SAVANNAH RIVER
ECOLOGY LABORATORY

ANNUAL TECHNICAL PROGRESS REPORT OF ECOLOGICAL RESEARCH FOR FY17

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SECTION I: Savannah River Ecology Laboratory – FY17 Overview of Achievements

The Savannah River Ecology Laboratory (SREL) is a research unit of The University of Georgia (UGA). SREL has been conducting ecological research on the Savannah River Site (SRS) near Aiken, South Carolina for over 65 years. The overall mission of the laboratory is to enhance our understanding of the environment by acquiring and communicating knowledge of ecological processes and principles that contribute to sound environmental stewardship. In addition, as directed in the Cooperative Agreement with the U.S. Department of Energy (DOE), SREL will provide the public with an independent evaluation of the ecological effects of SRS operations on the environment. Toward these goals, SREL conducts fundamental and applied ecological research, as well as education and outreach programs.

The laboratory's research mission during FY17 was fulfilled with the publication of 78 journal articles and several book chapters by faculty, technical staff, students, and visiting scientists. One book was also authored by SREL faculty and staff. Additional journal articles and books have been submitted or are in press. Significantly, SREL conducted over 450 outreach events reaching over 45,000 people of all ages. Other noteworthy events took place as faculty members, staff, and graduate students received awards for the quality of their research. These are described in Section IX ***Special Accomplishments***.

The vision, structure, and operations of SREL continue to evolve since changes in funding structure were instituted in FY07. However, the five-year Cooperative Agreement between the University of Georgia's Research Foundation and the Department of Energy for support of the Savannah River Ecology Laboratory has allowed funding from the DOE and other SRS tenants to fund SREL to meet the specific needs of DOE Environmental Management (EM) and DOE National Nuclear Safety Administration (NNSA) on the Savannah River Site. The current funding model for SREL is entrepreneurial and interdisciplinary, and seeks to pursue funding strategies that are competitive, responsive to sponsors' requirements, and based on a diverse and sustainable foundation. This model has required restructuring of research and supporting infrastructure at the laboratory.

Today, a leaner, but robust SREL presence continues to operate on the SRS. Currently, SREL's total employment is approximately 151 faculty, technicians, students, and support staff. Although the number of employees and level of funding is reduced relative to a decade ago, SREL continues progress toward stated objectives and does not compromise safety and security. New and continuing partnerships and collaborations with the Athens campus (Warnell School of Forestry and Natural Resources, UGA Complex Carbohydrates Center, Odum School of Ecology, College of Public Health, College of Agriculture and Environmental Sciences), other universities (University of South Carolina – Aiken, University of South Carolina – Upstate, Georgia Reagents University) and other agencies (US Department of Agriculture, US Army Corps of Engineers, US Department of Defense, Federal Aviation Administration) continue to be explored and developed in order to maximize the use of SREL assets. Graduate student programs have continued with funding provided by DOE, external grants, UGA, or the student's host university.

During FY16, DOE-SR funding was leveraged to acquire approximately $400,000.00 in salary and infrastructure investments from the University of Georgia, in addition to the 20% cost share negotiated under the terms of UGA's Cooperative Agreement with DOE. DOE funding also is being used to leverage cost shared faculty positions with UGA units on the main campus, resulting in three tenure track faculty lines at SREL and a portion of three tenure track faculty lines on the main UGA campus that will contribute to the SREL mission on the SRS during the coming years.

SREL faculty have responded to the revised funding structure for the laboratory and have sought financial support from multiple external funding agencies, DOE-EM, DOE-NNSA, Savannah River Nuclear Solutions-Area Closure Projects (SRNS-ACP), Savannah River Remediation (SRR) and UGA. In

addition, DOE-EM has provided additional infrastructure support to SREL to help revitalize aging facilities and meet safety standards for our working environment. Establishment of a new Cooperative Agreement with DOE allows SREL/UGA access to the SRS through 30 September 2021. The SREL continues to work closely with local community groups, local schools, and other area stakeholders on a number of research, environmental monitoring, education, and outreach activities.

During FY17, SREL has continued to optimize its research programs to address DOE and SRS concerns, maintain staff in critical research disciplines, and attract new personnel. SREL researchers are vigorously pursuing additional funding sources to leverage existing research funds, while continuing to focus the laboratory's research efforts on projects of interest to the SRS. In addition, personnel from SREL have been actively engaged in furthering DOE's SRS missions in Radioecology, Environmental Stewardship, Next Generation Cleanup Technologies and Renewable Energy.

Researchers at SREL received funding from 36 new and continuing external grants during FY17. Sources of grant awards range from private foundations to federal and state agencies including the U.S. Department of Interior, the U.S. Department of Agriculture, the National Science Foundation, and the Department of Defense.

SREL faculty members hold positions in varied departments at the University of Georgia. Several SREL faculty members (and emeritus faculty) have adjunct status at other colleges and universities. Faculty, staff, and students are active in providing outreach and service to the scientific community. Representatives from SREL hold editorial or committee positions in national groups and organizations and serve on several UGA academic and administrative committees. SREL faculty members continue to make scientific presentations, contribute posters to scientific meetings, and present seminars at colleges and universities.

Participants in the SREL Education Program increased dramatically during FY17 and SREL faculty and staff mentored over a dozen undergraduate students and over 101 graduate students from numerous colleges and universities in the United States.

The SREL Outreach Program communicates scientific awareness to area schools and the general public, an audience which differs significantly from science professionals. During the past year, SREL presented over 356 talks, 28 tours, 22 exhibits, and 43 ***Ecologist for a Day*** programs reaching a total of over 45,000 people. Topics for these presentations included ecological studies of reptiles and amphibians, southeastern plants and habitats, long-term research, safety, biodiversity, local wetlands and watersheds, conservation, and careers in ecology and research. In the past year, SREL has been a part of the SRS public tour program (approximately two tours per month of 30-40 attendees). SREL participates by providing presentations on the history and research of the lab as well as a "show and tell" session featuring research animals native to the SRS.

New for FY17, SREL's DOE-funded Radiological Education, Monitoring and Outreach Program has been focused on increasing public awareness and education on the topic of radiation in the environment and radiological risks to the general public. The outreach coordinator for this program has been providing monthly talks in the local Waynesboro, GA community as well as ad hoc presentations to a variety of local audiences. This program will conduct limited environmental monitoring in 2018 and will begin providing presentations to the local community using these data to explain and inform the public about monitoring programs that currently provide data to the region.

The UGA Conference Center continues to be a valuable asset to SREL and other entities on the SRS. SREL used the facility to host numerous meetings and environmental education programs for students, teachers, and other organizations this past year. The facility is also used by DOE, the USDA Forest Service, and other site tenants when available.

In summary, it is important to note that as one reads through the remainder of this document, the important roles that SREL plays on the SRS unfold prominently in several strategic areas. Such efforts by SREL staff play a critical role in helping the DOE and other SRS tenant organizations reduce costs and continue with their missions on the SRS by assisting them to maintain regulatory compliance, validating remediation efforts, providing basic research for the development of new technologies, promoting sound environmental stewardship of natural resources on the SRS, serving as an independent source of scientific expertise for reviews of technical data and monitoring programs, educating the next generation of radioecologists and nuclear biogeochemists, and conducting outreach efforts to educate local communities about the SRS, its missions, and environmental health. For example, as a critical source of scientific expertise for the Department of Energy on the SRS, SREL provides state of the art scientific support to both DOE-EM and DOE-NNSA. Examples include research on biogeochemical cycling and biological impacts of copper associated with the H-02 mitigation wetlands that provide data needed to validate regulatory compliance for the DOE-NNSA's Tritium mission on the SRS, research on the ecological impacts and potential options for recovery of function of the U-8 stream drainage associated with DOE-NNSA's construction efforts for the MOX fabrication facility on the SRS, research on the organismal effects (proteome and glycome) to aquatic organisms exposed to chronic levels of low dose radiation, and development of strategic management plans for Set Asides on the SRS to maintain the SRS designation as DOE's first National Environmental Research Park.

SREL also serves as a source of critical scientific expertise for other SRS tenant organizations, providing analytical and ecological expertise to assist these organizations with issues ranging from regulatory compliance to creative new technologies for remediation of contaminants on the SRS. Examples include research conducted in support of the SRR mission on the SRS to provide accurate and precise data for use in parameterization of models employed to comply with NRC requirements concerning long-term contaminant exposure risk from stored nuclear materials, research conducted in support of SRR and SRNS to assess biological exposure risks from leakage events involving stored nuclear materials into soil and groundwater, research on the design and efficiency of strategies for bioremediation of tritium in SRS groundwater for SRNS, and research conducted in support of SRNS ACP's remediation mission to assess radionuclide and heavy metal accumulation in long-lived vertebrates and game species to inform regulatory compliance and risk assessment issues associated with ecosystem and human health.

As a source of regional and national scientific expertise, SREL scientists attract external funding to conduct research that not only contributes to areas of national research priority, but also helps contribute to DOE's nuclear and environmental missions on the site. Examples include research on development of technologies for control of feral swine (funded by the US Department of Agriculture), which makes the SRS both a national focal point for feral swine research as well as a recipient of the technologies and strategies as they are developed, research on conservation and management of threatened and endangered species across the nation (funded by the US Department of Defense and the US Fish and Wildlife Service), which contributes to the strategies and tools available for environmental stewardship applications on the SRS, research on avian dispersal technologies (funded by the Federal Aviation Administration and the City of Augusta), which contributes to the ability of SRS tenants to manage nuisance wildlife populations, research on scavenging ecology (funded by the US Department of Agriculture and the Department of Defense), which provides insights into the role of scavengers in recycling of energy and contaminants in the environment and the potential transfer of contaminants off of SRS, and research on risk assessment models for heavy metals in avian species (funded by the US Army Corps of Engineers), which adds to the set of risk assessment modeling expertise available for study of fauna on the SRS.

SECTION II. Cooperative Agreement Key Tasks

TASK 1. SREL will assess the impact of Site operations on the environment, and will continue to provide the public and DOE with an independent view of the environmental management of the SRS

Through a Cooperative Agreement between the Department of Energy and the University of Georgia Research Foundation, SREL provides an independent evaluation of the ecological effects of SRS operations through a program of ecological research, education, and public outreach. This program involves basic and applied environmental research, with emphasis upon expanding the understanding of ecological processes and principles, and upon evaluating the impacts of industrial and land use activities on the environment.

This is accomplished through a broad-based program of field and laboratory research conducted on the SRS and published in the peer-reviewed scientific literature; by providing education and research training for undergraduate and graduate students from colleges and universities throughout the United States and abroad; and by engaging in community outreach activities and service to professional organizations.

The quality of research conducted by SREL scientists is facilitated by their unique expertise in environmental sciences and ecology, the unparalleled field research opportunities at the SRS, and the long-term data sets, research tools, and capabilities that SREL has developed over the last 65 years.

The FY17 SREL research plan can be divided into three critical research areas:

Environmental Characterization

Characterization is a necessary first step in determining environmental and health risks and in devising appropriate remediation and restoration strategies. Environmental information is also needed to make informed decisions about long-term stewardship and land management, and is a critical component of NEPA (National Environmental Policy Act) reports, Records of Decision (ROD), and other regulatory documents. Environmental characterization is more than simply measuring contaminant concentrations in biota or other media, or reporting the presence of organisms at various locations. It includes developing an understanding of the processes that control distributions of contaminants, chemical forms, and their bioavailability. Characterization is also necessary to construct models of how natural and engineered systems function, both in the presence and absence of environmental contamination.

Ecological Risks and Effects

Estimated risks and effects determine the need for remediation and restoration efforts, while perceived risks and effects determine the public's acceptance and support of DOE policies and actions. Estimating ecological risks and effects on the basis of sound science helps to ensure that good decisions are made by reducing uncertainties associated with complex environmental processes. A 1999 report from the National Academy of Sciences stated that *"Ecological risks are better characterized at the Savannah River Site than at any other DOE installation, due in part to the designation of the site as a National Environmental Research Park and the presence of the Savannah River Ecology Laboratory."*

Remediation and Restoration

The knowledge and expertise at SREL are ideally suited to address the remediation and restoration of large land areas contaminated with relatively low levels of metals, organics, and radionuclides. SREL conducts multidisciplinary research designed to assist in the development, evaluation and stakeholder acceptance of remediation and restoration efforts that protect human and ecosystem health. Fundamental to the success of various bioremediation, natural attenuation, and *in situ* remediation applications is an understanding of the underlying scientific principles on which they are based.

TASK 2. SREL will continue basic and applied environmental research with emphasis upon expanding the understanding of ecological processes and principles, and upon evaluating the impacts of site activities, new mission, and land use practices on the environment

In FY17, the Savannah River Ecology Laboratory received approximately 8 million dollars in funding from a variety of sources (Figure 2.1). These funds supported approximately 151 faculty, staff, and students conducting basic and applied environmental research for at least some portion of FY17 (Table 2.2). In total, University of Georgia funding (both direct and indirect funds returned to the lab) and external dollars received from non-SRS sources were responsible for approximately 38% of the laboratories budget. Laboratory personnel were productive and successful in attracting external funding to the site, and very active in graduate student education and service to their communities and professions (Table 2.2). SREL continues to be a productive, independent partner to DOE on the SRS and an excellent value to both stakeholders on the SRS and taxpayers.

Figure 2.1. Overview of funding received by SREL in FY17. Acronyms are as follows: University of Georgia (UGA), Savannah River Site Office of Department of Energy (DOE-SR), all combined sources of funding received from sources external to the Savannah River Site (External), Department of Energy National Nuclear Security Administration's Mixed Oxide Fuel Production Facility (NNSA-MOX), Department of Energy National Nuclear Security Administration's Tritium Facility (NNSA-Tritium), Savannah River Nuclear Solutions Area Closures Project (ACP) and Savannah River Remediation (SRR).

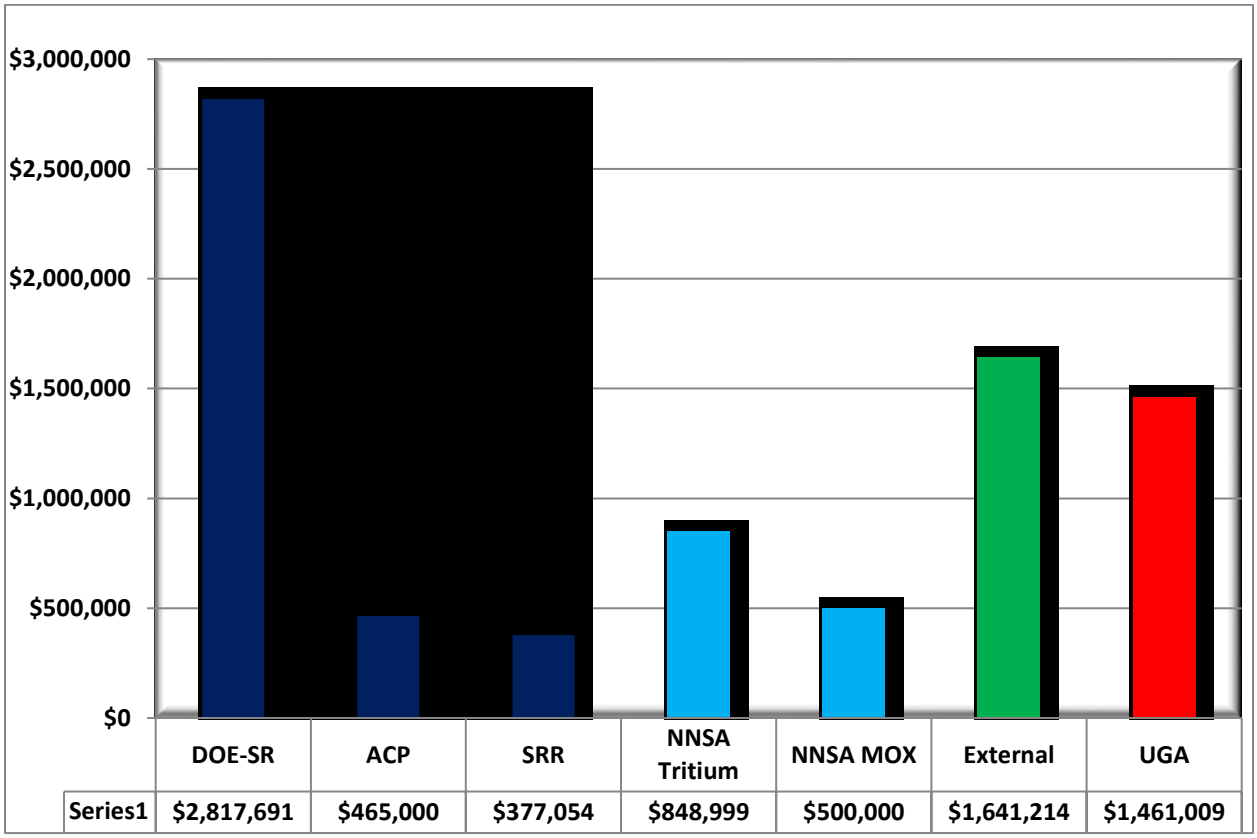

Table 2.2. SREL organizational structure for FY17. This table includes all research faculty, classified staff and Emeritus faculty in residence at the Savannah River Ecology Laboratory for any portion of the FY17 fiscal year.

SREL ORGANIZATIONAL CHART – FY17	
Director -- Dr. Olin E. Rhodes, Jr.	
Assistant Director Research Dr. J. Seaman **Research Faculty** Dr. S. Lance Dr. J. Vaun McArthur Dr. G. Mills Dr. T. Tuberville G. Dharmarajan **Tenure Track Faculty** Dr. J. Beasley Dr. D. Aubrey Dr. J. Martin Dr. D. Abbas Dr. K. Capps Dr. B. Parrott **Emeritus Faculty in Residence** Dr. D. Adriano Dr. I. Brisbin, Jr. Dr. J.W. Gibbons Dr. K. McLeod Dr. R. Sharitz **Post Docs** Dr. F. Coutelot Dr. J. Smith Dr. S. Mukherjee Dr. X Xu Dr. P. Schlichting **Research Professionals** Dr. K. Buhlmann R. Beasley A. Bryan D. Fletcher L. Lee R. Kennamer D. Scott A. Lindell P. Stankus K. Price **Research Technicians** R. Juarez C. Candal M. Dix C. Fulghum A. Korotasz M. Hamilton A. Lavere M. Mason B. Lindell M Oberkircher F. Depkin D. Pitt M Strassburg J. Ashe E. Bertucci S. Bock L. Bowman M. Brown J. Buskirk R. Demass	**Research Technicians (cont.)** D. Goin A. Hurst P. McGovern J. Nierman K. Norris J. Parks D. Quinn C. Roberts S. Madelin **Assistant Director Budget and Facilities** C. McBride **Safety** D. Mosser K. Coble **Computer Service and GIS Lab Manager** W. Taylor **Property Management** B. Morton **Outreach Program Staff** P. Perea V. Sutton-Jackson C. Eldridge M. Winzler J. Green-McLeod S. Poppy A. Tucker **Research and Facilities Technical Services** R. Christie M. Edwards C. Cooper D. Fraser D. Kling M. Squires P. Carroll C. Roberts **Administrative Services** L. LopezdeVictoria M. Roberts B. Giddens C. Summer M. Wilburn V. Taylor M. Wead
	(As of 10/1/2017)* Excludes Students

Table 2.3. Summary of professional activities and accomplishments by Savannah River Ecology Laboratory research faculty, research professionals, postdocs and students in FY17.

Publications and Reviews	Total
Peer Reviewed Journal Articles	78
Book and Book Chapters	2
Proceedings Articles	5
Primer or Other Scientific Notes	6
Non-Peer reviewed Articles	14
Articles In Press	15
Articles In Review	26
Peer Review of Manuscripts Conducted	42
External Funding (non-SRS)	**Total**
External Grants Submitted as PI or CoPI	48
External Grant Funding Submitted as PI or CoPI	$20,472,149
External Grants Funded as PI or CoPI[1]	36
External Grants Funded Dollars as PI or CoPI	$ 2,482,767
Graduate Education and Postdocs	**Total**
MS Graduate Students Chaired	32
MS Graduate Students Completed	6
PhD Graduate Students Chaired	19
PhD Graduate Students Completed	1
Graduate Student Committee Memberships	38
Graduate Students Hosted at SREL	24
Post Docs Supervised	4
Presentations	**Total**
Invited Presentations	51
Professional Oral Presentations	95
Professional Poster Presentations	61
Extension Presentations	17
Extension Publications	39
Other	**Total**
Awards or Honors	8
Professional Society Committee Memberships	19
Courses Taught	14
Technical Research Consultations	24

[1] – includes new grants and contracts, renewals and continuations associated with funding sources external to DOE. Total includes multi-year funding commitments received in FY17 and to be received in future fiscal years.

TASK 3. SREL will use the information collected in the environmental research to develop and test hypotheses that will contribute to the scientific foundation necessary to conduct meaningful ecological risk assessments and to understand the environmental consequences of energy technologies, remediation efforts, and other SRS activities

In FY17 SREL faculty, staff, and students conducted and completed a diversity of environmental research projects on the SRS in support of the missions of SRNS, SRR, and DOE-SR, specifically in the areas of risk assessment and elucidation of the environmental consequences of energy technologies, legacy contamination, and remediation activities on the SRS. Much of this work was funded through support to the SRNS Area Closures Project, through subcontracts from SRR to perform specialized sampling or analyses, and through commitment of funds received through SREL's Cooperative Agreement with the Department of Energy to address research topics of importance to the continuing missions of DOE on the SRS. The details of these projects are outlined below:

Research Support to SRNS Area Closure Projects, SRR, and DOE-SR

Contaminant burdens and sub-lethal effects of chronic contaminant exposure in semi-aquatic mammals

Funding Entity
SRNS Area Closure Project
Start Date and Funding Amount
April 2016; $130,000
PI and Co-PIs
Dr. Jim Beasley and Larry Bryan - SREL
Objectives
We are in the second year of a multi-year study to quantify radionuclide and trace element concentrations in tissues of beaver, raccoons, and river otters from the SRS as well as select locations throughout Georgia and South Carolina. The objectives are the study are to 1) quantify contaminant burdens in semi-aquatic mammals, 2) compare contaminant burdens in species collected from the SRS with those collected in off-site locations in SC and GA, 3) elucidate shifts in contaminant burdens as a function of trophic position, and 4) quantify parasite burdens as a function of species and contaminant burden.
Summary of Research Activities
This research began in spring of 2016 and all trapping and specimen collection activities have been completed. We are currently conducting necropsies to collect tissue samples for trace element analyses as well as determining parasite burdens. Processing of these samples will continue through the remainder of 2017 and results are anticipated by spring 2018.
Conclusions
This research has just begun, there are no conclusions at this time.
Major Impact(s) of Research
1) When completed, this research will be the most comprehensive evaluation of contamination burdens in beaver and river otters in the southeastern U.S. to date.
2) Observed concentrations of trace elements and radiocesium in raccoons, beaver, and especially river otters will be used to parameterize environmental risk assessment models for various ecosystems on the SRS.

Other Project Personnel
Ernest Borchert, MS Student – UGA
Katie Mcmanners, Undergraduate Student – UGA
External Collaborators
Chris Cleveland – UGA
Dr. Michael Yabsley –UGA

Products

Borchert, E.J., A.L. Bryan, and J.C. Beasley. February 2017. Trace element and radionuclide concentrations and parasite burdens in semi-aquatic mammals in the southeastern US. Warnell Graduate Student Symposium. Athens, GA.

Borchert, E.J., A.L. Bryan, and J.C. Beasley. October 2016. Trace element concentrations and parasite burdens in semi-aquatic mammals in the southeastern United States. 23rd Annual conference of the wildlife society. Raleigh, NC.

Borchert, E.J. and J.C. Beasley. 2017. Raccoon Spatial Ecology and Contaminant Exposure. Savannah River Ecology Laboratory's Annual Touch an Animal Day (TAAD). Aiken, South Carolina, USA.

Contaminants in Eastern Wild Turkeys

Funding Entity
SRNS Area Closure Project
Start Date and Funding Amount
April 2016; $25,000
PI and Co-PIs
Dr. Jim Beasley and Larry Bryan - SREL
Objectives
The primary objective of this research is to quantify levels of Hg, trace elements, and radiocesium in wild turkeys on the SRS to assess potential risks to hunters.
Summary of Research Activities
To date we have collected samples from ~20 wild turkeys harvested from various locations on the SRS during both the 2016 and 2017 annual turkey hunts. Samples of muscle and liver from turkeys collected in 2016 have been analyzed for Hg, trace elements, and radiocesium, and samples collected in 2017 are currently being prepared for analyses.
Conclusions
Data analyses are incomplete; thus there are no conclusions at this time.
Major Impact(s) of Research
1) This research will provide the first assessment of contaminant burdens in wild turkeys on the SRS, data necessary to inform potential risks to hunters consuming birds harvested during annual hunts on site.
2) Spatial analyses will be used to determine whether spatial variability in contaminant burdens exists among wild turkeys inhabiting various locations on the SRS.

Other Project Personnel
Kevin Eckert, Research Technician – SREL
Chris Leaphart, M.S. Student – UGA
External Collaborators
Odin Stevens – USDA-APHIS-WS
Robert Byrd – USDA-APHIS-WS
Products
This research has just begun, there are no products available at this time.

Examination of Mercury/Methylmercury in Aquatic Biota Associated with Fourmile Branch

Funding Entity
SRNS Area Closure Project
Start Date and Funding Amount
April 2017; $40,000
PI and Co-PIs
Larry Bryan, Dr. Gary Mills, and Dr. Xiaoyu Xu - SREL
Objectives
We are in the 4th year of a five-year project examining mercury bioavailability and uptake within the Fourmile Branch drainage, including the Savannah River Swamp System (SRSS), and H- and F-Area seeplines and adjacent stream riparian zone. All three areas had previously documented elevated levels of total mercury (THg). Our initial year focused on a general survey of all three regions, the 2nd year focused on the SRSS, the 3rd year focused on the stream reach associated with the H-Area seepline, and the current year (4th) focused on the stream reach associated with the F-Area seepline. Our summary includes (1) analytical (THg) results from the 3rd (H seepline) and 4th (F seepline). We also plan to examine relationships between THg and MeHg (methylmercury) within selected biological samples to enhance our understanding of bioavailability within these aquatic systems.
Summary of Research Activities
In Year 3, we collected sediment, biofilm, and aquatic fauna for Hg analysis along the reach of Fourmile Branch associated with the H-Area seepline as well as Mill Creek, an un-impacted stream, for comparison. Average total Hg (THg) concentrations were higher for most H-Area samples than Mill Creek. In 2017, we collected ~100 samples (ranging from biofilms to redfin pickerel) from the reach of Fourmile associated with the F-Area seepline. All 4th year samples have been analyzed for THg and the average THg concentrations are far lower for all species than found in similar species from H-Area and its control stream. Analysis of selected samples from Years 2-4 for MeHg is on-going.
Conclusions
1) Analyses of Year 3 samples confirmed elevated THg of the H-Area biological samples relative to the control stream.
2) In Year 4 we collected ~100 biota samples (biofilms, aquatic invertebrates, amphibians and fish) from the stream reach associated with F-Area seepline site and the average THg concentration were surprisingly low (all < 1.0 ppm). We are attempting to determine the environmental factors influencing these lower concentrations.
3) Total mercury (THg) analysis of all collected samples (Years 1-4) has been completed. Analysis of a subset of these samples for MeHg has been initiated.

Major Impact(s) of Research
1) When completed, we will have a better understanding of mercury accumulation in aquatic
2) biota and the conditions that make mercury bioavailable in these components of the Fourmile system.
3) THg/MeHg data from the various Fourmile samples will be compared to Mill Creek samples to determine if these portions of the drainage are still of regulatory concern.

Other Project Personnel
A.M. Korotasz, Research Technician - SREL
External Collaborators
N/A
Products
Xu X, Mills GL, Bryan AL. *In review*. Applying diffusive gradients in thin films (DGT) to study mercury bioavailability in a contaminated stream system on the southeastern coastal plain, USA. Submitted to *Chemosphere*.

Radiocesium in Biota Associated with an Abandoned Reactor Effluent Canal and Settling Basin

Funding Entity
SRNS Area Closure Project
Start Date and Funding Amount
February 2015; $58,000
PI and Co-PIs
Larry Bryan and Dr. Jim Beasley - SREL
Objectives
We are in the 3nd year of the project examining the degree of radiocesium uptake by various trophic components (ranging from biofilms to fish to snakes) of the Pond A/R-Canal system. The 3rd year focused on a follow-up study to the uptake study relative to exposure time (tadpoles in mesocosms) from the previous year. Uptake levels of radiocesium will be provided to ACP and used to assess wildlife health risks and used to assess whether it is biomagnifying within these systems.
Summary of Research Activities
Last year, bullfrog tadpoles deployed in mesocosms in R-Canal and Pond A were collected and analyzed (whole body, including GI tract) at 7-day intervals. These tadpoles were found to reach asymptote before or at 7 days. In June-July of 2017, tadpoles were again deployed in R-Canal mesocosms, but were collected at 2-day intervals and the GI tracts were removed prior to analyses. The results of this study indicated that the tadpoles reached an asymptote of ~4.3 Bq/g (dry wt) after 20 days of exposure to the R-Canal system.
Conclusions
1) Analyses of exposed tadpoles from R-Canal and Pond A mesocosms last year suggested a rapid ($\leq$ 7 days) accumulation to asymptote by these develop fauna, but there was concern that food with high levels of radiocesium contained within the GI tract may have been dominating the assays. This year's analyses confirms that gut content was a factor and that accumulation to asymptote in this system likely takes approximately 20 days.

Major Impact(s) of Research
1) We now have a better understanding of radiocesium uptake rates in lower trophic level components of this aquatic system. These rates can be utilized by ACP to assess potential risks to humans and wildlife. We also have a better understanding of accumulation rates in selected species relative to period of exposure.

Other Project Personnel
James Leaphart, MS Student –UGA
Alexis Korotasz, Research Technician
Kaitlen Wilms, REU Student – SREL
External Collaborators
N/A
Products
Leaphart, J., A. Bryan, A. Korotasz, and J. Beasley. Environmental fate of radiocesium in an aquatic and semi-aquatic food web on the Savannah River Site. Oral presentation at the Annual Meeting of the Society of Environmental Toxicology and Chemistry, November, 2016, Orlando, FL.
Leaphart, J., A. Korotasz, A. Bryan, and J. Beasley. Environmental fate of radiocesium in aquatic and semi-aquatic food webs on the Savannah River Site. Oral presentation at the Warnell Graduate Student Symposium (UGA), February, 2017, Athens, GA.
Wilms, K.C., J.C. Leaphart, A.L. Bryan, and J.C. Beasley. Accumulation of Radiocesium in bullfrog tadpoles (*Lithobates catesbeianus*) in a contaminated effluent canal on the SRS. SREL Undergraduate Student Symposium, 25 July 2017 (oral presentation).
Wilms, K.C., J.C. Leaphart, A.L. Bryan, and J.C. Beasley. Accumulation of Radiocesium in bullfrog tadpoles (*Lithobates catesbeianus*) in a contaminated effluent canal on the SRS. University of South Carolina 2017 Summer Research Symposium, Columbia, SC, July 27, 2017 (poster presentation).

Literature Review of Radionuclide Levels in SRS Fauna

Funding Entity
SRNS Area Closure Project
Start Date and Funding Amount
April 2016; $78,000
PI and Co-PIs
Larry Bryan, Dr. John Seaman and Dr. I. Lehr Brisbin, Jr. - SREL
Objectives
The overall goal of this project is to compile the known published information on uptake of radionuclides by SRS fauna, primarily from peer-reviewed manuscripts, theses/dissertations and SREL technical/final project reports.
Summary of Research Activities
To date, over 200 published manuscripts, 20 technical reports, and 20 theses/dissertations have been compiled. Manuscript evaluations (e.g.; determination of which radionuclides were found in which SRS areas) and summarization of radionuclide concentrations are on-going.
Conclusions
1) We have generally completed the search for information as well as the evaluations of the documents, although new literature is added as it becomes known.
Major Impact(s) of Research
1) When completed, information pertaining to radionuclide uptake by SRS fauna from 1960-2017 will be available in one document.
Other Project Personnel
A.M. Korotasz, Research Technician - SREL
External Collaborators
N/A
Products
No publications, presentations, or reports have yet been prepared.

Radiocesium in SRS Deer

Funding Entity
SRNS Area Closure Project
Start Date and Funding Amount
April 2016; $23,287
PI and Co-PIs
Larry Bryan - SREL
Objectives
The overall goal of this project is to examine data relative to uptake of ^{137}Cs by SRS deer to assist with a generic risk assessment. Specifically, the objective is to estimate background levels of ^{137}Cs in deer based on data collected during SRS hunts, avoiding data from deer that might be associated with known contamination areas (e.g., LTR drainage/IOU).
Summary of Research Activities
All data have been summarized and a final project report submitted to SRNS-ACP.
Conclusions
1) Background body burdens for SRS deer from global fall-out rather than SRS activities are generally in the range of 1.32-1.36 pCi/g ^{137}Cs.
2) Based on long-term site-wide estimates, most deer collected on the SRS should fall within 1.32-2.59 pCi/g ^{137}Cs.
3) Drought conditions can enhance ^{137}Cs bioavailability in some soils and raise background body burdens.

Major Impact(s) of Research
1) These analyses provide reference points of background levels (global fall-out only) as well as levels influenced by on-site activities of ^{137}Cs in deer on the SRS.
2) Such reference points are vital for on-going risk assessments.

Other Project Personnel
N/A
External Collaborators
Dr. Karen F. Gaines - Embry-Riddle Aeronautical University
Dr. James M. Novak - Embry-Riddle Aeronautical University
Products
Gaines, K.F., and J.M. Novak. 2017. ^{137}Cs body burdens in white-tailed deer on the Department of Energy's Savannah River Site: Estimation of biological background based on hunt data between 1965-2016. Draft final project report SRNS-RP-2016-00762, Ver. 1.0) to Savannah River Nuclear Solution, Area Closure Project, SRS, Aiken, SC.

Assessing Radiocesium in various biota in unstudied reaches of the R-Canal system

Funding Entity
NFP
Start Date and Funding Amount
May 2017; NFP
PI and Co-PIs
Larry Bryan - SREL
Objectives
The overall goal of this project is to examine radiocesium accumulation and potential biomagnification in biota within two unstudied cooling canals within the R-Reactor cooling canal/pond system. Specifically, we tested whether proximity to reactor influenced accumulation and examined whether weirs located in both canals had an influence on accumulation.
Summary of Research Activities
Approximately 250 biological samples, ranging from biofilms to fish, we collected for analyses from June through July of and all were analyzed by mid-August of 2017.
Conclusions
1) Proximity to reactor was not a factor as ^{137}Cs levels were higher in the more distant canal.
2) Location relative to weirs did not influence ^{137}Cs accumulation in biological samples.
3) Biomagnification of ^{137}Cs within these systems was not supported.

Major Impact(s) of Research
1) We provided radiocesium accumulation data in two unstudied components of the R-Reactor cooling canal system.

Other Project Personnel
Chris Leaphart – MS Student - UGA
Alexis Korotasz, Research Technician - SREL
Elizabeth DiBona, REU Student - SREL
External Collaborators
NA
Products
DiBona, E. Assessing Radiocesium in various biota in unstudied reaches of the R-canal system. SREL Undergraduate Student Symposium, 25 July 2017 (oral presentation).
DiBona, E., A.M. Korotasz and A.L. Bryan. Assessing Radiocesium in various biota in unstudied reaches of the R-canal system. University of South Carolina 2017 Summer Research Symposium, Columbia, SC, 27 July 2017 (poster presentation).

Tracking Sources of Mercury in Contaminated Aquatic Systems on the Savannah River Site

Funding Entity
SRNS Area Closure Project
Start Date and Funding Amount
April 2017; $31,954
PI and Co-PI
Dr. Xiaoyu Xu and Larry Bryan – SREL
Objectives
The Savannah River Site (SRS) has received mercury (Hg) contamination from multiple sources, including atmospheric deposition (local and non-local), off-site pollution (Savannah River – Olin Canal) and on-site activities. Accumulation of Hg by SRS biota has been documented frequently, occasionally at levels of regulatory concern, but the sources of Hg remain unclear. Our objective is to utilize a relatively new technique, Hg stable isotope analysis, in an attempt to confirm sources of Hg found in SRS biota. The isotope analysis will occur at the Center for Applied Isotope Studies at UGA after custom-fabricated accessories are installed on their existing instrumentation.
Summary of Research Activities
1) We collected sediment samples from the Savannah River (above and below Olin Canal) and Fourmile Branch to analyze Hg and MeHg (methylmercury) concentrations.
2) We had the needed accessories for Hg isotope analysis fabricated, they have been installed on the existing instrumentation, and the system has been calibrated and tested.
3) We anticipate the sediment samples will be analyzed for Hg isotopes before the summer of 2018.

Conclusions
1) We collected the sediment samples and customized the instrumentation to analyze for Hg isotopes.
2) Sample analysis is pending.

Major Impact(s) of Research
1) Impacts cannot be determined prior to the analyses of the samples.
2) Assuming we can isotopically differentiate among the various sources of Hg, when completed, we will have a better understanding of Hg sources in biota found on the SRS biota.

Other Project Personnel
Kathy Loft, Research Technician - UGA
External Collaborators
NA
Products
No publications, presentations, or reports have yet been prepared.

Examination of Selected SRS Aquatic Systems for Metal Contamination and Bioaccumulation

Funding Entity
SRNS Area Closure Project
Start Date and Funding Amount
April 2017; $88,999
PI and Co-PIs
Larry Bryan, Dean Fletcher, Dr. Stacey Lance, and Dr. J Vaun McArthur - SREL
Objectives
The primary objectives of this project are to fill environmental data gaps relative to metal contamination in drainages and/or aquatic systems on the Savannah River Site (SRS) for SRNS-ACP. Specifically, our objectives were to (1) analyze archived fish samples from Fourmile Branch and Beaver Dam Creek for metals and possibly radiocesium, (2) collect samples from the upper tributaries of Fourmile Branch, areas with environmental conditions potentially conducive to increased metals availability, and document metals within these samples, and (3) examine the environmental factors (e.g., hydroperiod, size, depth, water chemistry) that influence the background levels of mercury found in Carolina Bays, wetlands with no point-sources of Hg contamination other than atmospheric deposition.
Summary of Research Activities
1) We analyzed 50 archived fish samples from Fourmile Branch, that had previously been analyzed for THg, for a suite of metals and assayed them for radiocesium (^{137}Cs); 557 archived fish samples distributed across 11 families, 29 species and 2 sites from Beaver Dam Creek are presently being processed and analyzed for a suite of metals.
2) We collected a small number of sediment, biofilm and fish samples from 4 sites in the upper tributaries of Fourmile Branch and analyzed them for a suite of metals (including THg).
3) We collected replicated sediment, detritus, and biofilm samples from three locations within 12 Carolina Bays of varying hydroperiods to analyze for THg. To date we have analyzed 108 sediment and 24 biofilm samples for THg.

Conclusions
1) Assessment of metals accumulation in fish is pending completion of chemical analyses.
2) THg levels in sediment were slightly higher in the center of Carolina Bays than the edge of these wetlands.
3) THg levels were slightly higher in short hydroperiod Carolina Bay wetlands

Major Impact(s) of Research
1) When completed, we will have a better understanding of metal accumulation in aquatic
1) biota from two SRS drainages to aid in assessment of risk of previous site activities.
2) For headwaters streams with environmental conditions potentially conducive to greater metals bioavailability, we will determine if these conditions actually resulted in higher metal concentrations in biota.
3) When completed, we will have a better understanding of that amount of background Hg contamination exists in SRS wetlands and what drives variation in among wetland levels of THg.

Other Project Personnel
C. Love, PhD Student – UGA
D. Calloway, REU Student – SREL
Brooke Lindell, Research Technician – SREL
Paul Stankus, Research Professional – SREL
A.M. Korotasz, Research Technician – SREL
External Collaborators
NA

Products

Calloway, D., C. Love, D. Scott, S. Lance. 2017. Fate of atmospheric mercury (Hg) in ephemeral wetlands. The 2017 SREL NSF Research Experience for Undergraduates Symposium. Aiken, SC (Poster presentation).

Calloway, D., C. Love, D. Scott, S. Lance. 2017. Fate of atmospheric mercury (Hg) in ephemeral wetlands. The 2017 Southeastern Society of Toxicology Annual meeting. Fort Valley, GA (Poster presentation).

Technical Support Provided by the Savannah River Ecology Laboratory (SREL) for R&D of Cementitious-Type Materials (i.e., Saltstone) and Soils

Funding Entity
Savannah River Remediation (SRR)
Start Date and Funding Amount
October 2016; $332,921
PI and co-PI's
Dr. John C. Seaman - SREL
Objective
At the Department of Energy's Savannah River Site (SRS) a mix of cementitious dry feed materials (i.e., portland cement, blast furnace slag (BFS) and fly ash) are combined with low-level radioactive saltwaste solutions to form a cementitious material known as Saltstone, which is then deposited in a series of concrete vaults for long-term disposal at the Saltstone Disposal Facility (SDF). The objective for FY17 was to continue ongoing evaluations of contaminant leaching properties (^{99}Tc, ^{129}I, and ^{137}Cs) of saltstone simulants, produced utilizing Savannah River Remediation LLC (SRR) prescribed grout formulations, and actual saltstone samples collected from Saltstone Disposal Unit (SDU) Cell 2A. A major focus for FY17 was the continued development of the Dynamic Leaching Method (DLM), a newly developed method for evaluating contaminant partitioning within intact saltstone monoliths. In addition, SREL began characterizing the mineralogical composition and thermal properties of various saltstone formulations, i.e., heat capacity, heat of hydration and thermal conductivity. These properties can impact the rate of saltwaste processing and the eventual durability of the saltstone product.
Summary of Research Activities
For FY17, both ^{99}Tc and ^{129}I spiked saltstone simulants were produced utilizing SRR prescribed formulations and blast furnace slag (BFS) provided by a new supplier. These samples were subjected to a minimum of six months of curing under controlled temperature and humidity conditions chosen to mimic curing conditions within Saltstone Disposal Unit (SDU) Cell 2A. Contaminant mass transfer rates for ^{129}I in the saltstone simulants and SDF saltstone samples were assessed using EPA Method 1315. Results from Method 1315 are being compared to a novel test method under development at SREL known as the Dynamic Leaching Method (DLM). In the DLM method a flexible-wall permeameter cell is used to achieve saturated leaching through the intact monolith under an elevated hydraulic gradient in an effort to evaluate the persistence of reductive capacity and subsequent changes in contaminant partitioning that is occurring within intact saltstone monoliths. The composition of the chemical leachates from both tests can then be analyzed in an effort to identify potential critical reactions and solid phases controlling contaminant partitioning through geochemical modeling.

For FY17 the DLM system was modified to include mechanical pumps for greater control of sample leaching rates. Five ^{99}Tc-spiked samples produced in FY17 were mounted on the new DLM system for extensive testing. Two ^{129}I-spiked samples were also mounted on the older DLM system. Using an x-ray diffractometer (XRD, D2 Phaser; Bruker Instruments) and an x-ray fluorescence instrument (XRF, S2 Puma; Bruker Instruments) newly purchased through a matching agreement between SRR and SREL, SREL began evaluating the mineralogical and elemental composition of saltstone materials as impacted by grout formulations and curing conditions.

SREL also began evaluating the thermal properties of various saltstone formulations using a TAM Air calorimeter and a FOX50 Heat Flow Meter (TA Instruments, New Castle, DE 19720), both purchased using matched funds from SRR. Increases in grout temperature have the potential to impact the durability and potential for cracking that results from high temperature gradients. FY17 activities largely focused on the development and initial testing of instrumental protocols for evaluating the thermal properties of various saltstone grout formulations as impacted by compositional changes in the dry feed materials and water-to-dry feed material ratios.

Conclusions

1) DLM leaching results are generally consistent with EPA 1315 tests in terms of the degree of contaminant retention within the saltstone grout, with nitrate leaching much faster than ^{137}Cs or ^{99}Tc; however, leaching rates for ^{129}I were similar to that of nitrate.
2) In general, the hydraulic conductivity (K_{sat}) values obtained by common test methods are higher than the values observed by the DLM testing.

Major Impact(s) of Research

1) DLM results can be used in revising the upcoming SDF Performance Assessment (PA).
2) DLM results suggest that Tc leaching from Saltstone is controlled by the solubility (i.e., Tc $\approx 5 \times 10^{-9}$ *M*) of the reduced form (i.e., Tc(IV)), supporting the effectiveness of reductive immobilization in cementitious materials as an effective Tc immobilization method.

Other Project Personnel

F.M. Coutelot, Post Doc – SREL
K. Price, Research Professional – SREL

External Collaborators

Dr. D. Kaplan – SRNL
Dr. D. Li – SRNL
Dr. S. Simner – SRR

Products

Simmer, S., Cutlet, F., Chang, H., and Seaman, J.C. 2017. Technetium Leaching from Cementitious Materials. MRS Advances, 1-6.

Seaman, J.C. and F.M. Coutelot. 2017. Impact of Cementitious Material Leachate on Iodine Partitioning. SREL R-17-0004. Submitted to SRR September 29, 2017.

Seaman, J.C. and F.M. Coutelot. 2017. Contaminant Leaching from Saltstone. SREL R-17-0005. Submitted to SRR September 29, 2017.

Seaman, J.C. and F.M. Coutelot. 2017. Thermal Properties of Saltstone Simulants: Initial Method Development. SREL R-17-0006. Submitted to SRR September 29, 2017.

Coutelot, F.M., J.C. Seaman, S Sumner. 2017. Coupled geochemical-transport modeling of Tc and Re leaching from saltstone cementations waste forms. 14th International Conference on the Biogeochemistry of Trace Elements (ICOBTE), July 16-20, Zurich, Switzerland.

Seaman, J.C., F.M. Coutelot, and S.P. Simner. 2017. Contaminant Leaching from Intact Saltstone Monoliths. WM2017 Conference, March 5-9, 2017, Phoenix, AZ.

Tritium Distribution at the Tritiated Water Management Facility - Southwest Plume Interim Measures

Funding Entity

SRNS Area Closures Projects

Start Date and Funding Amount

October 2016; $127,000

PI and co-PI's

Dr. John C. Seaman - SREL

Objective

Evaluate the efficacy of ongoing remediation efforts at the SRS Mixed Waste Management Facility (MWMF) to address the tritium and 1, 4 dioxane plume originating from the Old rad Waste Burial Ground.

Summary of Research Activities

In FY 2017, SREL worked collaboratively with the SRS-US Forest Service, SRNS-ACP and DOE to complete the following activities: (1) collect and analyze soil core samples to evaluate tritium distribution as an estimate of irrigation efficiency; (2) maintain and update the Cornell Model for estimating water-use efficiency, including updating the model to account for recent site expansion; and (3) evaluate the persistence of 1, 4 dioxane in soils at the MWMF. Biannual soil samples are collected to a depth of three-meters in June and December to produce the annual report estimating irrigation efficiency.

Conclusions

1) The estimated tritium evapo-transpiration efficiency for individual irrigation plots through the end of calendar year 2016 based on soil core samples ranged from ≈ 82.1 to 97.8 %, with lower tritium use efficiencies generally reflecting the limited vegetative cover associated with the Western Expansion Area.
2) Monthly efficiency results derived from the Cornell 1D model ranged from 63.4 to 88.8 % between plots, with lower efficiencies observed for the Western Expansion Area plots. The average efficiency was approximately 86.6 ± 1.2 % for the original plots, 74.3 ± 1.7% for the EEA plots, and 65.8 ± 1.5 % for the WEA plots, resulting in an overall of annual efficiency of 79.5 ± 8.5 % for all 11 monitored plots.
3) Results from annual head space analysis and monthly sublimation (i.e., freeze drying) based soil extraction methods indicated no buildup in residual 1, 4 dioxane within the long-term irrigation plots.

Other Project Personnel

Matt Baker, Graduate Student - UGA
Sandra Cutts, Graduate Student, University of Alabama - Birmingham
K. Price, Research Technician - SREL

External Collaborators

NA

Products

Seaman, J.C. 2016. Estimating Evapo-Transpiration Losses for Tritium at the MWMF: 2016 End of Year Summary Report. Submitted to SRNS-ACP December 19, 2016.

TASK 4. SREL public outreach and communication programs will focus on the SRS environment and ecological research to increase the public's understanding of scientific issues affecting the Site and to increase general ecological awareness

SREL Outreach Activities in FY17

SREL's public outreach and communication programs focus on habitats and environments on the SRS and the ecological research that is conducted by SREL, with the purpose of increasing public understanding of scientific issues affecting the site and bringing general ecological awareness to the general public. Historically, the program's mission has been to educate the public about ecological research and environmental issues. SREL has also worked with the Citizens Advisory Board, various onsite organizations, state and federal regulatory authorities, and other stakeholder groups to raise awareness of the SRS and of regional ecological issues and opportunities for environmental stewardship. The program highlights SREL's ecological research on the SRS through oral presentations, exhibits, tours, and various electronic media. Outreach programs facilitate and encourage participation by students, regional teachers, resident and visiting faculty and training programs. SREL actively communicates information to the media via UGA Public Affairs and local and regional media outlets. To accomplish these goals and provide an overall educational outreach program, SREL has focused on the following specific objectives since its inception:

A. Publish articles on environmental issues and ecological research in popular press outlets including newspaper columns, popular magazines, University of Georgia publications, Department of Energy publications, encyclopedias, special publications such as alumni magazines and ancillary publications of scientific societies.

B. Provide news releases to newspapers and other appropriate media that relate to environmental activities of SREL, with particular emphasis on the SRS.

C. Develop and present an on-site tour program that focuses on the environments of the SRS and the ecological projects of SREL —conveying SREL's role as an independent evaluator.

D. Give presentations to the public, including schools, civic groups, and other organizations that focus on environments of the SRS region and on SREL's ecological projects.

E. Develop portable and permanent exhibits appropriate for use at special presentations at SREL, schools, other organizations, and special events.

F. Develop video and slide shows for presentations to groups or for use by onsite organizations, emphasizing SREL environmental programs and projects on the SRS.

G. Investigate opportunities for broadcast programs that focus on environmental issues, SREL's ecological research, and ecological projects on the SRS.

H. Develop and distribute brochures and publications that are informative the public and on-site tenants of SREL's ecological research, and the environments on the SRS.

I. Develop and establish displays of SREL research projects in appropriate areas of the SREL facilities.

J. Publish an internal newsletter (*The GrapeVine*) as a means of enhancing internal communications—promoting individual as well as organizational achievement.

K. Develop the UGA conference center as a focal site for environmental education.

L. Establish a photograph collection that tells SREL's story, is informative of plants, animals, and habitats of the SRS region, and that emphasizes current ecological projects of SREL.

M. Maintain a collection of live plants and animals that can be used to educate the public about environmental issues and ecological research.

N. Maintain an area of the website for education on wildlife native to the SRS to include identification of regional species and information on wildlife safety.

O. Develop and present SRS wildlife safety talks for site tenants and visitors.

In accomplishing the goal of communicating ecological information to non-scientists, the Outreach program has provided on-site training and services to demonstrate the potential sources of injury from animals and plants found on the SRS and the CSRA that could occur to remote workers engaged in field activities or to employees and their families at home. The Outreach program has conducted workshops and training sessions and has attended SRS monthly safety meetings to deliver PowerPoint presentations and introduce live animals and native plants. The Outreach program has also developed and distributed safety materials (protocol badge cards and safety fact sheets) to SRS employees, and has managed an educational section on the SREL website. While the primary focus of most of these wildlife safety programs has been on snakes and alligators, the programs have also provided information on plants, insects, spiders, snapping turtles, and mammals of concern.

The Outreach Program has been a participant in SRS's outreach to the general public via the SRNS Public Tours program, with SREL providing a 45-60 minute presentation bimonthly year-round (24 scheduled and up to 20 additional lab tours and impromptu presentations). These presentations provide a general introduction about the history and ongoing mission of SREL and the lab's involvement with research, teaching, and community service. The programs conclude with a question and answer period for participants on wildlife identification, site environmental research programs, safety, and other ecological matters of public interest.

SREL also hosts a seminar program, which is open to SRS employees, on a variety of research and educational topics which are pertinent to the SRS mission. Speakers include SREL research scientists, invited scientists from other university or agency programs, and graduate students who are conducting research on the SRS.

Other programs in which Outreach personnel participate include: ***Ecotalks***, an opportunity for students to have nature brought into their classroom for a face-to-face lesson on a variety of live animals found in local habitats; the ***Ecologist for a Day*** program allows students to spend the day in the field gaining hands-on knowledge of the plants and animals of the unique Upper Three Runs Creek area at the off-site UGA Conference Center. The conference center also hosts civic group presentations and ecological tours. All school programs incorporate science standards and curricula for particular school districts. Most of these programs provide an opportunity for participants to work with SREL staff as they catch, mark, and measure various species of reptiles, amphibians, fish, small mammals, and invertebrates. In addition, Outreach offers an annual free program, ***Touch an Animal Day***, to the local and regional community at the UGA Conference Center, which allows individuals of all ages to interact with live animals and plant species, to meet site researchers, and to learn more about SRS efforts, including our research and education components. Lastly, the Outreach Program offers tours of SREL facilities, as well as exhibits and workshops for the general public as well as onsite personnel.

The Outreach section of the SREL website receives numerous hits, as it has links to the popular ***Ecologist for a Day*** program, Outreach fact sheets and educational products, the ***Ecoviews*** weekly newspaper column. It also invites questions about wildlife native to the SRS that are answered by the Outreach personnel. This website is frequented by teachers from all over the country, who use the materials in their classrooms. SREL distributes thousands of educational products and materials nationwide to schools, organizations, and the general public.

TASK 5. SREL will maintain ecological data bases for use by the public, SRS, governmental, academic, and private organizations. These databases incorporate more than 60 years of data collection on the SRS and provide a resource for understanding changes impacting ecosystems on the SRS and elsewhere in the southeastern United States

SREL Data Management Activities in FY17

IT Infrastructure

Over the past year, the Savannah River Ecology Laboratory continued to improve our IT capabilities by making several upgrades and additions to our network. We worked with Site Networking, AT&T and UGA networking to move to a Metro E connection with a secure tunnel back to campus. This moves us off the site network and behind UGA's firewalls and security systems. We also made several other improvements to our IT systems in FY17 and they include:

1. **Replaced all network switches.**
   This brought us into compliance with UGA Networking for assistance with management and replacement.

2. **Added Wireless networking to two new building.**
   This gives our user community more flexibility when connecting to the network.

3. **Partnered with Dropbox**
   This not only increase our data storage capabilities at a reasonable cost it will also give our researchers and students secure access to the data from anywhere in the world.

4. **Used Zenworks to deploy GIS to all desktop network computers**.
   This gives all of our users ready access to GIS.

5. **Use Zenworks to deploy R and R Studio to all researches desktop.**
   This gives all researchers easy access needed statistical software.

6. **Use Zenworks for Patch Management of all network computers**.
   This not only keeps Microsoft products up to date, but all software installed on the computer. It also gives the Administrator the ability to choose what software in updated.

Database Management

Responsible management of research data plays an important role in preserving SREL's institutional memory. Data archiving supports DOE's mission, contributes to future research ecological research, and is now often required by funding agencies. SREL's current challenge is to rebuild the technological and policy infrastructure to support an active archiving program, as well as to address existing legacy data.

In FY17, work continued on the data submission web entry tool. The back end is complete, and consists of two databases: the data catalog, where accessioned entries will reside; and a staging database that mirrors the catalog structure, where data sets are temporarily staged for review and editing, before being officially accessioned into the catalog. The structure also allows for previously accessioned data sets to be retrieved from the catalog for editing; thus, long-term projects can be updated annually, rather than requiring each year to be accessioned separately. A few details remain regarding user authentication, and choices for temporarily staging the file uploads during the submission process before they have been assigned an accession number, as well as the final layout of the submission and review forms themselves.

The submission form will be an adaptation of the GCE application to conduct research, as it requests some of the same metadata. Users complete the metadata form and attach data file uploads. A separate review form available only to the data manager provides the ability to request changes, or to edit the submission directly, as well as to accession the data set into the catalog once it has passed review. The SREL database also retains the capability to enter submissions via MATLAB, bypassing the web form, though this option is mostly useful for sensor data that is collected on the same project year after year.

Last year SREL implemented data deposition as part of the SREL check-out process, and has been collecting these data sets via an Excel version of the data submission form, while the web entry tool is being finalized. As with the web tool, researchers are responsible for entering their own metadata and data, and the entry is reviewed by the data manager before it is considered complete.

Additionally, just before the close of FY17, removable media discovered in the old GIS lab were analyzed for potentially useful data. One of them, a CD from the late 1990s, contained archive-related materials that will allow recovery of many of the header files previously missing from the legacy archive.

TASK 6. SREL will serve as the point-of-contact for the "DOE Research Set-Aside" areas that are protected from site impacts so that they are available for environmental research and can serve to establish representative standards for comparison to impacted areas on the SRS. Currently SRS has 30 "set-aside" areas. SREL will also continue to promote the role of the SRS as a National Environmental Research Park.

SREL Set Aside and National Environmental Research Park Activities in FY17

The SRS's Set-Aside Program began in the 1960s when the Atomic Energy Commission (AEC) established 10 relatively small SREL Reserve Areas to represent the various habitats on what was formerly known as the Savannah River Plant and to secure study sites for conducting long-term ecological research. The program was expanded in the 1980s to 30 DOE Research Set-Aside Areas to better protect sensitive species habitats, preserve the biological integrity of Upper Three Runs Creek, and to buffer SREL's long-term research sites from forest management activities. These areas are a significant component of the SRS landscape (7% of SRS, totaling 14,560 acres/5,892 ha) and are found in 43 of the site's 89 timber resource compartments. There are approximately 275 miles (443 km) of posted boundary line. Set-Asides provide sites for long-term research, habitat for sensitive species, and protection for several archaeological sites.

Administration and Management of the Set-Aside Areas – SREL serves as the point of contact for the 30 Set-Asides and provides custodial oversight of the SRS Set-Aside Program. SREL chairs the DOE's Set-Aside Task Group, which approves management prescriptions, evaluates proposed ecological research, and ensures protection from onsite land use activities. SREL serves as the representative for the Set-Aside program in the SRS Site Use process and in the military training coordination meetings, reviewing activities in both venues for potential impacts.

Set-Aside Oversight – In recent years SREL has taken a more active approach to managing these areas, with wider application of prescribed fire, as well as some timber management. Management is conducted with an adaptive approach that gives the flexibility to address changing environmental conditions as well as research needs.

- In early FY17 the SREL graduate students held a cleanup day at Ginger's Bay Set-Aside, in which all unused peripheral fences west of SC125 were removed.
- Mona and Woodward Bay Set-Aside, and the Sandhills Fire Site have both been placed on the burn schedule for early FY18 (dormant season).
- In FY17 the Task Group met to look at the effects of a growing season burn several years ago in Compartment 24, and to discuss future management of the area. It was the first growing season burn allowed into the Set-Aside, and very unusual post-burn weather conditions caused re-ignition that burned the entire floodplain in this compartment. As a result of the burn, some areas of the floodplain have increased dominance of switchcane; however some other areas have had an increase in sweetgum instead. At this point continuation of growing season fire is desirable and may be a necessity. It has been requested for growing season burn in FY18.
- In conjunction with the Wetland and Aquatic Issues Task Group, the Set-Aside Task Group participated in discussions with SCDOT regarding erosion control measures for the HWY 278 bridge replacement crossing Upper Three Runs Creek and the E. P. Odum Wetland Set-Aside.
- Extended wet conditions at Sarracenia Bay and Craig's Pond throughout this FY have aided previous years' efforts to remove invading loblolly pine infill from the ecotones via prescribed fire. Mortality is highest in Sarracenia Bay, which didn't burn well, and on the privately-owned portion of the bay, which wasn't burned at all.
- An informal sampling of the Craig's Pond sand rim (located mostly offsite and accessed with permission) conducted by SRARP suggests that this wetland, despite its impressive size, is not likely

to be of archaeological significance. The rim is shallow, and has probably not been very stable through time; Long Pond is another probable indicator of rim migration.

- A non-native red-eared slider was discovered in Craig's Pond (a first for this species on SRS) and relocated to the SREL experimental ponds. It was found near the fenceline and is assumed to be a discarded pet from offsite.

Current research in SRS Set-Asides

- SRARP continues to catalog artifacts previously recovered from Flamingo Bay SA. No additional excavations have occurred there this FY. Long term archaeological research at Flamingo Bay has provided a wealth of information on early inhabitants of the CSRA, as well as information on bay formation.

- Studies of aquatic snake populations continue at Ellenton Bay. Long-term monitoring of community dynamics will aid in understanding their response to environmental variation (drought) and amphibian prey availability.

- Long-term mark-recapture studies of aquatic turtles continue at Ellenton Bay and Dry Bay. SREL began marking turtles in Ellenton Bay in 1967.

- Studies of the life history and ecology of sirens and amphiumas continue at the Dry Bay SA.

- Research on habitat use of state-endangered gopher frogs (*Lithobates capito*) continues at Craig's Pond and Sarracenia Bay SA.

- Researchers from SREL trapped aquatic snakes at Craig's Pond and Sarracenia Bay Set-Aside.

- Researchers from SREL, USFS-SR, and the University of Kentucky continue stream characterization in the UTR/Tinker Creek Set-Asides. This research will be used to inform future DOE restoration and mitigation efforts.

- The E.P. Odum Wetland Set-Aside provided reference locations for SREL's Research Experiences for Undergraduates (REU) in Radioecology student projects.

- Researchers collected aquatic insects from the E. P. Odum Wetland Set-Aside for a stream ecology station at SREL's annual lab-wide outreach event, Touch an Animal Day.

- The E. P. Odum Wetland, Organic Soils, Beech-Hardwood, Mature Hardwood, and Flamingo Bay Set-Asides provided field sites for a study of ecological factors affecting the success of rabies elimination in the southeastern US.

- The E. P. Odum Wetland Set-Aside provided several trapping locations for a study examining group structure and modeling disease transmission in wild pigs.

- The E. P. Odum Wetland Set-Aside provided a research site for a stable isotope study examining tropic level of two songbird species, northern cardinal and great crested flycatcher. It is part of a larger study examining heavy metal body burdens in these species, and for which this Set-Aside serves as a reference area.

- Craig's Pond, Sarracenia Bay, Mona Bay, and Thunder Bay, as well as several non-SA wetlands in the central and northeast regions of the SRS, continue to be monitored as egg-laying sites for the

state-endangered gopher frog, *Lithobates capito*, and as part of a regional southeastern phylogeographic study. In addition to visual surveys for egg masses, this year SREL assisted SCDNR in audio monitoring known or historic gopher frog sites on SRS. The audio monitoring included several Set-Aside wetlands: Craig's Pond, Sarracenia Bay, Rainbow Bay, Mona Bay, and Flamingo Bay. Egg masses were not seen in any Set-Aside wetlands this year, but have been found at 5 other SRS sites. Gopher frog calls have been recorded this year at Craig and Sarracenia; however the full audio analysis has not been completed.

- Rainbow Bay, Ellenton Bay, Ginger's Bay, and Flamingo Bay continue to serve as reference sites for several amphibian ecotoxicology studies, including effects of copper in the Tritium Facility's H-02 Treatment Wetlands and metals uptake in the D-Area Ash Basin system.

- The amphibian community at the Rainbow Bay Amphibian Reserve Set Aside has been monitored for 39 consecutive years, during which time local extinctions, species colonizations, and dramatic population fluctuations have occurred. Researchers are currently investigating how amphibian community changes over time have influenced nutrient fluxes between the wetland and upland habitats.

- SREL researchers continue collecting amphibian tissue samples from multiple wetlands for studies of amphibian landscape genetics and effects of future climate change. Samples from eight species have been collected from approximately 42 isolated wetlands across the SRS, including the following Set Asides: Rainbow Bay Amphibian Reserve, Cypress Bay, Dry Bay, Ellenton Bay, Mona and Woodward Bays, Flamingo Bay, Thunder Bay, Craig's Pond and Sarracenia Bay, Ginger's Bay, and Road 6 Bay.

- Amphibian species in bay Set-Asides and other site wetlands are being monitored for two amphibian diseases of concern, chytrid and ranavirus, to determine disease prevalence on the SRS and possible relationships to contaminant distributions.

- Rainbow Bay, Ellenton Bay, Thunder Bay, Flamingo Bay, and Mona Bay all provided sites for a summer REU project investigating mercury bioavailability in geographically isolated wetlands, which receive mercury from atmospheric deposition.

National Environmental Research Park Support - SREL serves as the official SRS point of contact for the DOE National Environmental Research Park System. In its role as a point of contact, SREL conducts a variety of functions, one of which is the improvement and archiving of critical historical research data on the SRS. For more information on this subject, see the Data Management section elsewhere in this report.

TASK 7. Through general research and public outreach programs, SREL will increase scientific understanding in the general areas of environmental characterization, ecological risk assessment, and environmental remediation and restoration. This will require research on topics such as terrestrial and aquatic ecology, environmental chemistry, molecular ecology and genetics, microbial ecology, radiation ecology, and ecotoxicology. SREL will also continue to communicate and coordinate with SRS contractors and the public on these issues

In FY17 SREL faculty, staff, and students conducted and completed a diversity of outreach and education programs for the public and environmental research projects on the SRS in support of the missions of DOE (EM & NNSA) on the site. Specifically, outreach programs were conducted for local community residents on behalf of DOE as part of ongoing community education programs to increase environmental awareness of citizens and provide independent information to community residents relative to the activities of site tenants. In addition, specific research programs were conducted for NNSA to assess the environmental consequences of the Mixed Oxide Fuel Fabrication Facility on local stream quality and function as well as to assess the function, performance, and environmental consequences of constructed wetland treatment systems for metal sequestration associated with the NNSA Tritium facility on the SRS. These programs were funded by NNSA and the details of these projects are outlined below:

Research Support to DOE National Nuclear Security Agency

Environmental Outreach Programs

Funding Entity
NNSA-MOX
Start Date and Funding Amount
March 2017; $285,355
PI and co-PI's
Dr. Olin E. Rhodes, Jr. and P.J. Perea - SREL
Objectives
SREL will assist the SRS NNSA mission and MOX Project by educating the public through community outreach activities that include organizing tours and exhibits featuring the local ecology and associated research; conducting environmental education workshops for teachers, students, and the general public, as well as for site personnel; development of a variety of environmental education materials for diverse audiences; increasing internet accessibility of information; distributing ecological information; presentation of data and reports on the local and regional environment; and assisting in educational efforts about the importance of environmental stewardship and National Environmental Research Park (NERP) programs at the SRS. Accomplishments relative to these tasks will be summarized in an annual report.
Summary of Program Activities
The SREL Environmental Outreach Program utilizes information from SREL's ongoing research and long-term research efforts to provide training and services to MOX and other SRS employees. The program also educates the public locally, regionally, and nationally about ecological research findings associated with on-site activities.

NNSA has continued to provide critical funding that has facilitated SREL's ability to achieve the goal of maintaining informative outreach programs for SRS personnel and stakeholders, as well as programs that educate the public through outreach. These programs enhance an individual's understanding of environmental issues affecting the SRS and increase general ecological awareness. In fiscal year 2017, SREL conducted engaging educational presentations to K-12 schools and adult audiences. These outreach efforts achieved DOE and NNSA goals of enhancing the public's knowledge and understanding of the ecological health of the SRS, and the importance of environmental stewardship and the National

Environmental Research Park (NERP) programs on the SRS. SREL also distributed educational resource materials to facilitate these goals.

The Outreach Program was readily available to conduct Lunch and Learn presentations to site personnel at the MOX Facility, provided tours for DOE site interns, new MOX employees, and children of SRS personnel. SREL developed and distributed literature and developed displays on animals and plants native to the SRS and the surrounding communities, produced materials on specific research programs, and maintained the MOX Conservation Garden at the facility.

The SREL Outreach Program is designed to enhance SREL's overall mission of acquiring and communicating environmental knowledge and to highlight NNSA's and DOE's focus on environmental issues on the SRS. To accomplish these goals, education initiatives are used that include 1) Environmental Safety on the SRS, 2) On-site outreach to the general public and site personnel, and 3) Off-site outreach activities at schools, civic organizations, and community events. Issues as diverse as wildlife safety in the field, wildlife population declines, potential responses of organisms to contamination, distribution of abundance of sensitive species, impacts of invasive species, wetland dynamics and remediation, water quality, and dispersal of organisms from radioactively or chemically contaminated sites are all important to on-site personnel and the general public.

Major Impact(s) of Program

1) SREL has been heavily involved in assisting the MOX project by facilitating the environmental component of the LEED (Leadership in Energy and Environmental Design) certification requirements.
2) SREL's Outreach program has consistently communicated information about the environmental activities on the SRS based on ecological research conducted on the site by SREL scientists. Regardless of format — presentations, tours, or exhibits, the SREL Outreach program's numerous efforts continue to succeed in raising awareness through education of the rich ecological diversity of the SRS MOX area and the region. The program continues to succeed in developing the general public's knowledge of and appreciation for the fauna and flora native to the area and in so doing develops an active interest in environmental stewardship, and an interest in protecting the integrity of the environment on the SRS and the communities that surround it.

Other Project Personnel

Vicky Sutton-Jackson, Public Relations Coordinator – SREL
Sean Poppy, Outreach Coordinator – SREL
Angela Tucker, Animal Caretaker – SREL
Judy Greene-McLeod, Research Professional – SREL
Carol Eldridge, Research Professional– SREL

External Collaborators

Dr. Kimberly Andrews – Georgia Sea Turtle Center

Products

1) Conducted 28 scheduled tours; number of attendees – 864 (includes 19 SRS Public Tours, attendees – 662; 9 tours for on-site employees/visitors, attendees – 202)
2) Provided 8 Wildlife Safety talks; number of attendees – 280 (includes 7 talks to SRS employees, number of attendees – 244; 1 talk to professional group, number of attendees – 36)
3) Presented 273 classroom education programs for elementary and secondary students; number of attendees – 17,214
4) Provided 52 environmental outreach presentations to college, civic, and professional groups; number of attendees – 5,789
5) Provided 22 exhibits at local and regional events; estimated number of attendees – 17,188 (includes 6 career exhibits at schools, estimated attendees – 3,384; 7 science exhibits at schools, estimated number of attendees – 2,507; and 1 SRS Safety Expo, estimated number of attendees – 2,500)

6) Conducted 43 Ecologist for a Day programs (school field trips to SREL's Conference Center); number of attendees – 1,115
7) Conducted 1 Touch an Animal Day event (August 26, 2017 at SREL's Conference Center); number of attendees – 813
8) Hosted 1 Eco-Meet event (May 5, 2017 at SREL's Conference Center); number of attendees –130
9) Provided 22 presentations at regional library summer reading programs – estimated number of attendees – 1,912

***Total Outreach events: 450; total estimated attendance: 45,305**

Restoration of the MOX stream (Tributary U8): Initial efforts

Funding Entity
NNSA - MOX
Start Date and Funding Amount
April 2017; $213,645
PI and co-PI's
Dr. J Vaun McArthur, Dean Fletcher and Dr. Olin E. Rhodes Jr. - SREL
Summary of Research Activities
Integration of our work on tributary U8 into additional SRS stream studies has expanded the geographic scope as well as incorporated additional critical expertise into our collaborative effort. The NNSA-MOX funded study, while providing a nucleus for the U8 work to be built around, is benefiting by contaminant analyses being placed into a broader spatial perspective with comparisons to other stressed SRS streams. Use of the same study taxa and environmental media along with identical laboratory and field protocols has allowed seamless comparison of data among these efforts. Overall, our contaminant assessments have included five streams in the Upper Three Runs basin and now expanded to include Upper Three Runs. The latter evaluates whether U8 is increasing contaminants in the main stem of Upper Three Runs. Geomorphic and hydrologic analyses of these streams have also been conducted in collaboration with the University of Kentucky and funded by the USDA Forest Service-SR in a project aimed at setting up a mitigation bank for SRS headwater streams. The restoration potential of U8 is being evaluated.

Evaluating impacts of environmental contamination is an essential component of assessing the need of and potential for stream restoration or enhancement and in determining whether risk of contaminant mobilization exists during enhancement efforts. A total of 247 sediment samples from U8, Upper Three Runs (UTR) and McQueen Branch are being analyzed. Total mercury concentrations were determined with a DMA-80 direct mercury analyzer and Cs-137 analyzed using an auto-gamma counter. Concentrations of 18 trace elements (Be, Mg, Al, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Sr, Cd, Ba, Pb, and U) will be determined by inductively coupled plasma mass spectrometry and reported in FY18. Water velocity at each sample location was measured at the time of sampling. Percent organic matter was determined by measuring the dry weight of the sediment and the ashed weight after four hours in a muffle furnace. Clay content of each sediment sample was determined using the micro-pipette method. Our efforts include a comprehensive baseline of contaminant distribution in the U8 system with 181 sediment samples being analyzed from the U8 drainage basin. Of 81 samples collected from the U8 stream channel, 42 were collected from the perennial stream that originates just below the MOX construction site, 8 from the short intermittent reach that lies in the cleared area beside of the construction site, and 24 from the ephemeral channel/ditches that extend to above the F Area coal fly ash basin. Additionally, 80 sediment samples are being analyzed from 9 sedimentation/retention basins and a borrow pit in the U8 drainage. Because ash was observed on the sides of the coal fly ash basin where it could be readily washed into the stream, we also analyzed 5 samples from the sides of this basin. We put the U8 drainage into a larger spatial perspective by analyzing 37 sediment samples distributed longitudinally down Upper Three Runs from the northern site border to below Road C. Another 36 samples were analyzed from McQueen Branch and 8 from Meyers Branch to evaluate background contaminant levels and to clarify the role of ponds and basins in the storage and redistribution of contaminants.

Percent organic matter in the sediment strongly influenced Hg and Cs-137 concentrations along the entire reach of UTR. In fact, the percent organic matter in the samples more strongly influenced concentration than UTR location. Similarly, within the U8 drainage, most variability within a site can be explained by percent organic matter in the sample. This illustrates the risk of taking single sediment samples and not characterizing the collection location or sediment composition as is routinely reported in SRS surveillance programs.

No significant patterns of higher Hg concentrations in Upper Three Runs sediments associated with the U8 confluence were found. Mercury concentrations from the segment above the McQueen Branch confluence (above SRS contaminant sources), the segment between the McQueen Branch and U8 confluences (SRS contaminant sources above U8), and below the U8 confluence did not significantly differ with organic matter content accounted. Moreover, Hg concentrations in all 37 Upper Three Runs sediment samples were relatively low with no samples exceeding the Ecological Screening Value (ESV; Friday 2005) of 0.13 ppm.

Sampling within the McQueen Branch drainage identified a beaver pond and retention basin to accumulate the highest concentrations of Hg. Average concentrations only exceeded the ESV in the main stem beaver pond where organic matter and contaminants settled out in a location with large drainage area above it. Although the average was lower, exceedance of the ESV by some samples collected from a Meyers Branch beaver pond illustrates the importance of atmospheric deposition in the Central Savannah River Area. Hg concentrations in the perennial segment of U8 did not exceed 0.05 ppm. Higher Hg concentrations (average = 0.08 ppm with one sample exceeding the ESV) occurred between the rip rap in the cleared area and the outfalls beside the MOX construction site. However, higher concentrations are expected in the base of a basin with a relatively large upstream drainage area and the average did not presently exceed that of the reference site. Additionally, average Hg concentrations exceeded the ESV in some locations upstream of the MOX construction site. Samples collected from the outer sides of the levee enclosing the coal fly ash basin averaged 0.16 ppm. The highest concentrations in the U8 drainage averaged 0.20 ppm with concentrations as high as 0.40 ppm in the Northwest SWDF Sedimentation Basin located beside the burial ground and associated with the E-02 Outfall. Identification of potential contaminant sources within the U8 drainage will be further evaluated with the analysis of additional trace element data. It is already apparent however, that any future assessments of contaminants potentially originating from the MOX construction site must account for contaminants originating from upstream.

Upper Three Runs sediments had accumulated only low levels of Cesium-137 with all less than < 0.5 Bq/g. Further, we found no evidence of increased levels below the confluence of tributary U8. Sites within the U8 drainage differed in Cs-137 levels, but all locations averaged less than 0.15 Bq/g clearly indicating no contamination problems.

The abundance and diversity of three taxa of macroinvertebrates are informative on the condition of a stream. Highest percentage of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa (EPT) were found at Tinker Creek. Next highest were found at U36 and McQueen Branch. Lowest percentage of EPT were found at middle and upper reaches of U8. Highest taxa diversity (all species) was found at U36 followed by McQueen Branch. The control stream U10 had the third highest diversity. The lower and upper reaches of U8 and U8 had the lowest taxa diversity. Stream U8 has significantly lower ($p < 0.05$) taxa richness, diversity and percentage of taxa that are Ephemeroptera, Plectoptera and Trichoptera than any of the other stream systems examined. .

Conclusions

1) U8 is severely degraded with impaired hydrology, channel form, substrate composition, and biological communities; impacts on stream macroinvertebrate communities and life histories have been observed.
2) Scouring by excessive flows has reduced organic matter content in the streams, influencing contaminant dynamics and potentially stream energetics.
3) Evaluation of sediments throughout the U8 indicated no concern of Cs-137 contamination.
4) Cs-137 levels in UTR sediments were low and not elevated below the U8 confluence.
5) Mercury concentrations in sediments of the U8 perennial did not exceed the Ecological Screening Values.

6) Substantially elevated Hg concentrations were found in locations upstream of the MOX construction site; any assessment of contaminants potentially originating from the MOX construction site must account for contaminants originating from upstream.
7) Patterns of trace element accumulation in biota tended to be element and taxa dependent, but patterns of elements frequently accumulating to higher concentrations in the disturbed sites were evident.

Major Impact(s) of Research

1) We are providing a comprehensive base line of the present status of the U8 drainage and are assessing potential impacts of MOX construction and other activities in the U8 drainage.
2) Extensive contaminant analyses combined with the physical characterization are helping distinguish whether contaminants are involved in the observed biological impairments or the impacts are primarily the result of excessive runoff.
3) A group of onsite and offsite collaborators are proposing a restoration plan including a post-treatment monitoring for tributary U8.

Other Project Personnel

Paul Stankus, Research Professional – SREL
Brooke Lindell, Research Technician – SREL
John Seaman, Senior Scientist – SREL
Angela Lindell, Research Professional – SREL
Danielle Pitt, Research Technician – SREL

External Collaborators

Dr. Christopher Barton – University of Kentucky
Dr. Richard Biemiller – University of Kentucky
James Fudge – SRNS
Dr. John Blake – USDA Forest Service

Products

McArthur, JV., D.E. Fletcher, R.C. Tuckfield, C. Baker-Austin. 2015. Patterns of multi-antibiotic-resistant *Escherichia coli* from streams with no history of antimicrobial inputs. Microbial Ecology 72(4): 840-850.

Fletcher, D.E., A.H. Lindell, J.C. Seaman, P.T. Stankus, D.B. Pitt, and JV. McArthur. Effects of industrial activity on trace element accumulation, community compositions, and population structure of dragonfly nymphs in coastal plain streams. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Orlando, FL, November 2016. (Poster).

Lindell, B.E., John C. Seaman, and D.E. Fletcher. Source and distribution of Hg, Cs-137, and trace elements in sediment of a coastal plain stream. Annual Meeting of the Society of Freshwater Science, Raleigh, NC, May 2017. (Poster).

H-02 Constructed Wetland Studies: Amphibian Ecotoxicology

Funding Entity
NNSA Tritium Facility via DOE CA
Start Date and Funding Amount
October 2016; $298,498
PI and co-PI's
Dr. Stacey Lance and David Scott – SREL
Objectives
Our research at the H-02 constructed wetland complex focuses primarily on several questions related to these treatment wetlands: 1) Over time, what amphibians, reptiles, and plants have become established in the wetlands? 2) Do the elevated trace metal levels (e.g., copper and zinc) in the wetlands affect amphibian reproductive success, disease ecology, and population dynamics? 3) How do the amphibian diversity and numbers compare to other, more natural, wetlands? and 4) As the constructed wetlands age, how will the amphibian community respond?
Summary of Research Activities
This report summarizes our amphibian studies related to the H-02 treatment wetlands from October 2016 to September 2017. Following up on previous research, during this year we continued analyzing data on amphibian communities and disease prevalence from 20 wetlands on the SRS. These data will be critical for establishing a baseline for amphibians in natural ephemeral wetlands. We sampled over 30,000 individuals and are screening several thousand for ranavirus. Similarly, we continued work to examine the landscape genetics of two species, the Southern toad and Southern leopard frog, from across the SRS. We have collected individuals from >20 wetlands and targeted several contaminated wetlands as well as wetlands from increasing distance from a contaminated wetland. We used subsets of these individuals to create genomic libraries for next-generation sequencing to identify single nucleotide polymorphism loci. We have identified thousands of loci and are currently designing capture baits for ~5,000 loci. We will use those baits to "capture" the same loci from all of our sampled individuals across the SRS. From these data, we will be able to establish baseline levels of genetic diversity in both species and examine patterns of gene flow across the SRS. These data are critical for establishing whether the contaminated wetlands on the SRS, such as the H-02 wetlands, are acting as ecological sinks or traps. In addition to these site-wide studies, we undertook a more targeted experimental analysis. We reared larval southern toads in two reference wetlands, fire pond and Bay 52, and two contaminated wetlands, H-02 and Pond B. The toads were reared *in situ* for several weeks and we monitored growth and development photographically. Upon metamorphosis, we returned toads to the lab and exposed half of them to ranavirus. Previously we had documented higher prevalence of disease in contaminated wetlands of the SRS. Our data indicate that growth and development of southern toads was not delayed in either contaminated wetland. Rather, it was accelerated in the H-02 wetlands. However, toads reared in the H-02 wetlands tended to have higher viral loads after exposure to ranavirus. Finally, we completed the 38th year of monitoring at RB, and finished analyzing the data in the context of community shifts in response to environmental change and subsequent impacts on nutrient cycling.
Conclusions
1) Southern toad juveniles exposed to copper as larvae grew faster but were more susceptible to ranavirus than larvae grown in reference sites.
2) Ranavirus remains present in multiple wetlands on the SRS and poses a risk to cause population die-offs.
3) Amphibian species richness ranges from 4-12 species and is largely driven by wetland hydroperiod.
4) The amphibian community at Rainbow Bay has shifted from long- to short-hydroperiod species over three decades in response to drought and associated shortened wetland hydroperiods.
5) Ignoring adult mortality in models of terrestrial flux of biomass leads to erroneous conclusions.
6) The probability of terrestrial flux of nutrients due to amphibian movements is tightly linked to wetland hydroperiod and amphibian biomass, but not specific species.

Major Impact(s) of Research

1) Our continued time series of metal concentrations in the H-02 system (in sediments, water, and biota) will enable informed assessment of how this type of constructed treatment wetland functions, and whether it provides suitable wildlife habitat in addition to enhancing water quality.
2) Our *in situ,* mesocosm and laboratory studies demonstrate the importance of looking a) at multiple stressors, b) beyond the larval period, and c) at multiple source populations. We have found significant latent effects that lead to completely different conclusions than the larval study alone—effects on juvenile survival were apparent five months later, largely due to Cu effects on body size at metamorphosis.
3) Our disease studies are ongoing, but are demonstrating the complexity of variables involved with disease incidence and prevalence in amphibians. The nature of the wetland—metal-contaminated vs. clean, permanent vs. ephemeral, and constructed treatment wetland vs. natural— impacts disease prevalence and variables are confounded with each other.
4) Exposure to a stressful environment may lead to accelerated growth of tadpoles but that may come at a cost of weakened immune responses.
5) Ranavirus exposure can cause serious sub-lethal effects such as growth rate, and more studies are required to determine if these effects can influence population dynamics.
6) Our understanding of the factors that drive the population dynamics of amphibians in natural systems, based on the long-term RB study, will allow predictions of the effects of climate change on isolated wetlands and provide insights to land managers who may need to design protective measures for rare species.

Other Project Personnel

Wes Flynn, PhD Student, – UGA
Cara Love, PhD Student – UGA
Austin Coleman, MS Student – UGA
Mariela Muñiz-Gonzalez, REU Student – SREL

External Collaborators

Dr. Scott Weir – Queens University
Dr. Krista Capps – UGA
Dr. Schyler Nunziata –University of Kentucky
Julie Ziemba – UGA

Products

Rumrill, C.T., D.E. Scott, and S.L. Lance (In review) Delayed effects and complex life cycles: How the larval aquatic environment influences terrestrial performance and survival. *Environmental Toxicology and Chemistry*.

Winzeler, M.E., D. Haskins, S.L. Lance, and T.D. Tuberville (2017) Survey of aquatic turtles on the Savannah River Site, SC for presence of ranavirus. *Journal of Wildlife Diseases*. In press.

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Weir, S.M., Scott, D.E., Salice, C.J., and S.L. Lance. 2016. Integrating copper toxicity and climate change to understand extinction risk to two species of pond-breeding anurans. *Ecological Applications* 26:1721-1732.

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Muñiz-Gonzalez, M., J. Ziemba, and S.L. Lance. 2017. The impact of contaminants on growth, development, and disease susceptibility of Southern toads. SREL NSF REU Undergraduate Research Symposium, Aiken, SC. (Platform presentation)

Scott, D.E., S. Weir, K. Capps, S. Nunziata, and S. Lance. 2017. Exploring ecological connectivity among geographically isolated wetlands. American Water Resources Association. Snowbird, Utah. (Platform).

Scott, D.E., S. Weir, K. Capps, S. Nunziata, and S. Lance. 2017. Exploring ecological connectivity among geographically isolated wetlands. Society for Freshwater Science. Raleigh, NC. (Platform).

Coleman, A., and S. Lance. 2017. Drivers of community structure and implications for amphibian disease dynamics. Annual meeting of the University of Florida Wildlife and Aquatic Veterinary Disease Laboratory, Gainesville, FL (Platform).

Coleman, A., and S. Lance. 2017. Drivers of community structure and implications for amphibian disease dynamics. Annual meeting of the Society for Integrative and Comparative Biology. New Orleans, LA (Poster).

H-02 Constructed Wetland Studies—Ecosystem Health

Funding Entity
NNSA - Tritium
Start Date and Funding Amount
October 2016; $152,811.78
PI and co-PI's
Dr. Gene Rhodes and Dean Fletcher - SREL
Objectives
The H-02 wetland water treatment system was constructed as a green technology initiative to remove metals and buffer pH in discharge waters from the NNSA Tritium Processing facility. Constructed wetlands have been widely employed to reduce nutrients and prevent eutrophication of surface waters. Their application for treatment of metal contaminated wastewater is still being refined. Our overall goal is to assess wetland effectiveness and develop strategies to maintain or improve treatment efficiency of the NNSA constructed wetlands to ensure long-term sustainability. Information is needed to assess: (1) the distribution of biologically available contaminants throughout and below the system, (2) effects of disturbance events (e.g., storms) on wetland effectiveness, (3) the potential export of metals to the terrestrial environment by organisms, (4) effects of daily discharge fluctuations on wetland efficiency, (5) the potential of managing the retention basin as a pre-filter for the wetland cells. Previous work indicated considerably higher levels of biologically available Cu below the wetland than expected. Work efforts are focusing on identifying the conditions under which metals pass through the wetland system and on developing strategies to improve wetland treatment efficiency.
Summary of Research Activities
Metal Mobilization by Stormwater Flows--Previous work demonstrated changes in metal concentrations and transport flux during storm events. Such events have the potential of explaining the higher than expected levels of bioavailable metals below the wetland treatment cells. Twenty-four bottle ISCO sampling units are in operation immediately above and below the wetland cells and are continually recording rainfall, discharge, and water quality parameters at 15 minute intervals. We are establishing relationships among rainfall, discharge, and water quality parameters measured by the probes. The observed patterns were used to develop an effective water sampling strategy to evaluate factors influencing contaminant concentrations and fluxes leaving the wetlands. Diurnal as well as rainfall-related variability in discharge and water quality parameters have been observed. Of particular interest are periodic peaks of turbidity variably associated with rainfall events. Conductivity of effluent water gradually increases over time during dry periods, but drops during rain events. Return to base flow results again in a gradual rise in conductivity. Oxidation reduction potential, in contrast, drops sharply during rain events, but rapidly rebounds.

Based on these analyses, we selected storm events that produce at least 0.3 cm of rainfall in 45 minutes to trigger the ISCO units to begin collecting water samples. Hourly composite samples were collected for the first 24 hours, followed by samples collected every two hours for the next four days. Each composite sample was composed of subsamples collected every 15 minutes, which evens out any momentary spikes uncharacteristic of overall discharge. Such a spike could result from an unusually large amount of sediment sucked into the intake tube during a single sampling episode. A total of 150 water samples were collected. A portion of each sample was acidified for analyses of total metals and a portion filtered to evaluate dissolved metals. Metal analyses will be conducted on these 300 samples early in FY18.

Metal Accumulation in Macroinvertebrates--Analyzing contaminant accumulation in macroinvertebrates is enhancing our assessments by verifying levels of contaminants entering wetland communities. Macroinvertebrates are known to accumulate a variety of contaminants and represent trophic links between primary production and higher trophic level vertebrates. Our previous work evaluated contaminant accumulation in aquatic dragonfly nymphs from six sites distributed throughout

the H-02 wetland system and from two reference wetland sites. We further evaluated contaminant accumulation in crayfish, crane fly larvae and dragonflies in Crouch Branch below the H-02 system as part of a larger collaborative effort. This work established bioavailable contaminants throughout and below the H-02 wetland system. We are now assessing the potential export of contaminants into terrestrial food webs as dragonflies and damselflies emerge from the water and fly from H-02 wetland system.

At the time of emergence, dragonfly nymphs climb out of the water, frequently onto emergent vegetation or wood structure. A crack then forms on the dorsal surface of their exoskeleton and the fully developed dragonfly unfolds its abdomen and wings. After the wings dry and harden the dragonfly flies away. The emergent dragonfly is referred to as a teneral. In addition to analyzing whole-body concentrations of metals/metalloids in the teneral dragonflies, we are also analyzing concentrations in exuviae (nymph exoskeleton) shed upon emergence. The latter indicates what proportion of the nymph's contaminant load is shed in the exuviae and left behind compared to what actually leaves the wetlands in the emerging teneral. Three collection sites in the retention basin were chosen because of both sampling logistics and the high density of dragonflies inhabiting the basin. Locations included the deep (west), middle (center) and shallow (east) portions of the basin. Traps were designed to sample both near-shore and pelagic habitats within each section. Comparing species compositions of 685 teneral dragonflies to previously collected nymphs revealed significant community shifts. Community changes appear to be in response to habitat modifications due to herbicide use. Species differed in emergence chronology, habitat use, and degree of size-related sexual dimorphism.

Corresponding collected exuviae were also identified using dichotomous keys to confirm correct species pairs of teneral and exuviae were matched for chemical analyses. Teneral dragonflies were photographed and head width measured using Image J software for size frequency analysis. Individual organisms and exuviae were then lyophilized to a constant weight and weighed to the nearest 0.1 mg. Teneral dragonflies were homogenized and then subsamples were acid digested. Due to their small mass, the entire exuviae was digested. A digest aliquot was diluted in preparation for analyses of Mg, Al, V, Cr, Mn, Fe, B, Co, Ni, Cu, Zn, As, Se, Cd, Ba, and Pb concentrations employing an inductively coupled plasma mass spectroscopy following EPA Method 6020A. Certified reference material, blanks, and replicates were included in the digestion and analysis procedures for quality control purposes. Trace element concentrations were analyzed in a total of 249 teneral dragonflies and 154 exuviae. Analyzed teneral dragonflies were distributed across 2 families, 6 subfamilies, 11 genera, and 14 species.

Patterns of trace element accumulation in both exuviae and teneral dragonflies differed among species, but some consistencies within subfamilies were apparent. Copper concentrations in exuviae differed more among species than among teneral dragonflies. In particular, accumulation was more consistent within some subfamilies. Four species of libellulinae analyzed in this study have a distinctive morphology suiting them to living slightly covered by bottom sediments or detritus. The libellulinae accumulated considerably higher Cu concentrations in exuviae than tenerals, with species averaging 217 to 384 ppm in the exuviae versus only 40 to 49 ppm in the tenerals. However, teneral mass being considerably higher than exuviae results in a greater mass of Cu occurring in the tenerals. The amount of Cu shed in the exuviae is not trivial with 31 to 40 % of the emerging nymph's total body burden being shed and left behind. A different pattern occurred among the three species of trameinae. Lower concentrations accumulated in the exuviae with species averages of 43 to 46 ppm accumulating in exuviae versus 33 to 40 ppm accumulating in the teneral. These similar concentrations result in only 16 to 19 % of the total nymph body burden being left behind in the exuviae. Whether a greater mass of Cu was exported by libellulinae or trameinae depended upon species and was influenced by total body mass.

Similarly, the 4 species of libellulinae accumulated Zn concentrations of 217 to 384 ppm in exuviae versus 133 to 151 ppm in tenerals. A greater mass occurred in the tenerals than exuviae, but 23 to 35 %

of the nymph total body burden was shed during emergence. The trameinae species exhibited less surface binding with species averaging lower concentrations in their exuviae (94 to 111 ppm) than in the teneral (127 to 131 ppm). This equates to only 5 to 6 percent of the total nymph body mass being left behind. Other elements differed greatly in their propensity to be surface bound or incorporated into the shed exuviae. For example within the 4 species of libelullinae, averages of 80 to 97 % of the Al, Fe, Ba, and Pb was shed in the exuviae and remained in the wetland. In contrast, less than 20 % of the Mg and B were shed. Very little Se was shed, but concentrations accumulating in the tenerals were low. Overall, concentrations of elements accumulating in nymphs are indicative of trophic doses when preyed upon directly, but not necessarily to that of predators preying on emerging dragonflies.

Effects of Sediment Exposure on Macroinvertebrates--Our work conducted in streams and wetlands frequently found taxa associated with sediments, particularly fine sediments rich in organic matter, to accumulate higher concentrations of metals/metalloids. However, because these comparisons involve different genera/species, we cannot rule out that some aspect each taxa's biology (e.g. rates of efflux) is responsible for producing these patterns. A study was designed to cage dragonfly nymphs individually in the retention basin. Cages will be held at multiple water levels ranging from the bottom sediments to near the water surface. This will allow comparison of the same genera held at different distances from the sediment. Prototype cages were designed and tested in FY17 by holding nymphs in the cages for over 2 months. Because of the higher metal concentrations and higher pH of retention basin water than unpolluted wetlands, we also tested and found that nymphs collected from unpolluted sites do survive when held in retention basin cages. After this testing, we began cage construction with deployment to occur in FY18.

Conclusions

1) The H-02 constructed wetland effectively reduces Cu and Zn concentrations in the Tritium Facility discharge wastewaters to achieve SCDEHC regulatory limits for wetland effluent at base flows, but Cu is accumulating downstream of the wetlands.
2) Elements differ in their propensity to accumulate in the exuviae that is shed during emergence and remains in the wetland.
3) The amount of each element exported from the wetland in the emerging teneral also differs among species, but similarities within subfamilies were observed.
4) Complex factors including habitat use and availability can influence contaminant accumulation in aquatic organisms.
5) Concentrations of trace elements accumulating in nymphs are indicative of trophic doses when preyed upon directly, but not necessarily to that of predators preying on emerging dragonflies.
6) Storm events significantly influence discharged water quality parameters.

Major Impacts of Research

1) This research supports the use of cost effective constructed wetlands for the treatment of metal contaminated waste water and supports DOE's goal of employing "green technologies" for waste cleanup and remediation. Constructed wetlands play an important role in the SRS environmental plan to achieve both federal and state regulatory compliance for the discharge of effluent waters.
2) Our research evaluates the potential transport of contaminants from constructed wetlands to downstream waters or terrestrial environments and supports DOE commitment to good ecological stewardship. Evaluations are aimed at developing management strategies to maximize wetland effectiveness.
3) Results of our studies support the EPA's goal of advancing our understanding of metal dynamics in wetland systems and developing better tools for predicting the fate and effects of metals in aquatic ecosystems.

Other Project Personnel

Danielle Pitt, Research Technician – SREL
Paul Stankus, Research Professional – SREL
Brooke Lindell, Undergraduate Student – College of Charleston

Dr. J Vaun McArthur, Senior Ecologist – SREL
Dr. Xiaoyu Xu, Postdoc – SREL
Angela Lindell, Research Professional – SREL

Products

Fletcher, D.E., A.H. Lindell, P.T. Stankus, G.L. Mills, and D.B. Pitt. Trace element accumulation in dragonfly nymphs and crayfish as indicators of constructed wetland effectiveness. Annual Meeting of the Society of Freshwater Science, Raleigh, NC, May 2017. (Oral presentation).

Lindell, A.H., P.T. Stankus, D.B. Pitt, G.L. Mills, and D.E. Fletcher. Trace element accumulation in six dragonfly genera from a wetland constructed for Cu and Zn Effluent treatment. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Orlando, FL, November 2017. (Poster).

H-02 Constructed Wetland Studies— Biogeochemical Processes

Funding Entity
NNSA - Tritium
Start Date and Funding Amount
October 2016; $275,823
PI and co-PI's
Dr. Gary Mills and Dr. Xiaoyu Xu - SREL
Objectives
The goal of this research is to support, assess and improve operations of the NNSA constructed wetlands to maintain treatment efficiency and ensure long-term sustainability. Our primary objectives are to study: (1) the bioavailability of metals in surface waters and sediment pore waters, (2) the chemical form and stability of sediment accumulated metals, (3) the potential for remobilizing sediment metals as a consequence of geochemical disturbances, and (4) the long-term sustainability of metal sequestration in the wetland
Summary of Research Activities
We continued monthly monitoring of metal (Cu and Zn) concentrations and water quality parameters (e.g., temperature, pH, ORP, alkalinity, DOC, sulfate, and chloride) in surface waters. Water samples were collected at the primary discharge pipes from the Tritium Facility, the retention basin, influent, and effluent in both wetland cells, and the discharge stream that carries the effluent to Upper Three Runs. Discharged metals from the Tritium Processing Facility were efficiently removed by the constructed wetland system, and the removal efficiency of Cu and Zn were over 60%. Influent and effluent concentrations of Cu and Zn in FY-17 were more variable and outside the range observed in FY-16. Total concentrations of Cu and Zn tended to decrease following the flow path of water in the wetland system. Samples collected from source pipes and influent prior to the wetland treatment cells showed higher total Cu concentrations than the monthly discharge permit (12.3 µg/L, NPDES). But the mean total Cu concentration in the stream (5.8 µg/L) was generally lower than this regulatory criteria. The mean total Zn concentration from each sampling location was consistently below the NPDES permit (110 µg/L). Most of the metal species was present in dissolved phase which accounts for over 50% the total species.

Water quality parameters were also studied in the water samples. There was no seasonal change for the pH values, but the alkaline waters became nearly neutral after running through the wetland cells as the mean pH values in the effluent (6.8) decreased significantly compared to the influent (8.6). These results are consistent with data from previous years. The ORP values in the effluent was generally higher than the influent with an exception of January. The ORP values were considerably variable with noticeable decrease in July and August, indicating a reducing state in the surface waters. Sulfate concentrations varied temporally: the effluent concentrations were much lower than the influent during the "warm" season (spring and summer, Feb. to Aug.) but higher than the influent during the "cold" season (fall and winter, Sep. to next Mar.). Sulfate concentrations in May to July were statistically lower compared to other months in that year. Water temperature varied seasonally with higher values in spring and summer (Feb. to Aug.) and lower values in fall and winter (Sep. to Feb.). Temperatures in the effluent and water cells were close to each other and constantly lower than the influent. Total alkalinity was presented by $CaCO_3$, and it was not statistically different between the influent and effluent waters. Chloride concentrations tended to increase from Jan. to Nov., and the effluent concentrations were generally lower than the influent. The overall DOC concentrations in the effluent were higher compared to the influent ($p < 0.01$).

Speciation of Cu and Zn in the influent and effluent waters were modeled in Windermere Humic Aqueous Model 7 (WAHM 7). The percentage of inorganic Cu and Zn were extremely low (<0.01%). The complexes of Cu-humic acid (HA) and Zn-HA averagely accounted for 71.5% and 72.9% of total Cu and Zn species, respectively, which were much higher than Cu- fulvic acid (FA, 28.5%) and Zn-HA (27.1%). The %metal-HA and %metal-FA in the effluent waters were relatively constant and less variable than that in the influent

waters. We observed temporal variations of metal-organic complexes in the influent waters. Take Cu for instance, the %Cu-FA / %Cu-HA in the influent were generally stable during a year except Oct. when it suddenly increased / decreased up to 30%. The %Cu-FA and %Cu-HA then gradually went back to previous levels at next Apr. The complexes of Zn-HA and Zn-FA in the influent present similar temporal trends. Concentrations of Cu-FA and Zn-FA complexes retained by wetland cells were also calculated: the Cu-FA and Zn-FA concentrations in wetland cells increased remarkably at Oct. and were much higher than the concentrations at the rest of that year. However, there was not any temporal change for Cu-HA and Zn-HA concentrations retained by wetland cells and they kept a relatively stable concentrations of 10 μg/L. We also modeled speciation of metal-organic complexes in WHAM 7. About 99.9% of Zn-HA and Zn-FA in both the influent and effluent waters binded by electrostatic attraction, which is defined as "non-specific binding" here. Similarly, 97.2% of Cu-HA and 95.4% of Cu-FA in the influent, and 81.7% of Cu-HA and 75.2% of Cu-FA in the effluent formed non-specific bonds. The rest of Cu-HA and Cu-FA complexes binded by chemisorptions that is definded as "specific binding" here. We explored three types of specific bindings: the trdentate, bidentate, and monodentate bonds, which made of >50%, <50%, and <0.01% of all specific Cu-organic complexes.

The metal-removal processes (Figure 1) by wetland cells were explored with metal concentrations in surface waters, water quality parameters, and output of speciation models. Sulfur plays a critical role in the biogeochemistry of wetlands due to the large inputs of organic matters and the aerobic and anaerobic conditions under which sulfur transformation occurs. Calcium sulfate added to the wetland soil provided large amount of inorganic sulfur that eventually fell into two main categories: oxidation and reduction of inorganic sulfur. Sulfate compounds were consumed by the wetland during the ***"warm" season (Feb. to Aug.)*** of a year since sulfate concentrations in the effluent were lower than the influent. High temperature, adequate labile organic matters, and anaerobic environment favored sulfate reduction that produced sulfide minerals to completely remove metals from water columns. Hydrogen sulfide (H_2S), the product of sulfate reduction, is able to react with metal ions to form metal-sulfide complexes, leading to precipitation and sequestration of metals by the formation of highly insoluble sulfide minerals. CuS and ZnS were major species removed from H-02 wetland waters during this time. ***Aug***. was a critical time relative to sulfur cycling when sulfate concentrations in the effluent suddenly increased at the end of Aug., presenting statistically higher concentrations ($p < 0.01$) than the influent during the "cold" season (Aug. to next Mar.). Rates of sulfate reduction substantially decreased with temperature fluctuation, greater penetration of oxygen, decreased availability of organic content, and decreased activity of mesophilic sulfate reducers. Meanwhile, sulfide compounds produced by sulfate reduction bacteria during the "warm" season were rapidly accumulated in the pore waters of the vegetated sediment, which can be uptaken and assimilated by the wetland plants. Upon the cease of plant growth at the end of Aug., sulfide concentrations increased to levels that inhibit sulfate reduction but favored sulfide oxidation. We believed sulfate compounds were oxidized during the ***"cold" season (Sept. to next Mar.)*** of a year as sulfate concentrations in the effluent were higher than the influent. Wetland plants transport oxygen to the roots, cause the loss of radial oxygen, and increase the redox potential, leading to the re-mobilization of precipitated metals. Although sulfate reductions still occurred during the "cold" season considering the water ORP values, sulfate concentrations in the effluent were much higher than the influent due to sulfate oxidation. The significant decrease of sulfide production indicated the fact that forming metal-sulfide minerals cannot efficiently remove metals anymore. However, the wetland system still functioned well since the removal efficiency of Cu and Zn did not change statistically ($p > 0.05$) between the "warm" and "cold" season. WHAM indicated: (1) more Cu-FA and Zn-FA were introduced to the wetland cells with influent and were also retained by the wetland sediment staring at each Oct.; (2) the concentrations of Cu-FA and Zn-FA in the wetland cells also peaked at each Oct. These results demonstrated the increase of interactions between metals and organic matters. Accordingly, we think adsorption to organic matters was the major metal-removal process in the "cold" season. There is a thick layer of organic flocculation on top of the surface sediment (0 to 5 cm) in H-02 wetland due to the seasonal cycling of growth, death, and decay of plants and animals. Heterotrophic bacteria are able to consume organic detritus and metabolically convert them to POC and DOC. As more

biomass accumulated in the "cold" season and the microbial decomposition proceeds, more labile components of organic matters react with contaminants in the wetland. In general, the increased organic contents greatly enhanced the wetland capacities of chelating inorganic compounds and kept the wetland system functioning well when sulfate reduction attenuated in the "cold" season. The speciation model also found out Cu and Zn binds FA and HA mostly by electrostatic attraction, which is unstable and influenced by environmental conditions easily. We think these compounds were most likely to form stable metal-organic complexes later with strong bindings such as chemisorptions, and then accumulate in the organic flocculation layer at the sediment surface. They may also unbind from each other, releasing free metal ions that form inorganic metal complexes, react with biotic ligand, or directly act on biological membranes. In summary, the metal-removal process in the wetland cells was season-related and regulated by sulfur cycling. The metal-FA accumulation in the wetland system may cause negative effects to the surrounding environments as they are biologically reactive, highly bioavailable, and can be easily transferred to terrestrial ecosystems by trophic flux. Future studies on metal accumulations and water chemistries in sediment pore waters are required to address the details of metal biogeochemical process.

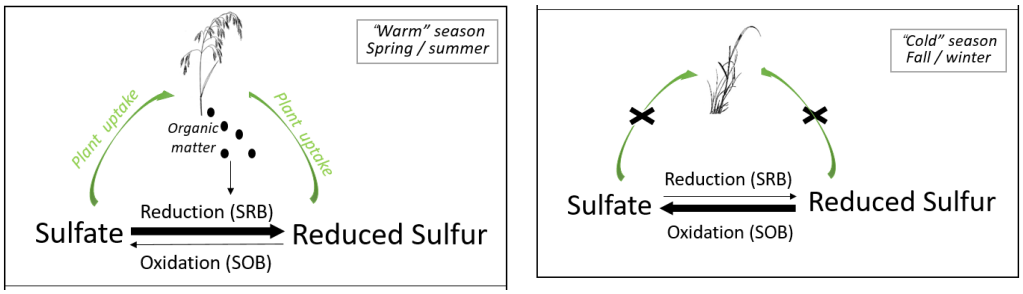

Figure 1: Schematic diagram of sulfur cycle in the wetland sediments during deffierent seasons.

In FY-17, we continued using DGT exposures coupled with aquatic organism bioassays to assess the use of DGT as a tool for estimating metal bioavailability. Cu and Zn concentrations in fathead minnow (*Pimephales promelas*) were compared with DGT accumulated metals after 4 days of exposure to wetland waters. The water solutions were prepared using the EPA recommended formulation to represent the composition of blackwater typical of the streams on the SRS (e.g., Upper Three Runs). DGT accumulated metals include free ions, labile inorganic complexes, and complexes between metal and labile dissolved organic matters when compared to metal speciation output from the Windermere Humic Aqueous Model. Regressions of DGT and fathead minnow accumulated metal demonstrated linear relationships, but WHAM predicted bioavailable metals didn't correlate with metal concentrations in fish. This suggest the *in-situ* field deployment of DGT is useful to assess bioavailability and bioaccumulation for fathead minnow. However, further studies involving deployment in the actual environment are need and will begin in FY-18.

Conclusions

1) The H-02 constructed wetland effectively reduces Cu and Zn concentrations in the Tritium Facility discharge wastewater to achieve NPDES regulatory limits.
2) The metal-removal process in the wetland cells is season-related and regulated by sulfur cycling. Composition of metal-sulfide minerals is the major removal process during the "warm" season (Feb. to Aug.) of a year and adsorption to organic matters became the primary process for removal during the "cold" season (Sept. to next Mar.).
3) DGT provide a good estimate of metal bioavailability and accumulation for fathead minnow at the exposure concentrations.

Major Impacts of Research

1) This research supports the use of cost effective constructed wetlands for the treatment of metal contaminated waste water and supports DOE's goal of employing "green technologies" for waste cleanup and remediation. Constructed wetlands play an important role in the SRS environmental plan to achieve both federal and state regulatory compliance for the discharge of effluent waters.

2) Our research evaluates the potential transport of contaminants from constructed wetlands to terrestrial environments and supports DOE commitment to good ecological stewardship.
3) Results of our studies support the EPA's goal of advancing our understanding of metal biogeochemistry in wetland systems and developing better tools for predicting the fate and effects of metals in aquatic ecosystems.

Other Project Personnel

Jasmine R Parks, Research Technician – SREL
Kara L Norris, Research Technician – SREL

External Collaborators

NA

Products

Philipps, RR, Mills GL, Bringolf RB, Xu X. Evaluation of diffusive gradients in thin-films for prediction of copper bioaccumulation by yellow lampmussel (*Lampsilis cariosa*) and fathead minnow (*Pimephales promelas*). *Submitted to Environmental Toxicology and Chemistry*.

Philipps, RR, Mills GL, Bringolf RB, Xu X. Bioaccumulation of copper and lead by fathead minnow (*Pimephales promelas*) and yellow lampmussel (*Lampsilis cariosa*): evaluation of DGT technique for predicting uptake of metal mixtures. *Submitted to Science of the Total Environment*.

Xu X, Mills GL. Does the constructed wetland remove metals or increase metal bioavailability? The removal processes of copper and zinc in a constructed wetland. *Prepare to submit.*

Xu X, Mills GL. Using diffusive gradients in thin-films for prediction of metal bioaccumulation by fathead minnow (*Pimephales promelas*) in a constructed wetland. *Prepare to submit.*

Tritium Distribution and Cycling on the Savannah River Site

Funding Entity
NNSA
Start Date and Funding Amount
November 2017; $99K
PI and co-PI's
Dr. John C. Seaman - SREL
Objectives
The objective of the current project is to develop and refine monitoring protocols for evaluating organically bound tritium (OBT) levels in various plant and animal receptor species. The SRS provides an excellent setting for evaluating low-level tritium cycling dynamics in the environment, including the transformation of tritiated hydrogen gas (HT) and tritiated water (HTO) to OBT.
Summary of Research Activities
Combusted and then analyzed numerous biological samples from the SRS, including samples from the SRS Mixed Waste Management Facility (MWMF) Tritium Irrigation Site (i.e., irrigation source pond, soil profile, pine needles, limbs, leaf litter, etc.). Continue to have problems with limited tritium recovery in standard materials. Began testing of Parr Bomb apparatus for extracting OBT to compare recoveries with the combustion furnace. Agreed to participate in an inter-laboratory study to evaluate OBT recovery in known materials.
Conclusions
Conclusions to date:
1) HTO levels in soils and plants tissues were lower than tritium source (dilution from precipitation)
2) HTO levels generally reflect soil levels, which vary with timing and duration of irrigation (i.e., recent tritium exposure)
3) OBT analysis confirms plant accumulation/uptake
4) OBT ≠ HTO (OBT reflects long-term exposure)
5) OBT in 2007 fish sample illustrates source persistence
6) HTO and OBT levels in control samples quite low despite proximity to NNSA source

Major Impact(s) of Research
Tritium accounts for >65% of the atmospheric and >99% of the stream water environmental releases of radioactivity from the SRS. As a low-energy beta emitter, ingestion is the primary source of environmental dose. Therefore, factors such as biological half-life and isotope discrimination can have a significant impact on tritium dose calculations in risk assessment scenarios, particularly under specific management strategies such as prescribed burns on the SRS where OBT may be released to the environment in a more available form (e.g., water vapor). However, such factors are not currently addressed through regulatory driven monitoring programs, and very little OBT monitoring data exists. Tritium compartmentalization data (i.e., free water vs. OBT) can be incorporated in existing dose models to better understand the effects of site practices on tritium exposure pathways. These activities will enable site management to estimate potential human and ecological tritium exposure levels associated with new SRS mission activities, ongoing site cleanup efforts, accidental release, and routine site custodial activities.
Other Project Personnel
Robert Thomas, MS Student – UGA
Matt Baker, MS Student – UGA
Sandra Cutts, PhD Student - University Alabama Birmingham
External Collaborators
Dr. S.B. Kim – Chalk River Laboratories
Dr. Rhett Jackson – UGA
Dr. Robert Peters – University Alabama Birmingham
Dr. Robin Brigmon – SRNL

Products

Cutts, S, J.C. Seaman, R. Brigmon, and R.P. Peters. 2017. An Evaluation of Organically Bound Tritium (OBT): Savannah River Site. The Alabama Water Resources Conference (AWRC) & Symposium, September 6-8, Orange Beach, Alabama.

Cutts, S, J.C. Seaman, R. Brigmon, and R.P. Peters. 2017. Tritium Distribution and Cycling on Savannah River Site (SRS). The American Institute of Chemical Engineers (AIChE) annual conference, October 27-November 3, Minneapolis, MN.

Peters, R. Cutts, S, J.C. Seaman, and R. Brigmon. 2017. An Evaluation of Organically Bound Tritium (OBT) Research. The American Institute of Chemical Engineers (AIChE) annual conference, October 27-November 3, Minneapolis, MN.

TASK 8. SREL will continue to serve as a regional resource for scientific expertise and environmental research. SREL staff scientists will continue to provide special technical assistance to other site contractors, area stakeholders, other researchers, and the public. SREL will also continue to collaborate with scientist from other institutions

In FY17, SREL faculty, staff, and students conducted a diversity of environmental research projects both on and off of the SRS in support of their mission to pursue collaborations and funding to serve as a regional source of scientific expertise and to provide technical assistance to other site contractors, stakeholders, other researchers, and the public. Due to both the specific technical expertise represented by research faculty and staff at SREL and the unique opportunities for scientific research represented on the Savannah River Site, SREL scientists are often sought out as potential collaborators by researchers across the globe. SREL staff served as collaborators on both funded and non-funded research involving environmental remediation, ecotoxicology and environmental stewardship and, as Principal Investigators or co-Investigators on funded research all over the United States and internationally. In addition, SREL faculty, staff and students served as hosts for over 227 researchers from other universities, federal and state agencies, and non-governmental organizations to discuss and conduct collaborative research and funding. Research, external funding, and requests for technical assistance conducted in support of this task are outlined below:

Collaborations and Externally Funded Research on the SRS

Effects of Chemical Contaminants on Coleopteran Carrion Assemblages

Funding Entity
SREL
Start Date and Funding Amount
May 2014; NFP
SREL Collaborators
Dr. James C. Beasley and Dr. Olin E. Rhodes, Jr. - SREL
Objectives
The objective of this study is to evaluate the influence of metal and radionuclide contaminants on the richness, diversity, and composition of coleopteran scavenging beetles and to determine levels of radionuclides and metals within adult beetles inhabiting contaminated sites on the SRS.
Summary of Research Activities
For this research caged rabbit carcasses were placed along transects at 0, 100, 200, and 300m from the water's edge at both the D-area ash basin and a control site in summer 2014, as well as Pond A and an additional control area in summer 2015. During 2016 we placed additional carcasses in selected areas to supplement insect numbers collected in 2014-2015. Insect traps were placed at each carcass and all beetles colonizing carcasses were collected. All beetles collected in 2014-2015 have now been characterized to species. In addition, sample testing to determine trace element and radiocesium burdens is currently ongoing and nearly complete.
Conclusions
To date >6,300 beetles have been collected for this research, representing 32 species in 6 families. Overall species in the Histeridae and Scarabidae families comprised >75% of the collected invertebrates. Analyses are ongoing but thus far this study has revealed a diverse community of beetles utilize carrion on the SRS. Beetles captured at D-area accumulated significantly greater amounts of Se and As than those captured at control sites. Generally low levels of radiocesium have been observed in beetles thus far, although 2 outlier samples were observed indicating potential for radiocesium accumulation in these species.

Major Impact(s) of Research

1) This research is amongst the first studies to quantify responses of invertebrate carrion communities to chemical contamination in the U.S. and will allow us to determine whether population-level effects exist to invertebrates inhabiting landscapes contaminated with radionuclides or metals.
2) This research will contribute greatly to our understanding of the fate and transport of contaminants within ecosystems, as well as the body burden levels of contaminants in invertebrate carrion communities.

Other Project Personnel

Kelsey Turner, M.S. Student – UGA
Erin Abernathy, M.S. Student – UGA
Ansley Silva, M.S. Student – UGA
David Coyle, Postdoc – UGA
Kamal Gandhi, Associate Professor – UGA
Chis Leaphart, M.S. Student – UGA

External Collaborators

Dr. Jeffery Tomberlin - Texas A&M

Products

Silva, A., D. Coyle, E. Abernethy, K. Turner, J. Beasley, and K. Gandhi. 2014. Effects of contamination on invertebrate Scavenging communities. Southern Forest Insect Work Conference, Charleston, SC

Silva, A., D. Coyle, E. Abernethy, K. Turner, J.C. Beasley, K. Gandhi. Effects of Contaminants on Scavenging Beetles. Entomological Society of America. Minneapolis, MN. 2015.

Silva, A., D. Coyle, E. Abernethy, K. Turner, J.C. Beasley, K. Gandhi. Death and destruction: effects of pollution on carrion beetles. 2015. Georgia Entomological Society. Jekyll Island, GA.

Silva, A., D. Coyle, E. Abernethy, K. Turner, J. Beasley, K. Gandhi. Death and Destruction: Effects of contamination on Coleopteran scavengers. Georgia Entomological Society. Jekyll Island, GA. 2014.

Silva, A., D. Coyle, E. Abernethy, K. Turner, J. Beasley, K. Gandhi. 2015. Effects of chemical contamination on Coleopteran scavenging communities. Warnell Graduate Student Association Annual Symposium, Athens, GA.

Fate of terrestrial and arboreal nestling bird carrion

Funding Entity
SREL
Start Date and Funding Amount
June 2015; NFP
SREL Collaborators
Dr. James C. Beasley - SREL
Objectives
The objective of this study is to evaluate the influence of 1) carcass size (baby chicken vs. quail), and 2) habitat (ground vs arboreal) on the composition and efficiency of vertebrate scavenging communities in the southeastern U.S. at assimilating resources sequestered within nestling bird carrion.
Summary of Research Activities
For this research, nestling quail and chicken carcasses were placed on the ground and in nests ~1m off the ground on the SRS. As of summer 2016 approximately 200 total trials had been completed. For each trial, we placed a single remote camera proximal to the carcass and monitored scavenger activity for up to 1 week, or until the carcass was completely removed.
Conclusions
Results of this research reveal that several species utilize nestling bird carrion, although snakes appear to be the dominant scavenger of this carrion type. Snake scavenging has been previously documented, although our results suggest snakes may specialize on this type of carrion over other types. Furthermore, we observed a substantial number of scavenged carcasses within above-ground nests, indicating scavenging is not limited to terrestrial carrion. However, significant differences in vertebrate consumption of carrion were observed between above ground and ground-level carrion, suggesting arboreal carrion may represent an important resource for invertebrates.
Major Impact(s) of Research
1) This is the first study of both nestling bird carrion and use of arboreal carrion by vertebrate scavengers. Thus, these data have advanced our understanding of the cycling of nutrients (and contaminants) within ecosystems, and provide a more comprehensive understanding of the ecosystem services provided by vertebrate scavengers.
2) This research revealed an extensive use of nestling carrion by snakes, indicating its potential importance to this group of vertebrates. Future studies should further focus on the importance of nestling carrion to snakes.

Other Project Personnel
Dr. Josh Smith, Postdoc – SREL
Lauren Laatsch, Undergraduate Student – UGA
External Collaborators
NA
Products
Laatsch, L., J.B. Smith, and J.C. Beasley. 2016. Vertebrate use of arboreal carrion: scavenger community composition and fate of avian nestling carcasses. Undergraduate thesis. Warnell School of Forestry and Natural Resources, UGA

Smith, J.B., L.J. Laatsch, and J.C. Beasley. 2017. Spatial complexity of carcass location influences vertebrate scavenger efficiency and species composition. *Scientific Reports* 7:10250, DOI: 10.1038/s41598-017-10046-1

Survival and Cause-Specific Mortality of Juvenile Wild Pigs

Funding Entity
USDA – Wildlife Services – National Wildlife Research Center
Start Date and Funding Amount
September 2014; $25,300.00
SREL Collaborators
Dr. James C. Beasley - SREL
Objectives
The objective of this study is to develop methods for quantifying survival and cause-specific mortality of juvenile wild pigs. Once appropriate techniques are developed, survival will be evaluated as a function of a suite of demographic and environmental attributes.
Summary of Research Activities
During fall 2014 through summer 2015 we placed ear tag transmitters on juvenile wild pigs 4-5 weeks of age. Since 2015 we have begun evaluating the performance of several additional VHF transmitter attachment methods for monitoring piglets <1 week of age when mortality is expected to be highest. In addition, we have evaluated the potential utility of vaginal implant transmitters (VITs) for use in pigs for locating newborn piglets. During 2016 we also began evaluation of surgical implantation of transmitters for monitoring survival of newborn piglets, and are currently evaluating a new form of ear-tag transmitter designed for neonate piglets.
Conclusions
This study is ongoing, however, we have observed very low mortality of piglets >4 weeks of age. VITs have proven successful as a tool for locating litters of wild pigs and we have successfully located several litters for which we have evaluated various VHF transmitter attachment methods. Specifically, previous ear tag transmitter models are suitable for piglets several weeks old, but are not a viable option for neonates. None of the transmitter attachment methods evaluated thus far has been 100% successful in neonates, and we are currently evaluating a new form of ear-tag transmitter specifically designed for neonates as a potential alternative.
Major Impact(s) of Research
1) This research will provide the first data to date on the survival of juvenile wild pigs, data that are essential to the development of robust population growth models.
2) This research will evaluate multiple transmitter attachment methods for monitoring piglet survival and provide future researchers with recommendations for a model from which future studies can be based.

Other Project Personnel
Sarah Chinn, M.S. Student – UGA
Dr. Peter Schlichting, Postdoc – SREL
External Collaborators
Dr. John Kilgo - USFS – Savannah River Site, Aiken, SC
Dr. Mark Vukovich - USFS – Savannah River Site, Aiken, SC
Dr. Frederick Cunningham, USDA-APHIS-WS-NWRC
Products
Beasley JC. USDA Wild Pig Research Update. 2016. Aiken, SC (*Oral Presentation*)
Beasley, JC. Wild Pig Research on the Savannah River Site. South Carolina Wild Pig Task Force Meeting, Columbia, SC, February 2017
Beasley, JC. Wild Pig Research on the Savannah River Site. National Wild Pig Task Force Meeting, Orange Beach, AL, March 2017
Keiter, DA, JC Kilgo, MA Vukovich, FL Cunningham, and JC Beasley. 2017. Development of known-fate survival monitoring techniques for juvenile wild pigs (*Sus scrofa*). *Wildlife Research* 44:165-173

Post-Translocation Movement Behavior of Wild Pigs

Funding Entity
USDA APHIS – Wildlife Services – Veterinary Services, National Wildlife Research Center
Start Date and Funding Amount
September 2014; $108,350.00
SREL Collaborators
Dr. James C. Beasley - SREL
Objectives
The objective of this study is to quantify the movement behavior of wild pigs post-translocation to elucidate the movement behavior of translocated individuals, as well as shifts in movement behavior in response to translocation.
Summary of Research Activities
This study is in the third year of a 4 year project. During January 2015 we deployed GPS transmitters on 8 wild pigs that were translocated ~15 km from their capture site, as well as several pigs that were left in situ as control animals. Translocated and in situ pigs were monitored for a minimum of 2-3 months and we have collected the majority of transmitters. An additional 12 translocation and 8 control pigs were fit with GPS transmitters in spring/summer 2016. We are currently analyzing these data to reveal shifts in movement rates home range, path tortuosity, etc. in translocated wild pigs. Additional GPS collars will be deployed in fall 2017 and spring 2018.
Conclusions
Although this study is still underway, data collected thus far clearly reveal translocated wild pigs make extensive movements post-release. Specifically, home range sizes of translocated pigs average several times larger than those of non-translocated individuals and move an average maximum distance of 13 km from their point of release. Several individuals have relocated back to their original point of capture (~15km). Extensive home ranges and movements are maintained for ~1 month, after which movements more closely resemble those of control animals. However, preliminarily, data suggest the magnitude of the post-translocation response is modulated by habitat, with pigs translocated to less preferred habitats tending to exhibit more extensive movements.
Major Impact(s) of Research
1) This research will produce the first comprehensive data to date on the spatial ecology of wild pigs subsequent to translocation.
2) This research will provide important insights to guide future management of invasive wild pigs and will produce critical data to better develop disease transmission models for wild pigs throughout the U.S.

Other Project Personnel
Dr. Josh Smith, Postdoc – SREL
Kevin Eckert, Research Technician – SREL
Sarah Chinn, Ph.D. Student - UGA
External Collaborators
Dr. Ryan Miller – USDA
Steve Sweeney – USDA
Products
D.A. Keiter, J.B. Smith, R.S. Miller, D.A. Grear, S.J. Sweeney, and J.C. Beasley. 2015. Pigs on the Wing: Movement Ecology of Translocated Pigs. Annual Meeting of the Georgia Chapter of The Wildlife Society. Athens, Georgia, USA. (*Oral Presentation*). *Awarded 1st place for student oral presentations category.*

Beasley JC. USDA Wild Pig Research Update. 2016. Aiken, SC (*Oral Presentation*)

D.A. Keiter, J.B. Smith, R.S. Miller, D.A. Grear, S.J. Sweeney, and J.C. Beasley. 2015. Pigs on the Wing: Movement Ecology of Translocated Pigs. Annual Meeting of The Wildlife Society. Winnipeg, Canada. (*Poster Presentation*). *Awarded 3rd place for student presentations category.*

Beasley JC, DA Keiter, JB Smith, RS Miller, and SJ Sweeney. 2016. Movement Ecology of Translocated Pigs. International Wild Pig Conference, Myrtle Beach, SC (*Oral Presentation*).
Beasley, JC. Wild Pig Research on the Savannah River Site. South Carolina Wild Pig Task Force Meeting, Columbia, SC, February 2017
Beasley, JC. Wild Pig Research on the Savannah River Site. National Wild Pig Task Force Meeting, Orange Beach, AL, March 2017
Beasley, J.C. Wild Pig Research on the Savannah River Site. North Carolina/South Carolina Wild Pig Technical Meeting, Garnett, SC, July 2017

Effects of sounder removal on the movement behavior of wild pigs

Funding Entity
USDA – Wildlife Services – National Wildlife Research Center
Start Date and Funding Amount
February 2016; $70,852.00
SREL Collaborators
Dr. James C. Beasley - SREL
Objectives
The objectives of this study are to evaluate the movement behavior of wild pigs following the removal of adjacent social groups, to simulate real-world trapping activities to control this invasive species. These data also will be used to evaluate the degree of territoriality among adjacent wild pig social groups (i.e. sounders).
Summary of Research Activities
During spring 2016 we selected 2 study sites on the SRS and trapped the majority of adjoining sounders in each site. We fit at least 1 adult female in each group with a GPS transmitter and also collared several boar within each study area. Subsequent to trapping we established bait stations to assess density using remote cameras. After 2-3 months we selectively removed pigs from the core of each study site. During 2016-2017 we have been recollecting GPS collars and are now beginning to analyze the data for this study.
Conclusions
The last remaining GPS collars were recovered from the field in fall 2017; thus there are no conclusions at this time.
Major Impact(s) of Research
1) This research will provide important data on the home range overlap of neighboring wild pig sounders, data that will provide inferences on the degree of territoriality exhibited by this species.
2) Data collected during this study will provide information on how wild pig movements are impacted by the removal of adjacent social groups, data essential to the development of robust management plans for this species.
3) Data derived from this study will be integrated into national-level research by the USDA to implement management of wild pigs.

Other Project Personnel
David Keiter, M.S. Student – UGA
Dr. Peter Schlichting, Postdoc – SREL
Kevin Eckert, Research Technician – SREL
External Collaborators
Dr. Kim Pepin – USDA-APHIS-WS-NWRC
Dr. Amy Davis – USDA-APHIS-WS-NWRC
Dr. Kurt Vercauteren – USDA-APHIS-WS-NWRC
Dr. John Kilgo – USFS – Savannah River Site
Products
Beasley JC. USDA Wild Pig Research Update. 2016. Aiken, SC (*Oral Presentation*)
Beasley, JC. Wild Pig Research on the Savannah River Site. South Carolina Wild Pig Task Force Meeting, Columbia, SC, February 2017
Beasley, JC. Wild Pig Research on the Savannah River Site. National Wild Pig Task Force Meeting, Orange Beach, AL, March 2017
Beasley, J.C. Wild Pig Research on the Savannah River Site. North Carolina/South Carolina Wild Pig Technical Meeting, Garnett, SC, July 2017

Evaluation of contact structure and disease dynamics in free-ranging wild pigs

Funding Entity
USDA – Wildlife Services – National Wildlife Research Center
Start Date and Funding Amount
February 2017; $58,883
SREL Collaborators
Dr. James C. Beasley - SREL
Objectives
The objectives of this study are to quantify the contact structure of invasive wild pig populations, and the influence of supplemental feeding and experimental population reduction on contact rates among groups. These data also will be used to evaluate the degree of territoriality among adjacent wild pig social groups (i.e. sounders).
Summary of Research Activities
During spring 2017 we captured 7 adjacent sounders as well as several adult male wild pigs on the SRS and fitted 1-3 members of each group with a GPS transmitter and contact logger. Samples were collected from all trapped pigs for DNA and disease analyses. After several months of establishing baseline data, we created bait stations to assess the influence of baiting on movements. Beginning in September 2017 we began culling groups at the core of the distribution of collared animals to assess the impact on animal movements. Collars are projected to fall off of pigs in mid-November 2017.
Conclusions
This research has just begun; there are no conclusions at this time.
Major Impact(s) of Research
1) This research will provide some of the first data to date on the contact structure of wild pig social groups.
2) Data collected during this study will provide information on how wild pig movements are impacted by the removal of adjacent social groups, data essential to the development of robust management plans for this species.
3) Data derived from this study will be integrated into national-level research by the USDA to implement management of wild pigs.

Other Project Personnel
Sarah Chinn, Ph.D. Student - UGA
Dr. Peter Schlichting, Postdoc – SREL
Kevin Eckert, Research Technician – SREL
External Collaborators
Dr. Toni Piaggio – USDA-APHIS-WS-NWRC
Dr. Kim Pepin – USDA-APHIS-WS-NWRC
Dr. Amy Davis – USDA-APHIS-WS-NWRC
Dr. Samantha Wisely – University of Florida
Dr. Raoul Boughton, – University of Florida
Dr. Kurt VerCauteren – USDA-APHIS-WS-NWRC
Products
Beasley JC. USDA Wild Pig Research Update. 2016. Aiken, SC (*Oral Presentation*)
Beasley, JC. Wild Pig Research on the Savannah River Site. South Carolina Wild Pig Task Force Meeting, Columbia, SC, February 2017
Beasley, JC. Wild Pig Research on the Savannah River Site. National Wild Pig Task Force Meeting, Orange Beach, AL, March 2017
Beasley, J.C. Wild Pig Research on the Savannah River Site. North Carolina/South Carolina Wild Pig Technical Meeting, Garnett, SC, July 2017

Restoring Headwater Streams and Riparian Corridors at the Savannah River Site, SC: Part A-Mitigation Plan Proposal Supporting Documentation

Funding Entity
USDA Forest Service-Savannah River
Start Date and Funding Amount
June 2017; $27,042
Collaborators
Dean E. Fletcher - SREL
Objectives
Our overall goal is to provide assessments of legacy and current stream disturbances to enable Savannah River Site management organizations and regulatory oversight agencies to move forward with specific restoration/enhancement treatments and a monitoring plan for a stream restoration-mitigation project.
Summary of Research Activities
Stream restoration and enhancement provides opportunity to correct or improve previous alterations that have destroyed, diminished, or impaired the character and function of stream systems. The Savannah River Site (SRS) provides an ideal research opportunity for restoration of coastal plain streams. SRS stream disturbances span a temporal range from pre-SRS legacy impacts, through the early infrastructure development in the early 1950s, to more recent and current industrial activities. In a collaborative effort, a multiphase program was conducted to characterize SRS streams, identify risks of legacy and recent disturbances, and identify disturbed stream reaches with potential for restoration. Three levels of assessments were completed with each level providing an increased level of detail and scientific rigor. A Level I assessment involved a broad scale survey of potential stream disturbances and stream basin characterization. Level II assessments assessed the effects of stream alterations on physical stream condition in a subset of Phase I identified streams. Level III assessments further evaluated a selected subset of stream reaches by measuring additional hydrology, physicochemistry, biology, and geomorphology features. This comprehensive stream evaluation identified management options and is guiding prescriptions for potential restorative actions.

Although the initial study showed many potential opportunities for restoration on the SRS, cost, regulatory impediments, and location reduced the feasibility of implementation in some streams and identified others as less practicable and/or more costly. Experience gained by restoration and enhancement efforts in less complex situations, may be applied to such systems in the future. The headwaters of Tinker Creek, on the other hand, offered several suitable areas/reaches for restoration and enhancement that could be performed cost effectively, in a timely fashion and with overarching goals that could improve stream and riparian condition. Restoration opportunities in the Tinker Creek watersheds include dam removal, ditch filling, and in-stream habitat enhancement. Riparian enhancement would involve opening of the closed-canopy forest to release native cane in the understory, increase in-stream primary productivity and potentially enhance water quality and aquatic habitat. Use of fire to manage forest understory including cane stands will be evaluated. All of these activities would restore natural sediment movement pathways, improve water quality and enhance wildlife habitat.
Conclusions
1) Amount of industrial area in a drainage has a strong influence on instream geomorphology, chemistry, and macroinvertebrate communities; streams receiving excessive stormwater runoff are generally the most disturbed streams within our study systems.
2) Basin and valley characteristics interact with landscape disturbance to influence level of stream disturbance.
3) Enhancement of tributaries of Tinker Creek represent cost-effective options for establishment of a mitigation bank.

Major Impact(s) of Research

1) We have identified effects of legacy and current disturbances on stream chemistry, hydrology, geomorphology, and biology on select SRS streams.
2) Through an effort with onsite and offsite collaborators, we are proposing restoration plans including post-treatment monitoring for 4 headwater streams while using a fifth as a reference system.
3) A framework upon which a headwater stream mitigation bank can be built is being developed.

Other Project Personnel

Dr. J Vaun McArthur, Senior Research Scientist – SREL
Paul Stankus, Research Professional – SREL

External Collaborators

Dr. Christopher Barton – University of Kentucky
Dr. Richard Biemiller – University of Kentucky
Dr. John Blake – USDA Forest Service-SR
James Fudge – SRNS-NEPA & Wetlands
Dr. Michael Paller – SRNL

Products

Fletcher, D.E., G.K. Stillings, M.H. Paller, and C.D. Barton. Legacy disturbances and restoration potential of coastal plain streams. Annual Meeting of the Southeastern Fishes Council, Chattanooga, TN, November 2011 (Oral Presentation).

Fletcher, D.E., G.K. Stillings, M.H. Paller, and C.D. Barton. Legacy disturbances and restoration potential of coastal plain streams. Annual Meeting of the American Fisheries Society, Seattle, WA, September 2011 (Oral Presentation).

Fletcher, D.E., G.K. Stillings, and C.D. Barton. 2012. Stream System Field Condition Assessments-Level I Surveys. Final report submitted to SRNS-ACP and USDA Forest Service-SR, 219 pp.

Fletcher, D.E., G.K. Stillings, and C.D. Barton. 2012. Can We Measure And Achieve Functional Restoration Objectives And Regulatory Standards By Applying Specific Treatments To SRS Streams? Task 1. Stream Basin and Valley Characterization, Establishing a Framework. Annual report submitted to USDA Forest Service-SR, 58 pp.

Barton C., D. Fletcher, R. Biemiller, and G. Stillings. 2012. Assessment of Structure, Function and Stability in a Gradient of Disturbed SRS Streams - Phase III. Annual report submitted to USDA Forest Service-SR, 9 pp.

Fletcher, D.E., R. Biemiller, M.H. Paller, C.D. Barton. Legacy disturbances and restoration potential of coastal plain streams. SRS Wetland and Aquatic Issues Task Group September 2013 (Oral Presentation).

Fletcher, D.E., R. Biemiller, and C.D. Barton. 2013, 2014, 2015. Annual reports: Can We Measure and Achieve Functional Restoration Objectives and Regulatory Standards by Applying Specific Treatments to SRS Streams? Annual report submitted to USDA Forest Service-SR, 3-4 pp each.

Biemiller, D.E. Fletcher, and C.D. Barton. Evaluating the influence of disturbance on macroinvertebrate colonization of leaf packs in Upper Coastal Plain headwater streams. Conference on Ecological and Ecosystem Restoration, New Orleans, LA, July 2014. (Poster).

Barton, C.D and D.E. Fletcher. Enhancement of disturbed upper coastal plain stream systems: potential projects. February 2015. (Oral Presentation to USDA-FS and SRNS representatives).

Fletcher, D.E., A.H. Lindell, J.C. Seaman, P.T. Stankus, and JV. McArthur. Land Use effects on trace element accumulation in sediment and biota of coastal plain streams. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Salt Lake City, UT, November 2015. (Poster).

Paller, M.H., B.A. Prusha, E. Kosnicki, S.A. Sefick, M.S. Jarrell, D.E. Fletcher, S.C. Sterrett, A.M. Grosse, T. D. Tuberville, and J. W. Feminella. 2016. Factors influencing stream fish species composition and functional properties at multiple spatial scales in the Sand Hills of the Southeastern United States. Transactions of the American Fisheries Society 145:545-562.

Biemiller, R. A. 2015. Influence of structural disturbance on stream function and macroinvertebrate communities in Upper Coastal Plain headwater streams. Dissertation, University of Kentucky.
Fletcher, D.E., R. Biemiller, and C.D. Barton. 2016. Assessment of factors controlling condition and restoration potential of SRS headwater streams. Final report submitted to USDA Forest Service-SR, 57 pp.

Assessment of terrestrial heavy metal contamination and trophic status on songbirds on the SRS

Funding Entity

SREL

Start Date and Funding Amount

August 2015; $20,000

PI and co-PI's

Dr. James A. Martin and A. Lawrence Bryan Jr. - SREL

Objectives

Our objective was to determine the spatial extent of terrestrial heavy metal contamination of resident and migratory songbirds during the breeding season through the use of non-lethal sampling techniques. We also added a diet component to determine trophic status for these species.

Summary of Research Activities

Heavy metal contamination in aquatic environments has been well established on the SRS but the movement of these metals to terrestrial food webs and specifically songbirds, has not been well established. We collected non-lethal blood and feather samples from Northern Cardinals and Great Crested Flycatchers from three locations on the SRS and one location in Jackson, SC. The on-site locations were Upper Three Runs, D-Area (adjacent to the Savannah River), and the Savannah River floodplain near Pen Branch. Seventy-five birds were captured from April to June 2016 using mist-netting techniques and banded with a unique aluminum band. Blood and feather samples were analyzed for Hg, As, Cd, Cr, Cu, Ni, Pb, Se, and Zn. A total of 61 individuals (30 cardinals and 31 flycatchers) were captured and sampled from April to May 2017. In 2017, samples were analyzed for total % C and N as well as $\delta^{13}C$ and $\delta^{15}N$.

Conclusions

1) Impacts of heavy metal contamination are minimal to resident Northern Cardinals and migratory Great Crested Flycatchers terrestrial environments near selected sites based on low concentration values
2) Non-lethal sampling techniques fulfill the requirements of determining contaminated/uncontaminated populations
3) Differences in body burdens between species were established indicating a differing diets and/or heavy metal uptake
4) Flycatchers forage at a higher trophic than cardinals which could possibly be linked to bioaccumulation of Se and Hg

Major Impact(s) of Research

1) Songbirds are able to accumulate potentially toxic pollutants in terrestrial environments on the SRS
2) Populations >1 km away from immediate point source pollution are likely unaffected by heavy metal contamination
3) Novel toxicity data on species and sex differences for both study species
4) Migratory species (i.e., flycatchers) may be vectors for contaminants from SRS and to SRS from their wintering grounds

Other Project Personnel

Zoe Cooper, M.S. Student – UGA

Christina Fulghum, Research Technician – SREL

External Collaborators

Dr. Robert Bringolf – UGA

Dr. Robert Cooper – UGA

Products

Cooper, Z. R., R. Bringolf, R. Cooper, K. Loftis, A. L. Bryan, J. A. Martin. Blood and feather heavy metal concentration of a resident and migratory songbird. Warnell Graduate Student Association Symposium. Oral Presentation. February 2016.

Cooper, Z. R., R. Bringolf, R. Cooper, K. Loftis, A. L. Bryan, J. A. Martin. Blood and feather heavy metal concentration of a resident and migratory songbird. Society of Environmental Toxicology and Chemistry. Poster. November 2016.

Cooper, Z., R. Bringolf, R. Cooper, K. Loftis, A. L. Bryan, & J. A. Martin. 2017. Heavy metal bioaccumulation in two passerines with differing migration strategies. Science of The Total Environment 592: 25-32.

Capture-Mark-Recapture Studies of Large Mouth Bass on Par Pond Reservoir

Funding Entity
DOE-EM Support to SREL
Start Date and Funding Amount
October 2016; $30,000
PI and Co-PIs
Dr. Olin E. Rhodes, Jr. and Matt Hamilton - SREL
Objective(s)
To estimate the population size and characterize movement patterns of largemouth bass, Micropterus salmoides, in relation to the distribution of contaminants on Par Pond reservoir.
Summary of Research Activities
We have individually marked >700 largemouth bass from Par Pond with a RFID (Radio-frequency identification) PIT (Passive Integrated Transponder) tag. With each capture, morphometric data (e.g., length, weight, sex), GPS coordinates, and physical condition (i.e., health status) are recorded before each individual is released at the point of capture. This initial capture effort is ongoing and will provide baseline data for characterizing movement patterns and estimating largemouth bass abundance on Par Pond.
Conclusions
1) This research is in the initial stages of data collection.
Major Impact(s) of Research
1) This research will provide insight into the seasonal distribution and the potential for contaminant exposure and transport of largemouth bass on a man-made reservoir.
Other Project Personnel
Chris McBride, Assistant Director – SREL
Dr. Peter Schlichting, Post Doc – SREL
Dr. Fanny Coutelot, Post Doc – SREL
Megan Winzeler, Project Coordinator II – SREL
Brian Morton, Property Management Coordinator – SREL
Wes Flynn, Ph.D. Student – UGA
Sarah Webster, Ph.D. Student – UGA
Austin Coleman, MS Student – UGA
External Collaborators
None
Products
No publications, presentations, or reports have yet been prepared.

Use of fecal genotyping and spatial capture-recapture modeling to investigate coyote abundance in South Carolina

Funding Entity
SC DNR
Start Date and Funding Amount
January 2017; $50,000
SREL Collaborators
Dr. Stacey L. Lance - SREL
Objectives
The overall goals of this research are to estimate coyote densities among regions in South Carolina and to evaluate densities relative to landscape composition and other variables.
Summary of Research Activities
Coyote scats from a previous study on the SRS were collected over four seasons for two years on the SRS. To date we have extracted DNA from all scats have completed an initial screen of all samples across 9-10 microsatellite loci. We have confirmed recaptures of individuals across seasons and years. The new project is an extension of that work and will include those samples. This year a PhD student position was advertised and a student recruited to begin his program at UGA in Fall of 2018.
Conclusions
The data are still being collected.
Major Impact(s) of Research
Until the data are fully acquired and analyzed we will not know the major impacts.
Other Project Personnel
Rochelle Beasley, Research Professional – SREL
External Collaborators
Dr. Gino D'Angelo – UGA
Dr. Karl Miller – UGA
Dr. John Kilgo – USFS, Aiken, SC
Products
Manuscripts will be prepared at a later date.

Total water use and source partitioning in woody bioenergy crops determined by coupled mass flux and stable isotope signatures.

Funding Entity
USDA National Institute of Food and Agriculture
Start Date and Funding Amount
September 2015; $915,593
SREL Collaborators
D. Aubrey - SREL
Objectives
The overall goal of this proposed research is to compare the water relations and the impact on local hydrology of intensively managed pine and eucalypt woody bioenergy crops over stand development. Specifically, we will quantify total water use and determine water sources for two preeminent woody bioenergy crops. Loblolly pine is the cornerstone of southern US forest production, whereas eucalypts represent even greater productivity potential. Our results will be used to parameterize a process based model to predict watershed-scale changes that might occur to the hydrologic cycle based on increasing the intensity of management and planting a woody crop species with even higher production potential than loblolly pine.
Summary of Research Activities
We just began year 5 of this 5 year project. Experimental plots were prepped and planted in year 1. Silvicultural treatments were applied in years 1 through 5. Experimental instrumentation to measure hydrologic inputs and outputs was deployed at the beginning of the third growing season in year 3 of the project. During the fourth year of our project, we continued water balance measurements that are central to this project. This includes the continued monitoring of precipitation, throughfall, and soil moisture, as well as continued monitoring of six trees of each species (loblolly pine and *Eucalyptus benthamii*) per plot (6 plots per species) to measure whole tree water use. It also includes the routine collection of water from plant tissues, soils, and groundwater for isotope analysis. We have been measuring leaf area index of the experimental plots monthly since May 2016. We will continue measuring these variables to complete a second growing season and will then try and maintain a subset of these measurements (sapflow and leaf area index) through a third growing season. A new cryogenic vacuum extraction method has been implemented for the purposes of extracting water from plants and soils for the comparison of stable isotopes of ^{2}H and ^{18}O. These stable isotopes are conservative tracers that can be used to tease out where trees are sourcing water from within the soil column. This method can then be used to model tree water usage and inform sustainable land management practices with respect to water resources and woody crops. We are continuing to work on evaluating issues of bias in the sampling and extraction of xylem water.
Conclusions
Hydrologic budgets and In addition to the work related to water budgets, we continue to learn a great deal about *Eucalyptus* and its potential as a production plantation species in the southeast US. We have found (and reported through a journal article) that *Eucalyptus* is susceptible to a fungus that causes a leaf disease that severely impacts growth. We have also found that non-native *Eucalyptus* leaf beetle populations find and exploit *Eucalyptus* stands in the southeast. These issues, along with the issues of frost tolerance, make *Eucalyptus* a rather risky choice for landowners and, despite the larger impact on the hydrologic budget compared to a native species like loblolly pine, we do not expect this species to become a large part of the forest production in the southeast until these issues are overcome. Finally, we have shown that it is not just the non-natives that exhibit significantly larger impacts on water resources than the widely planted loblolly pine. We have shown that native species, like sweetgum (*Liquidambar styraciflua* L.) may exhibit much lower water use efficiencies and use a much larger amountnt of soil water to produce similar amounts of biomass as loblolly pine.

Major Impact(s) of Research

1) Provides quantitative information on how the hydrologic cycle would be influenced by land-use shifts away from standard, low-input, forestry management for pulpwood and timber toward intensively managed forest stands for bioenergy production
2) Provides general information about production potential of Eucalyptus in southeast US.

Other Project Personnel

Mackenzie Dix, Research Assistant – SREL
Seth Younger, PhD Student – UGA

External Collaborators

P. Caldwell – USDA Forest Service
Dr. R. Jackson – UGA
Dr. J. McDonnell – University of Saskatchewan
Dr. C. Miniat – USDA Forest Service.

Products

Younger, S., D.P. Aubrey, and C.R. Jackson. 2017. Comparing Water Use of *Pinus taeda* and *Eucalyptus benthamii* in the Upper Coastal Plain of South Carolina: Experimental Design and Preliminary Data. Warnell Graduate Student Symposium, Athens, GA. (Poster presentation)

Aubrey, D.P., D.C. Coyle, and S. Fraedrich. 2016. Challenges associated with establishing *Eucalyptus benthamii* plantations in the southeast coastal plain. 11th Biennial Short Rotation Woody Crops Operations Working Group Conference. Fort Pierce, FL. (Poster presentation)

Aubrey, D.P., Sustainable Bioenergy: Juggling Productivity and Hydrologic Impacts. AFRI Project Director Meeting, New Orleans, LA. October17-20, 2017. (Oral presentation)

Aubrey, D.P. 2017. Forest Carbon and Water Cycling Research at the Savannah River Ecology Laboratory. Integrated Ecosystem Research Workshop, Joseph W. Jones Ecological Research Center, Newton, GA. June 12-15, 2017. Jones Ecological Research Center. (Oral presentation)

Aubrey, D.P. 2017. Forest Ecophysiology at the Savannah River Ecology Laboratory. August 31, 2017. Joseph W. Jones Ecological Research Center, Newton, GA. September 31, 2017. (Oral presentation)

Caldwell, Peter; Jackson, C Rhett; Miniat, Chelcy; Younger, Seth; Vining, Justin; McDonnell, Jeffrey; Aubrey, Doug. Woody bioenergy crop selection can have large effects on water yield: A southeastern United States case study. Journal article submitted to *Global Change Biology Bioenergy*.

Aubrey DP, Fraedrich SW, Harrington TC, Olatinwo R. **2017**. Cristulariella moricola associated with foliar blight of Camden white gum (*Eucalyptus benthamii*), a bioenergy crop. *Biomass & Bioenergy* 105: 464-469.

Oswald SW, Aubrey DP. Increasing biomass production on limited land area through an optimal planting arrangement. In Press at *Bioenergy Research*.

Differences in the physiological response of Liquidambar styraciflua caused by season of burn.

Funding Entity

USDA Forest Service-Southern Research Station

Start Date and Funding Amount

August 2015; $60,000

SREL Collaborators

D. Aubrey - SREL

Objectives

The goal of this project was to determine how the season of burning influenced mortality, resprouting, and subsequent growth of American sweetgum.

Summary of Research Activities

Planted seedlings in 20 L pots in spring 2016 and maintained them for an entire growing season. Subjected a subset of seedlings to experimental burns prior to leaf-out in early March 2017. Subjected another subset of seedlings to experimental burns after leaf-out and leaf expansion in June 2017. Whole plant carbon budgets were collected using gas exchange. Whole-plant harvests were conducted routinely throughout the growing season following experimental burns.

Conclusions

1) Data are currently being processed.

Major Impact(s) of Research

1) Results from this study will provide scientists and land managers empirical data to support or reject current thoughts on timing of prescribed fire and its efficacy in controlling sweetgum in southeastern forests.

Other Project Personnel

S. Ruswick, MS Student – UGA

External Collaborators

Dr. R.O. Teskey – UGA

Dr. J.J. O'Brien – USDA Forest Service-Southern Research Station

Products

Ruswick, S. J. O'Brien, R.O. Teskey, N. Wurzburger, and D.P. Aubrey. 2017. Does season of burn influence the efficacy of fire in controlling sweetgum saplings? Warnell Graduate Student Symposium, Athens, GA. (Oral presentation)

Completion of data analysis and publication of soil chemical and physical properties associated with production of short rotation woody crops for bioenergy.

Funding Entity
USDA Forest Service-Savannah River
Start Date and Funding Amount
August 2017; $107,897
SREL Collaborators
D. Aubrey - SREL
Objectives
The goals of this project were to complete processing, analysis, and manuscript preparation from a USDA FS project looking at fundamental drivers of forest productivity. The resulting manuscripts include: (1) nitrogen budgets for forest stands following 12 years of intensive forest management; (2) soil carbon dynamics following 12 years of intensive management; and (3) dynamics of perennial and ephemeral tissues through stand development under different resource availabilities. Another objective was to re-establish experimental plots with new planting stock.
Summary of Research Activities
Two of the three manuscript drafts are nearly complete and will soon be ready to submit for consideration in peer-reviewed journals. Experimental plots are currently being prepped for future planting in October 2018. An experimental plan is currently being drafted and planting material will be ordered before the end of the 2017 calendar year.
Conclusions
1) Data are currently being processed.
Major Impact(s) of Research
1) Results from this study will provide scientists and land managers empirical data to support or reject current thoughts on timing of prescribed fire and its efficacy in controlling sweetgum in southeastern forests.
Other Project Personnel
None
External Collaborators
Dr. D. Markewitz – UGA
Dr. D. Coyle – UGA
Products
Aubrey, D.P. 2017. Forest Carbon and Water Cycling Research at the Savannah River Ecology Laboratory. Integrated Ecosystem Research Workshop, Joseph W. Jones Ecological Research Center, Newton, GA. June 12-15, 2017. Jones Ecological Research Center. (Oral presentation)

Aubrey, D.P. 2017. Forest Ecophysiology at the Savannah River Ecology Laboratory. August 31, 2017. Joseph W. Jones Ecological Research Center, Newton, GA. September 31, 2017. (Oral presentation)

Coleman, M.D. and D.P. Aubrey. Fine-root dynamics of forest stands are controlled by inherent factors and modified by environmental factors. Journal article submitted to *Tree Physiology*.

Getting to the root of the matter: Determining the global significance of internal carbon dioxide transport in trees.

Funding Entity
UGA Research Foundation
Start Date and Funding Amount
July 2017; $9,829
SREL Collaborators
D. Aubrey - SREL
Objectives
The main objective of this proposed research is to develop and validate the foundational methodology necessary to investigate the global significance of internal carbon dioxide (CO2) transport in trees and to collect preliminary data that will help formulate and support testable hypotheses. This is a seed grant to prepare a larger external funding effort.
Summary of Research Activities
We have begun investigating methods and approaches to collect xylem sap pH and methods to collect and measure carbon dioxide from tree stems.
Conclusions
1) Data are currently being collected and processed.
Major Impact(s) of Research
1) The novelty in this proposed study is that we currently lack an understanding of the global significance of internally transported CO2, whereas the appeal of my approach is that we can examine this flux globally with a modest budget by leveraging existing instrumentation through a network of collaborators with the deployment of relatively simple and inexpensive sampling kits.
Other Project Personnel
Mackenzie Dix, Research Assistant – SREL
Tae Yoon Lee, PhD Student – UGA
External Collaborators
None
Products
None

Impacts of long term chronic exposure to low dose ionizing radiation on the epigenome

Funding Entity
DOE
Start Date and Funding Amount
NFP
SREL Collaborators
Dr. Benjamin B. Parrott, Dr. Olin E. Rhodes and Marilyn Mason - SREL
Objectives
The overall goal of this research is to assess the effects of chronic low dose ionizing radiation over long periods of time on the epigenome.
Summary of Research Activities
Environmental factors can influence developmental and aging trajectories leading to either health or disease. Epigenetic mechanisms mediate genome-by-environment interactions, and due to recent advances in sequencing technologies, the molecular modifications underlying these interactions can be assessed at genomic scales. DNA methylation is the best characterized epigenetic modification with roles in regulating gene expression and promoting chromosomal stability, and alterations to DNA methylation patterning characterize specific malignancies and in some cases, predict cancer prognosis. Ionizing radiation (IR) represents perhaps the most universal ecological stressor. With background levels present since the dawn of evolution, highly conserved pathways act to repair DNA damage caused by UV and other sources of IR. This project aims to assess how long-term chronic exposures to low doses of IR impact DNA methylation patterning in a small fish (*Oryzais latipes)* and further, how altered patterns of DNA methylation are linked to histopathological conditions that will also be assessed. These findings are expected to provide fundamental insights into how IR affects epigenomic processes associated with disease in environmentally, occupationally, and ecologically relevant exposure contexts.
Conclusions
This research has just begun, thus there are no conclusions at this time.
Major Impact(s) of Research
1) Establishing a IR model to assess impacts of chronic low-dose exposure. Once established, the model can be extended to examine impacts of combinatorial exposures.
2) The project will produce findings that are relevant to both wildlife as well as human health.

Other Project Personnel
Emily Bertucci, PhD Student –UGA
External Collaborators
Dr. Al Camus –UGA
Products
Topolski, C.R., M.W. Mason, E.M. Bertucci, O.E. Rhodes, Jr., and B.B. Parrott. Impacts of chronic exposure to gamma radiation on the DNA methylome using the medaka fish model. July 25, 2017. Savannah River Ecology Laboratory NSF REU symposium. Savannah River Ecology Laboratory, Aiken, SC, USA

Topolski, C.R., M.W. Mason, E.M. Bertucci, O.E. Rhodes, Jr., and B.B. Parrott. Impacts of chronic exposure to gamma radiation on the DNA methylome using the medaka fish model. July 27, 2017. University of South Carolina Summer Research Symposium; University of South Carolina, Columbia, SC, USA

Bertucci, E.M. and B.B. Parrott. Using small fish to understand environmental impacts of ionizing radiation. Poster presented at SREL's Touch An Animal Day. 2017.

Levels of Alpha-gal in Amblyomma americanum ticks collected from the Savannah River Site and adjoining areas: Implications for red meat allergy

Funding Entity
SREL
Start Date and Funding Amount
October 2016; NFP
SREL Collaborators
G. Dharmarajan - SREL
Objectives
The purpose of this study was to characterize α-gal in *Amblyomma americanum* and *A. maculatum* ticks reared in the lab and those collected naturally from hunter killed deer on the SRS and adjoining areas
Summary of Research Activities
Delayed anaphylaxis linked red meat is a newly recognized allergic disease. Individuals bitten by the lone star tick (Amblyomma americanum) may develop IgE antibodies to the carbohydrate galactose-α-1,3-galactose (α -Gal; a carbohydrate moiety). Upon exposure of sensitized subjects to mammalian meat containing α -Gal on glycoproteins or glycolipids, delayed anaphylaxis may ensue, often three to six hours after ingestion. Natural ticks were collected from hunter killed on the Savannah River Site and adjoining wildlife management areas. Tick saliva and salivary gland samples were reduced, alkylated, and then digested with trypsin in Tris-HCl buffer overnight. After protease digestion, glycopeptides were eluted using standard protocols and N-glycans recovered. The N-linked glycans were permethylated for structural characterization by mass spectrometry. Briefly, the permethylated glycans were reconstituted in 100% MeOH and introduced to the mass spectrometer (Thermo Fusion Tribrid Orbitrap) with offline emission. These data were used to search for a Hex-Hex-HexNAc signature, and when glycoforms matching a Hex-Hex-HexNAc signature were found in some of the samples, the rest of the samples were rerun and manually fragmented at masses corresponding to each of the possible N-linked glycoforms.
Conclusions
1) A large number of N-glycans was found in each of the tick samples, and these varied greatly from extended high mannose structures to highly complex and hybrid structures.
2) No indications of the α -Gal glycoforms were found in any of the samples from the Amblyomma maculatum (Gulf Coast Tick) samples, either by not finding a mass corresponding to the glycoform, or if the mass was found, MS/MS fragmentation indicated that the glycoform did not contain the Hex-Hex-HexNAc signature fragment.
3) No indications of the α -Gal glycoforms were found in the salivary glands from unfed *Amblyomma americanum*. However, multiple alpha-Gal glycoforms were found in salivary glands and saliva from partially or fully blood fed *Amblyomma americanum.*

Major Impact(s) of Research
1) Our preliminary data reveal α -Gal glycoforms are only associated with saliva and salivary glands of partially or fully fed *A. americanum.*
2) The presence of α –Gal in *A. americanum* has significant implications for red meat allergy in South Carolina, especially amongst individuals that have high risk of exposure to being bitten by these ticks (e.g., hunters)

Other Project Personnel
Amanda Hurst, Research Technician – SREL
External Collaborators
Dr. P. Azadi – UGA
Dr. S. Karim – University of Southern Mississippi
Products
A publication is in preparation based on the data collected

External parasites of fish as non-invasive bioindicators of contaminants in aquatic ecosystems on the Savannah River Site

Funding Entity
SREL
Start Date and Funding Amount
January 2017; NFP
SREL Collaborators
G. Dharmarajan - SREL
Objectives
To test if external parasites of fish can be used as bioindicators of contaminants in aquatic systems and non-invasive effect indicators of fish health at the individual and population levels.
Summary of Research Activities
Bioindicators are species whose abundance is clearly associated with a particular environmental gradient, and such species are considered valuable tools to evaluate the effects of contaminants at the individual, population and ecosystem levels. Macroinvertebrates have long been considered to be good bioindicators of pollution in aquatic systems. Parasitic macroinvertebrates are a unique group of organisms that depend upon another organism to obtain their nutrition (e.g., blood or tissue). Unlike other macroinvertebrates, parasitic species occupy high trophic levels in aquatic food webs, especially when these species parasitize top predators. Thus, parasitic macroinvertebrates likely are good, albeit understudied, bioindicators of contamination in natural ecosystems. We tested this hypothesis using external parasites from largemouth bass (*Micropterus salmoides*) inhabiting PAR pond on the Savannah River Site (SRS. The external parasites found on largemouth bass included three major taxonomic groups: fish lice (Argulidae), leeches (Hirudidae), and trematodes (Digenea).
Two sites were selected on PAR pond in the Middle (hot) and West (intake) arm. At each site largemouth bass were sampled by pole fishing. All individuals were weighed, and measured, and external parasites enumerated and collected. Muscle tissue from these fish were tested for mercury concentrations (μg/g dry weight) using a Milestone DMA 80. For quality assurance, samples will be analyzed in batches containing a blank and standard reference material of known concentration.
Conclusions
1) Significant differences in parasite load and parasite diversity in largemouth bass inhabiting different parts of the pond. Critically, the Hot Arm of the pond, which has the highest mercury levels in sediment also had the lowest load and diversity of parasites
2) Higher load and diversity of parasites in largemouth bass with low ($\leq$ 5 ppm) vs. high (>5 ppm) total mercury concentration in muscle
3) the above two patterns likely are driven by the high sensitivity of the parasite taxa to contaminants, as indicated by the significantly lower contaminant concentrations in the parasites vs. the fish hosts, despite the fact that these parasites obligatorily feed on the fish

Major Impact(s) of Research
1) Characterize effects of mercury on fish parasite burdens and community structure
2) Identify individual fish parasite taxa that display a clear response to effects of heavy metal pollution
3) Determine whether fish parasites can be used as effective bioindicators of contaminants in aquatic ecosystems on the SRS to support ongoing remedial action by ACP

Other Project Personnel
Amanda Hurst, Research Technician – SREL
Manette Tanelus, REU Student – SREL
External Collaborators
None
Products
No publications, presentations, or reports have been prepared yet. A grant has been submitted to ACP based on the preliminary results.

Effects of methylmercury on early life mortality of yellow fever mosquitoes (Aedes aegypti)

Funding Entity
SREL and NSF-REU
Start Date and Funding Amount
June 2017; NFP
SREL Collaborators
G. Dharmarajan - SREL
Objectives
To quantify the effects of methylmercury on early-life mortality and development of yellow fever mosquitoes (*Aedes aegypti*)
Summary of Research Activities
We conducted two experiments. Our preliminary experiment aimed to determine the mortality threshold of *A. aegypti* when subjected to methylmercury at four concentrations: 0, 10, 50, and 100 µg/L. Based on the results of the preliminary experiment, we designed a focal experiment to test our hypotheses. In the focal experiment we used methylmercury concentrations of 0,1.25, 2.5, 5, 10 and 20 µg/L to examine the effect of methylmercury on early life mortality and development. Specifically, we set up and maintained 14 containers, with each container randomly assigned to one of the methylmercury concentrations.
For all experiments we monitored the containers for pupation and mortality. Developing pupae were transferred to individual tubes and allowed to metamorphose to adults (which were sexed based on morphology). In the preliminary experiment, we used a Fisher's Exact test to evaluate differences among methylmercury concentrations and the proportions of pupae produced. In the focal experiment, we used linear regression models to test to examine the effects of methylmercury on early life mortality and development of *A. aegypti*.
Conclusions
1) There was a significant effect of methylmercury concentration on levels of pupation ($x^2 = 73.471$, df = 3, p-value < 0.01), with no pupation at concentrations >50 ppb
2) At lower doses there was a significant negative dose response between mercury concentration and pupal ($t= 8.37$, $P < 0.01$) and adult development ($t= 7.29$, $P<0.01$)
3) Pupal and adult development rates were significantly lower than controls at methylmercury concentrations $\geq$2.5 ppb

Major Impact(s) of Research
1) Mosquitoes are sensitive bioindicators of contaminants in aquatic environments, and show significant decreases in pupal and adult development rates at low methylmercury concentration (2.5 ppb)
2) The effects of contaminants on mosquito development could have important public health implications

Other Project Personnel
Dr. X. Xu, Postdoc – SREL
Amanda Hurst, Research Technician – SREL
M. Tanelus, REU Student – SREL
External Collaborators
Dr. M. Pilgrim – University of South Carolina Upstate
Products
M. Tanelus and G. Dharmarajan. Effects of Methylmercury on early life mortality of yellow fever mosquitoes (*Aedes aegypti*). 2017 Summer Research Symposium. July 27, 2017. University of South Carolina, Columbia, SC.
Tanelus, M., Dharmarajan G. and Pilgrim, M (submitted) Effects of Methylmercury on early life mortality of yellow fever mosquitoes (Aedes aegypti). University of South Carolina Upstate Student Research Journal

Comparative Analysis of Bioconversion and/or Bioprecipitation Strategies for In-Situ Bioremediation of Uranium

Funding Entity

DOE - Minority Serving Institutions Partnership Program (MSIPP)

Start Date and Funding Amount

October 2016; $54,000

SREL Collaborators

Dr. John C. Seaman and Dr. Fanny M. Coutelot - SREL

Objectives

Project objectives include: 1) establishing lab-controlled, anoxic, iron-replete and PO_4-amended serum bottle microcosms using SRS soils colonized by the wetland macrophyte- Sparganium americanum; 2) growing Sparganium americanum under iron-replete and PO_4-amendments in greenhouse mesocosms to monitor dynamics of U cycling; 3) using whole cell bacterial bioreporter to identify U bioavailability; 4) delineating SRS site-specific environmental, biogeochemial and microbial drivers promoting bioconversion/bioprecipitation and stable maintenance of insoluble U(IV) or U/P-mineral and; 5) training under-represented students in the field of environmental biotechnology and environmental restoration.

Summary of Research Activities

Radionuclide and heavy metal contaminated environments are remnants of the nuclear weapons production era and the Department of Energy (DOE) is charged with rehabilitation of such co-contaminated environments, such as the Savannah River Site (SRS). Such environments are difficult to remediate using conventional excavation and disposal or pump-and-treat approaches. Less expensive in-situ remediation, by applying additives, can alter contaminant speciation or microbial activities enhancing solid-phase partitioning to reduce migration, bioavailability and associated hazards. Towards this end, effectiveness of PO_4 minerals/compounds to stabilize heavy metals and radionuclides through sorption and/or the formation of secondary phosphate precipitates has been successfully demonstrated. However, the use of sparingly soluble, solid-phase PO_4 limits the effectiveness to surficial materials. To overcome these limitations, a range of soluble P materials, such as phytate has been evaluated with varied success. Moreover, in-situ remediation requires long-term monitoring of contaminants and the native microbiota that underpin biogeochemical transformations of contaminants.

Conclusion

1) Demonstrated the effectiveness of PO_4 based amendments in immobilizing U in SRS soils.
2) Identified SRS microbial isolates that are insensitive to U and Ni contamination, and developed a U biosensor.

Major Impact of Research

1) The current research has the potential to impact the long-term disposition of U contaminated areas within Steeds Pond/Tims Branch watershed on the SRS, and other U contaminated sites associated with DOE Facilities.

Other Project Personnel

Dr. Fanny Coutelot, Post Doc – SREL
Matt Baker, MS Student – UGA

External Collaborators

Dr. Ashvini Chauhan – Florida A&M University
Dr. Charles Jagoe – Florida A&M University

Products

Pathak, A., A. Chauhan, P. Stothard, S. Green, M. Maienschein-Cline, R. Jaswal, J.C. Seaman. 2017. Genome-centric evaluation of Burkholderia sp. strain SRS-W-2-2016 resistant to high concentrations of uranium and nickel isolated from the Savannah River Site (SRS), USA. Genomics Data 12, 62-68; doi: 10.1016/j.gdata.2017.02.011.

Baker, M.R., F.M. Coutelot and J.C. Seaman. 2016. Chemical Immobilization of Uranium in Contaminated Soil by Phosphate Amendments. 2016 Annual ASA/SSSA/CSA Meetings. Phoenix, AZ, Nov. 6-9.

Sorption Properties of Bimetallic Porous Iron (pFe) Materials

Funding Entity
SRNL – LDRD Program
Start Date and Funding Amount
October 2016; $30,000
SREL Collaborators
Dr. John C. Seaman and Dr. Fanny M. Coutelot - SREL
Objectives
Project objectives include: (1) prepare and characterize pFe materials with catalytic metallic nanoparticles (e.g., Cu, Zn, Ag, Sn and Pd) deposited into the pore structures; (2) evaluate the novel bimetallic pFe materials for Tc removal from a wide range of aqueous media; and (3) characterize Tc binding chemistry with bimetallic pFe materials using transmission electron microcopy (TEM) and synchrotron radiation X-ray absorption fine structure (XAFS) to provide information about its chemical speciation and bonding environment.
Summary of Research Activities
Remediation of Tc remains an unresolved technical challenge because it displays little or no adsorption to common environmental minerals and other synthetic sorbents. Porous iron composites (pFe) have macropores that provides reactive site heterogeneity, and consist of amorphous and alpha metallic iron. In batch studies, the pFe is much more effective in removing ReO_4^- and TcO_4^- from artificial groundwater than granular Fe. The second metal nanoparticles were successfully deposited on the porous iron by using chemical reduction methods. The bimetallic Zn-pFe was demonstrated to be more effective in removing ReO_4^- and TcO_4^- from artificial groundwater than pristine pFe and the other six bimetallic pFe materials.
Conclusions
1) Porous Fe is much more effective for removal of ReO_4^- and TcO_4^- from groundwater than granular zero valent iron (ZVI), with a removal capacity as high as 25 mg Tc/g Fe.
2) Tc K-edge XAFS data indicated that Tc species on the porous iron were both reduced Tc(IV) and Tc(VII), with Tc(IV) largely being incorporated into the structure of Fe oxy-hydroxide corrosion products and to a lesser degree Tc(IV) dioxide.
3) Zn-pFe was demonstrated to be superior among the six bimetallic pFe materials for removing ReO_4^- and TcO_4^- from groundwater.

Major Impact of Research
1) These results provide an applied scientific foundation for solving critical DOE and industrial needs related to nuclear environmental stewardship and nuclear power production.

Other Project Personnel
RJ Thomas, MS Student – UGA
E. Dorward, MS Student – UGA
External Collaborators
Dr. Dien Li – SRNL
Dr. Simona Murph – SRNL
Dr. Daniel I. Kaplan – SRNL
Dr. Kathryn Taylor-Pashow – SRNL
Products
Li, D., S.N. Egodawatte, D.I. Kaplan, S.C. Larsen, S.M. Serkiz, J.C Seaman, K.G. Scheckel, J. Lin, and Y. Pan. 2017. Sequestration of U(VI) from Acidic, Alkaline and High Ion-Strength Aqueous Media by Functionalized Magnetic Mesoporous Silica Nanoparticles: Capacity and Binding Mechanisms. Environ. Sci. & Technol. DOI: 10.1021/acs.est.7b03778.

Li, D., S. E. Murph, K. Coopersmith, D.I. Kaplan, K. Taylor-Pashow, and J.C. Seaman. 2017. Pertechnetate Immobilization from Aqueous Media by Bimetallic Porous Iron Composites (PICs). Migration 2017. Sept. 10-15, Barcelona, Spain.

Seaman, J.C., E. Dorward, J. Cochran, H.S. Chang, M. Tandukar, and F.M Coutelot. 2017. Removal of Radioactive materials from Groundwater using Porous Iron Composite Media. 14th International Conference on the Biogeochemistry of Trace Elements (ICOBTE), July 16-20, Zurich, Switzerland.

Ecological factors affecting the success of rabies elimination in the Southeastern US

Funding Entity
USDA-APHIS-WS
Start Date and Funding Amount
October 2016; $76,902
PI and Co-PIs
Dr. Olin E. Rhodes, Jr., Dr. Guha Dharmarajan and Dr. James Beasley - SREL
Objective(s)
1) Quantify variance in raccoon densities among three major habitat types found commonly in the Southeastern US and evaluate the latitudinal change in raccoon density from riparian to primarily upland pine habitats.
2) Evaluate the role of isolated wetlands surrounded by presumably inhospitable upland pine habitats in supporting raccoon populations in the Southeastern US.
3) Quantify realized levels of rabies vaccine bait uptake by raccoons occurring at varying densities and in various habitats in the presence of bait competition from opossums and other mesopredators and mammals in the Southeastern US

Summary of Research Activities
We have completed one season of field research, trapping raccoons and opossums across 24 field sites on the Savannah River Site, including collection of whiskers for dye marker analyses, tissues for genetic and disease analyses, and capture-mark-recapture data for abundance estimation.
Conclusions
1) This research is in the initial stages of data collection.

Major Impact(s) of Research
1) This research will provide insight into the densities of raccoons and opossums across four different habitats that are common in the Southeastern US and will quantify levels of bait completion between raccoons and other mesopredators to inform the application of rabies vaccination baits for the Oral Rabies Vaccination program conducted by the USDA.

Other Project Personnel
Kelsey Turner, Ph.D. Student – UGA
Matt Hamilton, Research Technician – SREL
David Bernasconi, MS Student – UGA
Jessica Buskirk, Research Technician – SREL
Dana Goin, Research Technician – SREL
Rebecca Juarez, Research Technician – SREL
Amanda Hurst, Research Technician – SREL
External Collaborators
Nikki Walker – USDA
Chad Wickham – USDA
Dr. Amy Gilbert – USDA
Rich Chipman – USDA
Products
Rhodes, O.E., Jr., G. Dharmarajan, J.C. Beasley, and K. Turner. 2017. Year 1 Annual Report for Ecological Factors Affecting the Success of Rabies Elimination in the Southeastern US. Submitted September 13, 2017.

Low dose radiation effects on Medaka

Funding Entity
DOE
Start Date and Funding Amount
October 2016; NFP
PI and Co-PIs
Dr. Olin E. Rhodes, Jr., Dr. Ben Parrott - SREL
Objective(s)
1) Evaluate the proteomic, glycomic, histopathological and epigenetic effects of 6 months of low dose radiation on Medaka.
2) Evaluate the proteomic, glycomic, histopathological and epigenetic effects of 6 months of low dose radiation on Medaka that have been pre-exposed to environmentally relevant levels of mercury

Summary of Research Activities
We have completed a six month exposure of Medaka to three levels of low dose radiation in combination with set of fish pretreated with aqueous mercury exposure to a constant level of tissue concentrations. The tissues from these fish are currently being evaluated in various laboratories at the SREL and UGA.
Conclusions
1) This research is in the initial stages of data collection.

Major Impact(s) of Research
3) This research will provide insight into the physiological response of Medaka to varying low doses of radiation which are similar to those that are chronically present in contaminated environments around the world.

Other Project Personnel
Marilyn Mason, Research Technician – SREL
External Collaborators
Dr. Carl Bergman – UGA
Dr. Al Calmus – UGA
Dr. Michael Tiemyer – UGA
Dr. Lance Wells – UGA
Dr. Gerardo Gutierrez-Sanchez – UGA
Yeni Natalia Carolina Perez-Gelvez - UGA
Products
No Products have yet been produced from this research

Collaborations and Externally Funded Research Non - SRS

Indirect transfer of acetaminophen /rodenticides to non-target organisms through scavenging during BTS and rodent control

Funding Entity
US Department of Defense - Navy
Start Date and Funding Amount
September 2014; $439,705.00
SREL Collaborators
Dr. Olin Rhodes, Jr. and Dr. James Beasley - SREL
Objectives
The overall goal of this research is to elucidate the transfer of toxicants through the food chain as scavenging occurs on carcasses resulting from eradication programs for Brown Tree Snakes and Rodents on the island of Guam.
Summary of Research Activities
While there is a growing literature on the indirect effects of toxicants on other organisms via direct consumption of toxicant baits, there is virtually nothing known about the fate and transfer of rodenticides via energy flow pathways associated with scavenging of poisoned rodents (e.g., rats – *Rattus spp.* and *Mus. spp.*) and/or Brown Tree Snakes (BTS; *Boiga irregularis*). Data published by our research group and others over the past decade have clearly demonstrated that scavenging of vertebrate carcasses is significantly more common than has previously been thought and that the use of carcasses by both other vertebrate and invertebrate species represents both a major energy flow pathway in food webs and a relatively understudied pathway for transfer of contaminants and toxicants among trophic levels. The widespread use of rodenticides for management and conservation objectives by federal organizations may face challenges to operational feasibility if the transfer rates and fates of these toxicants are not quantified for use in risk assessment models. In addition, operational utilization of acetaminophen for control of BTS could be compromised if transfer rates and fates of this toxicant are not accounted for in risk assessment models used to estimate indirect effects of BTS control programs on Guam.
Conclusions
1) None yet as this research is ongoing.
Major Impact(s) of Research
1) Novel data on scavenging community structure for an island ecosystem
2) Data for parameterization of transfer factors for toxicants through trophic pathways
Other Project Personnel
Dr. Josh Smith, Postdoc – SREL
Kelsey Turner, PhD Student - UGA
External Collaborators
Dr. Will Pitt – Smithsonian Institute
Dr. Travis DeVault – USDA
Products
Smith, J.B., K. Turner, T.L. DeVault, W.W. Pitt, J.C. Beasley, and O.E. Rhodes, Jr. Carcass locations of brown treesnakes (Boiga irregularis) on Guam following exposure to acetaminophen. *Ecotoxicology (In Press)*

Savannah Harbor Expansion Project: Cadmium in Birds

Funding Entity
U.S. Army Corps of Engineers
Start Date and Funding Amount
November 2015; $99,880
SREL Collaborators:
Dr. Olin E. Rhodes, Jr. and A. Lawrence Bryan, Jr. - SREL
Objectives
To monitor the potential uptake of cadmium and other metals in dredge materials by birds, including resident and migratory species, associated with the dredge material containment areas (DMCAs) being employed as part of the Savannah Harbor Expansion Project. A natural layer of cadmium is present in the harbor sediments and will likely be dredged (and enter the impoundments) in the 4th or 5th year of the project. Current samples are considered "control" or pre-contaminant samples to assess potential uptake.
Summary of Research Activities
We completed Year 3 winter avian blood collections (December 2016 – February 2017) and completed Year 4 summer collections (May – August 2017). We collected a sampling of potential avian prey (e.g., insects, seeds, fruit) and analyzed all prey and all Year 3 blood samples for cadmium. All Year 4 summer collections have been archived for future analyses.
Conclusions
1) 71% of the avian blood samples collected in Year 3 had cadmium levels below the instrument/method detection limits (MDL: 0.001-0.006 pp wet wt.).
2) Most of the avian blood samples that were > the MDL were collected from summer, terrestrial species, possibly due to increased consumption of insect prey.
3) Analysis of a sample of potential prey for cadmium was highly variable, but, as in previous years, certain species (e.g., potato beetles larvae) had relatively high concentrations of cadmium.
4) Analyses of kidney and liver tissues of lethally-collected birds on the DMCAs indicated that they were accumulating cadmium, but since most the blood samples from these were < MDL, this suggests they were accumulating it from off-site locations.

Major Impact(s) of Research
Preliminary analyses of avian samples during the 3rd control year indicated that, as in the two previous years, only a small proportion of the avifauna is currently exposed to cadmium on the Savannah DMCAs. However, analyses of potential avian prey indicate that cadmium is bioavailable at the site in selected potential prey items.
Other Project Personnel
Meghan Oberkircher, Research Technician – SREL
Brigette Haram, Graduate Student – UGA
Melissa Martin, Graduate Student – UGA
External Collaborators
Dr. Susan Wilde - UGA
Products
Rhodes, O.E., S.B. Wilde, J.C. Seaman, and A.L. Bryan, Jr. 2017. Monitoring Potential Cadmium Levels in Avian Tissues Associated with the Savannah Harbor Expansion Project: Annual Report of Year 3 Monitoring. Annual project report to the U.S. Army Corps of Engineers, Savannah District, Savannah, GA (August 2017).

Kings Bay Rare, Threatened and Endangered Wildlife Surveys: Loggerhead Shrikes

Funding Entity
DoD-Navy/USACE
Start Date and Funding Amount
June 2014; $46,000
SREL Collaborators:
A. Lawrence Bryan Jr. and Dr. Olin E. Rhodes, Jr. - SREL
Objectives
To document habitat use and approximate home range size of Loggerhead Shrikes, a regional species of concern, by use of radio telemetry.
Summary of Research Activities
At the request of the funding agency, we extended the project for a 2nd year to deploy additional transmitters on shrikes in 2016. We employed a contractor to capture 6 more shrikes and attach transmitters to them in May of 2016. We monitored their locations during a series of visits to the base, acquiring > 35 locations per bird before the transmitter batteries expired. Two of the 6 transmittered birds left the area or died within the 1st week post-capture, but the we received signals on the remaining 4 birds during the life of the transmitters. Home range data analyses were completed during October/November of 2016.
Conclusions
Loggerhead Shrikes on Kings Bay used maintained (typically mowed) habitats on the base for foraging. Home range sizes were smaller for shrikes that were successful breeders than for unsuccessful breeders. Home ranges determined in this study were within the range of ranges known for other locations in the southeast.
Major Impact(s) of Research
1) Loggerhead Shrikes, a regional species at risk, utilized maintained habitats (golf courses and grounds
1) around facilities) in 2015 and 2016.
2) Home range monitoring documented larger ranges for unsuccessful breeders, implying insufficient habitat.
3) Three of the unsuccessful breeders exhibited lengthy movements (> 1 km) during their period of monitoring.

Other Project Personnel
Dr. Peter Schlichting, Postdoc – SREL
External Collaborators
C.M. Muise - Consultant
Products
Bryan, A.L., F.C. Depkin, P.E. Schlichting, and C.M. Muise. 2016. Spring territory sizes of loggerhead shrikes (*Lanius ludovicianus*) on the Naval Submarine Base Kings Bay, Camden County, Georgia. Final project report to SUBASE Kings Bay Environmental/Natural Resources Department, Kings Bay, GA.

Movements of Wood Storks Associated with Colony Modifications at the Savannah International Airport

Funding Entity
Savannah Airport Commission, Savannah, Georgia
Start Date and Funding Amount
June 2017; $49,750
SREL Collaborators:
A. Lawrence Bryan Jr. and Dr. James Beasley - SREL
Objectives
To document the long-term movement patterns of wood storks, a federally-listed (ESA - Threatened) species, inhabiting a breeding colony destined for removal due to its proximity to active airport runways. Specifically, we will determine if these storks return to the same area to breed next year and/or determine where they breed.
Summary of Research Activities
We were able to capture two adult wood storks and attached satellite transmitters in July of 2017. The captured storks were released immediately post-transmitter attachment and have provided 50-300 locations daily. One stork provided > 8,000 locations and journeyed into eastern South Carolina prior to the transmitter ceasing to function in early September. The other stork has provided > 7,500 locations post-capture and is currently utilizing tidal creeks as foraging sites.
Conclusions
One stork has journeyed to freshwater wetlands in eastern South Carolina and the other stork is utilizing the salt marsh east of Savannah, Georgia.
Major Impact(s) of Research
1) We are collecting data on large-scale movements of a species at risk.
2) We will not know the specific impact of the research until the initiation of the 2018 breeding season (March/April 2018) when we can determine where the surviving stork attempts to nest.

Other Project Personnel
Dr. Peter Schlichting, Postdoc – SREL
Meghan Oberkircher, Research Technician - SREL
Alexis Korotasz, Research Technician - SREL
External Collaborators
NA
Products
None at this time.

Gray wolf movement behavior in relation to kill sites, raccoon dog spatial ecology, scavenging dynamics, and demography of Przwalski's horses in Chernobyl

Funding Entity
University of Georgia
Start Date and Funding Amount
October 2016; NFP
SREL Collaborators
Dr. James C. Beasley - SREL
Objectives
The objectives of this research are to 1) quantify kill rates of gray wolves inhabiting the Chernobyl Exclusion Zone and elucidate the movement behavior gray wolves relative to kill site locations, 2) quantify home ranges, resource selection patterns, and movement behavior of raccoon dogs and relative radiation exposure, 3) assess demographic rates of endangered Przwalski's horses in Chernobyl and use of abandoned buildings, and 4) quantify the efficiency and community composition of vertebrate scavengers.
Summary of Research Activities
During fall 2016 we travelled to the CEZ and deployed GPS collars on wolves and raccoon dogs throughout the CEZ. We collected samples from captured wolves and other wildlife and also deployed remote cameras to elucidate the efficiency and composition of the vertebrate scavenging community. We also deployed remote cameras to assess use of abandoned barns by Przwalski's horses as well as develop preliminary assessments of population demography. During fall 2017 we returned to Belarus to collect GPS collars. We are currently analyzing data collected on these research trips and are preparing various publications from this work. Collaborators at the National Academy of Science in Belarus are continuing to aid in collection of field data.
Conclusions
This research has just begun and no analyses are complete at this time. However, we recorded >50 kill site locations from GPS-collared wolves, and collected tens of thousands of GPS locations on collared animals that will be incorporated into analyses.
Major Impact(s) of Research
1) This research will provide critical data on the demography of one of the world's only free-ranging populations of Przwalski's wild horses.
2) Wolf and raccoon dog GPS data will provide novel information on the movement behavior and diet of carnivores inhabiting the CEZ, data that will be valuable for future management of populations in the CEZ.
3) Conducted the first study of vertebrate scavenging ecology in the CEZ, revealing an intact and highly efficient scavenging community.

Other Project Personnel
Sarah Webster, M.S. Student – UGA
Cara Love, Ph.D. Student – UGA
Dr. Peter Schlichting, Postdoc – SREL
External Collaborators
Dr. Thomas Hinton – Fukushima University, Japan
Dr. Dima Shamovich – Researcher and Wildlife Tour Guide, Belarus
Dr. Valery Dombrovski – National Academy of Science, Belarus
Products
V.C. Dombrovsky, J.C. Beasley, P. Schlichting, S.C. Webster, C. Love, D. Shamovich. May 2017. If you do not shoot: the number, territorial structure and predation of the wolf in the winter period 2016-2017 in the Chernobyl zone. International Scientific and Practical Conference "Modern Problems of Hunting and Preservation of Biodiversity. Minsk, Belarus

Occupancy and distribution of wildlife in Fukushima along a gradient of contamination and human land-use intensity, and spatial ecology of invasive civets

Funding Entity

University of Georgia Office of the Vice President for Research, Office of International Partnerships

Start Date and Funding Amount

June 2016; $15,350

SREL Collaborators

Dr. James C. Beasley - SREL

Objectives

The overall objectives in this project are to quantify the distribution and relative abundance of mammals and other scavengers in Fukushima, Japan across a gradient of radiation contamination and level of human disturbance. In addition, we will deploy radio collars on civets and potentially wild boar to assess their movement behavior and radiation exposure, which will be used to assess potential sub-lethal effects of chronic radiation exposure.

Summary of Research Activities

During spring 2016 we travelled to the Fukushima exclusion zone and conducted 120 2-month remote camera trials. Data from these cameras are currently being analyzed. During fall 2016 and summer 2017 we returned to Fukushima to conduct additional camera trials and attached GPS transmitters to civets and wild boar in the exclusion zone. Additional research activities are planned for summer 2018 within the Fukushima exclusion zone.

Conclusions

This research has just begun; there are no conclusions at this time. However, preliminary data suggest numerous species of mammals are abundant within the exclusion zone, and that the density of some species, especially wild boar, differs considerably between the exclusion zone and areas that remain occupied by humans.

Major Impact(s) of Research

This research has just begun; there are no impacts at this time.

Other Project Personnel

Phillip Lyons, M.S. Student – UGA

Hannah Gerke, M.S. Student – UGA

External Collaborators

Dr. Thomas Hinton – Fukushima University

Dr. Kei Okuda – Fukushima University

Products

Lyons, P.C., T.G. Hinton, K. Okuda, M. Hamilton, and J.C. Beasley. December 2016. Fukushima's wildlife: Mammalian species in and around the exclusion zone. Fukushima University Seminar, Japan.

Gerke, H., P.C. Lyons, T.G. Hinton, and J.C. Beasley. July 2017. Occupancy patterns of grass lizards within the Fukushima Exclusion Zone. Fukushima University Seminar, Japan.

Lyons, P.C., T.G. Hinton, K. Okuda, M. Hamilton, and J.C. Beasley. July 2017. Fukushima's wildlife: Mammalian species in and around the exclusion zone. Fukushima University Seminar, Japan.

Lyons, P.C., T.G. Hinton, K. Okuda, and J.C. Beasley. February 2017. Fukushima's wildlife: Population-level response to a nuclear disaster. Warnell Graduate Student Symposium. Athens, GA. February 2017

Evaluation of crop damage by wild pigs

Funding Entity
USDA-APHIS – Wildlife Services – National Wildlife Research Center
Start Date and Funding Amount
February 2017; $36,000
SREL Collaborators
Dr. James C. Beasley - SREL
Objectives
The objectives of this study are 1) to quantify timing and spatial distribution of wild pig damage to corn and peanut fields in SC, as well as 2) assess the utility of UAV's for quantifying wildlife damage to agricultural crops.
Summary of Research Activities
During spring 2017 we contacted landowners and selected crop fields adjacent to the Congaree National Forest and Savannah River Site in SC. Damage assessments were conducted throughout spring, summer, and fall 2017, with the final assessments to be completed in late fall. In addition, we conducted remote camera surveys in spring and fall to quantify the relative abundance of wild pigs at each site.
Conclusions
This research has just begun; there are no conclusions at this time.
Major Impact(s) of Research
1) This research will provide important data on the timing and spatial distribution of wild pig damage to corn and peanut fields, two important agricultural crops in the southeast
2) Data derived from this study will be integrated into national-level management of wild pigs by the USDA to mitigate damages caused by invasive wild pigs.

Other Project Personnel
Chris Boyce, M.S. Student – UGA
External Collaborators
Dr. Kurt VerCauteren – USDA-APHIS-WS-NWRC
Steve Smith – USDA-APHIS-WS
Products
Beasley, JC. Wild Pig Research on the Savannah River Site. South Carolina Wild Pig Task Force Meeting, Columbia, SC, February 2017
Beasley, JC. Wild Pig Research on the Savannah River Site. National Wild Pig Task Force Meeting, Orange Beach, AL, March 2017
Beasley, J.C. Wild Pig Research on the Savannah River Site. North Carolina/South Carolina Wild Pig Technical Meeting, Garnett, SC, July 2017

Integrating Gopher Tortoise Recovery in South Carolina

Funding Entity
Longleaf Alliance (LLA)
Start Date and Funding Amount
July 2017, $ 18,000
SREL Collaborators
Dr. K.A. Buhlmann and Dr. T.D. Tuberville - SREL
Objectives
Continue rearing head-start gopher tortoises for release onto protected state-owned lands, to achieve viable populations. Demonstrate where the methodology may be employed successfully of privately-owned and managed lands in South Carolina
Summary of Research Activities
1) The 2017 cohort consisting of 59 hatchling tortoises is being reared indoors for one winter.
2) Multiple meetings and discussions were held with partners and stakeholders to discuss the project
3) A Media event was held to inform funders, stakeholders, and the public about the project
Conclusions
None to Date
Major Impact(s) of Research
As head-starting is showing effectiveness in assisting with recovery of threatened tortoises on state-owned and managed lands, the next logical step will be to engage with willing private landowners how may be interested in maintaining gopher tortoise populations on their lands.
Other Project Personnel
NA
External Collaborators
Robert Abernethy – Longleaf Alliance
Lisa Lord – Longleaf Alliance
Will Dillman – SCDNR
Darrell Shipes – SCDNR
Products
Media Coverage:
http://www.wrdw.com/content/news/Gopher-Tortoises-Returning-To-The-WIld--448279013.html
http://www.aikenstandard.com/news/young-gopher-tortoises-get-head-start-before-being-released-at/article_57cf8758-a484-11e7-992f-5b18772d6b1f.html

Assessment of the National Park Service Soda Springs Facility, Mojave National Preserve, as a reintroduction site for Federally listed Pacific Pond Turtles (Clemmys marmorata).

Funding Entity

National Park Service (NPS)

Start Date and Funding Amount

October 2015, $ 5,000

SREL Collaborators

Dr. K.A. Buhlmann - SREL

Objectives

1) Assess current habitat availability and status at the Soda Spring Research Facility
2) Provide recommendations for habitat suitability, habitat improvements, and likelihood of reintroduction success.
3) Identity sources of turtles for reintroduction; identify and a propose turtle demography for the reintroduction, timeframe, seasonality, and monitoring plan.

Summary of Research Activities

Discussions were held with National Park Service staff, and agency personnel either knowledgeable about the species, or for whom permitting and regulatory requirements would need to be facilitated from the reintroduction project to proceed.

Conclusions

The Soda Springs Facility represents a potential in-situ "assurance colony" location for protecting and perhaps increasing population numbers of the extremely threatened Mojave Desert population of Western Pond Turtles. Re-visits to the site were made in February 2017.

Major Impact(s) of Research

We investigated an opportunity to help recovery a federally-listed species and restore a species to its historic range within the Mojave National Preserve boundary.

Other Project Personnel

NA

External Collaborators

Neal Darby – National Park Service

Products

Buhlmann, K.A. 2017. Pacific Pond Turtle Mojave Desert Region Recovery Planning. Unpublished Technical Report. Submitted to DOI National Park Service, Mojave National Preserve. 26 February 2017. 15 pp.

Head-starting, Reintroduction, and Habitat Use of Wood Turtles (Glyptemys insculpta) on the Great Swamp National Wildlife Refuge, New Jersey

Funding Entity
Friends of the Great Swamp National Wildlife Refuge, Pleasantville, NJ
Start Date and Funding Amount
March 2012, $ 86,900
SREL Collaborators
Dr. K.A. Buhlmann - SREL
Objectives
1) Determine if head-starting hatchling wood turtles (9 mos) post-hatching subsequently increases their survivorship after release.
2) Determine site fidelity, activity ranges, and home range of head-started wood turtles.
3) Compare survivorship and growth of head-started and direct-released wood turtles.

Summary of Research Activities
The Great Swamp National Wildlife Refuge, New Jersey contains a remnant population of state threatened wood turtles (*Glyptemys insculpta*). Surveys and monitoring via radio-telemetry of adult female wood turtles has been on-going for several years. Females nest on artificially constructed nesting areas, where the nests are subsequently protected from predators until hatching. Most hatchlings are retained for head-starting in collaboration with Bristol County Agricultural High School, a natural resource-focused high school in Massachusetts. Head-started turtles are measured weekly by the students and are returned to the Great Swamp NWR the following Spring. Head-started turtles are radio-tracked for their first growing season to monitor survival and habitat use.

Conclusions
1) Head-started wood turtles have greater survivorship than direct-released hatchlings.
2) Head-started hatchlings are the size of wild 3-4 year old juveniles when they are released.
3) Head-started wood turtles make the greatest movements during their first month post-release, but then occupy ranges with repeatable patterns of movement. Activity ranges of turtles tracked into their second year show even stronger fidelity to their selected range.
4) Head-started turtle may reach reproductive maturity sooner than wild-reared counterparts.

Major Impact(s) of Research
1) Turtle life histories include normally high first-year hatchling mortality. Head-starting increases the number of hatchlings surviving the period of normally greatest mortality, thus putting more juveniles on a trajectory towards maturity. For situations where the original cause of population decline has been remediated, head-starting may be an effective conservation tool to boost juvenile recruitment, thus increasing the likelihood of population recovery of endangered species.

Other Project Personnel
NA
External Collaborators
Colin Osborn – USFWS
Dorothy Fescke - USFWS
James Angley – Wildlife Volunteer
Brian Bastarache – Bristol County Agricultural High School
Brian Zarate – NJDEP Division of Non-Game and Endangered Wildlife
Amelia Russell – Wildlife Intern

Products
Osborn, C. and K.A. Buhlmann. 2017. Wood Turtle Head-Start Project 2016 Summary. Great Swamp Scenes Newsletter. Submitted to Friends of the Great Swamp. March 2017, 5 pp.
Buhlmann, K.A., C. Osborn, J. Green, B. Bastarache, T.D. Tuberville, B. Butler, A. Russell, and S. Koch. Comparison of head-start methodology and post-release survivorship and movements in head-

started wood and Blandings' turtles, with implications for other turtle species. Turtle Survival Alliance Annual Meeting, August 2017. (Invited Talk)
Buhlmann, K.A. and C.P. Osborn. 2011. Use of an Artificial Nest Mound by Wood Turtles (*Glyptemys insculpta*): A Tool of Turtle Conservation. Northeastern Naturalist 18(3): 315-334.

Evaluation of head-starting as a recovery tool for the Mojave desert tortoise

Funding Entity
National Park Service, California Energy Commission
Start Date and Funding Amount
November 2016; $493,089
SREL Collaborators
Dr. Tracey Tuberville and Dr. Kurt Buhlmann - SREL
Objectives
1) Determine behavior, survivorship, and habitat use of head-started juvenile desert tortoises compared to direct-release hatchings (i.e., juveniles released shortly after hatching).
2) Develop habitat suitability models for juvenile desert tortoises to identify optimal desert tortoise habitat.
3) Evaluate the efficacy of indoor rearing as a head-starting technique.

Summary of Research Activities
Our research activities included monitoring of hatchling and juvenile gopher tortoises in outdoor rearing pens, and radio-tracking of juveniles released into the wild.
Conclusions
Based on preliminary data analysis, most movement occurred within 30 days of release, and those with the greatest movements during that time were less likely to survive through the winter dormancy period. Animals head-started for 1 year in outdoor pens exhibited greater post-release survivorship than animals released immediately after hatching, but rearing animals for longer than 1 year in the enclosures may significantly reduce native forage inside pens. Indoor head-starting was effective in increasing growth, but did not result in increased survival compared to smaller outdoor head-starts when released at 1 yr of age.
Major Impact(s) of Research
1) Important life history data for a poorly understood life stage of a federally listed species
2) Improve management for species by factoring juvenile requirements into management and policy decisions, such as identifying habitats likely to serve as important areas of juvenile recruitment. These data will be helpful when selecting potential solar development sites by identifying areas to avoid.

Other Project Personnel
Jacob Daly, M.S. Student – UGA
Pearson McGovern, M.S. Student – UGA
External Collaborators
Dr. Brian Todd – University of California, Davis
Mark Peaden – University of California, Davis
Max Kern – University of California, Davis
Products
Tuberville, T.D., K.A. Buhlmann, D.P. Quinn, J.A. Daly, B.D. Todd, J.M. Peaden, and M.G. Nafus. Developing head-starting strategies that work for gopher tortoises and desert tortoises: an iterative process. Turtle Survival Alliance Annual Meeting, August 2017 (invited talk).

Daly, J.A., K.A. Buhlmann, B.D. Todd, C.T. Moore, J.M. Peaden, M.M. Kern, and T.D. Tuberville. Comparing neonate survivorship and growth of Mojave desert tortoises (*Gopherus agassizii*) under 3 head-start treatments. The Wildlife Society Annual Meeting, October 2016 (oral presentation)

Daly, J.A. 2017. Indoor-rearing as a component of head-starting the Mojave desert tortoise (*Gopherus agassizii*). MS Thesis, University of Georgia.

Daly, J.A., K.A. Buhlmann, B.D. Todd, C.T. Morre, J.M. Peaden, and T.D. Tuberville. Survival estimates and mortality risk factors for indoor head-started, outdoor head-started, and directly released

juvenile desert tortoises (*Gopherus agassizii*) in the eastern Mojave Desert. (presentation at Warnell Graduate Student Symposium (UGA), February 2017.

Effects of road fencing on desert tortoises

Funding Entity
Bureau of Land Management
Start Date and Funding Amount
July 2013; $230,000
SREL Collaborators
Dr. Tracey Tuberville and Dr. Kurt Buhlmann - SREL
Objectives
Investigate the effects of road fencing installed as a mitigation tool on desert tortoises.
Summary of Research Activities
We completed field work to investigate the "road zone effect" on desert tortoises by conducting transect surveys for desert tortoises sign at varying distances from roads of different size and traffic volume. We also radio-tracked desert tortoises along roads using both standard and GPS technology.
Conclusions
Both type of road (interstate or county road) and traffic volume influence road effect zone sizes. Mitigation fencing, although it can reduce road-related mortality, also creates barriers to movement and can result in unanticipated mortality or thermal risk of ectothermic animals that pace the fence.
Major Impact(s) of Research
1) Data on long-term demographic effects of roads on desert tortoise populations adjacent to roads and how effects vary as function of road size and traffic volume.
2) Comparison of pre- and post-fencing spatial ecology of desert tortoises living adjacent to roads and whose home ranges bisected by road to determine the potential positive and negative effects of fencing on desert tortoises.

Other Project Personnel
None
External Collaborators
Dr. Brian Todd - University of California, Davis
Mark Peaden - University of California, Davis
Products
Peaden, J.M., T.D. Tuberville, K.A. Buhlmann, M.G. Nafus, and B.D. Todd. 2015. Delimiting road-effect zones for threatened species: implications for mitigation fencing. Wildlife Research 42:650-659.
Peaden, J.M., A.J. Nowakowski, T.D. Tuberville, K.A. Buhlmann, and B.D. Todd. 2017. Effects of roads and roadside fencing on movements, space use, and carapace temperatures of a threatened tortoise. Biological Conservation 214:13-22.

Status of and threats to gopher tortoise populations on military installations in the southeastern U.S.

Funding Entity
US Department of Navy
Start Date and Funding Amount
August 2013; $162,00
SREL Collaborators
Dr. Tracey Tuberville - SREL
Objectives
1) Estimate population sizes of gopher tortoises on specific Department of Navy lands as part of their long-term monitoring efforts.
2) When available, compare historical data to contemporary date to document population trends.
3) When requested by Navy, provide in-depth evaluation of threats to existing populations on Navy lands and provide management recommendations based on those threats.

Summary of Research Activities
We completed a 12-month assessment of threats to gopher tortoise populations on Kings Bay Naval Submarine Base, FL using remote wildlife cameras at 20 gopher tortoise burrows. As part of the remote camera monitoring, we have also characterized the non-tortoise species that used tortoise burrows. We also initiated a survey to map and estimate population size of gopher tortoises on Pensacola NAS.
Conclusions
Populations on all surveyed properties are unlikely to be viable in long-term without significant intervention, including increase habitat management efforts and potentially even translocations or augmentations. Over 50 species of vertebrates were associated with gopher tortoise burrows, including several previously undocumented species.
Major Impact(s) of Research
This work will contribute to the commitment by the Department of Navy, who is a signatory on the gopher tortoise Memorandum of Understanding, to provide population assessment data for populations occurring on their lands.
Other Project Personnel
Larry Bryan, Research Professional – SREL
Katrina Woods, Research Technician – SREL
Kimberly Price, Research Technician – SREL
Kyle Brown, Research Technician – SREL
External Collaborators
N/A
Products
K.N. White, and T.D. Tuberville. In press. Birds and burrows: avifauna use and visitation of burrows of gopher tortoises at two military sites in the Florida panhandle. To appear in Wilson Journal of Ornithology.

Head-starting to augment gopher tortoise populations on protected areas in Georgia

Funding Entity
Georgia Department of Natural Resources
Start Date and Funding Amount
October 2013; $129,000
SREL Collaborators
Dr. Tracey Tuberville and Dr. Kurt Buhlmann - SREL
Objectives
Evaluate the effectiveness of head-starting as a means of establishing viable populations of gopher tortoises on protected lands in Georgia.
Summary of Research Activities
We protected and hatched nests from three donor sites in Georgia. We have released head-starts from 2013 and 2014 cohorts as well as hatchlings from the 2015 cohort, and are monitoring them using radio-telemetry post-release. We are also head-starting animals from the 2015 cohort for release in 2016.
Conclusions
Head-starting appears to be an effective way of increasing juvenile survivorship, although site-specific predator pressures from raccoons and fire ants can exert strong influence on outcome.
Major Impact(s) of Research
This work is among the first to evaluate post-release site fidelity and survival of released head-started gopher tortoises. Our results will help determine whether head-starting can be used as a potential recovery tool for the species.
Other Project Personnel
Dan Quinn, M.S. Student – UGA
Kimberly Price, Research Technician – SREL
External Collaborators
John Jensen – Georgia Department of Natural Resources
Dr. Terry Norton – Georgia Sea Turtle Center
Products
Quinn, D., T.D. Tuberville, and K.A. Buhlmann. 2016. Gopher tortoise egg and hatching data from predator-excluded nests at three sites in Georgia. Herpetological Review 47:13-16.
Quinn, D.P. 2016. Head-starting as a conservation tool for gopher tortoises (*Gopherus polyphemus*). M.S. Thesis, University of Georgia.
Quinn, D.P., K.A. Buhlmann, J.B. Jensen, T.M. Norton, and T.D. Tuberville. First year post-release movement and survivorship of head-started gopher tortoises. *In review*.

Can waifs be used to restore viability of gopher tortoise populations?

Funding Entity
South Carolina Department of Natural Resources / US Fish and Wildlife Service
Start Date and Funding Amount
May 2017; $70,559
SREL Collaborators
Dr. T.D. Tuberville and Dr. K.A. Buhlmann - SREL
Objectives
Evaluate the survivorship, site fidelity, and health metrics of translocated waif gopher tortoises used to build a viable population of state-protected land in South Carolina
Summary of Research Activities
1) Graduate student trained to survey the release habitat and capture and process (measure, assess health) of gopher tortoises previously translocated to the protected land.
2) Recapture of 50+ of original released animals, with collection of numerous biological samples for genetic analyses and disease testing.

Conclusions
None to date. Preliminary analyses planned for Winter 2017-18; further work planned for Summer 2018.
Major Impact(s) of Research
Waif adult tortoises represent valuable animals from a species recovery perspective, but methods need to be explored that use them for species recovery, even when these individuals cannot be returned to their original populations of origin.
Other Project Personnel
Rebecca McKee, MS Student – UGA
External Collaborators
Will Dillman – SCDNR
Barry Kesler – SCDNR
Products
McKee, R., K.A. Buhlmann, W. Dillman, B. Kesler, and T.D. Tuberville. An island of misfit tortoises: using waif animals to recover populations on the brink. Turtle Survival Alliance Annual Meeting, August 2017. (poster)

Integrating gopher tortoise recovery

Funding Entity
Longleaf Alliance (LLA)
Start Date and Funding Amount
May 2017; $18,000
SREL Collaborators
Dr. K.A. Buhlmann and Dr. T.D. Tuberville - SREL
Objectives
Continue rearing head-start gopher tortoises for release onto protected state-owned lands, to achieve viable populations. Demonstrate where the methodology may be employed successfully of privately-owned and managed lands in South Carolina
Summary of Research Activities
1) The 2017 cohort consisting of 59 hatchling tortoises is being reared indoors for one winter.
2) Multiple meetings and discussions were held with partners and stakeholders to discuss the project
Conclusions
None to Date
Major Impact(s) of Research
As head-starting is showing effectiveness in assisting with recovery of threatened tortoises on state-owned and managed lands, the next logical step will be to engage with willing private landowners how may be interested in maintaining gopher tortoise populations on their lands.
Other Project Personnel
Kyle Brown, Research Technician – SREL
External Collaborators
Robert Abernethy – Longleaf Alliance
Lisa Lord – Longleaf Alliance
Will Dillman – SCDNR
Darrell Shipes – SCDNR
Products
Media Coverage:

- http://www.wrdw.com/content/news/Gopher-Tortoises-Returning-To-The-WIld--448279013.html
- http://www.aikenstandard.com/news/young-gopher-tortoises-get-head-start-before-being-released-at/article_57cf8758-a484-11e7-992f-5b18772d6b1f.html

Disease implications of using waifs to create viable populations of gopher tortoises.

Funding Entity
Riverbanks Zoo Conservation Fund
Start Date and Funding Amount
April 2017; $6000
SREL Collaborators
Dr. T.D. Tuberville and Dr. K.A. Buhlmann - SREL
Objectives
1. Assess potential health risks and concerns of using waif tortoises to reestablish wild populations
Summary of Research Activities
1) Graduate student was trained during Summer 2017
2) Biological samples (swabs) were collected from 53 waif, translocated gopher tortoises during Summer 2017 and will be processed in Winter 2017-18.

Conclusions
None to Date
Major Impact(s) of Research
Health issues are a conservation concern when translocating tortoises of unknown origin into new populations for presumed conservation/recovery benefit.
Other Project Personnel
Rebecca McKee, MS Student – UGA
External Collaborators
Dr. Matt Allender – University of Illinois
Products
McKee, R., K.A. Buhlmann, W. Dillman, B. Kesler, and T.D. Tuberville. An island of misfit tortoises: using waif animals to recover populations on the brink. Turtle Survival Alliance Annual Meeting, August 2017. (poster)

Herpetofaunal surveys of Kings Bay Naval Submarine Base, Georgia

Funding Entity
US Department of Navy
Start Date and Funding Amount
September 2016; $75,742
SREL Collaborators
Dr. Tracey Tuberville and Larry Bryan - SREL
Objectives
1) Conduct herpetofaunal surveys of Kings Bay Naval Submarine Base, focusing on upland snakes and diamondback terrapins
2) Identify within-range species that were not documented but are likely to occur on Kings Bay based on nearby locality records or availability of suitable habitat.
3) Provide management recommendations and guidance for future research or inventory efforts

Summary of Research Activities
We initiated the herpetofaunal survey, which we plan to complete in December 2017. We employ a variety of techniques, including aquatic and terrestrial traps, coverboards, and road-cruising.
Conclusions
Project is ongoing – no conclusions at this time.
Major Impact(s) of Research
This work will constitute the first herpetological inventory for the installation, providing valuable information that the Department of Navy can incorporate into their Integrated Natural Resources Management Plan.
Other Project Personnel
Nicole White, Research Technician – SREL
External Collaborators
N/A
Products
No products to report at this time.

Population genetics of striped newts across Florida

Funding Entity
Florida Fish and Wildlife Commission
Start Date and Funding Amount
August 2017; $2622
SREL Collaborators
Dr. Stacey L. Lance - SREL
Objectives
The range of the striped newt, which is a candidate for federal protection under the Endangered Species Act, is limited to widely scattered populations in southern Georgia and northern Florida. This species has been extirpated from many historical localities, including recent enigmatic declines in Apalachicola National Forest, a former stronghold of the species. The overall objectives of this study are to 1) determine the amount of gene flow and degree of genetic variation among striped newt populations in different areas of peninsular Florida; 2) if sample collection in Georgia is possible, determine the amount of gene flow between Georgia and Florida populations and compare the degree of genetic variation in populations in both states; and 3) examine rates of gene flow and genetic variation among breeding ponds within a population
Summary of Research Activities
In the winter of 2016 we developed a suite of microsatellite markers for striped newts. In 2016 and 2017 we extracted DNA from 542 newts from 21 wetlands and screened them across 10 markers. After analyzing the results it was determined that 110 samples from additional populations should be examined to assess where there is an east-west divide and barrier to gene flow. We are currently analyzing those samples.
Conclusions
1) There is significant among pond genetic differentiation.
2) There is significant isolation by distance among the 21 wetland populations examined.
3) Ponds within 40 km of each other may act as a metapopulation.
Major Impact(s) of Research
Geographically isolated populations are unlikely to be re-founded by natural migration following extirpation. If translocations are chosen as a management strategy, repatriation from the nearest wetland with a stable population is recommended, or a mix from nearby wetlands. There is a need for captive assurance populations.
Other Project Personnel
Imogene Davis, Research Technician – SREL
Rochelle Beasley, Research Professional – SREL
External Collaborators
Anna Farmer – Florida FWC
Kevin Enge – Florida FWC
Dr. Eric Hoffmann – University of Central Florida
Dr. Sarah May – University of Central Florida
Dr. Steve Johnson – University of Florida
Products
Johnson, S., E. Hoffman, S. May, A. Farmer and S. Lance. Contemporary Versus Historical Connectivity: A Case Study of Gene Flow in an Imperiled Salamander. American Water Resources Association 2017 Specialty Conference—Connecting the Dots: The Emerging Science of Aquatic System Connectivity, Snowbird, UT 2017 (Platform presentation).

Hoffman, E., S. Johnson, S. May, A. Farmer, S. Lance and K. Enge. Connectivity vs. Isolation: a case study of gene flow in an imperiled salamander. 2017 Annual meeting of The Wildlife Society, Albuquerque, NM and 2017 Annual Joint Meeting of Ichthyologists and Herpetologists, Austin, TX (Platform presentations).

Multi-year mating dynamics and population structure in a coastal population of* Alligator mississippiensis *at the Tom Yawkey Wildlife Center

Funding Entity
MUSC, SC-DNR, The Yawkey Foundation
Start Date and Funding Amount
April 2017; $74,020
SREL Collaborators
Dr. Stacey L. Lance, Dr. Ben Parrott, and Joshua Zajdel - SREL
Objectives
The overall objectives in this project are 1) identify parentage for clutches of alligators from the Yawkey Wildlife Center (YWC) collected from 2011-2015, 2) characterize the breeding population with respect to animal size, range, and multiple paternity and 3) quantify the genetic diversity of alligators at YWC and compare to populations from other parts of South Carolina and Florida.
Summary of Research Activities
We have been collecting samples from adult alligators and nests at YWC in conjunction with the SC DNR. To date they have sampled eggs from >30 clutches from 2011-2016. In addition, females at nests have been sampled over several nesting seasons. Together, at SREL we are now analyzing the microsatellite genotypes of over 800 individuals across a panel of loci we developed. Initial screens indicated very low genetic diversity. We have screened hatchlings from 2011-2013 and extracted DNA from 2014 and 2015. We also captured and screened additional adults to increase the number of adults in our database. Toward objective 3 we have collected or acquired samples from two sites in North Carolina, and 1 additional site in South Carolina, and 1 in Georgia. To develop a panel of markers for the population genetics analyses we have completed an initial analysis of single nucleotide polymorphisms in 24 alligators and are designing baits to use for screening animals from all localities sampled.
Conclusions
Data are still being collected, thus there are no conclusions at this time.
Major Impact(s) of Research
Our findings will provide valuable information regarding the structures of coastal alligator populations in the northern range of this species. Effective management for the long-term preservation of a species attempts to conserve genetic diversity and adaptive potential our findings may have potentially large impacts on management practices moving forward as pressure increases to expand the hunting of alligators.
Other Project Personnel
NA
External Collaborators
Dr. Thomas Rainwater – Clemson University
Dr. Jason O'Bryhim – George Mason University
Phil Wilkinson – SCDNR
Jamie Dozier – SCDNR
Products
Lance, S.L., B. Parrott, J. O'Bryhim, T. Rainwater, P. Wilkinson, and L. Guillette. Parentage analyses in Yawkey gators: Take 3! 2016 Palmetto Alligator Research and Management Symposium. Georgetown, SC. (Platform presentation).

Lance, S.L., T.R. Rainwater, P.M. Wilkinson, and B.B. Parrott. Mating dynamics and population genetics in a coastal population of *Alligator mississippiensis* at the Tom Yawkey Wildlife Center. IUCN Crocodilian Specialist Group Meeting. Kruger, South Africa. (Platform Presentation).

Panmixia, promiscuity, and nest parasitism among Wood Storks (*Mycteria americana*)

Funding Entity
University of South Carolina
Start Date and Funding Amount
May 2016; $14,988
SREL Collaborators
A. Lawrence Bryan Jr. and Dr. Stacey Lance - SREL
Objectives
To sample US Wood Storks (nestlings) from selected colonies throughout their range and use a subset of storks to develop a panel of SNP (single nucleotide polymorphism) capture probes. These probes will then be used for capturing loci from additional stork DNA samples for genotyping via next generation sequencing to provide a robust examination of genetic structure and mating system in US WOST colonies as well as in other parts of their range.
Summary of Research Activities
Blood samples were obtained from > 130 total stork nestlings from 4 southeastern U.S. colonies in 2016 and will be compared to archived samples from 2 additional colonies. Additionally, samples from Brazil have been acquired and an agreement is in place to obtain samples from Cuba. Samples in had are currently being prepared for analyses. A subset of 24 stork samples were used to create genomic libraries for sequencing and identification of SNP loci. Currently, those data are being analyzed to design capture probes.
Conclusions
None at present, pending completion of genetic analyses.
Major Impact(s) of Research
When completed, will have a thorough analyses of the genetic structure of the US population of Wood Storks and should know the prevalence, if any, of non-standard mating strategies.
Other Project Personnel
NA
External Collaborators
Dr. Kristina Ramstad – USC-A
Dr. Natalia Bayona – UGA
Products
No publications, presentations, or reports have yet been prepared.

Demographic and behavioral impacts of an intensive male sterilization program for free-ranging white-tailed deer on Staten Island, New York

Funding Entity
NY Department of Conservation to White Buffalo.
Start Date and Funding Amount
August 2016; ~$15,000
SREL Collaborators
Dr. Stacey L. Lance - SREL
Objectives
1) Assess demographic (fecundity and recruitment) and behavioral impacts of capturing and sterilizing varying percentages of male white-tailed deer over a three-year period.
2) Determine male immigration and dispersal patterns in an urban-park complex.
3) Assess male responses to bait.
4) Examine movement patterns, survival rates, and dispersal during breeding seasons.
5) Primary role of SREL is to determine patterns of parentage for all sterilized males.

Summary of Research Activities
The field component of the project initiated on September 5, 2016. Field efforts went beyond expectations and over 700 deer were sterilized and sampled in 2016. A second season has been initiated for fall of 2017.
Conclusions
No conclusions are available at this time.
Major Impact(s) of Research
Until the data are fully acquired and analyzed we will not know the major impacts.
Other Project Personnel
Rochelle Beasley, Research Professional – SREL
External Collaborators
Dr. Anthony DeNicola – White Buffalo
Dr. Andrew DiSalvo – White Buffalo
Dr. Nathan Kotschwar – White Buffalo
Products
Manuscripts will be prepared at a later date.

Costs of Incubation: Linking Incubation-Induced Alterations in Phenotype to Changes in Fitness

Funding Entity
National Science Foundation
Start Date and Funding Amount
October 2016; NFP
SREL Collaborator
Robert Kennamer - SREL
Objectives
Our overall goals have been to examine the importance of incubation temperature during early development, and to provide a better understanding of how reproductive tradeoffs made by females influence their fitness. In a recent part of the project, we collected eggs from SRS wood duck nests and artificially incubated the eggs at different temperatures known to influence phenotype. Following hatching, the ducklings were subjected to a battery of challenges that are typical for wood duck ducklings, including for example, the ability to successfully exit a nest cavity and make vocalizations to attract the attentions of an attending adult female (all challenge events were timed and video-taped).
Summary of Research Activities
In FY16, field/lab work on the project was completed; in FY17, manuscript preparation was initiated.
Conclusions
1) Clutch size is an important moderator of incubation temperature for individual eggs within naturally incubated clutches, with larger clutches having greater variation in individual egg temperatures, and resulting in varying duckling quality at hatching.
2) This is the first study to determine how the early thermal and social environments interact to influence offspring behavior and suggests that these factors may play an important role in shaping offspring behaviors and performance metrics that are critical for survival.
3) In another analysis, we found that egg-laying sequence interacted with incubation (artificial) temperature to affect embryonic development and hatching synchrony, implying that egg characteristics (egg components) differed with laying sequence to facilitate better hatching synchrony in a precocial bird species.

Major Impacts of Research
1) Illustrates the potential importance of incubation as related to offspring quality/performance.

Other Project Personnel
John Hallagan, Research Technician – Virginia Tech
Sydney Hope, MS Student – Virginia Tech
External Collaborators
Dr. Bill Hopkins – Virginia Tech University
Dr. Sarah DuRant – Oklahoma State University
Products
Hope, S.F., S.E. Durant, J.J. Hallagan, M.L. Beck, R.A. Kennamer, and W.A. Hopkins. The effect of clutch size on incubation behavior and with-in nest egg temperature variation. The 2017 Society for Integrative and Comparative Biology Annual Meetings, New Orleans, LA. January 6, 2017. (Oral presentation).

Hepp, G.R. and R.A. Kennamer. *In review*. Laying sequence interacts with incubation temperature to influence rate of embryonic development and hatching synchrony in a precocial bird. Submitted to: *PLoS ONE*.

The Ecological Study of Birds in the Vicinity of Augusta Regional Airport at Bush Field

Funding Entity
City of Augusta, GA
Start Date and Funding Amount
October 2016; $113,854
SREL Collaborator
Robert Kennamer and Dr. Lehr Brisbin, Jr. - SREL
Objectives
Conduct bird hazard research associated with the placement of a wastewater treatment wetland system adjacent to a commercial airport and provide wildlife hazard consultation to airport and wastewater treatment plant personnel.
Summary of Research Activities
Since December 2001, we have been monitoring temporal and spatial activities of birds around Augusta Regional Airport. Within 2 years of the 2001 completion, the 360-acre wastewater treatment wetlands served as a nighttime roost for millions of migratory blackbirds that crossed the airfield daily at sunrise and sunset during fall/winter periods. We have been investigating the use of habitat alteration techniques to displace blackbirds, including use of airboats since 2008 to mechanically crush wetland vegetation in treatment wetlands each fall. Results have been highly significant, with long-term post-crush bird monitoring indicating that blackbird roosting within the wetlands became almost non-existent and blackbird activity around the airport was reduced. The ability of the wetland vegetation to process wastewater effluent was not negatively affected by vegetation alteration.
Conclusions
1) Long-term monitoring showed a reduction in blackbirds around the airport by 2 orders of magnitude and this reduction has been maintained for seven years now.
2) Fall crushing of wastewater treatment wetlands vegetation has not harmed the vegetation and regrowth has been experienced each subsequent spring.

Major Impacts of Research
1) The work demonstrated that with thoughtful wildlife hazard management, including the use of novel techniques, one can mitigate undesirable wildlife attraction associated with certain land-use activities.
2) Successful reduction of the bird-aircraft strike hazard was accomplished through non-lethal means.
3) Wastewater effluent concentrations of TSS, NH_3-N, and BOD_5 were reduced (improved) as a result of the vegetation crushing (i.e., vegetation crushing contributed an added benefit).

Other Project Personnel
Carol Eldridge, Research Professional – SREL
Meghan Oberkircher, Research Technician – SREL
External Collaborators
D. Allen Saxon, Jr. – Augusta GA Utilities Department
Tim Weegar – Augusta Regional Airport
Products
Kennamer, R. A., M.C. Oberkircher, C.S. Eldridge, and I. L. Brisbin, Jr. 2016. Abundance, Distribution, and Movement Patterns of Avifauna in the Vicinity of Bush Field Airport: 2015–2016 Report. Final report submitted to Augusta Utilities Department, 159pp.

Kennamer, R. A. Summertime cattle egret and swallow activity/mitigation at Augusta Regional Airport. Wildlife Hazard Management Group Meeting, Augusta Regional Airport, GA. November 16, 2016. (Oral Presentation).

Kennamer, R. A. Bird activity at AGS and constructed wetlands during fall 2016-spring 2017.Wildlife Hazard Management Group Meeting, Augusta Regional Airport, GA. May 25, 2017. (Oral Presentation).

Monticello Reservoir and Parr Reservoir waterfowl surveys

Funding Entity
Kleinschmidt Associates/South Carolina Electric and Gas Company
Start Date and Funding Amount
November 2015; $21,628
SREL Collaborator
Dr. James C. Beasley and Robert Kennamer - SREL
Objectives
To evaluate the current (two-year) abundance and distribution of wintering waterfowl (ducks, geese, swans, and coots) using Monticello and Parr reservoirs, South Carolina, using fixed-wing aircraft aerial surveys.
Summary of Research Activities
In year two, 9 additional fixed-wing aerial surveys of the entire Monticello Reservoir basin and Parr Shoals Reservoir from the Parr Shoals Dam to Henderson Island were conducted between November 15, 2016 and March 21, 2017, during which just over 1,250 waterfowl, representing 10 species, were documented using the Monticello Reservoir and over 3,000 waterfowl, representing 11 species, were recorded using Parr Reservoir.
Conclusions
1) Greater diversity and numbers of dabbling ducks were seen on Parr Reservoir than on Monticello Reservoir.
2) Most waterfowl seen on Parr Reservoir were found at Broad River Waterfowl Management Area (WMA) and/or Enoree WMA, where active management for waterfowl by S.C. Department of Natural Resources Department has created favorable conditions (e.g., food, cover, limited human disturbance) preferred by waterfowl.

Major Impacts of Research
1) There was no clear relationship between Parr Shoal Reservoir water levels at the time of aerial surveys and numbers or types of waterfowl seen at Parr Shoals reservoir, including the WMAs. However, as water levels at Broad River WMA impoundments were actively drawn down for management purposes in March, following the hunting season, waterfowl naturally moved out of those managed impoundments.
2) Sightings of bald eagles (*Haliaeetus leucocephalus*) made during the waterfowl surveys were of great interest. Bald eagles were seen on 13 of 18 (72%) surveys of Parr Reservoir and 6 of 18 (33%) surveys of Monticello Reservoir. Bald eagle sightings included both adults (16) and immature (16) birds.

Other Project Personnel
Carol Eldridge, Research Professional – SREL
External Collaborators
Shane Boring – Kleinschmidt Associates
Products
Kennamer, R.A., C.S. Eldridge, and J.C. Beasley. 2017. Waterfowl Aerial Surveys of Monticello and Parr Reservoirs, South Carolina: Final Report. Project report to Kleinschmidt Associates. Savannah River Ecology Laboratory Report, Aiken, SC, 28pp.

Interspecific variation in hydraulic redistribution and its importance to ecosystem processes in a xeric longleaf pine savanna.

Funding Entity
Joseph W. Jones Ecological Research Center
Start Date and Funding Amount
August 2016; $40,643
SREL Collaborators
D. Aubrey - SREL
Objectives
The goal of this project is to quantify the importance of hydraulic distribution to the plant communities of the longleaf pine ecosystem. Specifically, we aimed to determine: (1) which mature tree species of the longleaf ecosystem performed hydraulic redistribution and the absolute quantity of water redistributed; (2) how the water status of understory plants were influenced by hydraulic redistribution; and (3) if a portion of the water being hydraulically redistributed originated from groundwater sources.
Summary of Research Activities
Bidirectional sapflow sensors were fabricated and installed to measure water transport in roots and stems of longleaf pine and co-occurring oaks. Sapflow was measured throughout the 2017 growing season. Trenched plots were created to eliminate potential hydraulic redistribution and water status of understory plants in these plots were compared with those in untrenched controls. Water samples from precipitation, soil, groundwater, and tree xylem water were collected routinely and analyzed to determine the origins and relative contributions of evapotranspiration water.
Conclusions
Work is ongoing and will be completed at the end of FY18 or beginning of FY19.
Major Impact(s) of Research
1) In longleaf pine dominated savanna, hydraulic redistribution may moderate effects of soil moisture stress during times of water scarcity, especially in excessively well-drained soils.
2) Access to a water subsidy may affect ecosystem level processes, such as evapotranspiration and net ecosystem exchange, and provide valuable data to complete a full water budget for the region.

Other Project Personnel
M. Belovitch, MS Student – UGA
External Collaborators
Dr. S. Brantley – Joseph W. Jones Ecological Research Center.
Products
Belovitch, M., and D.P. Aubrey. 2017. Warnell Graduate Student Symposium, Athens, GA. (Poster presentation)

Longleaf pine ecophysiology.

Funding Entity
Joseph W. Jones Ecological Research Center
Start Date and Funding Amount
August 2016; $11,615
SREL Collaborators
D. Aubrey - SREL
Objectives
The goal of this project was to complete ecophysiological research at the Joseph W. Jones Ecological Research Center, engage with resident scientists, and participate in an integrated ecological research workshop.
Summary of Research Activities
Collected, processed, and analyzed data related to carbon dynamics in longleaf pine ecosystems and submitted a manuscript. Participated in an integrated ecosystem research workshop.
Conclusions
1) Belowground respiration can be maintained for extended periods through utilization of stored carbohydrates in the root system.
Major Impact(s) of Research
1) Provided data that challenges a contemporary paradigm in ecophysiological literature by showing that belowground respiration can be completely decoupled from canopy photosynthesis.
2) Demonstrated that the mechanism responsible for decoupling belowground respiration from canopy processes was the mobilization of stored carbohydrates from larger roots to smaller, more metabolically active roots.
3) Demonstrated that root mortality occurs with substantial amounts of stored carbohydrates still present in the form of starch, but that this substrate may be unavailable for use due to lack of water for hydrolysis and mobilization.
Other Project Personnel
S. Oswald, MS Student – UGA
External Collaborators
Dr. L. Boring – Joseph W. Jones Ecological Research Center
Products
Aubrey, D.P., J.T. Mims, S.W. Oswald, R.O. Teskey, and R.J. Mitchell. 2016. Stored Carbon Dynamics are Controlled by a Combination of Evolutionary, Physiological, and Ecological Pressures. American Geophysical Union, San Francisco, CA. (Oral presentation)
Oswald, S.W. and D.P. Aubrey. 2017. Carbon storage and water availability in longleaf pine (*P. palustris*). Warnell Graduate Student Symposium, Athens, GA. (Oral presentation)
Aubrey, D.P. and R.O. Teskey. Stored carbon compensates for disrupted supply of current photosynthate. Journal article submitted to *New Phytologist*.
Aubrey, D.P. 2017. Forest Carbon and Water Cycling Research at the Savannah River Ecology Laboratory. Integrated Ecosystem Research Workshop, Joseph W. Jones Ecological Research Center, Newton, GA. June 12-15, 2017. Jones Ecological Research Center.
Aubrey, D.P. 2017. Forest Ecophysiology at the Savannah River Ecology Laboratory. August 31, 2017. Joseph W. Jones Ecological Research Center, Newton, GA. September 31, 2017.

Addressing Modern Day Health Risks Stemming from Historical Dioxin Contamination

Funding Entity
South Carolina Department of Health and Environmental Control
Start Date and Funding Amount
February 2017; $12,194
SREL Collaborators
Dr. Benjamin B. Parrott - SREL
Objectives
The overall goal of this research is to determine if dioxin levels are correlated to biomarkers of exposure in developing alligator embryos.
Summary of Research Activities
2,3,7,8-tetrachlorodibenzo-*para*-dioxin (TCDD, or "dioxin") is the most toxic congener of the class of chemical chemicals known as dioxins, and is one of the most toxic anthropogenic contaminants known. With an array of deleterious effects associated with exposure, including mortality, multi-organ toxicity, carcinogenicity, teratogenicity, and tumor-promotion, US Federal and state regulatory agencies initiated a series of surveys in the late 20th century to characterize the scope of dioxin contamination in the environment and its sources. This investigation uncovered the role of Kraft pulp mills as sources of high levels of dioxin contamination in receiving waters and downstream aquatic systems (US EPA 1989). Of the 104 total surveyed, the International Paper Company's Georgetown facility (Georgetown County, SC) had the highest levels of dioxin (TCDD) in its effluent (US EPA 1989, 1990a, 1990b) at 0.640ppt.

We have recently detected significantly elevated gene expression of an established biomarker of dioxin exposure, *CYP1A2*, in liver tissue from embryonic American alligators at a site directly adjacent to this historically-dioxin contaminated system. This project directly measures TCDD and dioxin-like congeners and seeks to connect them to previously established biomarkers of exposure and developmental processes. *Questions*: (1) At what levels are 2,3,7,8-TCDD and other dioxin-like congeners associated with a historical point source detectable as maternally-deposited contaminants in alligator egg yolk from the Tom Yawkey Wildlife Center and Heritage Preserve (TYWCHP)? (2) Do these levels in yolk correlate to hepatic expression of *CYP1A2* in the matching embryo?
Conclusions
This research has just begun, thus there are no conclusions at this time.
Major Impact(s) of Research
1) Connecting specific dioxin congener levels in alligator yolks to alterations in embryonic development
2) Estimate the presence of historical contaminants in biological systems
3) Provide data and rationale for studies assessing human exposure and potential health impacts.
Other Project Personnel
Matthew Hale, PhD Student – UGA
External Collaborators
Dr. Thomas Rainwater – Clemson University
Products
Hale MD, Galligan TM, Rainwater TR, Moore BC, Wilkinson PM, Guillette LJ, Parrott BB. 2017. AHR and CYP1A expression link historical contamination events to modern day developmental effects in the American alligator. *Environmental Pollution* 230: 1050-1061

Assessing interactions between contaminant exposure and incubation temperatures in an environmental model of endocrine disruption

Funding Entity
DOE
Start Date and Funding Amount
NFP
SREL Collaborators
Dr. Benjamin B. Parrott - SREL
Objectives
The overall goal of this research is to determine how ecologically relevant thermal dynamics impact developmental responses to endocrine disrupting contaminant exposures.
Summary of Research Activities
The etiology of many reproductive disorders is complex and likely involves interactions between an individual's genetics and external environmental factors, including contaminant exposures and climate. Alligators from environments contaminated by endocrine disrupting compounds (EDCs) display disorders of the reproductive system including alterations in circulating sex hormone levels, a decreased robustness of sexually dimorphic gene expression, and morphological abnormalities of ovarian follicles. Perturbations in alligator reproduction appear to originate during embryonic development, as eggs removed from contaminated environments and placed in the laboratory yield juvenile alligators in which the aforementioned abnormalities persist. These reports suggest a model in which EDC exposure at early developmental time-points affects epigenetic programming and leads to stable and long-term alterations to genetic networks that ultimately culminate in decreased reproductive health.

Alligators, like many non-mammalian species, undergo temperature-dependent sex determination (TSD) and because almost all studies on TSD take place under artificial constant temperature, little is known regarding how ecologically relevant thermal fluctuations interact with contaminant exposures to affect reproductive development. This project aims to address this gap by utilizing traditional ecotoxicology dosing approaches in combination with incubators with fully programmable control units that are capable of replicating natural thermal variation measured in alligator nests in the field. The project will test the hypothesis that EDC exposure during specific windows of development negatively impact reproductive development, and that ecologically relevant thermal fluctuations impact organismal responses to EDC exposures.
Conclusions
This research has just begun, thus there are no conclusions at this time.
Major Impact(s) of Research
1) Establish fundamental insights into how EDC exposure during development affects reproductive development
2) Provide a basic understanding of how variable environmental conditions interact with contaminant exposures in biological systems

Other Project Personnel
Matthew Hale, PhD Student – UGA
Samantha Bock, PhD Student – UGA
External Collaborators
Dr. John Drake – UGA
Dr. Andrew Kramer – UGA
Products
3 poster presentations, 4 oral presentations at regional, national and international conferences

Ecological and evolutionary dynamics of Avian malaria, an emerging infectious disease in wild bird populations

Funding Entity

SREL, Department of Science and Technology and Department of Biotechnology, Govt. of India

Start Date and Funding Amount

October 2015; $150,000

SREL Collaborators

Dr. G. Dharmarajan - SREL

Objectives

Emerging infectious diseases are considered to be one of the greatest challenges of our times, and their recent proliferation has been associated with anthropogenic factors such as global climate change. Avian malaria (AM) – a vector-borne disease caused by protozoan parasites *Plasmodium* spp. (Plasmodiidae) and *Haemoproteus* spp. (Haemoproteidae) is an important emerging disease in bird populations where the pathogen has been recently introduced (e.g., Hawaii). However, avian malaria is relatively benign in its native range, and previous research has shown that introduced *Plasmodium* parasites associated with large-scale mortalities originated from India, This study will characterize patterns of avian malaria in a natural bird community in India to improve our understanding of the disease. Birds were sampled using mist netting in the sky islands located in the southern 600 km mountain range of Western Ghats. The objective of this study is to elucidate the ecological and evolutionary dynamics of avian malaria in bird communities in the tropical sky-islands of the Western Ghats, India

Summary of Research Activities

Blood, sampled (50-100 µl) from the ulnar vein of birds was used to genomic DNA using Qiagen Blood and tissue extraction kit (Qiagen, Hilden, Germany) following manufacturer's protocol and screened for avian malaria infection. A nested Polymerase chain reaction (PCR) approach was employed to amplify the partial mitochondrial cytochrome b gene (478bp) of avian haemosporidian parasites. The reference genomic DNA of Plasmodium relictum provided by National Institute of Malaria Research, New Delhi, India, was used as a positive control for all PCR reactions. Positive samples were sequenced in both forward and reverse direction using BigDye v. 3.1 on an ABI 3130 automated DNA sequencer. Paired DNA sequences were aligned, trimmed and assembled in Geneious 9.1.5 for analyses.

Conclusions

1) A total of 1177 birds from 28 bird species were sampled, and our data revealed that 24 out of 28 species were infected with avian malaria parasites (*Plasmodium* spp. and *Haemoproteus* spp.) with an overall prevalence of 41.6% (490 individuals).
2) We identified a total of 47 different mitochondrial cytb lineages, with 18 *Plasmodium* and 29 *Haemoproteus* parasites, but only six *Plasmodium* and four *Haemoproteus* lineages showed identity with sequences available in the Genbank/Malavi database
3) *Haemoproteus* lineages showed greater levels of species specificity as compared to *Plasmodium*

Major Impact(s) of Research

1) Our data reveal that relatively few lineages of avian malaria are shared between India and areas where the parasite has been newly introduced, thus indicating that disease emergence is associates with rare *Plasmodium* lineages
2) Our data also reveal that *Plasmodium* is generally less species specific compared to *Haemoproteus,* which could explain why EIDs are generally associated with the former rather than the latter pathogen.

Other Project Personnel

P. Gupta, PhD Student – UGA

External Collaborators

Dr. R. V. Vijayan – Indian Institute of Science Education and Research Tirupati

Products

A publication is in preparation based on this data

Interspecific competition in ticks: implications for tick-borne disease dynamics

Funding Entity
SREL
Start Date and Funding Amount
October 2016; NFP
SREL Collaborators
Dr. G. Dharmarajan and Dr. J. Beasley - SREL
Objectives
Ticks are obligatory parasites whose development and reproduction depends upon obtaining a blood meal from a vertebrate host. In the US, ticks transmit a greater diversity of pathogens and are responsible for more cases of human disease than any other arthropod vector, including mosquitoes. Research on tick-borne diseases (TBD), and hence public health policy, has focused on tick species that are competent at transmitting a pathogen to humans. This study questions this prevailing paradigm which ignores effects of non-competent vectors on TBD dynamics. Indeed hosts are a heterogeneous landscape for ticks, wherein only a few specific sites are suitable for a tick to attach and feed (e.g., areas protected from host grooming). Consequently, whenever two species of ticks infest a common host, interspecific competition for these feeding sites is expected. The objective of this study is to test how competitive interactions amongst ticks are affected by: (a) Direct competition for optimal feeding sites on a host; (b) Immune-mediated competition; (c) Pathogen-mediated competition
Summary of Research Activities
We have carried out preliminary mathematical modeling and spatial epidemiological analyses at local and regional scales to test how interspecific competition amongst ticks can impact tick-borne disease dynamics in human populations. Our analyses currently focus on Lyme disease (a TBD caused by *Borrelia burgdorferi*), the most important vector-borne disease in the US responsible for over 300,000 cases annually
Conclusions
1) Our mathematical model reveals that competition between non-competent and competent vectors for limited feeding sites on a host can lead to reduced prevalence, or even elimination, of a TBD in a host community, irrespective of whether hosts are themselves limiting.
2) Our analyses reveal that this reduction in TBD is because from a tick-borne pathogen's perspective, feeding sites occupied by non-competent ticks are "wasted". Thus, as the proportion of non-competent vectors increases the risk of pathogen transmission from infected to uninfected hosts, and hence disease prevalence, decreases.
3) Our analyses also reveal that some paradoxical spatio-temporal patterns associated with Lyme disease (e.g., the Lyme disease gradient) can be effectively explained by competitive interactions between competent (*Ixodes scapularis*) and non-competent (*Amblyomma americanum*) vectors of this disease.

Major Impact(s) of Research
1) Our models reveal that non-competent vectors for disease can critically impact the persistence of a vector-borne disease in natural populations
2) Our analyses reveal how interspecific competition between vectors at the individual host level scales up to alter pathogen dynamics at the level of population and communities
3) Our analyses has critical implications for US *public health policy* because it is expected to provide an ultimate explanation for some enigmatic spatial patterns associated Lyme disease,

Other Project Personnel
Amanda Hurst, Research Technician – SREL
External Collaborators
Dr. R. Ostfeld – Cary Institute of Ecosystem Studies
Dr. M. Lynn – University of Southern Florida
Products
The preliminary data has been used to submit a grant to the National Science Foundation

Using population genetics to explore the origins of macrocyclic lactone resistance in Dirofilaria immitis

Funding Entity

SREL, Filariasis Reagent and Resource Center UGA, Department of Infectious Diseases UGA

Start Date and Funding Amount

January 2017; NFP

SREL Collaborators

Dr. G. Dharmarajan - SREL

Objectives

Canine heartworm (*Dirofilaria immitis*) is the single most important parasite of dogs in the United States. Prevention of heartworm is based on compliant administration of macrocyclic lactone (ML) drugs, and all products are labeled as 100% effective. However, over the past 10-15 years we have seen a dramatic rise in numbers of 'lack of efficacy' cases, and resistance to ML drugs is now proven definitively. The large majority of ML-resistance cases have been diagnosed in dogs living in the Mississippi Delta region, however at present the distribution of resistant heartworms remains uncertain. The objective of this study is to test if drug resistance in the canine heartworm (*Dirofilaria immitis*) is associated with a single event with subsequent spread (hard selective sweep), or as several independent events (soft selective sweep).

Summary of Research Activities

We developed a panel of highly polymorphic microsatellite markers specific to *D. immitis* to examine the population genetics of canine heartworm. The top 24 sets of markers were initially confirmed using pools of 500 microfilariae from three susceptible and two resistant laboratory strains of *D. immitis*. Fragment analysis was conducted using the ABI 3730xl system, and a total of 15 novel highly polymorphic markers were identified. These markers were used in combination with two previously published microsatellite markers to screen microfilariae from 2 resistant and 3 susceptible laboratory isolates, and from 32 high-suspect resistant and 10 likely-susceptible field isolates, based on case history and/or results of microfilariae suppression tests.

Conclusions

1) Analyses of the microsatellite data reveal weak spatial structuring of *D. immitis* populations in the US.
2) Our analyses also reveal relatively weak signatures of genetic differentiation between drug resistant and susceptible strains of *D. immitis,* indicating that soft selective sweeps are the most likely cause of drug resistance in this parasite

Major Impact(s) of Research

1) This project improves our understanding of the epidemiology of drug resistance in *D. immitis*. Evidence of soft selective sweeps indicates that there are multiple origins of drug resistance in this parasite, and this finding has important implications for the control of this disease in the US.

Other Project Personnel

Julie Sanchez, MS Student – UGA

External Collaborators

Dr. R. Kaplan – UGA

Dr. A. Wolstenholme – UGA

Products

J. Sanchez, M.M. George, G. Dharmarajan, J.S. Gilleard, and R.M. Kaplan. Using population genetics to explore the origins of macrocyclic lactone resistance in Dirofilaria immitis. The American Association of Veterinary Parasitologists, 62nd Annual Meeting, July 22-25, 2017, Indianapolis, IN, USA.

Pathogen-mediated behavioral modification in ticks: implications for tick-borne disease dynamics

Funding Entity

SREL, Department of Environmental Health Sciences UGA, University of Southern Mississippi

Start Date and Funding Amount

March 2017; NFP

SREL Collaborators

Dr. G. Dharmarajan - SREL

Objectives

Lyme disease is a bacterial infection transmitted by ticks to more than 300,000 Americans annually. In the eastern US, the pathogen causing Lyme disease (*Borrelia burgdorferi*) is transmitted by the black-legged tick (*Ixodes scapularis*). This study proposes that behavioral manipulation of ticks will impact the spread and persistence of Lyme disease. Thus, the main aims of this study are to test if *I. scapularis* ticks colonized from natural populations in the North vs. the South: (1) differ in pathogen load when infected, and fitness (i.e., ability to survive desiccation and freezing) when infected or uninfected by *B. burgdorferi,* and how these factors are likely to impact vector competence; and (2) differ in tissue-specific gene expression profiles when infected or uninfected by *B. burgdorferi*, and if there is evidence of positive or negative selection at differentially expressed genes using genomic approaches

Summary of Research Activities

Initial mathematical modeling of the system has been completed, and these results have been analyzed within a spatial epidemiological framework. We have also collected preliminary data of tissue-specific transcriptomics from the lone star tick (*Amblyomma americanum*), which reveals that environmental stress and infection with pathogens *interact strongly to affect tick gene expression profiles.* We assembled 344 million Illumina reads, totaling over 34 billion nucleotides derived from 4 cDNA libraries constructed from adult female *A. americanum* that were unfed, or blood-fed for 12-48 hrs, 72-144 hrs, and 6-11 days. The libraries were assembled, and 5,792 coding sequences (CDS) that mapped 143 million reads were extracted. Digital expression of GRPs in four libraries revealed 9 differentially regulated *grp* genes, these differentially regulated *grp* genes were validated using qRT-PCR. We have also used the 3RAD workflow to obtain RADseq data from 16 Ixodidae individuals from four species (*I. scapularis, Amblyomma americanum, A. maculatum,* and *Dermacentor variabilis*). We obtained data from 332,057 loci in total, with 4,484 polymorphic loci genotyped in ≥75% of individuals (i.e., polymorphic loci shared among three genera of ticks). These loci contained a total of 13,136 SNPs.

Conclusions

1) The project is at a very preliminary stage, and no conclusions can be drawn at this time

Major Impact(s) of Research

1) This project will help improve our understanding of Lyme disease mechanisms and dynamics, and is especially timely given rapid northward range expansion by *I. scapularis*

Other Project Personnel

T. Kiernan, PhD Student – UGA

Dr. N. Vasquez, Postdoc – UGA

External Collaborators

Dr. T. Glenn – UGA

Dr. S. Karim – University of Southern Mississippi.

Products

No publications, presentations, or reports have yet been prepared. The preliminary data was used to submit a grant to Department of Defense, Tick Borne Disease Program, and will be used to submit a grant to National Institutes of Health (October 2017).

The global phylogeography of Plasmodium relictum and related Plasmodium species

Funding Entity
SREL and Department of Environmental Health Sciences UGA
Start Date and Funding Amount
May 2017; NFP
SREL Collaborators
Dr. G. Dharmarajan and Dr. S. Lance - SREL
Objectives
Haemosporidians (Phylum: Apicomplexa) are a diverse yet specialized group of vector borne protozoan parasites that infect numerous vertebrate hosts, including mammals, birds and reptiles via dipteran vectors (Perkins 2014). Most common haemosporidian genera include *Plasmodium* (mammal and bird hosts), *Haemoproteus* and *Leucocytozoon* (bird hosts), *Hepatocystis* (mammal and bat hosts), among others. About 300 species have been described across 20 haemosporidian genera, with over 200 species belonging to just one genus: *Plasmodium*. In addition to lack of well resolved phylogenies for haemosporidian parasites in general, the taxonomy and evolutionary origins of avian haemosporidians, in particular, remains unresolved. There is a huge gap in our understanding of avian malaria parasites and its relationship with other malaria parasites, due to the lack of good quality genomic data and limited number of informative molecular markers. The objective of this study is to optimize target enrichment approach and next generation sequencing for avian malaria parasites and examine its utility in field bird samples
Summary of Research Activities
Based on the evolutionary relationships, shared and conserved regions of four *Plasmodium* (*P. chaubadi*, *P. falciparum*, *P. vivax* and *P. gallinaceum*) and one *Haemoproteus* genome (*H. tartakovskyi*) were examined to design target capture probes. Baits (size ~160 bp) were designed to capture the shared conserved loci (as identified at the previous step) across malaria genomes by optimizing tiling density and gene overlap. Resulting baits were filtered to remove baits containing repetitive sequences (>25% repeat content) and having a high GC content ((30 % > GC > 70%) will be removed. Any duplicate baits generated at this stage were also removed from the bait set. The final bait set were used to perform an *in silico* analysis for testing the ability of these baits to capture the desired loci and infer phylogenetic relationship across the five malaria genomes (used for generating baitset) and other eight *Plasmodium* genomes of interest (*P. ashfordi*, *P. relictum*, *P. berghei, P. yoelii*, *P. knowlesi, P. ovale, P. malaria, P. reichenowi*. The resulting bait set has been sent for commercial synthesis as 'MYBaits' (MYcroarray, Inc.). For initial screening of the baits we will use whole genomic DNA will be extracted from several *Plasmodium* species (i.e., *P. falciparum, P. malaria, P. berghei, P. gallinaceum* and *P. relictum*).
Conclusions
1) The project is at a very preliminary stage, and no conclusions can be drawn at this time
Major Impact(s) of Research
1) This project is expected to improve our understanding of the global phylogeography of *Plasmodium*
2) Specifically, the study will provide the tools to improve our understanding of the evolutionary dynamics of disease emergence in *P. relictum*
Other Project Personnel
P. Gupta, PhD Student –SREL
External Collaborators
Dr. T. Glenn – UGA
Dr. M. Yabsley – UGA
Dr. B. Faircloth – Louisiana State University
Dr. R. Rickleffs – University of Missouri-St. Louis
Dr. R. V. Vijayan – Indian Institute of Science Education and Research Tirupati
Products
No publications, presentations, or reports have yet been prepared.

The Atlanta Mosquito Control and Monitoring Project (Mosquito-CAMP)

Funding Entity
SREL and Tucker Middle School, Atlanta
Start Date and Funding Amount
July 2017; NFP
SREL Collaborators
Dr. G. Dharmarajan and P. J. Perea - SREL
Objectives
Mosquitoes transmit some of the most deadly diseases globally (e.g., malaria) and are responsible for the spread of many new and emerging infectious pathogens in human populations worldwide and in the US (e.g., Zika, Dengue and Chikungunya viruses). Thus, mosquito control remains one of the most important public health challenges especially in urban areas. The control of mosquito populations is particularly critical for Atlanta, a city that has the dubious distinction of topping Orkin's list of Top 50 Mosquito Cities for past four years. It has long been recognized that environmental hygiene and sanitation are the foundation for successful and sustainable mosquito control in urban environments. It has also been recognized that the broad adoption of good practices related to hygiene and sanitation require the active participation of local communities. We propose that empowered children can be the most effective catalysts of change in their own communities. Thus, educating students in the broader public health issues related to mosquito control and actively engaging them in mosquito monitoring and control programs can bring about rapid and lasting social change to support ongoing mosquito control efforts by local communities, as well as Federal, State and Local government agencies.
Summary of Research Activities
We have initiated a pilot project at the Tucker Middle School in Atlanta, to obtaining data on mosquito abundance at fine spatial (e.g., neighborhood) scales. is a critical need for local communities and mosquito control authorities. The project engages high school students in the school to monitor mosquitoes in their own backyards and neighborhoods using established methods (e.g., mosquito oviposition traps) and/or novel techniques developed by the students themselves.
Conclusions
1) The project is at a very preliminary stage, and no conclusions can be drawn at this time
Major Impact(s) of Research
1) The long-term goal is to expand the network of schools so as to create a city-wide mosquito index for the media similar to a pollen index and UV index to keep the public better informed about public health risks in their locality.
Other Project Personnel
NA
External Collaborators
E. Knapp – Tucker Middle School Atlanta
Products
E. Knapp (Tucker Middle School), G. Dharmarajan (SREL) and P.J. Perea (SREL). Mosquito Monitoring- Biology Investigations using Technology and Engineering (BITE). Integrated STEM Instruction Workshop. 2017 Georgia STEM/STEAM Forum. Athens, GA. October 23, 2017
G. Dharmarajan, The most deadly animal. August 29, 2017. Tucker Middle School, Atlanta, GA (Invited talk)
G. Dharmarajan, Harnessing citizen science to monitor and control urban mosquitoes. August 30, 2017. EPA Regional Office, Atlanta, GA (Invited talk)

Factors affecting parasite resistance and tolerance in mosquitoes: implications for vector competence

Funding Entity

SREL, Filariasis Reagent and Resource Center UGA, Department of Infectious Diseases UGA

Start Date and Funding Amount

August 2017; NFP

SREL Collaborators

Dr. G. Dharmarajan - SREL

Objectives

Recent decades has seen the reemergence of many mosquito-borne diseases in human and animal populations (e.g., filariasis and malaria) The evolution of resistance against anti-parasitic drugs is one of the most important drivers of reemergence In the US the dog heartworm (*Dirofilaria immitis*; DI) is an important filarial parasite transmitted by mosquitoes which impacts the health of over 100,000 dogs in the US alone. The rising incidence of DI strains that are resistant to commonly used chemoprophylatic drugs (e.g., macrocyclic lactones and ivermectin) is a major concern in the US An improved understanding of the factors contributing to the evolution of drug resistance in this filarial parasite is critical from the perspective of veterinary epidemiology. The epidemiological dynamics of vector-borne diseases is affected by three biological entities: the vertebrate host, the parasite and the mosquito. Research on the evolution of drug resistance has primarily focused on the host (e.g., drug exposure and/or compliance) and the parasite (e.g., the rise of resistance genes). However, our understanding of the role of mosquitoes on the evolution of drug resistance remains limited. The focus of this study is to test if mosquitoes act to enhance or reduce the risk of a drug resistant parasite genotype spreading in the vertebrate host population. The objectives of this study are to: (1) Test if resistant and susceptible strains of DI differ in terms of their pathogenicity and virulence in mosquitoes, and test how these differences impact mosquito vector competence; (2) Test if there are competitive interactions between the strains within an individual mosquito, and determine if these competitive interactions impact vector competence; (3) Test if natural mosquito populations reveal signatures of local adaptation to sympatric vs. allopatric parasite populations, and test if local adaptation tends to increase or decrease vector competence

Summary of Research Activities

The experimental study design has been finalized, and the drug resistant and susceptible strains of DI have been identified. These strains are currently being maintained in infected dogs at the Filariasis Reagent and Resource Center, UGA. The student in the project is currently being trained in mosquito infection and dissection procedures. Initial experiments will commence in January 2018.

Conclusions

1) The project is at a very preliminary stage, and no conclusions can be drawn at this time

Major Impact(s) of Research

1) This study will elucidate the role of the mosquito vector in the rise and spread of drug resistant genotypes of mosquito-borne parasites in natural populations, and will thus improve the control of these diseases.
2) The study has important implications for our understanding of the factors affecting the evolution of parasite resistance and tolerance in mosquitoes, and hence has implications for our understanding of the evolution of vector competence.

Other Project Personnel

Erik Neff, MS Student – UGA

External Collaborators

Dr. A. Moorehead – UGA
Dr. R. Kaplan – UGA

Products

G. Dharmarajan, Do disease hotspots breed more deadly mosquitoes? July 27, 2017. SCDHEC, Columbia, SC (Invited talk)

Evolutionary moving envelopes to predict range expansion (EMERGE)

Funding Entity
SREL, Department of Environmental Health Sciences UGA
Start Date and Funding Amount
August 2017; NFP
SREL Collaborators
Dr. G. Dharmarajan - SREL
Objectives
Emerging infectious diseases impact the lives of millions of people globally. Close to a third of emerging infectious diseases are those caused by pathogens transmitted by vectors, such as mosquitoes and ticks, and this number is only expected to rise due to the rapidly expanding ranges of many vectors. The aim of this study is to develop a new approach – Evolutionary Moving Envelopes to predict Range Expansion (EMERGE) to better predict range expansion of disease vectors.
Summary of Research Activities
We have carried out a thorough analysis of the patterns of range expansion in the lone star tick (*Amblyomma americanum*). Our analyses revealed that climate change alone is not sufficient to explain the observed patterns of range expansion in this species over the past several decades. We have also completed the development of the preliminary EMERGE model. The model uses an explicit, and novel, evolutionary genetic framework to integrate two powerful established methods: environmental niche modeling and landscape resistance. We have also used the 3RAD workflow to obtain RADseq data from seven *A. americanum* individuals from two populations. We obtained data from 128,899 loci in total, with 19,843 polymorphic loci genotyped in ≥75% of individuals. The polymorphic loci contained a total of 69,815 SNPs.
Conclusions
1) Climate change alone is insufficient to explain observed range expansion in *A. americanum*, and that dispersal and adaptation play important roles
2) Patterns of range expansion are not gradual but take the form of discrete jumps, an indication of gene swamping (i.e., the negative effects of migrant load on local adaptation)
3) Large allele frequency differences between source and edge populations at selectively neutral loci, an indication of allele surfing (i.e., the combined effects of low density and strong founder effects)

Major Impact(s) of Research
1) Initial tests with EMERGE reveal that range expansion of *A. americanum* is likely driven by intricate interactions between climactic factors, dispersal and local adaptation.
2) EMERGE's novel framework in conjunction with its ability to explicitly integrate genomic information, provides us with a unique opportunity of obtaining a more mechanistic understanding of the factors driving range expansion in vectors.
3) By integrating niche modelling and genomic approaches our study will culminate in a robust new approach to modeling range expansion that can readily be applied to other species of epidemiological (e.g., other vector species) and ecological (e.g., invasive species) importance, and thus has the potential for broad applicability in the fields of both public health and ecosystem health.

Other Project Personnel
T. Kiernan, PhD Student – UGA
Dr. N. Vasquez, Postdoc – UGA
External Collaborators
Dr. T. Glenn – UGA
Dr. M. Yabsley – UGA.
Products
No publications, presentations, or reports have yet been prepared. The preliminary data will be used to submit a grant to National Institutes of Health (October 2017).

Kin structure in wild turkey populations

Funding Entity
SREL, Warnell School of Forestry UGA
Start Date and Funding Amount
August 2017; NFP
SREL Collaborators
Dr. G. Dharmarajan - SREL
Objectives
Kin-selection is an evolutionary strategy of natural selection where an individual exhibits altruistic behavior towards close relatives, resulting in an increase in the individual's genetic contribution to sequential generations and fitness. Kin-selection was recently observed to occur within a wild turkey population in the United States. Specifically, previous research has identified several mating coalitions of 2 to 4 similar-aged males, where subordinate males supported a single dominant male in the mating process without direct reproductive benefit. The coalition groups were observed to court and defend females against other coalition groups or solitary males. Using genetic measures of relatedness and reproductive success from both subordinate and dominant males within a coalition and solitary males on the landscape, analyses have shown that the conditions of Hamiliton's rule re met, showing the net benefit of a subordinate male helping a dominant male was +1.7 offspring per male. Additionally, dominant males within coalitions mated with more females and produced more offspring than solitary males. However, if the dominant male within a coalition group disappears or is harvested, the remaining subordinate(s) transition into solitary males which could ultimately change mating dynamics. The objective of this study is to evaluate the role of kin selection in the behavior and ecology of wild turkeys in the US, with a specific focus on the implications for managing wild turkey populations.
Summary of Research Activities
In 2016, we collected blood from 23 males (14 toms, 9 jakes) translocated to Angelina National Forest (ANF) in east Texas. Of the 23 males released into ANF, 16 individuals (13 toms, 3 jakes) were affixed with μGPS-telemetry transmitters. Additionally, we collected blood from 60 translocated females (34 adults, 26 subadults) affixed with μGPS-telemetry transmitters into ANF. During the nesting season, we collected egg shells from every nest initiated by females for genotyping. Using telemetry data collected from the males and genetic data collected from eggshells, we would like to determine the extent of which kin-selection or reproductive cooperation occurs within a translocated population. Extraction of DNA from these samples has been started, and we hope to complete genotyping all individuals by mid-2018.
Conclusions
1) The project is at a very preliminary stage, and no conclusions can be drawn at this time
Major Impact(s) of Research
1) This study has important implications for the management of wild turkeys in the US. For example, does the success of translocation depend upon the maintenance of kin-structured populations (e.g., factors affecting the breeding and reproductive success of wild turkey populations and factors impacting success of translocation efforts).
2) This study will also shed important insights into the basic ecology of wild turkeys including occurrence or rate of multi-paternal vs. single paternal clutches, and the occurrence of nest/brood parasitism as survival strategy and its effect on genetic diversity.

Other Project Personnel
Daniel Sullivan, PhD Student – UGA
Pooja Gupta, PhD Student – UGA
Jacob Ashe, Research Technician – SREL
External Collaborators
Dr. M. Chamberlain – UGA
Products
No publications, presentations, or reports have yet been prepared.

External (non-SRS) Funding Received in FY17

Savannah Harbor Expansion Project: Cadmium in Birds
Funding Entity
U.S. Army Corps of Engineers
Start Date and Funding Amount
April 2017; $99,980
SREL Collaborators and Roles
Dr. Olin E. Rhodes, Jr. (PI) and A. Lawrence Bryan, Jr. (Co-PI)
External Collaborators
Dr. Susan Wilde, UGA

Kings Bay Rare, Threatened and Endangered Wildlife Surveys: Loggerhead Shrikes
Funding Entity
DoD-Navy/USACE
Start Date and Funding Amount
June 2014; $46,000
SREL Collaborators and Roles
A. Lawrence Bryan Jr. (PI) and Dr. Olin E. Rhodes, Jr. (Co-PI)
External Collaborators
None.

Movements of Wood Storks Associated with Colony Modifications at the Savannah International Airport
Funding Entity
Savannah Airport Commission, Savannah, Georgia
Start Date and Funding Amount
June 2017; $49,750
SREL Collaborators and Roles
A. Lawrence Bryan Jr. (PI) and Dr. James Beasley (Co-PI)
External Collaborators
None.

Survival and Cause-Specific Mortality of Juvenile Feral Swine
Funding Entity
USDA-APHIS – Wildlife Services – National Wildlife Research Center
Start Date and Funding Amount
September 2014; $25,300.00
SREL Investigators and Roles
Dr. James C. Beasley (PI), David Keiter (student), Sarah Chinn (student), Dr. Peter Schlichting (postdoc)
External Collaborators
Dr. John Kilgo, USFS – Savannah River Site,
Mark Vukovich, USFS – Savannah River Site
Dr. Frederick Cunningham, USDA – Wildlife Services – National Wildlife Research Center

Post-Translocation Movement Behavior of Feral Swine
Funding Entity
USDA-APHIS – Wildlife Services – Veterinary Services, National Wildlife Research Center
Start Date and Funding Amount
September 2014; $108,350.00
SREL Investigators and Roles
Dr. James C. Beasley (PI), David Keiter (student), Dr. Josh Smith (postdoc), Dr. Peter Schlichting (postdoc), Sarah Chinn (student)
External Collaborators
Dr. Ryan Miller, USDA – Wildlife Services – Veterinary Services
Dr. Steven Sweeney, USDA – Wildlife Services – Veterinary Services

Effects of sounder removal on the movement behavior of wild pigs
Funding Entity
USDA-APHIS – Wildlife Services – National Wildlife Research Center
Start Date and Funding Amount
May 2014; $70,852.00
SREL Collaborators
Dr. James C. Beasley (PI), David Keiter (student), Dr. Peter Schlichting (postdoc)
External Collaborators
Kim Pepin, USDA – Wildlife Services – National Wildlife Research Center
Amy Davis, USDA – Wildlife Services – National Wildlife Research Center

Evaluation of contact structure and disease dynamics in free-ranging wild pigs

Funding Entity

USDA-APHIS – Wildlife Services – National Wildlife Research Center

Start Date and Funding Amount

February 2017; $58,883.00

SREL Collaborators

Dr. James C. Beasley (PI), Sarah Chinn (student), Dr. Peter Schlichting (postdoc)

External Collaborators

Dr. Toni Piaggio, USDA – Wildlife Services – National Wildlife Research Center
Dr. Kim Pepin, USDA – Wildlife Services – National Wildlife Research Center
Dr. Amy Davis, USDA – Wildlife Services – National Wildlife Research Center
Dr. Samantha Wisely, – University of Florida
Dr. Raoul Boughton, – University of Florida
Dr. Kurt VerCauteren, USDA – Wildlife Services – National Wildlife Research Center

Evaluation of crop damage by wild pigs

Funding Entity

USDA-APHIS – Wildlife Services – National Wildlife Research Center

Start Date and Funding Amount

February 2017; $58,883.00

SREL Collaborators

Dr. James C. Beasley (PI), Chris Boyce (student)

External Collaborators

Dr. Kurt VerCauteren, USDA – Wildlife Services – National Wildlife Research Center
Steve Smith, USDA – Wildlife Services

Distribution and relative abundance of wildlife in Fukushima along a gradient of contamination and human land-use intensity, and spatial ecology of invasive civets

Funding Entity

UGA, Office of International Partnerships, Office of the Vice President for Research

Start Date and Funding Amount

June 2016; $15,350.00

SREL Collaborators

Dr. James C. Beasley (PI), Phillip Lyons (student), Hannah Gerke (student)

External Collaborators

Dr. Thomas Hinton, Fukushima University
Dr. Kei Okuda, Fukushima University

Integrating gopher tortoise recovery

Funding Entity

Longleaf Alliance

Start Date and Funding Amount

May 2017; $18,000

SREL Investigators and Roles

Dr. Kurt Buhlmann (PI)
Dr. Tracey Tuberville (co-PI)

Co-Investigators, Roles, and Affiliations

Mr. Kyle Brown, SREL, Research technician
Mr. Robert Abernethy, Longleaf Alliance

Can waifs be used to restore viability of gopher tortoise populations?

Funding Entity

South Carolina Department of Natural Resources / USFWS

Start Date and Funding Amount

May 2017; $70,559

SREL Investigators and Roles

Dr. Tracey Tuberville (PI)
Dr. Kurt Buhlmann (co-PI)

External Collaborators

Will Dillman, South Carolina Department of Natural Resources
Barry Kesler, South Carolina Department of Natural Resources

Desert tortoise head-starting as a mitigation strategy

Funding Entity

California Energy Commission

Start Date and Funding Amount

September 2017; $493,089

SREL Investigators and Roles

Dr. Tracey Tuberville (PI)
Dr. Kurt Buhlmann (co-PI)

External Collaborators

Dr. Brian Todd, University of California-Davis
Pearson McGovern, UGA
Dr. Mark Peaden, University of California-Davis

Disease implications of using waifs to create viable populations of gopher tortoises
Funding Entity
Riverbanks Zoo Conservation Fund
Start Date and Funding Amount
April 2017; $6,000
SREL Investigators and Roles
Dr. Tracey Tuberville (PI)
Dr. Kurt Buhlmann (co-PI)
External Collaborators
Ms. Rebecca McKee, UGA

Evaluation of head-starting as a recovery tool for the Mojave desert tortoise
Funding Entity
National Park Service
Start Date and Funding Amount
June 2013; $450,000
SREL Investigators and Roles
Dr. Tracey Tuberville (PI), Dr. Kurt Buhlmann (co-PI)
External Collaborators
Dr. Brian Todd, University of California-Davis

Developing mitigation tools for relocation and reintroduction of species of concern on mining lands in Georgia
Funding Entity
Southern Ionics
Start Date and Funding Amount
January 2015; $336,866 (multiple contracts)
SREL Investigators and Roles
Dr. Kimberly Andrews (PI)
Dr. Tracey Tuberville (co-PI)
External Collaborators
N/A

Gopher tortoise population survey and habitat management at NAS Pensacola and associated properties.
Funding Entity
US Department of Navy
Start Date and Funding Amount
September 2016; $33,847
SREL Investigators and Roles
Dr. Tracey Tuberville (PI)
External Collaborators
N/A

Herpetofaunal surveys of Kings Bay Naval Submarine Base, Georgia.
Funding Entity
US Department of Navy
Start Date and Funding Amount
September 2016; $75,742
SREL Investigators and Roles
Dr. Tracey Tuberville (PI)
Larry Bryan (co-PI)
External Collaborators
N/A

Head-starting to augment gopher tortoise populations on protected areas in Georgia
Funding Entity
Georgia Department of Natural Resources
Start Date and Funding Amount
October 2013; $128,865
SREL Investigators and Roles
Dr. Tracey Tuberville (PI), Dr. Kurt Buhlmann (co-PI)
External Collaborators
Dr. Terry Norton, Georgia Sea Turtle Center
John Jensen, GADNR

NSF REU site: Radioecology.
Funding Entity
National Science Foundation
Start Date and Funding Amount
May 2015; $301,200
SREL Investigators and Roles
Dr. J Vaun McArthur (PI)
Dr. Tracey Tuberville (co-PI)
External Collaborators
Dr. Melissa Pilgrim, University of South Carolina-Upstate

Gopher tortoise population dynamics and movements in intensively managed forest landscapes.
Funding Entity
National Council for Air and Stream Improvement
Start Date and Funding Amount
Summer 2016; $40,000
SREL Investigators and Roles
Dr. James Martin (PI), SREL/UGA
Dr. Tracey Tuberville (co-PI)
External Collaborators
Dr. Michael Chamberlain, UGA

Population genetics of striped newts across Florida

Funding Entity
Florida Fish and Wildlife Commission
Start Date and Funding Amount
January 2016; $17,320, Aug 2017; $2622.
SREL Investigators and Roles
S. Lance (Co-PI)
External Collaborators
Dr. A. Farmer, Florida Fish and Wildlife Commission
Dr. K. Enge, Florida Fish and Wildlife Commission
Dr. E. Hoffmann, University of Central Florida

Multi-year mating dynamics and population structure in a coastal population of* Alligator mississippiensis *at the Tom Yawkey Wildlife Center

Funding Entity
South Carolina Department of Natural Resources and the Yawkey Foundation
Start Date and Funding Amount
April 2017; $74,020
SREL Investigators and Roles
S. Lance (Co-PI)
B. Parrott (Co-PI)
J. Zajdel (Graduate Student)
External Collaborators
Dr. Thomas Rainwater, Clemson University

Use of fecal genotyping and spatial capture-recapture modeling to investigate coyote abundance in South Carolina

Funding Entity
South Carolina Department of Natural Resources and Warnell School of Forestry and Natural Resources.
Start Date and Funding Amount
January 2017; $50,000
SREL Investigators and Roles
S. Lance (Co-PI)
External Collaborators
Dr. G. D'Angelo, UGA.
Dr. J. Kilgo, USFS - Savannah River Site.
Dr. K. Miller, UGA.

The Ecological Study of Birds in the Vicinity of Augusta Regional Airport at Bush Field

Funding Entity
City of Auusta, GA
Start Date and Funding Amount
October 2016; $113,854
SREL Investigators and Roles
R. A. Kennamer, and Dr. I. L. Brisbin, Jr. (co-PIs)
External Collaborators
D. A. Saxon, Jr., Augusta, GA Utilities Department

Monticello Reservoir and Parr Reservoir waterfowl survey

Funding Entity
Kleinschmidt Associates/South Carolina Electric and Gas Company
Start Date and Funding Amount
November 2017; $21,628
SREL Investigators and Roles
J. C. Beasley and R. A. Kennamer (co-PIs)
External Collaborators
Shane Boring, Kleinschmidt Associates

Total water use and source partitioning in woody bioenergy crops determined by coupled mass flux and stable isotope signatures.

Funding Entity
USDA National Institute of Food and Agriculture
Start Date and Funding Amount
September 2015; $915,593
SREL Investigators and Roles
D. Aubrey (PI)
External Collaborators
P. Caldwell, USDA Forest Service
R. Jackson, UGA
J. McDonnell, University of Saskatchewan
C. Miniat, USDA Forest Service.

Total water use and source partitioning in woody bioenergy crops determined by coupled mass flux and stable isotope signatures.

Funding Entity
USDA National Institute of Food and Agriculture
Start Date and Funding Amount
September 2015; $915,593
SREL Investigators and Roles
D. Aubrey (PI)
External Collaborators
P. Caldwell, USDA Forest Service
R. Jackson, UGA
J. McDonnell, University of Saskatchewan
C. Miniat, USDA Forest Service.

Interspecific variation in hydraulic redistribution and its importance to ecosystem processes in a xeric longleaf pine savanna.

Funding Entity
Joseph W. Jones Ecological Research Center
Start Date and Funding Amount
August 2016; $40,643
SREL Investigators and Roles
D. Aubrey (PI)
Co-Investigators, Roles, and Affiliations
None.

Longleaf pine ecophysiology.

Funding Entity
Joseph W. Jones Ecological Research Center
Start Date and Funding Amount
August 2016; $11,615
SREL Investigators and Roles
D. Aubrey (PI)
External Collaborators
None.

Getting to the root of the matter: Determining the global significance of internal carbon dioxide transport in trees.

Funding Entity
UGA Research Foundation
Start Date and Funding Amount
July 2017; $9,829
SREL Investigators and Roles
D. Aubrey (PI)
External Collaborators
None

Differences in the physiological response of Liquidambar styraciflua caused by season of burn.

Funding Entity
USDA Forest Service-Southern Research Station
Start Date and Funding Amount
August 2015; $60,000
SREL Investigators and Roles
D. Aubrey (PI)
External Collaborators
R.O. Teskey, UGA
J.J. O'Brien, USDA Forest Service Southern Research Station

Completion of data analysis and publication of soil chemical and physical properties associated with production of short rotation woody crops for bioenergy.

Funding Entity
USDA Forest Service-Savannah River
Start Date and Funding Amount
August 2016; $107,897
SREL Investigators and Roles
D. Aubrey (PI)
External Collaborators
D. Markewitz, UGA.

Regional Water Plan Seed Grant, Georgia Environmental Protection Division, Investigating increasing bromide concentrations in the Butts County drinking water supply to support activities outlined in the Middle Ocmulgee Regional Water Plan

Funding Entity
Georgia Environmental Protection Division
Start Date and Funding Amount
August 15, 2017: $115,214
SREL Investigators and Roles
K. A. Capps, PI
External Collaborators
None

Technical Expertise Requests in FY17

SREL Investigator
Dr. K. Buhlmann
Date of Request
October 2016
Requesting Entity
University of South Carolina- Upstate
Nature of Request
Presented a 1-hr guest lecture seminar in the Department of Natural Sciences and Engineering, October 2016. Title: "Population Recovery: Concepts and Methods for Threatened Amphibians and Reptiles"

SREL Investigator
Dr. K. Buhlmann
Date of Request
2016; ongoing
Requesting Entity
South Carolina Department of Natural Resources
Nature of Request
Serve as biological expert on gopher tortoise population biology and reintroduction techniques.

SREL Investigator
Dr. K. Buhlmann
Date of Request
Nov 2016; ongoing
Requesting Entity
National Park Service, Gulf Coast Monitoring Network
Nature of Request
Help design and conduct population monitoring of Texas tortoises (*Gopherus berlandieri*) at Palo Alto National Battlefield in order to inform management of the park.

SREL Investigator
Dr. K. Buhlmann
Date of Request
Jan 2017
Requesting Entity
Massachusetts Wildlife Dept
Nature of Request
Provide information on turtle nest protection designs

SREL Investigator
Dr. K. Buhlmann
Date of Request
Jan 2017
Requesting Entity
Richard Conniff, Journalist
Nature of Request
Provide info for article on commercial trade in wildlife for Scientific American

SREL Investigator
Dr. K. Buhlmann
Date of Request
Jan 2017
Requesting Entity
Lisa Feldcamp, The Nature Conservancy
Nature of Request
Provide info on turtle hibernation for TNC Magazine and TNC Green Blog

SREL Investigator
Dr. K. Buhlmann
Date of Request
2016; ongoing
Requesting Entity
US Fish and Wildlife Service
Nature of Request
Serve as biological expert on population viability and reintroduction of Blanding's turtles for Great Meadows Wildlife Refuge Complex, MA.

SREL Investigator
Dr. K. Buhlmann
Date of Request
Feb 2017
Requesting Entity
SCDNR
Nature of Request
Provide a gopher tortoise for Wildlife Expo in Charleston

SREL Investigator
Dr. K. Buhlmann
Date of Request
Feb 2017
Requesting Entity
US Forest Service, Sumter National Forest
Nature of Request
Provide expert opinion on the effects of the Palmetto Pipeline on Websters Salamander habitat in the Sumter NF

SREL Investigator
Dr. K. Buhlmann
Date of Request
February 2016; August 2016
Requesting Entity
Turtle Conservation Fund
Nature of Request
Review, evaluate, and rank proposals (February 2017) and (July 2017) for potential funding support by this non-profit conservation group. Attended Executive Board meetings via phone (March 2017), and in person in Charleston, SC (August 2017).

SREL Investigator
Dr. K. Buhlmann
Date of Request
April 2017
Requesting Entity
USFWS, Warnell School of Forest Resources
Nature of Request
Asked to provide location and population information for "At-Risk" snake species that inhabit the SRS.

SREL Investigator
Dr. K. Buhlmann
Date of Request
April 2017
Requesting Entity
Town of Hilda , SC
Nature of Request
Help with design of their SCDNR-permitted gopher tortoise pen

SREL Investigator
Dr. K. Buhlmann
Date of Request
April 2017
Requesting Entity
Dr. Joe Pechmann, Western Carolina University
Nature of Request
Asked to host and lead a Herpetology class field trip on the SRS, field trip occurred weekend of 7-9 April

SREL Investigator
Dr. K. Buhlmann
Date of Request
Mar 2017
Requesting Entity
DOD, Robby Smith, Environmental Biologist
Nature of Request
Help build a .ppt about amphibians and reptiles on Navy Bases for presentation at a DOD meeting

SREL Investigator
Dr. K. Buhlmann
Date of Request
Apr 2017
Requesting Entity
National Park Service
Nature of Request
Asked to assist with reptile IUCAC for their Monitoring Program

SREL Investigator
Dr. K. Buhlmann
Date of Request
April 2017
Requesting Entity
The Amphibian Ark (non-profit) and Fort Stewart Army Base DOD
Nature of Request
Provide opinion on highest priority wetlands to survey for endangered Flatwoods salamanders

SREL Investigator
Dr. K. Buhlmann
Date of Request
May 2017
Requesting Entity
USFWS, and Friends of the Great Swamp NWR., NJ
Nature of Request
Gave an outdoor presentation about the wood turtle head-starting project to an audience that included project funders, as well as local residents.

SREL Investigator
Dr. K. Buhlmann
Date of Request
Aug 2017
Requesting Entity
USFWS, Dr. Roy Averill-Murrray, Desert Tortoise Recovery coordinator
Nature of Request
Meet with and discuss desert tortoise recovery efforts while working in the Mojave Desert

SREL Investigator
Dr. Tracey Tuberville
Date of Request
FY2017 (ongoing)
Requesting Entity
SCDNR
Nature of Request
Serve as species expert on gopher tortoise population biology and reintroduction

SREL Investigator
Dr. Tracey Tuberville
Date of Request
FY2017 (ongoing)
Requesting Entity
USFWS
Nature of Request
Serve as species expert on Blanding's turtle population biology and reintroduction

SREL Investigator
Dr. Tracey Tuberville
Date of Request
FY2017 (ongoing)
Requesting Entity
Gopher Tortoise Council
Nature of Request
Participate in working group and subsequent workshop on identifying range-wide conservation targets for gopher tortoises.

SREL Investigator
Stacey L. Lance
Date of Request
September 2016
Requesting Entity
Faculty member, University of Nebraska-Lincoln
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request:
December 2016
Requesting Entity Faculty member, California State University
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
December 2016
Requesting Entity
Graduate Student, University of Georgia
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
February 2017
Requesting Entity
Post Doc, University of California, Berkley
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
April 2017
Requesting Entity
PI, Exotic and Invasive Weed Research Unit, Albany CA
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
April 2017
Requesting Entity
Faculty, University of Georgia
Nature of Request
Fragment analysis and DNA extractions

SREL Investigator
Stacey L. Lance
Date of Request
March 2017
Requesting Entity
Faculty Universidad Veritas, San Jose Costa Rica
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
May 2017
Requesting Entity
PI, NC Wildlife Resources Commission
Nature of Request
PCR and fragment analysis

SREL Investigator
Stacey L. Lance
Date of Request
May 2017
Requesting Entity
Faculty Virginia tech
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
July 2017
Requesting Entity
Faculty Universidad Autonoma de Mexico
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
August 2017
Requesting Entity
Faculty Buenos Aires NWR
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
August 2017
Requesting Entity
PI, Toledo Zoo
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
R. A. Kennamer
Date of Request
October 2016
Requesting Entity
Augusta Regional Airport at Bush Field
Nature of Request
Wildlife hazard consultant for Augusta Regional Airport at Bush Field, under contract with City of Augusta, GA. Member of Augusta Regional Airport Wildlife Hazard Management Group.

SREL Investigator
Dr. B. Parrott
Date of Request
July 2017
Requesting Entity
Law Enforcement Division Officer, Florida Fish and Wildlife Commission
Nature of Request
Genetic techniques to determine parentage in potentially illegal alligator farming operations.

SREL Investigator
Dr. James C. Beasley
Date of Request
December 2016
Requesting Entity
International Atomic Energy Association
Nature of Request
Consult with Fukushima Prefecture, Japan

SREL Investigator
Dr. Olin E. Rhodes, Jr.
Date of Request
March 2017
Requesting Entity
EPA
Nature of Request
Technical Review of Needs Assessment

SREL Investigator
Dr. Olin E. Rhodes, Jr.
Date of Request
September 2017
Requesting Entity
NSF
Nature of Request
Grant Review Panel

SREL Investigator
Dr. James C. Beasley
Date of Request
July 2017
Requesting Entity
International Atomic Energy Association
Nature of Request
Consult with Fukushima Prefecture, Japan

TASK 9. SREL scientists will work closely with SRS personnel to assist DOE and other SRS contractors in making wise and informed decisions concerning land and facilities management. SREL will continue to publish its scientific findings in peer-reviewed scientific journals to aid the public and to assist DOE in making policy decisions by providing a basis of independent, verifiable science

Please see SECTION VIII of this report for a list of SREL publications in FY17. Below we provide examples of specific activities that SREL personnel have conducted in FY17 to assist DOE and other SRS tenants with ongoing missions and to leverage federal funding provided to SREL to attract non-federal funding to conduct research activities on the SRS.

Department of Energy – EM

- SREL Director provided presentations to the Citizens Advisory Board on the Radiological Education, Monitoring and Outreach program and on the status of wild pigs on the SRS
- SREL Director participated in meetings with the staff of LM1 to provide an overview of SREL and its mission on the SRS
- SREL personnel participated in site visits with USDA personnel to evaluate potential research on wild pig control technologies on the SRS
- SREL leveraged DOE funding against UGA funding to conduct research on the development of pilot projects in proteomics/metabolomics at the SREL low dose facility to examine consequences of low dose exposures to aquatic species on the SRS
- SREL leveraged DOE funding and SRS site assets to obtain ~ 1.5 million dollars in new external funding during the FY17 fiscal year
- SREL personnel hosted multiple DOE personnel to tour SREL's analytical capabilities that might be used in support of SRS missions

Department of Energy – NNSA

- SREL personnel leveraged funding from NNSA to conduct research on biogeochemical cycling and efficiency of metal treatment of the HO2 wetland associated with the regulatory requirements of tritium production on the SRS
- SREL personnel leveraged funding from NNSA to conduct ecotoxicological research on amphibians utilizing the HO2 metal treatment wetlands to elucidate the biological effects of copper and other metals associated with tritium production on the SRS
- SREL personnel leveraged funding from NNSA to conduct studies of ecosystem health associated with the HO2 metal treatment wetlands
- SREL personnel leveraged funding from the NNSA to conduct research focused on the impacts of MOX construction on the viability of upper three runs creek
- SREL outreach personnel conducted extensive community outreach and education programs for NNSA and SRS

Savannah River Remediation

- SREL provided a support to SRR on technical aspects of saltstone weathering and radionuclide release over time
- SREL personnel renewed a contract with SRR to perform work scope related to derivation of Kd values for cementitious materials

Savannah River Nuclear Solutions

- SREL personnel leveraged funding from ACP to conduct radioecology research programs involving long-lived reptiles, game species, Four Mile Branch, waterfowl and tritium mitigation activities at the Mixed Waste Facilities on SRS
- SREL personnel met with ACP senior management team and representatives from SRNL's environmental programs to discuss data needs related to future IOU remediation activities
- SREL provided tours and presentations as requested to provide support to ACP during visits by regulators to the SRS
- SREL provided support to SRNS Corporate Communications by providing programs for 31 public tours to the general public or site visitors

Savannah River National Laboratory

- SREL collaborated with Dr. Larry Lowe to provide research opportunities on the SRS in support of the SRNL's Minority Serving Institution Initiative
- SREL hosted a 2-day workshop with SRNL to explore ways in which SREL and SRNL might collaborate on future research
- SREL faculty collaborated with various SRNL scientists to accomplish a variety of research projects focused on environmental remediation and monitoring

US Forest Service

- SREL personnel worked with staff from the USFS-SR to explore ways to make historical rare species data easily accessible to SRS Forest Managers and to discuss methods to use digital technologies to collect, record, and make available rare species observations as they are encountered going forward.
- SREL personnel continue to inform USFS of habitat conditions at the Gopher Tortoise (*Gopherus polyphemus*) reintroduction site (Compartment 24).
- SREL personnel met multiple times with USFS personnel to discuss potential funding opportunities for SRS as a center for development of feral swine control methods
- SREL personnel worked with USFS personnel to plan and implement habitat management objectives for various Set-Aside areas on the SRS to facilitate environmental stewardship objectives of the site

TASK 10. SREL will provide stipend support to college undergraduates, graduate students, and visiting faculty to conduct research on the Savannah River Site in association with ongoing environmental research studies. The objective of the program will be to provide participants, including minority students and Historically Black Colleges and Universities, with an opportunity to pursue ecological research and training under the direction and supervision of SREL scientific staff members

The objectives of the SREL Education Program are to (1) recruit and develop additional professionals to the environmental sciences and (2) enhance environmental awareness and research opportunities among undergraduate and graduate students with emphasis on conducting ecological research important to the DOE and Savannah River Site mission. We have made special efforts in the recruitment from under-represented minority groups and our faculty members have worked with both students and faculty from Historically Black Colleges and Universities (HBCU) throughout the Southeast.

SREL has a long history of graduate and undergraduate education, training over 400 graduate and over 600 undergraduate researchers since 1967. Undergraduate students from more than 275 different colleges and universities have coauthored more than 170 peer reviewed research publications and more than 200 of these students have gone on to pursue careers in science. SREL offers students state-of-the-science laboratory facilities, a wide variety of natural and impacted habitats for field research, a diversity of faculty expertise, and more than sixty years of experience in ecological research. Since 1967, an average of six students per year have completed graduate studies at SREL, resulting in a total of more than 335 dissertations and theses. Since 1985, our graduate students have won over 200 awards from regional, national, and international competitions at numerous professional societies and foundations. In recent years, SREL has undergone significant changes in administrative infrastructure and transitioned to self-supporting funding model. Throughout this transition period, SREL has maintained its commitment to student research and education as an integral component of its mission. In fact, many of the current graduate students initiated their program of study in the past fiscal year.

In FY17, SREL faculty and staff mentored and supervised over a dozen undergraduate students (Table 1) from a variety of universities. These students were supported from several funding sources including DOE supported projects and other extramural grants (see REU: Radioecology below) and projects. In addition, SREL faculty provided research support and mentoring for over 101 graduate students (Table 2) from universities across the country in FY17. In many cases, this included formal involvement by serving as major advisors/co-major advisors and committee members for M.S. and Ph.D. candidates and in a few cases students received stipend support. However, support for students also included various activities in less formal relationships such as assistance at and access to field sites, use of field equipment, temporary lab space, as well as analytical and GIS resources for their studies.

During the FY17 fiscal year, an emphasis has been placed on finding creative ways to cost share graduate students by leveraging UGA funding with federal funding acquired through SREL's cooperative agreement with the Department of Energy. In addition, new emphases have been placed on enhancing participation of SREL Research Faculty in both graduate and undergraduate instruction. To these ends, SREL accomplished the following in FY17.

- SREL leveraged SRS site assets to acquire external resources to conduct UGA Maymester courses in wildlife ecology and genetics in May 2017

- SREL leveraged SRS site assets to acquire external resources to conduct a Spring Break course in Prescribed Fire during the spring of 2017

- SREL leveraged UGA funding against project specific funding from DOE and other sources to cost share over 50 graduate students all of whom have projects which will contribute to the knowledge base and needs of the SRS

- SREL leveraged DOE dollars to obtain salary support for 7 faculty members to provide instructional support to UGA departments as a means to maintain critical environmental expertise on the SRS

- SREL personnel successfully conducted activities under a National Science Foundation Grant to develop a *Research Experience For Undergraduates* internship program for undergraduates in radioecology and the third cohort of 13 students were funded to participate in this program during the summer of FY17. Details on this effort are below:

REU: Radioecology

Funding Entity
National Science Foundation
Start Date and Funding Amount
April, 2015; $302,000
PI and co-PI's
Dr. J Vaun McArthur, Dr. Tracey Tuberville, Dr. Melissa Pilgrim (USC-Upstate)
Objectives
For each participant, the primary research activity was an independent research project. Students worked with their mentors to develop the scope of their independent research projects and were involved in all stages of the research process—from articulating the hypotheses and project objectives, designing the study, collecting data, analyzing and synthesizing data, and communicating results to their colleagues and other on-site researchers. In addition to conducting independent research projects, students participated in recurring activities designed to provide them with the foundation needed to perform critical research activities during the REU program and in their future scientific endeavors: a radioecology seminars series, weekly workshops and weekly workdays.
Summary of Research Activities
During our third summer of funding we hosted 13 students using NSF funds and an additional student from other funds. These students were chosen from 65 applications. Each student completed RAD Worker II training and job specific safety training. Each participant conducted individual independent research on a diversity of topics. Students were taken on tours of SREL field sites and special tours of the MOX construction site. Although the total research experience was completed in ten weeks some very interesting work was accomplished and will provide the basis for additional work in the area of radioecology on the Savannah River Site.
Conclusions
1) The results from these studies are varied and cover a range of scientific import. Some of these studies may become stand-alone publications while others will be built upon either by other future REU students or by graduate students.

Major Impact(s) of Research ([1]2015 cohort, [2]2016 cohort, [3]2017 cohort)
1) ***Josh King***[1] was selected to represent the 2015 Radioecology REU cohort at the Research Experiences for Undergraduates Symposium hosted by the Council on Undergraduate Research, Fall 2015.
2) ***Naya Eady***[1] was awarded (May 2017) and completed a competitively awarded fellowship to the Virginia Tech Post Baccalaureate Research and Education Program.
3) ***Mel Thomson***[1] submitted her REU research as a manuscript to USC Upstate's Student Research Journal; the submission was the co-recipient of the Best Student Paper Award for the 2015 journal volume.

4) ***Kyle Brown***[2] was selected to represent the 2016 Radioecology REU cohort at the Research Experiences for Undergraduates Symposium hosted by the Council on Undergraduate Research, Fall 2016.
5) ***Kyle Brown***[2] submitted his REU research as a manuscript to USC Upstate's Student Research Journal; the submission recognized as the co-recipient of the Best Student Paper Award for the 2016 journal volume.
6) ***Kyle Brown***[2] received the 2017 USC Upstate Advanced Undergraduate Information Literacy Award based on the quality and extent of his REU work.

Employment in STEM

1) ***Jarad Cochran***[1] was hired into a Research Technician position in Dr. John Seaman's Geochemistry Laboratory following completion of the REU program.
2) ***Josh King***[1] was hired as a Radiation Protection Specialist on the SRS starting in October 2016.
3) ***Alexis Korotasz***[1] worked as a research technician during the summers of 2016 and 2017 with her REU mentor, Larry Bryan.
4) ***Lauren Laatsch***[1] continued working in her mentor's lab during Fall 2015 through Spring 2016 at the University of Georgia.
5) ***Marilyn Mason***[1] was hired as a research technician working for Dr. Rhodes (director of the Savannah River Ecology Laboratory).
6) ***Marty Kyle Brown***[2] graduated from USC Upstate in December 2016 and was hired as a research technician by Drs. Tracey Tuberville and Pilgrim (his REU mentors).
7) ***Sheldon Davis***[2] graduated in Spring 2017 and accepted an internship with the South Carolina Department of Natural Resources to conduct research on bats.
8) ***Christina Fulghum***[2] worked at SREL as a research technician during the Fall/Winter of 2016, working half-time for her REU mentor, Larry Bryan, and half-time with an SREL faculty member.
9) ***Brooke Lindell***[2] returned to work at SREL as a research technician in her REU mentor's lab in December 2016 and returned again for summer 2017.
10) ***Amelia Russell***[2] graduated in Fall 2016 and accepted an internship with UGA and US. Fish and Wildlife Service at the Great Swamp National Wildlife Refuge in Basking Ridge, NJ.
11) ***Caleigh Quick***[3] has accepted a research internship at the Georgia Sea Turtle Center, Georgia that will start in Spring 2018.

Other Project Personnel

The following SREL personnel were mentors for these students: Dr. James Beasley, Dr. John Seaman, Dr. Tracey Tuberville, Dr. Stacey Lance, Dr. J Vaun McArthur, Dr. Guha Dhamarajan, Dr. O. E. Rhodes, Dr. Ben Parrott, David Scott, Larry Bryan, and Dean Fletcher.

External Collaborator

Dr. Melissa Pilgrim, USC-Upstate

Products

Radioecology REU undergraduate students funded by NSF are in bold italics with superscripts indicating their cohort (2015 cohort[1], 2016 cohort[2], 2017 cohort[3]). Other participating undergraduates are underlined.

Publications ([1]2015 cohort, [2]2016 cohort, [3]2017 cohort)

1) Seaman, J.C., ***E.R. Dorward***[1], D. Li, H. Chang, M. Tandukar, and F.M. Coutelot. In review. Removal of Radioactive Materials from Groundwater Using Iron Composite Media. Submitted to *Water Research*.
2) Kennamer, R.A., R.E. Oldenkamp, J.C. Leaphart, ***J.D. King***[1], A.L. Bryan Jr., and J.C. Beasley. 2017. Radiocesium in migratory aquatic game birds using contaminated U.S. Department of Energy reactor-cooling reservoirs: a long-term perspective. *Journal of Environmental Radioactivity* 171:189-199.
3) Smith, J.B., ***L.J. Laatsch***[1], and J.C. Beasley. In press. Spatial complexity of carcass location influences vertebrate scavenger efficiency and species composition. Submitted to *Nature-Scientific Reports*.

4) McArthur, J V., ***C.A. Dicks***[2], A.L. Bryan, and R.C. Tuckfield. In press. The effects of low-level ionizing radiation and copper exposure on the incidence of antibiotic resistance in lentic biofilm bacteria. To appear in *Environmental Pollution*.
5) Russell, A.L., ***M.K. Brown***[2]***, M.L. Lambert***[2], T.D. Tuberville, and M.A. Pilgrim. 2016. Mercury bioaccumulation in Florida green watersnakes (*Nerodia floridana*) among three wetlands on the Savannah River Site. USC Upstate Student Research Journal Volume 9:43-52.
6) **Brown**[2]**, M.K.,** A.L. Russell, **M.L. Lambert**[2]**,** T.D. Tuberville, and M.A. Pilgrim. 2016. Mercury bioaccumulation in Florida green watersnakes (*Nerodia floridana*) among three wetlands on the Savannah River Site. USC Upstate Student Research Journal 9:19-28.
7) **Thompson**[1]**, M.**, **M. Reed**[1], M. Pilgrim, S. Unger, and O. Rhodes, Jr. 2015. Mastering medaka culture: improved techniques for increasing egg and fry production in Japanese rice fish (*Oryzias latipes*). USC Upstate Student Research Journal 8:26-33.

Senior Theses

1) ***Lauren Laatsch***[1] used her research as an undergraduate thesis with Dr. Beasley as part of her undergraduate degree.
2) ***Kyle Brown***[2] used his REU work with Drs. Melissa Pilgrim and Tracey Tuberville as his senior research project.
3) ***Nia Peak***[2] conducted a senior capstone research project based on the work she completed as an REU under Dr. Stacey Lance.
4) ***Kip Callahan***[3] will be turning his research project with REU mentors Drs. Tracey Tuberville and Melissa Pilgrim into his senior thesis project.
5) ***Melissa Lech***[3] will conduct a senior research thesis project based on her REU project conducted under Drs. Melissa Pilgrim and Tracey Tuberville.
6) ***Eric Tokuyama***[3] will incorporate his REU research with mentor Dean Fletcher into a senior Capstone project.

Oral Presentations

1) ***Dorward, E.R.***[1], J.C. Seaman, ***J. Cochran***[1], H. Chang, M. Tandukar, and F.M. Coutelot. Removal of Radioactive Materials from Groundwater Using Iron Composite Media. 2016 Annual Soil Science Society of America Meetings. Phoenix, AZ. 6-9 Nov 2016.
2) ***Cochran, J.P.***[1]***, N.A. Eady***[1]**,** M.A. Pilgrim, T.D. Tuberville, and D. Haskins. Influence of coal ash contamination on metabolic rates of eastern mud turtles. 12th Annual SC Upstate Research Symposium. Spartanburg, SC. 8 April 2016.
3) ***Cochran, J.P.***[1]**,** D. Haskins, ***N.A. Eady***[1]**,** M.T. Hamilton, M.A. Pilgrim, and T.D. Tuberville. Influence of coal combustion residues on metabolic rates and immune responses in eastern mud turtles (*Kinosternon subrubrum*). Joint Meetings of Ichthyologists and Herpetologists. Austin, TX. 12-16 Jul 2017.
4) Leaphart, J.C., ***A.M. Korotasz***[1], A.L. Bryan, and J.C. Beasley. Biomagnification of radiocesium (^{137}Cs) in aquatic ecosystems on the Savannah River Site. 2016 Warnell Graduate Student Association Symposium, University of Georgia, Athens, GA. Feb 2016.
5) Leaphart, J., A. Bryan, ***A. Korotasz***[1], and J. Beasley. Environmental fate of radiocesium in an aquatic and semi-aquatic food web on the Savannah River Site. Annual Meeting of the Society of Environmental Toxicology and Chemistry. Orlando, FL. 5-9 Nov 2016.
6) ***Brown, M.K.***[2], A.L. Russell, ***M.L. Lambert***[2], T.D. Tuberville and M.A. Pilgrim. Bioaccumulation of ^{137}Cs in Florida green watersnakes (*Nerodia floridana*) inhabiting former nuclear cooling reservoirs on the Savannah River Site. 13th Annual SC Upstate Research Symposium, Spartanburg, SC. 14 Apr 2017.
7) ***Brown, M.K.***[2], A.L. Russell, ***M.L. Lambert***[2], T.D. Tuberville and M.A. Pilgrim. Bioaccumulation of ^{137}Cs in Florida green watersnakes (*Nerodia floridana*) inhabiting former nuclear cooling reservoirs on the Savannah River Site. Joint Meetings of Ichthyologists and Herpetologists. Austin, TX. 12-16 Jul 2017.

8) ***Lambert, M.M.[2], M.K. Brown[2]***, D.L. Haskins, A.L. Russell, M.A. Pilgrim, and T.D. Tuberville. Sublethal effects of ^{137}Cs and Hg contamination in Florida green watersnakes (*Nerodia floridana*). 13th Annual SC Upstate Research Symposium. 14 Apr 2017.
9) Seaman, J.C., **E. Dorward[1], J. Cochran[1]**, H.S. Chang, M. Tandukar, and F.M Coutelot. Removal of Radioactive materials from Groundwater using Porous Iron Composite Media. 14th International Conference on the Biogeochemistry of Trace Elements (ICOBTE), Zurich, Switzerland. 16-20 July 2017
10) ***Peak, N.[2],*** C.N. Love, R.W. Flynn, D.E. Scott, and S. Lance. Effects of parental and early life exposure to metals on genome methylation in two anuran species. Medical College of Georgia's 6th Annual Igniting the Dream of Medicine Conference in Augusta, GA. 25 Feb 2017.
11) Russell, A.L., ***M.K. Brown[2], M.L. Lambert[2]***, T.D. Tuberville, and M.A. Pilgrim. Bioaccumulation of ^{137}Cs in Florida green watersnakes (*Nerodia floridana*) inhabiting former nuclear cooling reservoirs on the Savannah River Site. 13th Annual SC Upstate Research Symposium on 14 Apr 2017.
12) ***Dicks, C.A.[2]***, and J.V. McArthur. The interaction of radiation and copper on the incidence of antibiotic resistance. 13th Annual SC Upstate Research Symposium. University of South Carolina Upstate, Spartanburg, SC. 14 Apr 2017**.**
13) ***Callahan, K.M.[3], M.E. Lech[3]*****,** J.C. Leaphart, TD. Tuberville, and MA Pilgrim. Mecury and radiocesium concentrations among tissues of Florida green watersnakes (*Nerodia floridana)* inhabiting former nuclear reactor cooling reservoirs. 2017 SREL Summer REU Symposium.
14) ***Christianson, M.R.[3], B.E. Lindell[2]***, OE Rhodes, Jr, and DE Fletcher. Assessing concurrence between non-lethal and lethal sampling methods for estimation of contaminant distributions in *Micropterus salmoides*. 2016 SREL Summer REU Symposium**.**
15) **Calloway, D[3]**, C Love, D Scott, and SL Lance. The fate of atmospheric mercury (Hg) in ephemeral wetlands. 2016 SREL Summer REU Symposium.
16) **DiBona E[3], A Korotasz[2]**, and AL Bryan. Assessing radiocesium in various biota in unstudied reaches of the R-canal system. 2016 SREL Summer REU Symposium.
17) ***Gray, J.[3], B.E. Lindell[2], M.R. Christianson[3]***, PT Stankus, OE Rhodes, Jr, and DE Fletcher. Comparison of contaminant accumulation in reservoir fishes of different trophic levels and habitats. 2017 SREL Summer REU Symposium.
18) ***Jakielaszek, J[3]*****,** A.L. Bryan, and J.V. McArthur. Impact of radionuclides and heavy metals on antibiotic resistance in sediment and water column bacteria. 2017 SREL Summer REU Symposium.
19) ***Lech, M.E.[3]***, T.D. Tuberville, and M.A. Pilgrim. Investigating biomagnification of mercury and radiocesium in *Nerodia* floridana using stable nitrogen isotopes. 2017 SREL Summer REU Symposium.
20) ***Lewis III, R.T.[3]***, JC Seaman, FM Coutelot, and M Baker. Impact of biomineralization of organophosphates on uranium availability in riparian sediments. 2017 SREL Summer REU Symposium.
21) ***Muñiz-Gonzalez, M[3]***, J.L. Ziemba, and S.L. Lance. The impact of contaminants on growth development and disease susceptibility of southern toads. 2017 SREL Summer REU Symposium.
22) ***Quick, C[3]***, D. Haskins, M. Pilgrim, and T. Tuberville. The effects of mercury and radiocesium on the probability of hemoparasite infections in *Nerodia foridana*. 2017 SREL Summer REU Symposium.
23) ***Tanelus, M[3]***, and G Dhamarajan. Parasites as potential indicators of individual and ecosystem health: A case study with largemouth bass (*Micropterus salmoides*). 2017 SREL Summer REU Symposium.
24) ***Tokuyama, E[3]***, JV McArthur, ***BE Lindell[2]***, PT Stankus, and DE Fletcher. Comparison of contaminant accumulation among functional feeding groups of stream macroinvertebrates. 2017 SREL Summer REU Symposium.
25) ***Topolski, CR[3], MW Mason[1]***, ***EM Bertucci[2]*****,** OE Rhodes, Jr., and B.B. Parrott. Impacts of chronic exposure to gamma radiation on the DNA methylome using the Medaka fish model. 2017 SREL Summer REU Symposium.

26) ***Wilms, KC[3],*** JC Leaphart, AL Bryan, and JC Beasley. Accumulation of radiocesium in bullfrog tadpoles (*Lithobates catesbeianus*) in contaminated effluent canal on the SRS. 2017 SREL Summer REU Symposium.

Poster Presentations

1) ***Thompson, M.F.[1], M.E. Reed[1]***, M.A. Pilgrim, S.D. Unger, and O.G. Rhodes, Jr. Mastering medaka culture: improved techniques for increasing egg and fry production in Japanese rice fish (*Oryzias latipes*). 12th Annual SC Upstate Research Symposium. Spartanburg, SC. 8 Apr 2016.
2) ***Korotasz, A.[1]***, C. Leaphart, and L. Bryan. Comparison of ^{137}Cs accumulation in larval and adult ranid species on the Savannah River Site. 12th Annual SC Upstate Research Symposium. University of South Carolina Upstate, Spartanburg, SC. 8 April 2016.
3) ***Eady, N.A.[1], J.P. Cochran, J.P.[1]***, T.D. Tuberville, M.A. Pilgrim, and M.T. Hamilton. Influence of coal ash exposure on eastern mud turtle immune response. 12th Annual SC Upstate Research Symposium. University of South Carolina Upstate, Spartanburg, SC. 8 April 2016.
4) ***Eady, N.A.[1], J.P. Cochran, J.P.[1]***, T.D. Tuberville, M.A. Pilgrim, and M.T. Hamilton. Influence of coal ash exposure on eastern mud turtle immune response. Society for the Advancement of Chicanos and Native Americans in Science. Washington, DC. 29-31 Oct 2015.
5) ***Eady, N.A.[1], J.P. Cochran, J.P.[1]***, T.D. Tuberville, M.A. Pilgrim, and M.T. Hamilton. Influence of coal ash exposure on eastern mud turtle immune response. Annual Biomedical Research Conference for Minority Students. Seattle, WA. Nov 2015.
6) ***Eady, N.A.[1], J.P. Cochran, J.P.[1]***, T.D. Tuberville, M.A. Pilgrim, and M.T. Hamilton. 2016. Influence of coal ash exposure on eastern mud turtle immune response. Trinity Washington University Research Day. Spring 2016.
7) ***Burston, D.[2]***, R.W. Flynn, C.N. Love, D.E. Scott, and S. Lance. Influence of long-term environmental contamination and parental body burden on metal tolerance in southern toads (*Anaxyrus terrestris*). Southeastern Society for Toxicology Conference. Athens, GA. Oct 2016.
8) ***Burston, D.[2]***, R.W. Flynn, C.N. Love, D.E. Scott, and S. Lance. Influence of long-term environmental contamination and parental body burden on metal tolerance in southern toads (*Anaxyrus terrestris*). Society for Toxicology. Baltimore, MD. March 2017.
9) ***Carrington, S.[1]***, D. Scott, M. Winzeler, A. Coleman, ***C. Tapia[1]***, and S. Lance. Presence of ranavirus and chytrid fungus in *Lithobates sphenocephalus* in long and short hydroperiod wetlands. Minorities in Agriculture, Natural Resources and Related Sciences National Conference, Jacksonville, FL. 30 Mar – 2 Apr 2016.
10) Russell, A.L., ***M.K. Brown[2], M.L. Lambert[2]***, T.D. Tuberville and M.A. Pilgrim. Mercury bioaccumulation in Florida green watersnakes (*Nerodia floridana*) inhabiting former nuclear cooling reservoirs on the Savannah River Site. Joint Meeting of Ichthyologists and Herpetologists. Austin, TX. 12-16 July 2017.
11) ***King, J.D.[1]***, R.E. Oldenkamp, R.A. Kennamer, A.L. Bryan Jr., and J.C. Beasley. Radiocesium (^{137}Cs) uptake in ring-necked ducks (*Aythya collaris*) using a contaminated reservoir on the US-DOE Savannah River Site. Research Experiences for Undergraduates Symposium hosted by the Council on Undergraduate Research. Arlington, VA. Oct 2015.
12) **Brown, M.K.[2]**, **M.L. Lambert[2]**, A.L. Russell, T.D. Tuberville and M.A. Pilgrim. Bioaccumulation of ^{137}Cs in Florida green watersnakes (*Nerodia floridana*) from three wetlands on the Savannah River Site. Research Experiences for Undergraduates Symposium hosted by the Council on Undergraduate Research. Arlington, VA. Oct 2016.
13) ***Lambert, M.M.[2], M.K. Brown[2]***, D.L. Haskins, A.L. Russell, M.A. Pilgrim, and T.D. Tuberville. Sublethal effects of ^{137}Cs and Hg contamination in Florida green watersnakes (*Nerodia floridana*). 6th Annual Sustainability Forum. University of Kentucky. 1 Dec 2016.
14) ***Lindell, B.[2]***, J.C. Seaman, J.V. McArthur, and D.E. Fletcher. Distribution of trace elements and Cs-137 in sediments of a Coastal Plain stream impacted by industrial activities. Society of Freshwater Science, Raleigh, NC. 4-8 June 2017.

15) ***Peak, N.[2],*** C.N. Love, R.W. Flynn, D.E. Scott, and S. Lance. Effects of parental and early life exposure to metals on genome methylation in two anuran species. 13th Annual SC Upstate Research Symposium in Spartanburg, SC. 14 Apr 2017.

Graduate Degrees / Positions / Fellowships in STEM

1) ***Emily Dorward[1]*** started on her master's degree at UGA in Fall 2016 working with her REU mentor Dr. John Seaman.
2) ***Morgan Reed[1]*** started working on her master's degree in 2016 as part of Virginia Tech's Department of Fish and Wildlife Conservation.
3) ***Jarad Cochran[1]*** started a MS degree in the Interdisciplinary Toxicology Program at UGA, where he is co-advised by his REU mentor Dr. Seaman in Spring 2017.
4) ***Naya Eady[1]*** started a PhD program in Cornell University's Biological and Biomedical Science Program in Fall 2017.
5) ***Carlos Tapia[1]*** has changed his post-baccalaureate plans, partly as a result of his REU experience, from medical school to graduate school.
6) ***Michaela Lambert[2]*** was accepted into a MS in Forestry and Natural Resource Sciences at the University of Kentucky.
7) ***Kyle Brown[2]*** will begin a MS program in January 2018 in Forestry and Natural Resources at University of Georgia with his REU mentor, Dr. Tracey Tuberville.
8) ***Sarah Abercrombie[2]*** has been accepted into a graduate program at Purdue University.
9) ***Christina Fulghum[2]*** has been accepted to graduate school at University of South Carolina as part of the Master of Earth & Environmental Resources Management program.
10) ***Emily Edwards[2]*** has been accepted into medical school at Auburn University.

In addition, three undergraduate students that were part of the Gap REU (through the USFS-Savannah River) participated in our symposium.

Table 10.1. SREL Undergraduate Student Program Participants, FY 17

Undergraduate	University	Faculty Advisor
Kip Callahan	USC-Upstate	Pilgrim
Michael Christenson	USC-Aiken	Rhodes
Elizabeth DiBona	Presbyterian College	Bryan
Jessica Gray	Univ. of Georgia	Fletcher
Jacob Jakielaszek	Temple University	McArthur
Melissa Lech	USC-Upstate	Tubberville/Pilgrim
Robert Lewis	Florida A&M University	Seaman
Mariela Muniz-Gonzalez	USC-Aiken	Lance
Caleigh Quick	State University of New York	Tuberville
Manette Tanelus	USC-Upstate	Dharmarajan
Eric Tokuyama	Colorado State University	Fletcher
Collin Topolski	Embry-Riddle University	Parrott
Katlin Wilms	Texas Tech University	Beasley

Table 10.2. SREL Graduate Student Program Participants, FY17

Student	Degree	University	SREL Faculty	Role
Seth Younger	Ph.D.	University of Georgia	Aubrey	Advisor
Scott Oswald	M.S.	University of Georgia	Aubrey	Advisor
Michael Belovitch	M.S.	University of Georgia	Aubrey	Advisor
Stephen Ruswick	M.S.	University of Georgia	Aubrey	Advisor
Elliot Lewis	M.S.	University of Georgia	Aubrey	Advisor
Tae Yoon Lee	Ph.D.	University of Georgia	Aubrey	Advisor
Joseph Hanson	M.S.	University of Georgia	Aubrey	Advisor
Ashley Rae	Ph.D.	University of Georgia	Aubrey	Committee
Callie Oldfield	Ph.D.	University of Georgia	Aubrey	Committee
Karuna Paudel	Ph.D.	University of Georgia	Aubrey	Committee
Lauren Brockman	M.S.	University of Georgia	Aubrey	Committee
Tyler Reeves	M.S.	University of Georgia	Aubrey	Committee
Sara Chinn	Ph.D.	University of Georgia	Beasley	Advisor
Pooja Gupta	Ph.D.	University of Georgia	Beasley	Co-Advisor
Sara Webster	Ph.D.	University of Georgia	Beasley	Advisor
Eric Neff	M.S.	University of Georgia	Beasley	Co-Advisor
David Bernesconi	M.S.	University of Georgia	Beasley	Co-Advisor
David Keiter	M.S.	University of Georgia	Beasley	Advisor
Ansley Silva	M.S.	University of Georgia	Beasley	Co-Advisor
Chris Leaphart	M.S.	University of Georgia	Beasley	Advisor
Phillip Lyons	M.S.	University of Georgia	Beasley	Advisor
Ernest Borchert	M.S.	University of Georgia	Beasley	Advisor
Chris Boyce	M.S.	University of Georgia	Beasley	Advisor
Hannah Gerke	M.S.	University of Georgia	Beasley	Advisor
Jacob Hill	PhD.	Mississippi State University	Beasley	Committee
Kelsey Turner	Ph.D.	University of Georgia	Beasley	Committee
Felipe Hernandez	Ph.D.	University of Florida	Beasley	Committee
Chris Cleveland	M.S.	University of Georgia	Beasley	Committee
Carly Landa	M.S.	University of Georgia	Beasley	Committee

Student	Degree	University	SREL Faculty	Role
Sarah Sapp	M.S.	University of Georgia	Beasley	Committee
Alexandra Wickson	M.S.	University of Georgia	Beasley	Committee
Kayla Buck	M.S.	University of Georgia	Beasley	Committee
John Grinder	M.S.	University of Georgia	Beasley	Committee
Juan Sebastian Ortiz	M.S.	University of Georgia	Beasley	Committee
Madeline Pfaff	Ph.D.	University of Georgia	Beasley	Committee
Chris Cleveland	M.S.	University of Georgia	Beasley	Committee
Carly Landa	M.S.	University of Georgia	Beasley	Committee
Rebecca McKee	M.S.	University of California-Davis	Buhlmann	Committee
Jacob Daly	M.S.	University of Georgia	Buhlmann	Committee
Pearson McGovern	M.S.	University of Georgia	Buhlmann	Committee
Nate Tomczyk	M.S.	University of Georgia	Capps	Advisor
Keysa Rosa-Rodriguez	Ph.D.	University of Georgia	Capps	Advisor
Julie Ziemba	Ph.D.	University of Georgia	Capps	Advisor
Elizabeth Solly	M.S.	University of Georgia	Capps	Advisor
Denzell Cross	Ph.D.	University of Georgia	Capps	Advisor
Rachel Gauer	Ph.D.	University of Georgia	Capps	Committee
Greg Jacobs	Ph.D.	University of Georgia	Capps	Committee
Austin Coleman	M.S.	University of Georgia	Capps	Committee
Eric Neff	M.S.	University of Georgia	Dharmarajan	Co-Advisor
David Bernesconi	M.S.	University of Georgia	Dharmarajan	Co-Advisor
Pooja Gupta	Ph.D.	University of Georgia	Dharmarajan	Co-Advisor
Chris Leaphart	M.S.	University of Georgia	Dharmarajan	Committee
Julie Sanchez	M.S.	University of Georgia	Dharmarajan	Committee
Hannah Gerke	M.S.	University of Georgia	Gibbons	Committee
Sydney Hope	M.S.	Virginia Tech	Kennamer	Host
Wesley Flynn	Ph.D.	University of Georgia	Lance	Advisor
Cara Love	Ph.D.	University of Georgia	Lance	Advisor
Joshua Zajdel	M.S.	University of Georgia	Lance	Co-Advisor
Austin Coleman	M.S.	University of Georgia	Lance	Advisor
Sara Webster	M.S.	University of Georgia	Lance	Committee
Schyler Nunziata	Ph.D.	University of Kentucky	Lance	Committee
Zoe Cooper	M.S.	University of Georgia	Martin	Advisor

Student	Degree	University	SREL Faculty	Role
Douglas Fairbanks	M.S.	Brigham Young University	McArthur	Committee
Jesse Thomas	Ph.D.	University of Georgia	McArthur	Committee
Matthew Baker	M.S.	University of Georgia	Mills	Committee
Robert Thomas	M.S.	University of Georgia	Mills	Committee
Liyun Zhang	Ph.D.	University of Georgia	Mills	Committee
Matthew Hale	Ph.D.	University of Georgia	Parrott	Advisor
Josh Zajdel	M.S.	University of Georgia	Parrott	Co-Advisor
Emily Bertucci	Ph.D.	University of Georgia	Parrott	Advisor
Samantha Bock	Ph.D.	University of Georgia	Parrott	Advisor
Cara Love	Ph.D.	University of Georgia	Parrott	Committee
Jarad Cochran	M.S.	University of Georgia	Parrott	Committee
Alexis Temkin	Ph.D.	University of South Carolina	Parrott	Committee
Jesse Thomas	Ph.D.	University of Georgia	Rhodes	Co-Advisor
Kelsey Turner	Ph.D.	University of Georgia	Rhodes	Advisor
Wes Flynn	Ph.D.	University of Georgia	Rhodes	Committee
David Keiter	M.S.	University of Georgia	Rhodes	Committee
Ansley Silva	M.S.	University of Georgia	Rhodes	Committee
Matt Beard	Ph.D.	Purdue University	Rhodes	Committee
Daniel Sullivan	Ph.D.	University of Georgia	Rhodes	Committee
David Bernesconi	M.S.	University of Georgia	Rhodes	Committee
Pooja Gupta	Ph.D.	University of Georgia	Rhodes	Committee
Liyun Zhang	Ph.D.	University of Georgia	Seaman	Advisor
Matt Baker	M.S.	University of Georgia	Seaman	Advisor
R.J. Thomas	M.S.	University of Georgia	Seaman	Advisor
Emily Dorward	M.S.	University of Georgia	Seaman	Advisor
Jarad Cochran	M.S.	University of Georgia	Seaman	Advisor
Sandra Cutts	Ph.D.	Alabama Birmingham University	Seaman	Committee
Angela Burrows	M.S.	University of Georgia	Scott	Host
Rebecca McKee	M.S.	University of Georgia	Tuberville	Advisor
David Haskins	Ph.D.	University of Georgia	Tuberville	Advisor
Nicole White	M.S.	University of Georgia	Tuberville	Advisor
Jacob Daly	M.S.	University of Georgia	Tuberville	Advisor
Pearson McGovern	M.S.	University of Georgia	Tuberville	Advisor

Student	Degree	University	SREL Faculty	Role
Lance Peadan	Ph.D.	University of Georgia	Tuberville	Committee
Rebecca Cozad	M.S.	University of Georgia	Tuberville	Committee
Mark Peaden	Ph.D.	University of CA-Davis	Tuberville	Committee
Chris Leaphart	M.S.	University of Georgia	Tuberville	Committee
Rick Bauer	M.S.	University of Georgia	Tuberville	Committee
Max Kern	M.S.	University of CA-Davis	Tuberville	Committee

TASK 11. The participant will operate and maintain the SREL facilities on the SRS to efficiently and successfully perform the research, education and outreach programs described in this project description (Appendix A of the Cooperative Agreement)

Facilities Maintenance

The Savannah River Ecology Laboratory is the custodian of eleven DOE owned buildings with the largest of these being our 45,000 square foot main laboratory and office complex. We also have a 4,000 square foot radioecology laboratory located near Par Pond, four animal holding facilities, a greenhouse complex, two office buildings, and an assortment of utility buildings (maintenance shops, receiving building, and storage sheds). SREL also assumed the custodianship of building 772-25B in FY 17. This facility had been under SREL's custodianship at one time, but recently SRNL had operated the facility until they turned it over to facility excess last year. 772-25B is an 8000 square foot building that contains 12 laboratories that are in various states of functionality. SREL's custodianship of this facility will provide us the opportunity to create new laboratory spaces as the research efforts at SREL expand.

We operate our own maintenance staff which consists of three full time technicians, three part time temporary workers, and one full time custodial worker. This group is responsible for all grounds maintenance, custodial duties, routine infrastructure repair, and preventive maintenance duties for over 115 infrastructure assets. Our maintenance group also undertakes a limited number of fabrication projects in support of our research efforts.

As a partner here on the Savannah River Site, we strive to maintain our facilities in such a way that they comply with all of the DOE guidelines for property use and safety standards. We have also worked to develop facilities that are not only aesthetically pleasing, enjoyable, and safe to work in, but facilities that lend themselves toward providing our researchers with the best possible environment to conduct their research. To that end, we have set aside significant parts of our overhead budget and dedicated many man-hours to the maintaining and renovation of our facilities.

In FY 17 we carried out three extensive facility improvement projects. The first of these was the renovation of our outdoor low dose radiological effects facility known as the Lo-Dif. This facility consists of 8 fenced pads, with each pad containing three different low level sealed sources which are positioned above water filled tanks. A variety of aquatic subjects can be placed in the tanks and then exposed to varying low levels of radiation. Subjects can then be studied to determine what effects if any the exposures had upon them. While this 22 year old facility was taken out of a mothballed state in FY14, the Lo-Dif suffered from numerous problems including inoperable sealed sources and significant problems with the tanks and their associated plumbing and electrical systems. To be able to reliably use this facility, a renovation was in order. The renovations started with a coordinated effort between SRNS radiological protection and SREL to ship fifteen of the inoperable sealed sources to the manufacture to be refurbished. Once the refurbished sources were returned to us, we prepared for their deployment by refitting the pads with new heavy duty composite tanks and reworking the plumbing and electrical systems needed for the pads to be operational. Heavy steel frames were painted and reworked to serve as mounting bases for the sealed sources and the sources were then mounted to the frames, leveled, and adjusted to required height dimensions. SRNS Radiological Protection then assisted SREL technicians in the initial leak test and operational startup of the sealed sources. Subsequently, the renovated facility was used to conduct a three month set of exposure experiments during FY17.

The second major facility effort in FY 17 was the removal and replacement of the vinyl tile flooring in our laboratory wing. Over the last two year we have completely renovated over 90% of our working laboratories, and the floors in those laboratories were replaced during those renovations. This year we undertook the effort of replacing the 40 year old tiles in the hallways and entrances of the laboratory wing.

This required the removal of over 3,000 square feet of vinyl tile, and the abatement of the asbestos mastic that was used to adhere the tile. SREL maintenance operated under a SCDEHEC permit and used specialized tile heaters to remove the tiles and complete the asbestos abatement. New low maintenance LVT (Luxury Vinyl Tile) flooring was installed to match the flooring installed during the laboratory renovations. This flooring not only enhanced the overall aesthetics of the laboratory, but will not require the regular waxing and buffing the old flooring required. This will lower maintenance costs and reduce the man-hours required to maintain the new flooring.

The third major facility renovation this year centered on the construction of an aquatics laboratory in the newly acquired 772-25B facility. This laboratory is designed to raise and house fish primarily, but it is capable of rearing a number of aquatic species. The renovation included the removal of the old lab casework, vinyl tile flooring, and unneeded plumbing and electrical systems. The lab was repainted, new flooring tiles applied, and a new HVAC system specific to that laboratory was installed. Contractors installed the automated aquarium systems to complete the aquatics lab's renovation.

Over the last year we have also completed a number of other significant renovations to our facilities. Some of these significant projects include:

- **The continued renovation of our faculty and staff offices:** This year we successfully renovated another three offices. This included re-carpeting, painting, furnishing, and making any other necessary repairs. These renovations marked our 29th office renovation over the last three years.

- **Repairs to the patio front entrance to SREL:** The entrance to SREL is a brick tiled patio which over the last few years began to deteriorate due to age, and its poor condition presented a tripping hazard. Contractor estimates ranged from $24,000 to $8,500 to make the needed repairs and restore the integrity of the walkway. After a thorough assessment, SREL maintenance personnel were able to complete the repairs in-house for less than $2,500 and restore the integrity of the entrance walkway.

- **Laboratory Renovations:** SREL maintenance completed three lab renovation efforts in FY 17 to support the research activities at SREL. One of the lab spaces was totally renovated and reworked to house our OES (Optical Emissions Scanner) analyzing equipment, along with two microwave digesters. The other two labs were partially renovated with one serving as a Biological Safety Cabinet work room, and the other as a radiation experiments laboratory.

- **Improvements to air handling infrastructure (steam lines):** SREL maintenance took advantage of a FY 17 planned SRNS steam outage to make significant repairs to our existing steam lines. We replaced three pressure relief valves and also replaced a 12 ft. section of corroded steam line along with a number of steam traps.

- **Installation of LED lighting:** SREL maintenance started the phased replacement of the fluorescent lighting throughout our facility with new LED fixtures. To date approximately 15% of the old fixtures have been replaced with LED's and the new fixtures have dramatically improved the interior lighting through the facility.

We also continued our emphasis on cleaning and proper organization this year. Our property coordinator is tasked to lead our efforts to clean our laboratories and storage facilities by disposing of any unneeded supplies and excessing any surplus equipment. We made significant progress in this area and we will continue to work diligently in the coming year to continue to improve our facilities in terms of proper organization and housecleaning.

While much has been achieved this past year, we will still remain institutionally committed to aggressively pursuing our goal of developing facilities that comply with DOE guidelines, as well as reflect positively on our staff and research efforts. To that end, we will continue to use our in-house maintenance staff to cost effectively maintain the DOE owned facilities that we occupy.

Environmental Health and Safety (EH&S) Program

The Savannah River Ecology Laboratory (SREL) continues to operate successfully under safety and environmental requirements and standards established by The University of Georgia, the SREL Safety Manual, and the Savannah River Site Policy Manual promulgated by the U.S., Department of Energy. These standards continue to address the hazards associated with SREL operations by permitting a focused effort on the health and safety issues most pertinent to SREL operations. SREL supports and promotes an integrated approach to SRS environmental health and safety issues as a signatory to the SRS Workplace Safety, Health and Security Policy and the SRS Environmental Management System Policy Statement.

SREL maintains a commitment of two, full-time positions (SREL EH&S Manager and SREL Radiation Safety Specialist) dedicated to the support of the SREL EH&S Program. The SREL Radiation Safety Specialist is a newly created SREL position within the 4th quarter of FY2017. The SREL EH&S Manager interfaces with other SRS Contractor Environmental Health and Safety Programs and Professionals through participation in site level management Committees (ISM Integration Council and the SRS Senior Environmental Managers Council). The SREL Radiation Safety Specialist serves as SREL's Radiation Safety Officer and interfaces with the SRNS Radiological Protection Department to implement the SRS Radiological Control Program at SREL.

The SREL EH&S Manager functions as an interface with other SRS organizations in receiving and distributing applicable Lessons Learned information. By integrating with other SRS organizations to share Lessons Learned information, SREL takes advantage of the collective experience and improvements identified by other organizations for similar work processes and controls at SREL. SREL's internal computer network was used to provide targeted safety information to specific groups in the laboratory. The SREL EH&S Manager electronically distributed **18 (eighteen)** targeted lessons learned and safety notices in FY2017 to specific worker groups at SREL. Additionally, in excess of **90 (ninety)** SRS operational safety and environmental related announcements and notices were communicated to all SREL personnel.

The SREL EH&S Manager provided weekly reports of recordable personnel accidents or injuries to DOE-SR line management. SREL also provided monthly, SREL personnel work hour statistics to DOE-SR. SREL personnel reported **3 (three)** work related recordable injury/illness during FY2017. This represents an injury/illness rate over the previous FY2016 reporting period (total of one recordable injury). The FY2017 recordable injuries included a back injury (field), a needle stick injury (field), and a chemical exposure (nitric acid) to a worker's skin (laboratory). The back injury and needle stick injury resulted in changes to procedures and supervisory reinforcement of task hazards and controls. The chemical skin exposure resulted in an SREL safety stand down, followed by a review of all laboratory work controls across all SREL projects, and organizational level corrective actions (including job specific training and provision of additional personal protective equipment).

The SREL EH&S Program continues to place an emphasis on safety and environmental training of SREL personnel. All new SREL personnel receive an initial, SREL-specific orientation on the topic of SREL safety and environmental programs, policies, and procedures in addition to the SRS required General Employee Training (GET). New SREL personnel also receive general SREL safety training and job specific safety training provided for by their SREL supervisor. Approximately **43 (forty-three)** SREL

personnel received this required training during FY2017. Additionally, SREL personnel received EH&S related training during FY2017 in the following functional areas as their job tasks required:

- Radiological Training – Radiological Worker Training, Radioactive Sealed Source User Training, and Radiation Generating Device training
- Remote worker training in accordance with SRS remote worker requirements
- Georgia Right-To-Know Law (GRTK- HAZCOM equivalent) chemical specific training for UGA/SREL employees who utilize hazardous chemicals in the work place.
- Resource Conservation Recovery Act (RCRA) training for employees involved in the management, handling, or manipulation of hazardous or universal wastes.

SREL waste minimization and chemical disposal issues continue to be refined to promote sound environmental practices and support SRS environmental initiatives. Waste minimization techniques such as source reduction continue to be incorporated into experimental protocols, reducing the generation of chemicals wastes while supporting the SRS's pollution prevention efforts. SREL generated approximately **565 (Five hundred and sixty-five)** pounds of hazardous wastes in FY2017. **100 (one hundred)** percent of the hazardous wastes generated was from disposal of laboratory research process generated wastes. Approximately **25 (twenty-five)** percent of SREL's hazardous wastes was generated from active waste streams while **75 (seventy-five)** percent of SREL's hazardous wastes was from Lab Pack disposal of legacy laboratory chemicals. As part of SREL waste minimization efforts and to ensure that chemical hazards are addressed prior to purchasing chemicals, the SREL EH&S Manager reviewed and approved **28 (twenty-eight)** separate chemical purchase orders made by SREL personnel.

SREL received no Notices of Violation in FY2017 as the result of external or internal reviews, inspections, or assessments. During FY2017, SREL's assigned DOE Facility Representative (FR) conducted periodic walk-down inspections of SREL operated SRS facilities in which minor safety issues were identified and promptly corrected. Additionally, SREL conducted assessments in the areas of chemical and radiological air emissions, community right-to-know, and the Georgia Right-to-Know law in compliance with state and federal requirements.

Savannah River Ecology Laboratory Analytical Services

The Savannah River Ecology Laboratory Analytical Services was established to assist SREL researchers with sample preparation and to provide in-house analysis of metals/metalloids, mercury, and radionuclides from environmental samples. Fee for Service analysis by Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) provides researchers with data on metals/metalloids. Total mercury analysis employing one of two Milestone DMA-80 Direct Mercury Analyzers is also available with a fee for service. Multiple research programs at SREL rely on metals analysis, mercury analysis and radiocesium counting for a wide range of research projects through multiple funding agencies.

Seven laboratories have dedicated workspace for all tasks associated with sample prep through analysis. One full-time position (SREL Analytical Services Manager) is dedicated to maintain these lab spaces and to operate and maintain the equipment. The manager maintains Standard Operating Procedures, Project Safety Appraisal Forms, and provides and documents Job Specific Training in sample preparation and equipment operations. In addition, the manager performs chemical coordinator duties: maintains all safety related information including chemical inventories and safety data sheets. The manager coordinates equipment operation schedules and maintenance. These services allow students and other researchers to receive hands-on experience in sample preparation and equipment operation. In FY17, 26 people received training in order to utilize the analytical services labs.

Instrumentation, services and sample preparatory equipment include:

ICP-MS Analysis: The Perkin-Elmer NexION 300X is a fee for service ICP-MS. The Analytical Services manager maintains this instrument, performs calibrations, quality control checks, and analyzes samples for a fee. In FY17, we analyzed 5,290 samples that provided data for ten research groups at SREL including undergraduate students, graduate students, and principle investigators.

Mercury Analysis: Two Milestone DMA-80s measure total mercury following EPA Method 7473. These are fee for service instruments with charges per sample for analysis. The manager is responsible for maintenance, calibration, quality control checks, and data output. The manager provides training to students and researchers for operation of these instruments. In FY17, 15 researchers, including undergraduate and graduate students and principle investigators, performed total mercury analysis on 1,434 samples. A Brooks Rand MERX Methyl mercury analyzer, purchased in FY16, is currently utilized by one research group. In FY17, approximately 100 samples were analyzed for methyl mercury.

Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES): The Perkin Elmer Optima 4300DV analyzes samples for trace and major elements. This instrument is available on a supply reimbursement basis with a small fee imposed for argon use. In FY17, 452 samples were analyzed providing data for four research programs at SREL.

Sample Preparation for Metals and Mercury: Four laboratories house three chemical fume hoods, two laminar flow clean hoods, and two CEM microwave digestion ovens. These are used for acid digestions for metals analysis and for sample and calibration standards preparation. Four freeze dryers with a total capacity of 50 ports, 5 drying ovens, sample-grinding equipment, and an analytical balance are available for use for sample preparation. Consumables are supplied by either the researchers or are provided on a supply reimbursement basis in lieu of fees for lab use. Multiple research programs benefit from these dedicated lab spaces that allow for streamlined sample processing in a well-equipped setting while following SREL lab safety guidelines.

Auto-Gamma Counter for Cs-137: The Packard Cobra II Auto-Gamma Counter has a sodium iodide detector to analyze gamma emitters such as Cs-137 in samples. It is ideal for small sample masses and is utilized for Cs-137 determination in background environmental samples. Ten personnel representing seven groups analyzed 1,495 samples in FY17.

In FY17, one laboratory space was renovated to house the ICP-OES, one laminar flow clean hood, and the two microwave digesters.

Analytical Services FY 2017 Summary

Personnel Trained in FY 2017	Number of Individuals
Graduate Students	7
Undergraduate Students (REU Program)	9
Post Docs	2
Principle Investigators	1
Technicians/Research Professionals	7
Total	26

Equipment Description	Number of Samples Analyzed	Number of Users/Research Groups	Number of Days/Times Used
ICP-MS	5290	Samples from 10 groups	131 days
DMA-80 Dual Cell	577	5 users, 5 groups	26 days
DMA-80 Tri Cell	867	11 users, 8 groups	50 days
Methyl Mercury Analyzer	100	3 users, 1 group	n/a
ICP-OES	452	6 users, 4 groups	17 days
CEM Microwaves (2)	n/a	15 users, 7 groups	120 times
Freeze Dryers (4)	n/a	20 users, 10 groups	394 days
Auto-Gamma Counter	1495	10 users, 7 groups	98 days

Equipment Acquisition and Maintenance

Each year SREL reviews its capital equipment resources to ensure we maintain the analytical instrumentation as well as the laboratory and field equipment needed to meet the goals and objectives of our research programs. Regular review of our equipment infrastructure is important for maintaining and improving our research productivity, completing the tasks and objectives of our grants and contracts, and acquiring new equipment that employs technological advances needed to maintain the high quality of SREL's research programs. Based on input from the SREL research staff and prioritization by the Capital Equipment Committee the following equipment was approved for purchase by the SREL Director. The lists include a mix of new instruments as well as equipment upgrades and/or repairs that allowed us to best achieve our priority equipment needs within our budget constraints. The total expenditure for FY17 was $119,387.

Table 11.1. SREL Equipment Purchases in FY17.

Description	Total Cost	Purpose	Programs Served
Digestion Vessels	$6,185	Digestion of material before analyses on ICP-MS	Ecotoxicology Biogeochemistry Environmental Chemistry Wildlife Ecology
Line Conditioner	$4,981	Protection of ICP-MS from power surges	Ecotoxicology Biogeochemistry Environmental Chemistry Wildlife Ecology
Centrifuge	$16,611	Centrifuge capable of spinning large volumes	Ecotoxicology Biogeochemistry Environmental Chemistry Wildlife Ecology
Heat Flow Meter	$91,610	Measure ability of material to transfer heat	Biogeochemistry Environmental Chemistry
Totals	**$119,387**		

TASK 12. UGARF will be responsible for management and engineering services for the planning, design, and construction of approved projects as may be required to repair, modify, or upgrade existing facilities or construct new facilities, not to include line item projects, necessary to support the UGARF scope of work, as approved by the Contracting Officer and appropriate DOE program personnel. Funding for major repairs and new construction will be provided by DOE

No new construction was undertaken in FY17. See Task 11 (above) for summary of facilities upgrades.

SECTION III. Cost Status Report

Provided to DOE-SR budget office monthly and final FY17 report was submitted on time.

SECTION IV. Schedule Status Report

No significant changes in the schedule of deliverables or achievement of milestones were experienced by SREL in FY17.

SECTION V. Changes in Approach or Goals

In FY17 SREL continued to implement a number of cost sharing initiatives with main campus units at UGA designed to improve accountability, facilitate the conduct of business, and focus resources and procedures within those areas deemed most critical to carrying out the mission of the laboratory. These initiatives include:

- Cost sharing of 6 tenure track faculty lines with UGA main campus units (3 housed at SREL and 3 housed at UGA)
- Cost sharing graduate student stipends with UGA main campus units to leverage additional graduate students working on research issues on the SRS
- Leveraged research funding with UGA main campus faculty and with external funding agencies to increase SREL-based research activities on the SRS in mission critical areas such as radioecology and human wildlife conflict resolution
- Cost sharing support personnel salaries such as the Outreach Program and equipment costs with the Office of the Vice President for Research at UGA to increase the quality of SREL programs

In addition, the director of SREL has challenged the research scientists and staff at the laboratory to increase the proportion of total funding received by the laboratory from sources external to the SRS in an effort to both diversify funding streams for the laboratory and effectively leverage federal dollars to attract external funding to the SRS. In FY17, external funding (non-SRS or UGA dollars) totaled 25% of the laboratories budget. It is the intent of laboratory management to increase this proportion to >30% in future fiscal years.

SECTION VI. Actual or Anticipated Problems, Delays and Remedial Actions

Savannah River Nuclear Solutions has withdrawn their support for SREL participation in public tours on the SRS. As a result, the SREL director chose to redirect DOE-SR funding to cover the deficit and continue to provide SREL support for the SRNS program. In the latest Facilities Service Agreement with SRNS, SREL has indicated that it will continue to try and provide support for public tours as long as it (SREL) has the funding to support these activities.

SREL continues to work with SRNS to achieve a balance in Site Services that meets the needs of the laboratory as it increases in size and work scope to meet the needs of the SRS site tenants. Delays have occurred in delivery of services to SREL for a variety of activities despite the availability of funding. The inability to get these issues resolved has resulted in delays in research activities as well as unexpected costs to SREL's operating budget to prepare facilities for renovation or repairs. The SRS Interface Management Team has been helpful in resolving a number of these issues and with their help, there have been some success stories in FY17, despite these delays.

SECTION VII. Absence or Changes in Key, non-temporary Personnel or Team Arrangement.

Administrative
No Change

Support Staff
No Change

Tenure-track Faculty
Separated – Dalia Abbas

Research Faculty
Retired – Gary Mills

Postdoctoral Researchers
Separated – Josh Smith

Research Professionals
No Change

Research Technicians
Separated – Kimberly Andrews
Separated – Rebecca Juarez
Separated – Meghan Oberkircher
Separated – Daniella Pitt
Separated – Carol Eldridge
Separated – Frank Depkin
Hired/Separated – Emily Bertucci
Hired/Separated – Samantha Bock
Hired/Separated – Lauren Bowman
Hired/Separated – Carmen Candel
Hired/Separated – Reid Demass
Hired/Separated – Dana Goin
Hired/Separated – Amanda Hurst
Hired/Separated – Ashley Lavere
Hired/Separated – Jena Nierman
Hired/Separated – Colby Roberts
Hired – Marty Brown
Hired – Alexis Kortosiz
Hired – Brooke Lindell
Hired – Pearson McGovern
Hired – Jasmine Park
Hired – Daniel Quinn
Hired – Madeline Sams

SECTION VIII. Products or technology transfer accomplished: Publications, websites, collaborations, technologies, inventions/patents, other products

SREL faculty and staff added 30 new publications to the SREL reprint list in FY17

3376 Kosnicki, E., S. A. Sefick, M. H. Paller, M. S. Jerrell, B. A. Prusha, S. C. Sterrett, T. D. Tuberville and J. W. Feminella (2016). "A Stream Multimetric Macroinvertebrate Index (MMI) for the Sand Hills Ecoregion of the Southeastern Plains, USA." Environmental Management 58(4): 741-751.

3377 McArthur, J. V., D. E. Fletcher, R. C. Tuckfield and C. Baker-Austin (2016). "Patterns of Multi-Antibiotic-Resistant Escherichia Coli from Streams with No History of Antimicrobial Inputs." Microbial Ecology 72(4): 840-850.

3378 Smith, J. B., K. L. Turner, J. C. Beasley, T. L. DeVault, W. C. Pitt and O. E. Rhodes Jr. (2016). "Brown tree snake (Boiga irregularis) population density and carcass locations following exposure to acetaminophen." Ecotoxicology 25(8): 1556-1562.

3379 Podder, J., J. Lin, W. Sun, S. M. Botis, J. Tse, N. Chen, Y. Hu, D. Li, J. C. Seaman and Y. Pan (2017). "Iodate in calcite and vaterite: Insights from synchrotron X-ray absorption spectroscopy and first-principles calculations." Geochimica et Cosmochimica Acta 198(2017): 218-228.

3380 Abernethy, E. F., K. L. Turner, J. C. Beasley, T. L. DeVault, W. C. Pitt and O. E. Rhodes Jr. (2016). "Carcasses of invasive species are predominantly utilized by invasive scavengers in an island ecosystem." Ecosphere 7(10): e01496.

3381 DeGregorio, B. A., T. D. Tuberville, R. A. Kennamer, B. B. Harris and I. L. Brisbin Jr. (2017). "Spring emergence of Eastern Box Turtles (*Terrapene carolina*): influences of individual variation and scale of temperature correlates." Canadian Journal of Zoology 95(1): 23-30.

3382 Cooper, Z., R. Bringolf, R. Cooper, K. Loftis, A. L. Bryan Jr. and J. A. Martin (2017). "Heavy metal bioaccumulation in two passerines with differing migration strategies." Science of the Total Environment 592(2017): 25-32.

3383 Edge, C. B., N. Rollinson, R. J. Brooks, J. D. Congdon, J. B. Iverson, F. J. Janzen and J. D. Litzgus (2017). "Phenotypic plasticity of nest timing in a post-glacial landscape: how do reptiles adapt to seasonal time constraints?" Ecology 98(2): 512-524.

3384 Fletcher, D. E., A. H. Lindell, G. K. Stillings, S. A. Blas and J. V. McArthur (2017). "Trace element accumulation in lotic dragonfly nymphs: Genus matters." PLos ONE 12(2): 1-27.

3385 Kennamer, R. A., R. E. Oldenkamp, J. C. Leaphart, J. D. King, A. L. Bryan Jr. and J. C. Beasley (2017). "Radiocesium in migratory aquatic game birds using contaminated U.S. Department of Energy reactor-cooling reservoirs: A long-term perspective." Journal of Environmental Radioactivity 171(2017): 189-199.

3386 Skupien, G. M., K. A. Andrews and L. R. Larson (2016). "Teaching Tolerance? Effects of Conservation Education Programs on Wildlife Acceptance Capacity for the American Alligator." Human Dimensions of Wildlife 21(3): 264-279.

3387 Skupien, G. M. and K. A. Andrews (2017). "Factors Influencing the Abundance of American Alligators (*Alligator mississippiensis*) on Jekyll Island, Georgia, USA." Journal of Herpetology 51(1): 89-94.

3388 Finger Jr., J. W., M. T. Hamilton, T. C. Glenn and T. D. Tuberville (2017). "Dietary Selenomethionine Administration in the American Alligator (*Alligator mississippiensis*): Hepatic and Renal Se Accumulation and Its Effects on Growth and Body Condition." Archives of Environmental Contamination and Toxicology 72(3): 439-448.

3389 Haskins, D. L., M. T. Hamilton, A. L. Jones, J. W. Finger Jr., R. B. Bringolf and T. D. Tuberville (2017). "Accumulation of coal combustion residues and their immunological effects in the yellow-bellied slider (*Trachemys scripta scripta*)." Environmental Pollution 224(2017): 810-819.

3390 Simner, S., F. Coutelot, H. Chang and J. C. Seaman (2017). "Technetium Leaching from Cementitious Materials." MRS Advances 2(13): 717-722.

3391 Keiter, D. A. and J. C. Beasley (2017). "Hog Heaven? Challenges of Managing Introduced Wild Pigs in Natural Areas." Natural Areas Journal 37(1): 6-16.

3392 Hernandez, F., R. E. Oldenkamp, S. Webster, J. C. Beasley, L. L. Farina and S. M. Wisely (2017). "Raccoons (*Procyon lotor*) as Sentinels of Trace Element Contamination and Physiological Effects of Exposure to Coal Fly Ash." Archives of Environmental Contamination and Toxicology 72(2): 235-246.

3393 Byrne, M. E., A. E. Holland, A. L. Bryan Jr. and J. C. Beasley (2017). "Environmental conditions and animal behavior influence performance of solar-powered GPS-GSM transmitters." The Condor/Ornithological Applications 119(3):389-404.

3394 Nagle, R. D., O. M. Kinney, J. W. Gibbons and J. D. Congdon (2017). "A Simple and Reliable System for Marking Hard-Shelled Turtles: The North American Code." Herpetological Review 48(2):327-330.

3395 Keiter, D. A., J. C. Kilgo, M. Vukovich, F. L. Cunningham and J. C. Beasley (2017). "Development of known-fate survival monitoring techniques for juvenile wild pigs (*Sus scrofa*)." Wildlife Research 44(2):165-173.

3396 McArthur, J. V., C. A. Dicks, A. L. Bryan Jr. and R. C. Tuckfield (2017). "The effects of low-level ionizing radiation and copper exposure on the incidence of antibiotic resistance in lentic biofilm bacteria." Environmental Pollution 228(2017): 390-397.

3397 McArthur, J. V., R. C. Tuckfield, D. E. Fletcher and A. H. Lindell (2017). "Effect of heavy metal pollution on the incidence of antibiotic resistance in *Aeromonas hydrophila* isolates obtained from the surface of fish." Aquatic Microbial Ecology 79(3): 197-207.

3398 Pappas, M. J., J. D. Congdon and B. J. Brecke (2017). "Orientation in Five Species of Hatchling River Turtles Dispersing from Experimental Nests." Chelonian Conservation and Biology 16(1): 3-11.

3399 Peaden, J. M., A. J. Nowakowski, T. D. Tuberville and K. A. Buhlmann (2017). "Effects of roads and roadside fencing on movements, space use, and carapace temperatures of a threatened tortoise." Biological Conservation 214(2017): 13-22.

Lovell, J. A., D. E. Fletcher, S. D. Cooper and J. V. McArthur (2017). "Fish predation and macroinvertebrate abundance on snags in low-gradient blackwater streams." Freshwater Science 36(3): 626-634.

Nafus, M. G., T. D. Tuberville, K. A. Buhlmann and B. D. Todd (2017). "Precipitation quantity and timing affect native plant production and growth of a key herbivore, the desert tortoise, in the Mojave Desert." Climate Change Responses 4(4): 1-10.

Turner, K. L., E. F. Abernethy, L. M. Conner, O. E. Rhodes Jr. and J. C. Beasley (2017). "Abiotic and biotic factors modulate carrion fate and vertebrate scavenging communities." Ecology 98(9): 2413-2424.

Holland, A. E., M. E. Byrne, A. L. Bryan Jr., T. L. DeVault, O. E. Rhodes Jr. and J. C. Beasley (2017). "Fine-scale assessment of home ranges and activity patterns for *resident black vultures (Coragyps atratus) and turkey vultures (*Cathartes aura)." PLos ONE 12(7): e0179819.

Meshaka, J., W.E., J. W. Gibbons, D. F. Hughes, M. W. Klemens and J. B. Iverson (2017). "*Kinosternon subrubrum* (Bonnaterre 1789) - Eastern Mud Turtle." Conservation Biology of Freshwater Turtles and Tortoises, Chelonian Research Monographs, No. 5: 101.101 - 101.116.

Schlichting, P. E., A. E. Holland, J. C. Beasley, A. L. Bryan Jr., R. A. Kennamer, T. L. DeVault, B. F. Blackwell and O. E. Rhodes Jr. (2017). "Efficacy of an Acoustic Hailing Device as an Avian Dispersal Tool." Wildlife Society Bulletin 41(3): 453-460.

SECTION IX. **Special Accomplishments by Laboratory Personnel**

- Kavid Kieter, an SREL Graduate Student, was the recipient of the 2017 Cheatum Award in the Warnell School of Forestry and Natural Resources
- Krista Capps recieved the Odum School of Ecology Outstanding Teacher Award in FY17
- Krista Capps was named as a UGA Service Learning Fellow in Fy17
- Over a dozen SREL graduate students won awards for presentations at regional, national or international meetings
- SREL research was highlighted in print, TV, and web-based media hundreds of times
- Numerous SREL faculty were asked to serve as peer reviewers on national funding panels for NSF, USDA, and other entities
- SREL Faculty were asked to give over 50 invited presentations to professional audiences in FY17