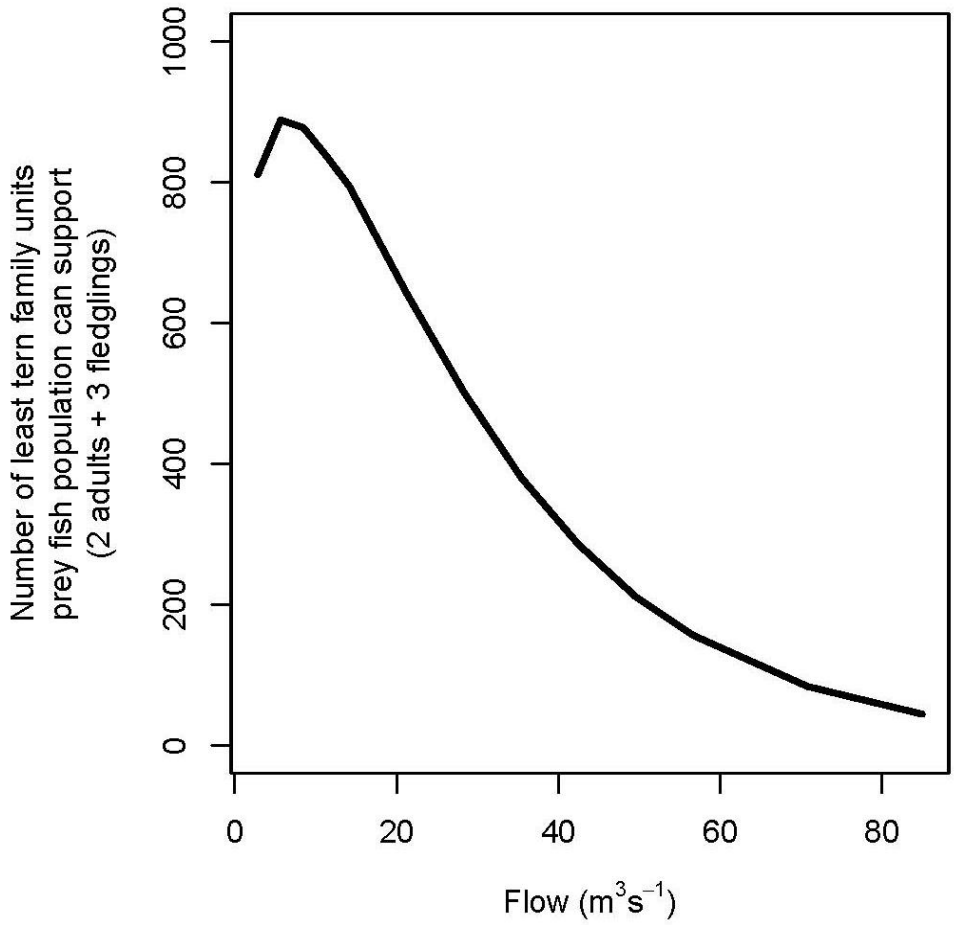


Figure 12. Numbers of least tern family units (defined as 2 adults + 3 chicks) the prey fish population in the Program Associated Habitat Area could potentially support. See Table 1 and text for details of calculations.

during a large portion of our study period (3 nesting sites; 2001-2006), the proximity of forage fish sampling sites to nesting areas should represent realized foraging areas for least terns. However, inference from the forage fish data is limited to sites in "close proximity to areas managed as least tern nesting habitat." Given the limits of our data, it would be difficult to estimate what proportion of the forage fish can be sustainably consumed annually by least terns. However, if half of the forage fish could be consumed and recover annually, we estimate the AHR could support approximately 450 family units at low flows (5.66 m^3s^{-1}; 200 ft^3s^{-1}). Finally, we calculated a single estimate of the number of family units the forage fish population could potentially support at a given flow. We did not attempt to propagate the uncertainty associated with each component of our calculations. At each step (e.g., channel area calculations, estimated forage fish

density, energetic calculations, etc.) there is likely a large amount of uncertainty surrounding the estimate. It would be challenging if not impossible to obtain accurate estimates of uncertainty and propagate it throughout at each step. Error propagation and estimation, however, may be feasible under a Bayesian paradigm using the so-called "prior predictive distribution" if suitable priors can be determined (Gelman *et al.* 2013). Given we found it difficult to obtain suitable point estimates for some quantities (e.g., forage fish energy content) it seems unlikely meaningful priors are determinable.

Summary

The maximum numbers of least tern pairs observed within the AHR between 2001 and 2014 was 98 (Cahis and Baasch 2014). We estimate the forage base in the AHR could support more than twice that many least tern family units at flows <50 m^3s^{-1} (1,766 ft^3s^{-1}) and a maximum of 903 least tern family units at 5.66 m^3s^{-1} (200 ft^3s^{-1}). However, there is a high degree of uncertainty in our estimates. In order to fully evaluate the adequacy of the forage base within the AHR as compared to other river systems believed to have an ample forage base (e.g., Mississippi River), one would likely need to compare growth rates of least tern chicks within each system to see if they are similar. Program participants, however, have agreed the risks outweigh the benefits of implementing a research protocol that involves weighing chicks multiple times throughout the breeding season to allow for a comparison between river systems that support subpopulations of least terns.

SECTION 6 – Evaluation of a Program Priority Hypothesis, Sub-hypothesis, and Big Question that Relate Flow, and thus Forage Fish Abundance and Diversity, to Least Tern Productivity

The Program's Biological Opinion includes flow targets to increase forage fish abundance and diversity to increase productivity of least terns within the AHR. One of several purposes for the flow targets is to maintain flows in the central Platte River to increase forage fish abundance and diversity to increase productivity of least terns within the AHR (USFWS 2006). The assertion that flow, and thus forage availability, limits least tern productivity is articulated in Priority Hypothesis T2 in the Program's AMP and states: "Tern productivity is related to the number of prey fish (<3 inches) and fish numbers limit tern production below 800 cfs from May–Sept[ember]." (Program 2006). The Big Question associated with these hypotheses states: "Does forage availability limit tern […] productivity on the central Platte River." Even though this premise is articulated in a priority hypothesis and Big Question for the Program, the Environmental Impact Assessment (EIS) for the Program states:

> "No indication was found in the literature that food currently limits least terns from nesting on channel sandbars in the Central Platte River between Lexington and Chapman. However, no definitive studies have been conducted that evaluated the link between prey abundance and nesting success. Obviously, no flow (i.e., a dry channel) or very low flow conditions would affect forage fish and, thus, least terns if such a flow event occurred during the nesting season." (Department of Interior 2006).

The Biological Opinion (BO) for the Program states:

> "…no studies have been conducted to demonstrate whether, when flows are present in the river, the availability of forage fish and invertebrates in the central Platte River is insufficient to support tern and plover nesting in the river. The Program's IMRP will investigate whether the distribution, abundance, and species composition of the aquatic

fish community and the invertebrate food base are adequate for the least tern and piping plover, respectively, and if inadequate, what factors are limiting." (USFWS 2006).

In short, at the time of the writing of the EIS and BO there was no evidence supporting the assertion that flow, and thus forage fish abundance, limited least tern productivity but there was a concern that this issue had not been sufficiently addressed. Thus, the Program's Biological Opinion includes an expectation to continue to evaluate any potential relationships between flow, forage fish abundance and diversity, and least tern productivity within the Associated Habitat Reach (AHR) of the central Platte River.

In order to fully evaluate the adequacy of the forage base within the AHR as compared to other river systems believed to have an ample forage base (e.g., Mississippi River), one would likely need to compare growth rates of least tern chicks within each system to see if they are similar. Program participants, however, have agreed the risks outweigh the benefits of implementing a research protocol that involves weighing chicks multiple times throughout the breeding season to allow for a comparison between river systems that support a flourishing sub-population of least terns. As such, we used a weight of evidence approach, several sources of data, and multiple lines of evidence to determine if there is any indication flow, and thus forage fish availability, limits least tern productivity within the AHR. Results of our approach indicate there continues to be no evidence to support the relationships postulated in Hypotheses T2 and T2a. Instead, our results indicate forage fish abundance and least tern productivity increase as flows decrease to 5.7 m^3s^{-1} (200 ft^3s^{-1}). It seems intuitive there is a critical threshold at some level of flow below 5.7 m^3s^{-1} (200 ft^3s^{-1}) where forage fish abundance would diminish and potentially have an influence on productivity. No forage fish data has been collected below this level of flow, but productivity data indicates high productivity within the AHR even during the drought of the early 2000s when flow regularly approached 0 ft^3s^{-1}. As such, our results indicate one should reject priority hypothesis T2 and sub-hypothesis T2a as well as the notion least tern productivity is negatively influenced by flows below 800 ft^3s^{-1} articulated in the Program's associated Big Question.

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ATTACHMENT B

PRRIP Peer Review Guidelines for Reports

Appendix A – Peer Review Guidelines

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

SCIENTIFIC PEER-REVIEW GUIDELINES

These guidelines have been developed to provide a general process for peer-review of scientific documents during the Platte River Recovery Implementation Program (Program). Peer-reviews conducted during the Program will be conducted in accordance with "INSTRUCTIONS TO PEER-REVIEWERS" (Attachment A).

WHAT IS PEER-REVIEW? Scientific peer-review is a process by which technical experts provide unbiased comments, suggestions, and evaluation of the science and technology of proposals, study plans, reports of data analyses, and other documents. Peer-review provides evaluation of the technical quality and relevancy of a document in meeting objectives or in addressing hypotheses. Peer-review usually involves obtaining comments from appropriate technical experts ("peers") who have no financial, supervisory, or familial relationship to the authors of the work. Peer-review is not an administrative review, nor does peer-review address political or other non-scientific features of a project or document.

Peer-review typically involves review by several technical experts in the appropriate subject area. By obtaining multiple, independent technical opinions, the peer-review process provides a means of evaluating the scientific soundness of a product, further minimizing introduction of bias or conflict of interest. The process of peer-review ultimately cannot insure that a document or product is without fault.

Peer-review should be an efficient process so that monitoring, research, publications, and other work can proceed in a timely manner. This process should be streamlined and not create a bottleneck of bureaucracy, delaying appropriate publications, fieldwork, data analyses, or modeling.

WHY IS PEER-REVIEW NECESSARY? Peer-review serves to strengthen a document, whether it is a study plan, proposal, or report, in several ways. A review can provide suggestions for improvements of the work. Experts typically suggest better approaches, more efficient methods, innovative approaches to analysis, and supporting data or literature. A document or plan that has been viewed as being sound, through peer-review, achieves improved credibility in the eyes of the scientific community. Peer-review enhances the reliability of a document, having been examined by peer-scientists. Where proposals or study plans are developed to address specific needs, peer-review can insure that the project serves the specific objectives of the program.

WHEN WILL PEER-REVIEW BE USED? The process described in this document may be used for products (proposals, plans, models, data, reports, protocols, etc.) funded by the Program or for other products essential to meeting Program milestones, but lacking adequate review. All

products relied upon by the Program that influence management decision may be subjected to the following peer review process at the discretion of the Governance Committee with advice from the Technical Advisory Committee or other advisory committees. For some products, however, a high level of scientific quality may be maintained by existing quality control and administrative review procedures, and peer review will be unnecessary.

WHAT ARE THE PRIORITIES FOR PEER REVIEW? The first priority for peer review are items identified for peer review in the 1997 Cooperative Agreement Milestones, which include all water depletion/accretion impact analyses, and all habitat and species monitoring and research activities. Proposals and protocols for new research and monitoring activities necessary for meeting Program milestones will receive the second priority for peer review. Third priority will be given to recent reports of completed studies considered essential to meeting Program milestones. Already peer-reviewed products will receive the lowest priority for peer review. Priorities may change depending on issues.

PEER-REVIEW PROTOCOL

1. The Executive Director will administer the peer-review process for the Governance Committee. The duties of the Executive Director are as follows:

    a) Assemble Master List of potential reviewers with assistance from the standing advisory committees (Technical, Land, Water).
    b) Select reviewers for each work product to be reviewed, and obtain approval of selected reviewers by the Governance Committee.
    c) Handle all correspondence with reviewers.
    d) Compile and transmit all relevant materials from reviews to Panel members for decision-making.
    e) Coordinate revision of work product if needed.
    f) Prepare, obtain approval from the Governance Committee, and administer budget for reviews.
    g) Ensure the review process works in a timely and efficient manner.

2. The Governance Committee and its recognized advisory committees (Technical, Land, Water) identify the need for peer-review as requirements for proposals, studies, or reports arise. The requesting committee identifies each need for peer-review to the Executive Director (see figure below).

3. The Executive Director will determine priorities for peer review in keeping with the guidelines noted above, and develop budgets for peer review for approval by the Governance Committee. A Peer Review Working Group consisting of one member of the Governance Committee and one member from each of the Governance Committee's standing advisory committees (Technical, Land, Water) or other group as identified will assist the Executive Director in this effort. Budgets and priorities will be subject to the approval by the Governance Committee and may change as the Program evolves.

4. Reviewers meeting the standards outlined in these guidelines will conduct the peer-review.

5. When peer review is appropriate the Executive Director, in consultation with the Peer Review Working Group, will select three peer-reviewers from scientific areas appropriate to the subject or discipline of each request. The reviewers will conduct independent peer-reviews and send reviews to the Executive Director. According to the specific needs of each peer-review task, the reviewers could complete review of a single or group of related proposals, plans, or reports. A statistician will participate as a fourth reviewer when the subject or discipline includes experimental design and/or statistical analyses.

6. A list of qualified and willing experts will be assembled in a number of technical topic areas; reviewers will be carefully selected from this list to ensure reviewers are the most appropriate based on the subject matter being reviewed. The Executive Director will maintain a file with the resume and credentials of each peer-reviewer.

7. Criteria for peer-reviewers include:

   a) No conflict of interest for or against the project document or its authors based on financial interest in the product or author(s), familial relationship with the author(s), personal bias for or against the institution or author(s), professional connection to the institution or author(s), organizational affiliation, or potential to be influenced by lobbying or other political pressure to produce a certain result or more work in the area of this product.

   b) Expertise appropriate for the theme of the project or document(s).

   c) The ability to complete a technical review in a reasonable time, as determined by the requesting committee.

   d) Individuals will be selected from a diversity of institutions, including state, federal, local government, and non-governmental organizations for each project, while avoiding members from the same institution or agency as the author(s).

8. The committee requesting review, in conjunction with the Peer Review Working Group, will approve the Peer-review Panel. Objections regarding individuals must relate to the criteria outlined in number 7. The Governance Committee will resolve all conflicts.

9. An attempt will be made to obtain voluntary participation on Peer-review Panels without cost to the Governance Committee. A stipend or honorarium will be offered for review when necessary. The Governance Committee will approve an annual budget for peer-reviews.

10. The requesting advisory committee will prepare specific guidance for each review task. Suggested guidance includes an outline of the specific need for peer-review, the milestones or objectives to be addressed by the work, and other specific criteria for the document.

11. Reviewers shall provide written comment on the document(s) under review. Reviews will be conducted similar to the system and methods used by the National Science Foundation and major scientific journals and in accordance with the Proposal, Protocol and Study Plan Review Guidelines and Report Review Guidelines (see Attachment A).

12. Upon completion of the reviews, the Executive Director will:
    a) Prepare a package of material including all reviews and any relevant material,
    b) Distribute all material to requesting committee for a determination of action,
    c) If appropriate work with the requesting committee and author to make any needed revisions,
    d) Maintain a file of peer-reviews for each document, and
    e) Provide a summary of items a-c to the Governance Committee for approval.

13. The peer-review process does not determine the approval or disapproval of the activity associated with the request (funding a study, use of data or analytical results, publication of a report, etc.). Peer reviews may not be definitive (i.e., there may be disagreement among reviewers). The Committee seeking the review may or may not have the authority to approve the review; however, at a minimum, it is responsible for transferring the review summary and document(s) to the Governance Committee, who will have final authority to approve the review.

DOCUMENTATION OF PEER-REVIEW CONDUCTED OUTSIDE THE PROGRAM

There will likely be cases where the Program will benefit from models, data, analyses, or conclusions drawn by projects developed in the past or ongoing, but supported by institutions outside the oversight of the Program. The committee requiring the information will determine the need for peer-review of these products.

There is no intent to duplicate the peer-review conducted by others. Scientific journals typically conduct their own peer-review. Most major journals have high-quality peer-review that is universally accepted. Scientists are encouraged to publish their findings in the peer-reviewed scientific literature whenever possible and appropriate. In most instances this level of peer review is considered adequate for the purposes of the Program.

Institutions and agencies may administer their own peer-review process for study plans and reports. In using the models, data, or conclusions (reports) from studies not funded by the Program, the appropriate advisory committee is responsible for determining if additional peer-review is necessary. In making the decision regarding the need for peer-review it may be helpful to document an institution's peer-review process for the project or report. With the assistance of the appropriate advisory committee, it may be useful to consider the following information on alternative peer-review processes when available:

I. Title of Study / Project / Report:
II. Type of Work: __report __study plan/proposal __model __ other (specify)
III. Principal Investigators: name, address, phone number, and e-mail
IV. Source of financial support for project / report:

V. Peer-Review Documentation

A. Names / Institutions of peer-reviewers (may have been anonymous)

B. Brief Description of the peer-review process:

C. Were revisions made to the project/report in response to reviewers' comments?

ATTACHMENT A

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

INSTRUCTIONS TO PEER-REVIEWERS

Thank you for agreeing to review this product. The following is a summary of expectations for peer-review and the topics that we wish each peer-reviewer to address.

A. INDEPENDENCE OF A PEER-REVIEW

Peer-review must provide an unbiased opinion of the scientific quality of a product (proposal, report, data, map, etc.) by individuals who are independent from the authors and external to them and their institution. A review must be independent of various types of conflicts of interest with the author(s) and with the product under review. The Platte River Recovery Implementation Program (Program) places considerable reliance on the objectivity, integrity, and professionalism of each peer-reviewer to provide technical opinion of each product without bias or conflict of interest.

Please review each question about your bias or independence. Your peer-review will be anonymous to the author unless you choose to share it. Your review will be held in the file for the Program as documentation of the peer-review process for this product.

YOUR CONSIDERATIONS SHOULD INCLUDE THE FOLLOWING FACTORS THAT COULD LEAD TO BIAS OR CONFLICT OF INTEREST:

- financial interest in the product or the author(s);
- familial relationship with the author(s);
- bias, for personal reasons, for or against the author(s) or institutions of this product;
- professional connection (current or former: student or advisor, supervisor or supervised, employer, etc.) to the author(s) or the institution of this product;
- organizational affiliation (same agency, department, organization, business, etc.);
- impacts of lobbying or political pressure exerted by persons looking for a particular result or more work in the area of this product;

IF YOU FEEL THAT YOU CANNOT PROVIDE AN UNBIASED REVIEW, PLEASE DO NOT REVIEW THIS PRODUCT AND IMMEDIATELY RETURN THE DOCUMENT TO THE PROGRAM'S EXECUTIVE DIRECTOR.

C. REPORT REVIEW GUIDELINES

CONFIDENTIALITY - The enclosed manuscript is a privileged communication. Please do not show it to anyone or discuss it, except to solicit assistance with a technical point. Your review and your recommendation should also be considered confidential.

TIMELINESS - In fairness to the author(s) and to the needs of the Program, please return your review within __ days. If it seems likely that you will be unable to meet this deadline, please return the manuscript immediately or contact the Executive Director.

CONFLICTS OF INTEREST - Please review the "Independence of a Peer-Review" above. If you feel you might have any difficulty writing an objective review, please return the manuscript immediately, un-reviewed. If your previous or present connection with the author(s) or an author's institution might be construed as creating a conflict of interest, but no actual conflict exists, please discuss this issue in the cover letter that accompanies your review.

YOUR REVIEW SHOULD ADDRESS THE FOLLOWING:
What is the major contribution of this document? What are its major strengths and weaknesses, and its suitability for publication and/or use by the Program? Are conclusions based on sound scientific methods and reasoning? Please include both general and specific comments bearing on these questions and emphasize your most significant points.

General Comments:
1. Scientific soundness
2. Organization and clarity
3. Conciseness
4. Degree to which conclusions are supported by the data
5. Cohesiveness of conclusions

Specific Comments:
Please support your general comments with specific evidence and literature. You may write directly on the manuscript, but please summarize your handwritten remarks separately. Comment on any of the following matters that significantly affected your opinion of the manuscript:

1. Presentation: Is a tightly reasoned argument evident throughout? Does the manuscript wander from the central purpose?

2. Methods: Are they appropriate? Current? Described clearly and with sufficient detail so that someone else could repeat the work?

3. Data presentation: When results are stated in the text of the manuscript, can you easily verify them by examining tables and figures? Are any of the results counterintuitive? Are all tables and figures clearly labeled? Well planned? Too complex? Necessary?

4. Statistical design and analyses: Are they appropriate and correct? Can the reader readily discern which measurements or observations are independent of which other measurements or observations? Are replicates correctly identified? Are significance statements justified?

5. Conclusions: Has the author(s) drawn conclusions from insufficient evidence? Are the interpretations of the data logical, reasonable, and based on the application of relevant and generally accepted scientific principles? Has the author(s) overlooked alternative hypotheses?

6. Errors: Point out any errors in technique, fact, calculation, interpretation, or style.

7. Citations: Are all (and only) pertinent references cited? Are they provided for all assertions of fact not supported by the data in the manuscript?

D. FAIRNESS AND OBJECTIVITY

If the research reported in this paper is flawed, criticize the science, not the scientist. Harsh words in a review will cause the reader to doubt your objectivity; as a result, your criticisms will be rejected, even if they are correct!

Comments should show that:
1. You have read the entire manuscript carefully,
2. Your criticisms are objective and correct, and are not merely differences of opinion, and are intended to assist the author in improving the manuscript, and
3. You are qualified to provide an expert opinion about the research reported in this manuscript.

E. ANONYMITY

You may sign your review if you wish. If you choose to remain anonymous, avoid comments to the authors that may serve as clues to your identity, and do not use paper that bears the watermark of your institution.

RATING:
Please score each aspect of this manuscript using the following rating system: 1=excellent, 2=very good, 3=good, 4=fair, 5=poor.

	Rating
Scientific soundness	___
Degree to which conclusions are supported by the data	___
Organization and clarity	___
Cohesiveness of conclusions	___
Conciseness	___
Importance to objectives of the Program (For use by internal review panel only)	___

RECOMMENDATION	(check one)
Accept	___
Accept after revision	___
Unacceptable	___

Peer-Review Sequence Platte River Cooperative Agreement (CA) and Proposed Platte River Recovery Implementation Program (PPRRIP)