SAVANNAH RIVER
ECOLOGY LABORATORY

ANNUAL TECHNICAL PROGRESS REPORT OF ECOLOGICAL RESEARCH FOR FY16

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The University of Georgia
and
The U.S. Department of Energy
for the period of
1 October 2015 – 30 September 2016

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SECTION I: Savannah River Ecology Laboratory – FY16 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 FY16 was fulfilled with the publication of 75 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 400 outreach events reaching over 39,000 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 103 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 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 $500,000.00 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 has been used to leverage new cost shared faculty positions with UGA units on the main campus, resulting in the addition of three new tenure track faculty lines at SREL (3 of 3 in place in FY16) and a portion of three new tenure track faculty lines on the main UGA campus (3 of 3 in place in FY16) 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 will allow 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 FY16, 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 31 new and continuing external grants during FY16 and increased non-SRS external funding levels significantly in FY16. 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 FY16 and SREL faculty and staff mentored over a dozen undergraduate students and over 84 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 310 talks, 31 tours, 20 exhibits, and 45 ***Ecologist for a Day*** programs reaching a total of over 39,000 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.

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 FY16 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 FY16, the Savannah River Ecology Laboratory received approximately 8 million dollars in funding from a variety of sources (Figure 2.1). These funds supported approximately 103 faculty, staff, and students conducting basic and applied environmental research for at least some portion of FY16 (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 43% 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 FY16. 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).

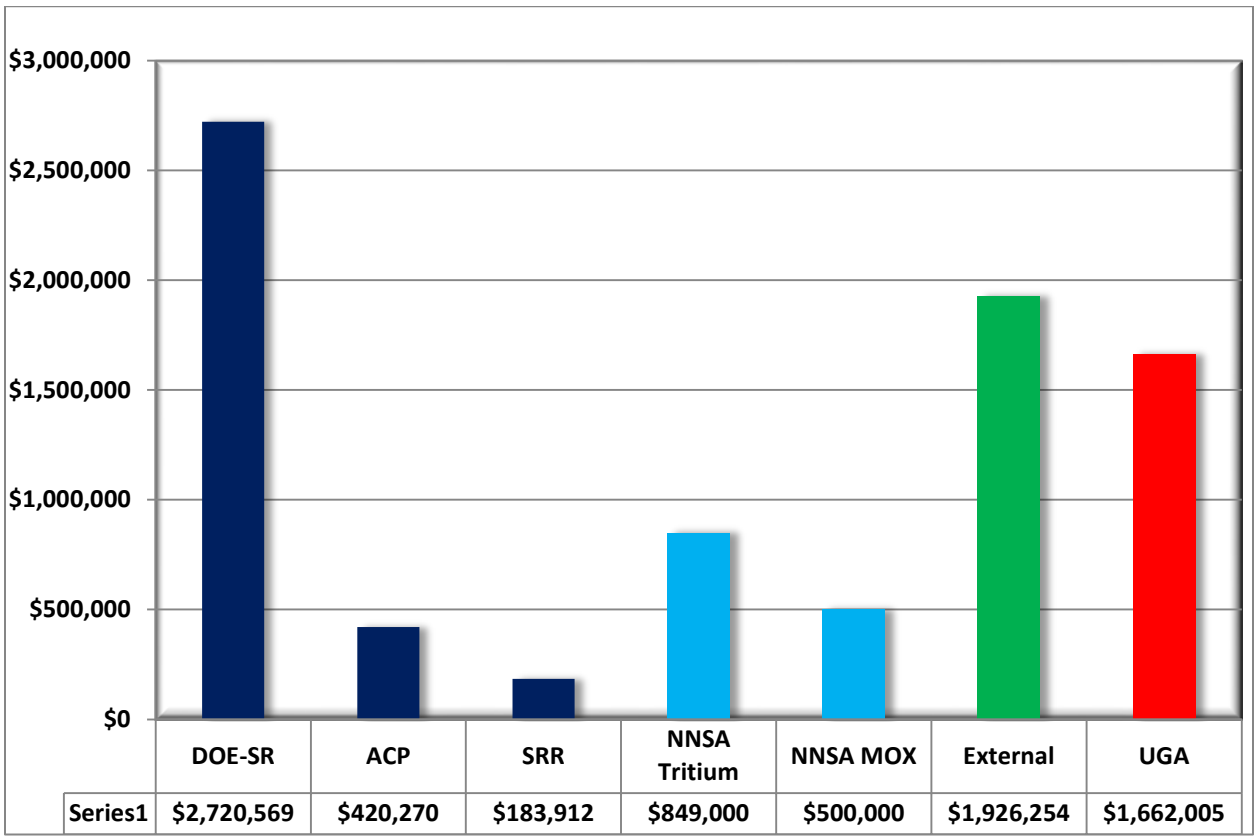

Table 2.2. SREL organizational structure for FY16. This table includes all research faculty, classified staff and Emeritus faculty in residence at the Savannah River Ecology Laboratory for any portion of the FY16 fiscal year.

SREL ORGANIZATIONAL CHART – FY16	
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. James Martin Dr. Dalia Abbas Dr. Krista Capps 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. X. Xu Dr. J. Smith Dr. S. Weir Dr. F. Coulet Dr. A. Kremer Dr. L. Kierepka Dr. P. Schlichting **Research Professionals** Dr. K. Buhlmann R. Beasley A. Bryan D. Fletcher L. Lee R. Kennamer D. Scott A. Lindell P. Stankus **Research Technicians** R. Juarez C. Candal M. Dix C. Fulghum A. Korotasz C. Burckhalter J. Cochran I. Davis K. Eckhart A. Lavere P. Lyons S. Macmahon A. Rana B. Lindell A. Russell Z. Smith K. Woods J. Zajdel F. Depkin C. Boyce	**Assistant Director Budget and Facilities** C. McBride **Safety and Environmental Manager** D. Mosser **Computer Service and GIS Lab Manager** W. Taylor **Property Management** B. Morton **Outreach Program Staff** V. Sutton-Jackson Dr. K. Andrews C. Eldridge 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 10/1/2016)

Table 2.3. Summary of professional activities and accomplishments by Savannah River Ecology Laboratory research faculty, research professionals, postdocs and students in FY16.

Publications and Reviews	Total
Peer Reviewed Journal Articles	75
Book and Book Chapters	6
Proceedings Articles	1
Primer or Other Scientific Notes	3
Non-Peer reviewed Articles	14
Articles In Press	15
Articles In Review	55
Peer Review of Manuscripts Conducted	74
External Funding (non-SRS)	**Total**
External Grants Submitted as PI or CoPI	37
External Grant Funding Submitted as PI or CoPI	$13,978,019
External Grants Funded as PI or CoPI[1]	31
External Grants Funded Dollars as PI or CoPI	$ 2,476,848
Graduate Education and Postdocs	**Total**
MS Graduate Students Chaired	27
MS Graduate Students Completed	10
PhD Graduate Students Chaired	8
PhD Graduate Students Completed	0
Graduate Student Committee Memberships	39
Graduate Students Hosted at SREL	14
Post Docs Supervised	6
Presentations	**Total**
Invited Presentations	34
Professional Oral Presentations	84
Professional Poster Presentations	57
Extension Presentations	18
Extension Publications	33
Other	**Total**
Awards or Honors	23
Professional Society Committee Memberships	18
Staff Teaching Courses for UGA	11
Technical Research Consultations	29

[1] – includes new grants and contracts, renewals and continuations associated with funding sources external to DOE. Total includes multi-year funding commitments received in FY16 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 FY16 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

Evaluating the Potential for Sulfate Attack at the Saltstone Disposal Facility

Funding Entity
Savannah River Remediation (SRR)
Start Date and Funding Amount
July 2015; $76,518
PI and co-PI's
Dr. John C. Seaman (SREL)
Objective
The objective is to develop and initiate laboratory tests to evaluate the potential for chemical attack to occur when saltstone and/or saltstone bleed solution come into contact with concrete material and protective coatings/liners used in Saltstone Disposal Units (SDU).
Summary of Research Activities
Concrete can undergo deleterious chemical reactions, such as sulfate attack and alkali-silica reaction (ASR), when exposed to harsh chemical environments. Concrete SDUs at the Savannah River Site (SRS) are used to contain low-level salt solution encapsulated in a cementitious matrix. The salt solution contains high concentrations of components such as nitrate, nitrite, sulfate, hydroxide, and chloride. SREL has initiated a series of laboratory tests to evaluate the potential for chemical attack to occur when saltstone and/or saltstone bleed solution come into contact with concrete material representative of the SDUs. SDU concrete test cylinders (4" x 8") were exposed to various test solutions at elevated temperatures (68 °C) for 1000 hours before compressive strength testing (ASTM C39) to evaluate any loss in physical integrity. SREL also evaluated the effectiveness of several coating materials to protect SDU concrete, and potential liner materials (MARSEAL 3500, MARSEAL 2000, and CHEMOLINE-4CN) used to address leak issues and providing added chemical resistance to Saltstone Disposal Unit (SDU) concrete.
Conclusions
1) No loss in physical integrity (i.e., compressive strength) was observed for SDU samples exposed to the sulfate test solution.
2) No loss of integrity or significant delamination was observed for the three coating materials.

Major Impact(s) of Research
1) In collaboration with SRR, DOE and SRNL, SREL developed a recipe for use as a salt solution simulant for evaluating the potential for deleterious interactions between corrosive simulant constituents and Saltstone Disposal Unit (SDU) concrete (see G-ESR-Z-00018. Rev 0). The simulant

recipe was then used to evaluate the suitability of concrete coatings and liner materials that may be applied to the SDU concrete structure.

Other Project Personnel

Jarad Cochran, Research Professional - SREL

Emily Dorward, Research Technician/Graduate Student - SREL

External Collaborators

Dr. S. Simner - SRR

Products

Seaman, J.C., J. Cochran and E. Dorward. 2016 SDU Liner Performance Testing. SREL Doc. No. R-16-002. Submitted to SRR August 16, 2016.

Seaman, J.C. and J. Cochran. 2016. Sulfate Attack for SDU Concrete. Submitted to SRR August 23, 2016.

Seaman, J.C. and J. Cochran. 2016. Sulfate Attack for Coated SDU Concrete. Submitted to SRR August 23, 2016.

Chemical and Physical Properties of Saltstone as impacted by Curing Environment

Funding Entity
Savannah River Remediation (SRR)
Start Date and Funding Amount
October 2015; $132,393
PI and co-PI's
Dr. John C. Seaman (SREL)
Objective
The project objective for FY2016 was to evaluate the 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.
Summary of Research Activities
For FY16, ^{99}Tc-spiked saltstone simulants were produced utilizing SRR prescribed formulations and subjected to varying curing durations under controlled temperature and humidity conditions chosen to mimic curing conditions within Saltstone Disposal Unit (SDU) Cell 2A. The grout simulants were compared to actual intact saltstone retrieved (cured in place for approximately 20 months) from SDF-SDU Cell 2A. Contaminant mass transfer rates for the saltstone simulants and SDF saltstone samples were assessed using EPA Method 1315. This method was recently adopted for evaluating contaminant leaching from intact monolithic materials. Results from Method 1315 were also 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 the ^{99}Tc-spiked simulants, leaching rates for poorly sorbing contaminants like NO3-, as indicated by high effective diffusivities and low leachability indices were much higher than ^{99}Tc, which was attributed to ^{99}Tc partitioning under reducing conditions. Technetium-99 leaching rates for the spiked saltstone samples also appeared to be sensitive to curing duration and the reduction capacity of the dry feed materials (i.e., BFS) used in making grout, a characteristic that can vary between different BFS sources. Technetium-99 leaching rates for the intact SDU saltstone samples in the EPA 1315 test were extremely similar for the three test samples, but a bit higher than observed for the ^{99}Tc-spiked samples made with the new BFS materials when taking exposed surface area into account. Somewhat surprisingly, the leaching rates for ^{137}Cs from the SDU samples were generally lower than the poorly sorbing contaminant, NO_3^-, with LI values that were comparable to those observed for ^{99}Tc. There was some variability in ^{137}Cs leaching rates between the three samples, but this variability may reflect differences in total ^{137}Cs present in the three SDU samples.

For DLM testing, the permeameter system was upgraded to accommodate three test samples at the same time by using the laboratory air compressor to provide the driving force for leaching. The three materials tested include a ^{99}Tc-spiked sample described in Seaman (2015) and two of the SDU samples. The three samples have been leached with an artificial groundwater (AGW) surrogate that has either been degassed to remove O_2 or equilibrated with standard atmosphere. It is important to note that previous DLM tests indicated that Re was a poor surrogate for ^{99}Tc, with DLM leaching rates similar to that of non-reactive grout constituents, consistent with EPA 1315 leaching rates for Re observed in previous studies. The Ksat values for the three samples vary greatly and make it difficult to control pore water residence times and maintain constant flow rates. Higher initial ^{99}Tc leaching has been observed for the two SDU samples. Therefore, the DLM system is being modified in FY17 to provide greater mechanical control of flow rates

so that factors such as pore water residence times can be manipulated to provide greater experimental control.

Conclusions

1) Similar ^{99}Tc diffusivities were observed for SDU and ^{99}Tc-spiked saltstone
2) LI values for ^{137}Cs were greater than generally expected, indicating that ^{137}Cs was being immobilized in the SDU saltstone

Major Impact(s) of Research

1) Similar ^{99}Tc leaching rates were observed for spiked simulants and SDU Cell 2A samples.
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

J. Cochran, Research Professional - SREL

External Collaborators

Dr. D. Kaplan - SRNL

Dr. D. Li – SRNL

Dr. S. Simner - SRR

Products

Seaman, J.C., F.M. Coutelot, J. Cochran, R.J. Thomas and M.R. Baker 2016. Contaminant Leaching from Saltstone. SREL Doc. No. R-16-003. Submitted to SRR September 16, 2016.

Seaman, J.C., S.P. Simner, F.M. Coutelot, and H. Chang. 2016. Technetium and Rhenium Leaching from Chemically Reducing Grout. Submitted to Chemosphere.

Simner, S.P. and J.C. Seaman. 2016. SRR WDA Research Status update presented at Vanderbilt University. August 9-10, 2016.

Seaman, J.C., S.P. Simner, H.S. Chang, and F.M. Coutelot. 2016. Assessing Technetium Immobilization in Cementitious Materials. 2016 Goldschmidt Conference. June 26 through July 1, 2016, Yokohama, Japan.

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

Funding Entity

SRNS Area Closure Projects

Start Date and Funding Amount

November 2015; $130,628

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 FY16, 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.

Conclusions

1) The estimated tritium evapo-transpiration efficiency for individual irrigation plots through the end of calendar year 2015 based on soil core samples ranged from ≈ 89.4 to 90.7 %, with lower tritium use efficiencies generally reflecting the limited vegetative cover associated with the Western Expansion Area.
2) Efficiency results derived from the Cornell 1D model were consistent with the soil-based calculations, ranging from 59.5 to 88.7 % between plots, with a yearly average of 79.0 ± 9.2 % for all 11 plots. As noted above, the large range in water use efficiency reflects differences in the lower vegetative cover associated with the expansion plots.
3) The 1, 4 dioxane levels in conventional soil headspace samples collected in FY14 from the original irrigation plots were below the detection limit, indicating no obvious accumulation of 1, 4 dioxane in soils from the irrigation plots.
4) The soil tritium extraction method based on the sublimation (i.e., freeze drying) proved to be an effective means of extracting 1, 4 dioxane from soils for subsequent VOC analysis; however, residual soil 1, 4 dioxane levels were routinely below the detection limit.

Other Project Personnel

Matt Baker, Graduate Student - SREL

Jarad Cochran, Research Technician - SREL

External Collaborators

NA

Products

Seaman, J.C. 2016. Estimating Evapo-Transpiration Losses for Tritium at the MWMF: 2013 End of Year Summary Report. Submitted to SRNS-ACP March 15, 2016.

Radiocesium in American Coots on Pond B: A Long-Term Perspective

Funding Entity
SRNS Area Closures Projects
Start Date and Funding Amount
October 2013; $43,281
PI and co-PI's
Robert A. Kennamer, A. Lawrence Bryan Jr., and Dr. James C. Beasley (SREL)
Objectives
Our overall objectives for this project were to examine current levels of radiocesium in waterfowl (American coots [*Fulica americana*; hereafter coots] and ring-necked ducks [*Aythya collaris*]) on Pond B of the SRS and: (1) establish current/future risk for human consumption, (2) combine new and historic data to demonstrate a long-term natural attenuation of radiocesium in Pond B waterfowl, and (3) elucidate potential species differences in radiocesium accumulation.
Summary of Research Activities
With all collections of waterfowl from Pond B completed in May of 2015, in 2016 we focused on analysis of the data and preparation of a final report and manuscript for journal submission.
Conclusions
1) An examination of relationships among coot and ring-necked duck whole-body and tissue radiocesium concentration data showed that slopes are higher than found in an earlier study conducted in the mid-1980s for coots on Pond B, which has implications for comparing whole-body radiocesium levels to EEC limits in fresh meat.
2) Pond B coots averaged 1.64 (0.12SE) Bq/g, wet mass and 1.02 (0.06SE) Bq/g, wet mass for muscle and liver tissues, respectively. Pond B ring-necked ducks averaged 2.24 (0.20SE) Bq/g, wet mass and 1.25 (0.10SE) Bq/g, wet mass for muscle and liver tissues, respectively.
3) An estimate of ecological half-life for coots using Pond B was determined as 16.8 years (95% CI=12.9-24.2 yrs). An estimation of ecological half-life for ring-necked ducks using Pond B was not possible because of apparent differences in residence times of ring-necked ducks on Pond B in the historic data versus the newly acquired data.
4) New work relating ratios of GI content and muscle tissue radiocesium concentrations to residence times on Pond B showed promising results and earned undergraduate Joshua King the honor of being one of only 120 REU program participants from around the county to participate in a National REU Symposium held in October, 2015.

Major Impact(s) of Research
1) We estimated that radiocesium-exposed Pond B coots would not decline to the European Economic Community (1986) limit of radiocesium in fresh meat (0.600 Bq/g) until 2037, and even longer (not until 2049) before approaching background.
2) Continued periodic waterfowl collections at contaminated SRS reservoirs will be useful to refine estimates of contaminant natural attenuation rates and track progress of natural attenuation.
3) Future research with a goal of estimating residency time of unmarked, full-flighted birds using SRS-contaminated sites is desirable and results suggest that it may be possible.

Other Project Personnel
Ricki Oldenkamp, MS Student - SREL
Joshua King, REU undergraduate student – USC-A
Chris Leaphart, Research Technician - SREL
External Collaborators
NA

Products

Kennamer, R.A., R.E. Oldenkamp, J.C. Leaphart, J.D. King, A.L. Bryan, Jr., and J.C. Beasley. *In review*. Radiocesium in migratory aquatic game birds using contaminated U.S. Department of Energy reactor-cooling reservoirs: a long-term perspective. Submitted to: *Journal of Environmental Radioactivity*.

Kennamer, R.A., A.L. Bryan, Jr., J.C. Beasley, R.E. Oldenkamp, J.C. Leaphart, and J.D. King. 2016. Radiocesium in American Coots and Ring-Necked Ducks on Pond B: A Long-Term Perspective. Final project report to Savannah River Nuclear Solutions-Area Completion Projects, Savannah River Ecology Laboratory Report, Aiken, SC, 32pp.

Beasley, J.C. ^{137}Cs uptake and movement within biota. International Atomic Energy Agency meeting with the Fukushima Prefecture. December, 2015. (Oral Presentation).

King, J.D., 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. The 2015 NSF Research Experience for Undergraduates Symposium, Arlington, VA. October 25–26, 2015. (Poster Presentation).

Recalculating ^{137}Cs ecological half-lives for American coots on Par Pond since the 1994-95 refill and contaminant burdens of waterfowl inhabiting Fourmile Branch

Funding Entity
SRNS Area Closures Projects
Start Date and Funding Amount
February 2015; $41,500
PI and co-PI's
Dr. James C. Beasley, Robert A. Kennamer, and A. Lawrence Bryan Jr. (SREL)
Objectives
Our overall objectives for this project are to: (1) examine current levels of radiocesium in American coots [*Fulica americana*; hereafter coots] on Par Pond of the SRS to establish current/future risk for human consumption, (2) use new Par Pond coot radiocesium data with historic data collected before and after the 1991-95 drawdown of Par Pond to compare and contrast estimates of long-term natural attenuation of radiocesium in Par Pond waterfowl before and after the reservoir drawdown, and (3) trap and release flightless ring-necked ducks [*Aythya collaris*] and another suitable waterfowl species onto a Fourmile Branch beaver pond to examine uptake of radiocesium and mercury in that system.
Summary of Research Activities
In December 2015, January 2016, and February, 2016, we made lethal collections of coots on Par Pond (using shotguns from an airboat). Birds were collected from North Arm (27), Hot Arm (30), and West Arm (32). Collected birds were transported to SREL where they body mass was recorded (nearest 1g) and live whole-body radiocesium was determined. Data analysis of the Par Pond data is underway. In December 2015 and January 2016, wild-caught ring-necked ducks and game-farm mallards were whole-body counted (a subset) and had blood collected prior to being rendered flightless (scissoring flight feathers) and released in the Fourmile Branch beaver pond at Road 4 and collected over a 4 to 94-day period to examine uptake.
Conclusions
1) Preliminary analysis of the Par Pond coot whole-body radiocesium data from fall/winter of 2015-16 indicates that levels are elevated as compared to collections last made at that reservoir in 1998-99, indicating increased radiocesium bioavailability since the pumping of river water into Par Pond ceased in 1998.
2) At Fourmile Branch beaver pond at Road 4, Mallards (dabbling ducks) accumulated higher concentrations of both Hg and radiocesium and accumulated both more quickly than ring-necked ducks (diving ducks) probably due to different foraging strategies (shallow vs deeper water, respectively) and prevalence of contaminants in more shallow portions of the aquatic system.

Major Impact(s) of Research
1) Current work with Par Pond coots indicates increased radiocesium bioavailability in that ecosystem since the pumping of river water into Par Pond ceased in 1998.
2) Waterfowl introduced to a Fourmile Branch beaver pond accumulated contaminants at different rates due to differences in foraging behavior and heterogeneous contaminant distribution. Wild waterfowl using this aquatic system could be a potential source of contaminant exposure to hunters.

Other Project Personnel
Ricki Oldenkamp, MS Student - SREL
Chris Leaphart, MS Student - SREL
Sarah Abercrombie, REU Student - SREL
External Collaborators
NA
Products
Abercrombie, S. Bioaccumulation of radiocesium and mercury in diving and dabbling ducks on the Savannah River Site. SREL Undergraduate Student Symposium 2016. (Oral Presentation).

Abercrombie, S. Bioaccumulation of radiocesium and mercury in diving and dabbling ducks on the Savannah River Site. University of South Carolina 2016 Summer Research Symposium, Columbia, SC, July 2016. (Poster Presentation).

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 2nd year of the project to determine the degree of radiocesium uptake by various trophic components (ranging from biofilms to fish to snakes) of the Pond A/R-Canal system. The 2nd year focused in filling in data gaps (e.g.; sample sizes of individual species) as well as initiating new studies examining uptake relative to exposure time in selected species in on-site mesocosms. 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
In 2016 we collected ~200 additional samples from the Pond A/R-Canal system to assay for radiocesium, building on the >1300 samples collected in 2015. In addition, bullfrog tadpoles from control areas were deployed in 10 mesocosms within the R-Canal system to determine the rate of radiocesium uptake for this species. The analyses of these samples are on-going.
Conclusions
1) We have completed field collections of biota for 2016.
2) Analyses of "wild" biota collected from R-Canal and Pond A and the mesocosm samples for radiocesium are on-going.

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

Other Project Personnel
James Leaphart, MS student – SREL
Alexis Korotasz, Research Technician - SREL
Christina Fulghum, REU student – USC-A
David Haskins, Research Technician - SREL
External Collaborators
NA
Products
Leaphart, J.C., A.M. Korotasz, A.L. Bryan, and J.C. Beasley. 2016. Biomagnification of radiocesium (137Cs) in aquatic ecosystems on the Savannah River Site. Oral presentation at the 2016 Warnell (UGA) Graduate Student Association Symposium, University of Georgia, Athens, GA (January 2016)

Korotasz, A.M., J.C.Leaphart, and A.L. Bryan. 2016. Comparison of ^{137}Cs in larval and adult Ranid species on the Savannah River Site. Poster presentation at the 12th Annual University of South Carolina Upstate Research Symposium (8 April 2016), Spartanburg, SC.

Bryan, L., J. Beasley and C. Leaphart. 2016. Interim report: Radiocesium in biota from Lower Three Runs, specifically R-Canal, Pond A, Pond 2, and the Old Discharge Canal (Joyce's Branch). Report submitted to Area Closure Project, SRNS, SRS. 20 April 2016.

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

Funding Entity
SRNS Area Closure Project
Start Date and Funding Amount
April 2016; $40,000
PI and Co-PIs
Larry Bryan, Dr. Gary Mills, Angela Lindell (SREL)
Objectives
We are in the 3rd 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 mercury. Our initial year was focused on a general survey of all three regions, the 2nd year focused on the SRSS whereas the current study (3rd year) is focused on the stream reach associated with the H-Area seepline. Our summary includes (1) analytical (Hg) results from the 2nd year (SRSS) as well as the collections (H seepline) for the 3rd year.
Summary of Research Activities
In year 2 we collected sediment, biofilm, and aquatic fauna for Hg analysis within 7 sites in the SRSS associated with Fourmile Branch and 8 sites within the SRSS associated with Crackerneck (up-river from Fourmile). Total Hg concentrations were generally higher in Fourmile SRSS samples than Crackerneck, although not consistently so, continuing the pattern of a patchy distribution of Hg in the SRSS. In year 3, we sampled sediments and biota along the reach of Fourmile associated with the H-Area seepline. We collected ~270 samples (ranging from biofilms to redfin pickerel) from Fourmile as well as ~290 samples from Meyers Creek, as a control site. All year 3 samples have been prepped for mercury analysis and analysis have just been initiated. Analysis of selected SRSS and seepline samples for methylmercury is on-going.
Conclusions
1) Analyses of Year 2 samples confirm a patchy distribution of Hg within the Fourmile SRSS with certain sites exhibiting higher concentrations than other Fourmile SRSS sites or the up-river control sites.
2) In Year 3 we collected ~270 biota samples (biofilms, aquatic invertebrates, amphibians and fish) from the stream reach associated with H-Area seepline site and ~300 biota samples from Meyers Creek as a control site.
3) Mercury (total) analysis of all collected samples has just been initiated. Once completed, a subset of
4) SRSS and H-area seepline samples will be analyzed for methylmercury.

Major Impact(s) of Research
1) When completed, we will have a better understanding of mercury accumulation in aquatic biota and the conditions that make mercury bioavailable in the Fourmile system.
2) Mercury/methylmercury data from the current samples from the H-Area seepline region will be compared to Meyers Creek samples and can be assessed to determine if this portion of theSRS is still of regulatory concern.

Other Project Personnel
Dr. Xiaoyo Xu, Postdoctoral Research Associate – SREL
E.J. Borchert, Research Technician – SREL
A.M. Korotasz, Research Technician - SREL
D.L. Haskins, Research Technician - SREL
External Collaborators
NA
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 compile the information on uptake of radionuclides by SRS deer and possibly pigs (from SRS hunts) and provide a generic risk assessment.
Summary of Research Activities
To date, data from 2015 have been obtained and analyses is on-going.
Conclusions
1) None at present since analyses is on-going.
Major Impact(s) of Research
1) When completed, information pertaining to radionuclide uptake by SRS deer and possibly pigs from SRS hunts will be summarized and "risk" assessed.
Other Project Personnel
NA
External Collaborators
Dr. Karen Gaines – Eastern Illinois University
Dr. Jim Novak – Eastern Illinois University
Products
No publications, presentations, or reports have yet been prepared.

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 140 manuscripts, 11 technical reports, and 10 theses have been compiled. We are currently beginning the manuscript evaluations (e.g.; which radionuclide and SRS areas) as we continue to search for appropriate documentation.
Conclusions
1) We have initiated the search for information as well as the evaluations of the documents.
Major Impact(s) of Research
1) When completed, information pertaining to radionuclide uptake by SRS fauna from 1960-2016 will be available in one document.
Other Project Personnel
NA
External Collaborators
NA
Products
No publications, presentations, or reports have yet been prepared.

Bacterial Metagenomics of the Rodent Microbiome Under Conditions of Long-Term, Chronic Exposure to Contaminants on the SRS

Funding Entity
DOE-EM Support to SREL
Start Date and Funding Amount
October 2015; $24,000
PI and Co-PIs
Olin Rhodes (SREL)
Objectives
To evaluate changes in the gut microbiome of rodents related to long-term, chronic exposure to radionuclides and heavy metals.
Summary of Research Activities
In year 2 we evaluated metal and radionuclide contamination in soil samples and rodents within each of 3 study areas on the SRS (reference site, radionuclide contaminated site and heavy metal contaminated site). Rodent gut samples have been subjected to bacterial metagenomic analyses for targeted genes of interest to evaluate differential adaptation and physiological responses to long term chronic exposure to contaminants. These analyses are ongoing.
Conclusions
1) This research is in the initial stages of data analysis.
Major Impact(s) of Research
1) This research will provide insights into the adaptation and evolution of the microbiome of mammals in response to long-term, chronic exposure to radionuclides and heavy metals
Other Project Personnel
Jesse Thomas, Ph.D. Student – SREL
Dr. James Beasley, Assistant Professor – SREL
Erin Abernethy, M.S. Student – SREL
Kelsey Turner, MS Student - SREL
External Collaborators
Dr. Travis Glenn – UGA
Products
No publications, presentations, or reports have yet been prepared.

Reptiles as Long-lived Bioaccumulators of Contaminants & Potential Exposure Risk to Local Residents Through Consumption

Funding Entity
SRNS Area Closures Projects
Start Date and Funding Amount
November 2012; $319,165
PI and co-PI's
Dr. Tracey D. Tuberville, David Scott and Dr. Stacey Lance (SREL)
Objectives
1) Assess body burdens of select metals and cesium-137 in alligators and aquatic turtles from IOUs where known contaminant issues occur and that are likely to experience trespass by humans;
2) survey / interview local hunters and fishermen in communities surrounding SRS with regard to harvesting and consumption of aquatic turtles and alligators; and
3) evaluate alternative fitness-related endpoints using standard veterinary diagnostic tools & health parameters for assessing the biological implications of contaminant exposure and bioaccumulation in alligators and aquatic turtles, thereby addressing the ecological risk of contaminants.

Summary of Research Activities
This fiscal year focused on analysis of samples and data collected to date and writing results for publication in peer-reviewed journals. Two graduate students also completed their theses (see products). We also hosted 3 REU students who conducted research investigation accumulation and sublethal effects of Cs-127 and Hg in green water snakes.

Conclusions
1) Juvenile alligators subjected to chronic dietary exposure to CCW-contaminated prey for two years accumulated significant levels of Se in kidney, liver, scutes and muscle. The low doses of contaminants in natural prey items do not appear to induce sublethal effects on growth or immune parameters, even when chronically ingested.
2) Juvenile alligators subjected to acute dietary exposure to Se can accumulate up to 100 ppm concentrations of Se in their kidney and liver over relatively short exposure periods (7 weeks). These concentrations are sufficient to induce lethargy, neurological impairment, and even mortality in at least some individuals.
3) Acute exposure to Se can induce selenosis in yellow-bellied sliders even over relatively short time periods.
4) Mud turtles occupying CCW-contaminated wetlands can accumulate significant levels of As, Se and Cd as a result of chronic exposure. However, differences in metabolic rates and immune parameters among individuals appear to be influenced more by size or age than by site of capture.
5) Corticosterone can be successfully extracted from alligator scutes
6) Alligator populations at L-Lake and Par Pond appear stable, with site operations apparently having overall net population-level benefit by providing large aquatic habitats not historically present prior to site establishment.

Major Impact(s) of Research
1) Comparative data regarding bioaccumulation of Se in alligators under two different dietary exposure scenarios – acute exposure (such as that following an accidental or intentional release of CCW waste) and chronic low-dose exposure (such as that likely to occur at historically-contaminated sites undergoing natural attenuation).
2) Incorporation of new biological endpoints for evaluating sublethal effects of contaminants on alligators and freshwater turtles.
3) Assessment of the relative rates at which a wide variety of game species are consumed by people who hunt in South Carolina and Georgia.

Other Project Personnel

Matt Hamilton, MS Student – SREL
David Haskins, MS Student – SREL
Kimberly Price, Research Technician – SREL
Katrina Woods, Research Technician – SREL

External Collaborators

Dr. John Finger - Auburn University
Dr. Nicole Stacy – University of Florida
Dr. Elizabeth Howell - UGA

Products

Winzeler, M.E., M.T. Hamilton, T.D. Tuberville, and S.L. Lance. 2015. First case of ranavirus and associated morbidity and mortality in an eastern mud turtle (*Kinosternon subrubrum*) in South Carolina. Diseases of Aquatic Organisms 114:77-81.

Hamilton, M.T., J.W. Finger Jr., M.L. Winzeler, and T.D. Tuberville. 2016. Evaluating the effect of sample type on analyte values in a point-of-care (i-STAT) blood analyzer for the American alligators (*Alligator mississippiensis*). Conservation Physiology 4:1-7.

Hamilton, M.T., C.A. Kupar, M.D. Kelley, J.W. Finger, Jr., and T.D. Tuberville. 2016. Blood and plasma biochemistry reference intervals for wild juvenile American alligators (*Alligator mississippiensis*). Journal of Wildlife Diseases 52:631-635.

Winzeler, M.E., D. Haskins, S.L. Lance, and T.D. Tuberville. *In review*. Survey of aquatic turtles on the Savannah River Site, SC for presence of ranavirus. Submitted to: Journal of Wildlife Diseases.

Tuberville, T.D., D.E. Scott, B.S. Metts, J.W. Finger, Jr., and M.T. Hamilton. 2016. Hepatic and renal concentrations in American alligator (*Alligator mississippiensis*) following chronic dietary exposure to coal fly ash contaminated prey. Environmental Pollution 214:680-689.

Finger, J.W., Jr. 2014. Stressor induced immunomodulation in crocodilians. PhD dissertation, University of Georgia.

Hamilton, M.T. 2016. Characterizing stress and immune parameters in the American alligator (*Alligator mississippiensis*). M.S. Thesis, University of Georgia.

Haskins, D.L. 2016. Physiological and immunological effects of coal combustion residues in the yellow-bellied slider. M.S. Thesis, University of Georgia.

Finger, Jr., J.W., M.T. Hamilton, B.S. Metts, T.C. Glenn, and T.D. Tuberville. *In press*. Chronic ingestion of coal fly ash-contaminated prey and its effects on health and immune parameters in the American alligator (*Alligator mississippiensis*). To appear in: Archives of Environmental Contamination and Toxicology.

Tuberville, T.D., J. Smith, J. Beasley. 2016. Wildlife hunting and consumption patterns in South Carolina and Georgia. A report to Area Closures Project. January 2016.

Tuberville, T.D., M.T. Hamilton, D.L. Haskins, and J.W. Finger, Jr. Long-lived Reptile Project Final Report, Project Period FY2013-FY2015. A report to Area Closures Project. February 2016.

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; $65,000
PI and Co-PIs
Dr. Jim Beasley and Larry Bryan (SREL)
Objectives
We are in the first 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 and thus far we have collected ~ 67 beaver, 17 river otter, and 13 raccoons among our sampling locations. 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 2016 and additional specimens will be collected during 2017 to supplement sample sizes.
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 – SREL
Katie Mcmanners, undergraduate student – UGA
External Collaborators
Chris Cleveland - UGA
Dr. Michael Yabsley - UGA
Products
This research has just begun, there are no products available at this time.

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 collected from various locations on the SRS during the 2016 annual turkey hunt. Samples of muscle and liver from each turkey are currently being prepared for analysis of Hg, trace elements, and radiocesium.
Conclusions
This research has just begun, 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.
Other Project Personnel
Kevin Eckert, Research Technician – SREL
External Collaborators
NA
Products
This research has just begun, there are no products available at this time.

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 FY16

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 FY16

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 Cyber Security to help identify and remediate weaknesses that left us open to cyber-attack. In addition to the work done with Site Cyber Security we are also working with UGA networking to move to a Metro E connection with a secure tunnel back to campus. This will move us off of the site network and behind UGA's firewalls and security systems. We also made several other improvements to our IT systems in FY16 and they include:

1. **Upgraded our backup software to Backup Exec 2015**. This enabled us to upgrade the backup server operating system to Windows 2012.
2. **Installed new hard drive arrays on both Primary and Secondary Backup server.** Replaced 6-year-old drive arrays for better performance and reliability.
3. U**pgraded Server anti-virus software to Endpoint 2015**.
   This keeps the anti-virus software up-to-date on our servers.
4. **Installed new Windows Hyper-V server.**
   This allowed us to replace 5 ageing secondary servers. This also allowed us to move some functions off of our primary fill and print server.
5. **Setup Annex for computer use.**
   Installed wireless access point as well as sheared computer in Annex for REU student use.
6. **Upgraded Zenworks to version 11.3.**
   This keeps Zenworks up-to-date
7. **Used Zenworks to deploy GIS to all desktop network computers**.
   This gives all of our users ready access to GIS.
8. **Use Zenworks to deploy R and R Studio to all researches desk top.**
   This gives all researchers easy access needed statistical software.
9. **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.
Do to the constantly increasing demands for data storage space we are in the process of partnering with a cloud storage company to securely host our reached data. This will 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.

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 FY16 SREL formally integrated data management into its strategic plan with the formation of a data management committee. Data deposition has also been included as part of the checkout process, although this is a stopgap until more formal policy is in place.

Work on the new data archive and legacy data were hampered by firewall issues in late FY15 and early FY16, but these issues have been resolved. Work on the database itself consisted primarily of bug fixes, refinements, and filling in some gaps. All citations now have reprints attached, and DOIs where applicable. Legacy data are at least 95% entered. Efforts to mine spatial information from titles and abstracts have begun but have not been completed. Some datasets (42 projects) have been linked to geospatial data through information extracted from the Wildlife Literature Survey. Work on a web application for data submission continued in FY16 but it has not been completed. In the meantime SREL has been using an Excel-based submission form to begin prepping some contemporary data sets for entry, and to learn the process of formatting and vetting data and metadata for entry to the archive.

Also at the close of FY16 SREL is in the process of acquiring cloud-based storage for ongoing projects as a more economical option than in-house servers, where storage must be purchased in triplicate for adequate backup. Additionally cloud storage is designed for seamless access from multiple geographic locations, such as SREL and the UGA main campus, or from distant field sites.

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 FY16

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.

- Flamingo Bay Set-Aside was burned February 29, and the slash pine stand 16049 has been marked for thinning. Though an early winter burn would have been preferable, it was not an option, nor was waiting until FY17. Burning cannot occur again until after the timber is harvested in 16049.

- Eight acres at Thunder Bay have been marked for a first thin. This stand was planted just prior to establishment of the Set-Aside.

- A late dormant season burn was planned at the Sandhills Fire Site, but did not occur. This SA has been placed on the burn schedule for 2017.

- A first thin has been planned for ~23 acres at Dry Bay, on the south side of the wetland, as part of the UTR South prescription. This stand was prescribed to be thinned during the previous entry, but the thin did not occur.

- During FY16 SRS reactor waterline maintenance changed from mowing to broadcast herbicide. SREL requested no herbicide on the line where it passes through Ellenton Bay SA, and no herbicide on the portion of waterline along Rainbow Bay SA. Although Rainbow Bay itself is buffered from the line, the amphibian population there uses a network of wetlands, one of which has no buffer from the waterline at all.

- In August 2016 invasive Asiatic clams were discovered in the EP Odum Wetland Set-Aside below Kennedy's Pond. They are known to migrate upstream to a limited extent, but finding them this far from the Savannah River was a surprise.

- In early February 2016 standing water was observed in Woodward Bay for the first time in a number of years. Egg masses of spadefoot toads and southern chorus frogs were also seen in the bay.

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.

- 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. Egg masses were observed at Sarracenia Bay and a new location, Bay 5143 slough, in 2016.

- 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. Population models predicting effects of copper exposure and climate change on leopard frog and southern toad populations were published this year in *Ecological Applications*.

- The amphibian community at the Rainbow Bay Amphibian Reserve Set Aside has been monitored for 38 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.

- Meyers Branch, Rainbow Bay, and Flamingo Bay Set-Asides served as reference locations for SREL's Research Experiences for Undergraduates (REU) in Radioecology student projects.

- UGA researchers studying zooplankton assemblages in several Carolina bay Set-Asides have completed field sampling. They will continue to analyze the samples in the laboratory for some time to come. Already their work has shown the zooplankton community in SRS bays to be some of the most species-rich of any comparable system yet studied

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

- The E.P. Odum Wetland Set-Aside provided reference sites for contaminant-related sediment sampling in the industrialized section of the watershed.

- Researchers continue to maintain duck boxes at Ellenton Bay, Steel Creek Bay, and Flamingo Bay, as part of a long-term (since the 1970s) study of the breeding ecology of wood ducks on the SRS.

- SREL's Outreach Program continues to use the E.P. Odum Wetland Set-Aside as an outdoor classroom during its popular "Ecologist for a Day" programs. These programs give K-12 students hands-on experiences in ecological research, foster understanding of environmental issues, promote environmental stewardship, and encourage students to consider careers in science.

- 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 Set-Aside served as a reference site for a UGA graduate student studying contaminant levels in passerine birds on the SRS.

- Meyers Branch Set-Aside provided a field site for a student examining wallowing behavior of wild pigs.

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 FY16 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 2016; $285,355
PI and co-PI's
Dr. Olin E. Rhodes, Jr. (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 2016, 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 31 scheduled tours; number of attendees – 1,031 (includes 22 SRS Public Tours, attendees – 832; 8 tours for on-site employees/visitors, attendees – 151; and 1 DOE Kids' Day tour, attendees – 48)
2. Provided 5 Wildlife Safety talks; number of attendees – 354 (includes 2 talks to SRS employees, number of attendees – 134; 3 talks to professional groups – number of attendees 220)
3. Presented 251 classroom education programs for elementary and secondary students; number of attendees –15,826
4. Provided 32 environmental outreach presentations to college, civic, and professional groups; number of attendees – 1,058
5. Provided 20 exhibits at local and regional events; estimated number of attendees – 18,054 (includes 5 career exhibits at schools, estimated attendees – 4,092; 5 science night at schools, estimated number

of attendees – 1,280; 1 SRS Safety Expo, estimated number of attendees – 2,000; and 1 DOE Kids' Day, estimated number of attendees – 530)

6. Conducted 45 Ecologist for a Day programs (school field trips to SREL's Conference Center); number of attendees – 1,079
7. Conducted 1 Touch an Animal Day event (August 20, 2016 at SREL's Conference Center); number of attendees – 608
8. Provided 22 presentations at regional library summer reading programs – estimated number of attendees –1,570

***Total Outreach events: 407; total estimated attendance: 39,580**

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

Funding Entity
NNSA - MOX
Start Date and Funding Amount
February 2016; $213,645
PI and co-PI's
Dr. J Vaun McArthur, Dean Fletcher, Dr. Olin E. Rhodes Jr. (SREL)
Objectives
Our overall goal is to provide a comprehensive assessment of the Upper Three Runs tributary (U8) that originates beside the MOX construction site. Contaminants accumulating in stream sediments and biota are being assessed as well as impact on hydrologic, geomorphic, and biologic stream features. Through a collaborative effort, restoration and post-treatment monitoring plans are being developed.
Summary of Research Activities
Integration of our work on tributary U8 into additional SRS stream studies has expanded the geographic scope of our work 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 (e.g. Crouch Branch and McQueen Branch funded by NNSA-Tritium and SRR, respectively). Use of the same study taxa along with identical laboratory and field protocols is allowing seamless comparison of data among these efforts. Overall, our contaminant assessments include five streams in the Upper Three Runs basin. Geomorphic and hydrologic analyses 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 a stream's need of and potential for restoration or enhancement. We used seven genera of dragonfly nymphs, three species of crayfish and one genus of crane fly larvae as biomonitors of contaminants entering the aquatic food web and impacts of excessive stormwater runoff. Two reference streams were compared to three streams receiving varying amounts of stormwater runoff and effluents with two streams being more severely scoured. From composite samples of each taxa, concentrations of 18 trace elements (Be, Mg, Al, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Sr, Cd, Ba, Pb, and U) were determined by inductively coupled plasma mass spectrometry. Total mercury concentrations were determined with a DMA-80 direct mercury analyzer and Cs-137 analyzed using an auto-gamma counter. Stable isotopes of C and N are being used as indicators of carbon diet source and trophic position in all study taxa. Dragonfly nymph generic richness and diversity were reduced in the two most scoured streams as more sensitive species were missing and others reduced in relative abundance. Life history differences between disturbed and reference streams also included missing or poorly represented cohorts based on size frequency analyses. Additionally length-weight relationships differed between disturbed and reference streams in some genera. Variation in element accumulation among genera clearly exceeded variation within genera suggesting that genus is a reasonable taxonomic level for both spatial and taxonomic comparisons. 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. Some elements such as Mn, Co, Ba, and Ni showed particular taxonomic variability that was compounded in disturbed sites. *Boyeria*, *Hagenius*, *Macromia*, and *Erpetogomphus* accumulated higher concentrations of these elements than *Dromogomphus*, *Gomphus*, and *Cordulegaster*. In contrast, Se and As tended to accumulate higher in *Dromogomphus* and were elevated in most genera at the two most disturbed sites. Al, V, and Fe were also consistently elevated in all three disturbed sites in most genera. Influences of body size, trophic level, carbon sources and surface area to mass ratios on trace element accumulation were evaluated. Overall, dragonfly nymph community and population structures were altered in the two

most scoured streams and several trace elements were accumulating to higher levels in all three disturbed systems.

Accumulation of elements in crayfish and cranefly larvae tended to be element and taxa dependent, but patterns of trace elements frequently accumulating to higher concentrations in the disturbed streams was evident. Accumulation sometimes differs between crayfish species and sexes, but the magnitude of differences between crayfish and crane fly larvae were usually greater. Additionally, taxonomic differences were more pronounced in the disturbed streams. In disturbed sites, more but not all, elements consistently accumulated to higher concentrations in crane fly larvae than crayfish. Biota-Sediment Accumulation Factors for the crayfish species and crane fly larvae were also higher in the disturbed than reference streams. Despite scoured sediments, elements frequently accumulated to higher concentrations in biota of the disturbed streams.

Aquatic macroinvertebrate community analyses continued with identification of samples collected from six sampling periods employing five Hester-Dendy samplers in each of five streams. A total 7616 individual macroinvertebrates have been identified to lowest possible taxonomic designation. Preliminary analyses indicate significant differences in species richness, EPT metrics and diversity between disturbed and reference sites.

A comprehensive baseline of contaminant distribution in the U8 system is being conducted. A total of 85 sediment samples have been collected across the perennial, intermittent, and ephemeral reaches of U8. Additionally, 80 sediment samples have been collected from 10 basins in the U8 drainage. Potential impact of SRS activities on Upper Three Runs is being assessed from 37 sediment samples distributed longitudinally down Upper Three Runs from the northern site border to below Road C. Another 44 samples were collected from the McQueen Branch data to help evaluate the role of ponds and basins in the storage and redistribution of contaminants. We are analyzing Cu, Zn, Cd, Pb, Ni, Be, Se, As, Cr, Ba, V, Co, Al, Fe, Mg, and Mn with an ICP-MS, total Hg with a direct mercury analyzer, and Cs-137 with an auto-gamma counter. Clay and organic matter content of each sample is also being measured.

Conclusions

1) Initial results are indicating tributary U8 to be severely degraded with impaired hydrology, channel form, substrate composition, and biological communities.
2) Impacts on stream macroinvertebrate communities and life histories have been observed.
3) Scouring by excessive flows has reduced organic matter content in the streams, potentially influencing stream energetics and contaminant dynamics.
4) Variation in element accumulation among genera clearly exceeded variation within genera suggesting that genus is a reasonable taxonomic level for both spatial and taxonomic comparisons.
5) 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
Angela Lindell, Research Professional – SREL
John Seaman, Senior Scientist – SREL
Danielle Pitt, Research Technician – SREL

External Collaborators

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

Products

McArthur, JV., D.E. Fletcher, R.C. Tuckfield, C. Baker-Austin. Patterns of multi-antibiotic-resistant *Escherichia coli* from streams with no history of antimicrobial inputs. (in press, published online November 2015) Microbial Ecology.

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).

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

H-02 Constructed Wetland Studies: Amphibian Ecotoxicology

Funding Entity
NNSA Tritium Facility via DOE CA
Start Date and Funding Amount
October 2016; $400,028
PI and co-PI's (and Affiliations)
Dr. Stacey Lance and David Scott (SREL)
Objectives
Our research at the H-02 constructed wetland complex focuses on several questions related to these treatment wetlands: 1) Over time, what amphibians have become established in the wetlands? 2) Do the elevated trace metal (e.g., copper [Cu] and zinc [Zn]) levels in the wetlands affect amphibian reproductive success, disease ecology, and population dynamics? 3) How do the amphibian diversity and numbers compare to 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 2015 to September 2016. We used aquatic trapping to characterize biota of the treatment wetlands. We completed a third field season examining the influence of wetland hydroperiod on the prevalence of two amphibian diseases, chytridiomycosis and ranavirus. We also expanded that study to include community structure and water quality surveys of 20 wetlands. To more directly examine the effect of copper on disease susceptibility we conducted an experimental challenge. To do this we reared southern toad and eastern narrowmouth toad larvae under conditions of no and low levels of copper. After 7 days we exposed them to known concentrations of ranavirus and then reared them for an additional 10 days. We completed studies examining the interactive effects of exposure to both Cu and Zn in three species of amphibians and lab studies examining the effects of Cu on three larval ambystomatid salamander species. We initiated studies examining effects of contamination on methylation patterns in southern toads and southern leopard frogs and to investigate how distance from a contaminated wetland influences tolerance to copper. We combined natural history data with copper toxicity results from prior experiments to model the potential combined effects of copper contamination and climate change on reproductive success in toads and leopard frogs. We also analyzed long-term data from Rainbow Bay (RB) in the context of nutrient flux between aquatic and terrestrial habitats. Rainbow Bay and other isolated wetlands serve as comparison sites for the H-02 amphibian studies. We completed the 38th year of monitoring at RB, and have begun analyzing the data in the context of community shifts in response to environmental change and altered hydrology.
Conclusions
1) Southern toad juveniles exposed to ranavirus had reduced growth rates, but Cu did not affect viral loads.
2) Over time there has been a shift in nutrient flux from a net flow to the terrestrial environment to a flow into the aquatic environment that is likely tied to climate change.
3) Exposure to ranavirus causes a decline in growth rate.
4) Larval ambystomatids were highly sensitive to Cu with 50% mortality at 18.7, 35.3, and 47.9 ppb for three species. Cu also caused reduced growth rates in *A. talpoideium*.
5) Amphibians inhabiting reference wetlands are less tolerant to a novel metal stressor than those from metal impacted wetlands.
6) 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. The RB data are useful to build a conceptual model of the impact of climate change on southeastern isolated wetlands. Initial models showed that Cu toxicity alone did not result in significant extinction risk for two

species unless toxicity was >50% for survival parameters, whereas shortened hydroperiods could greatly increase the chance of local extinction.

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. We have found that the levels of Zn in the wetlands do not pose a threat to amphibians.
2) Our lab and mesocosm studies demonstrate the importance of looking a) at multiple stressors, b) beyond the larval period, and c) at multiple source populations.
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) 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.
5) 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

Dr. Scott Weir, Faculty - Queens University
Wes Flynn, PhD student - SREL
Caitlin Rumrill, MS student - SREL
Megan Winzeler, MS student - SREL
Austin Coleman, MS student, SREL

Products

Nunziata, S.O., S.L. Lance, D.E. Scott, E.M. Lemmon, and D. Weisrock. In review. Genomic data detect corresponding signatures of very recent population size trends in two salamander species impacted by climate change. Submitted to: *Global Change Biology*.

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Weir, S.M., D.E. Scott, C.J. Salice, 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.

Flynn, R.W., A.M. Welch, and S.L. Lance. 2016. Quantifying evolutionary potential and phenotypic divergence of an amphibian population with long-term exposure to coal combustion wastes. Odum School of Ecology, Graduate Student Symposium, Athens, GA. (Platform)

Flynn, R.W., A.M. Welch, and S.L. Lance. 2016. How coal combustion waste influences phenotypic variation of an amphibian through genetic and maternal effects. Society of Environmental Toxicology & Chemistry, 36th Annual Meeting, Salt Lake City, UT. 2015. (Platform)

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Winzeler, M.E., and S. L. Lance. January 2016. *Effects of Multiple Stressors on Amphibian Susceptibility to Ranavirus*. Odum School of Ecology Graduate Student Symposium, Athens, GA. (Platform)

Winzeler, M.E. Advised by S. L. Lance. January 2016. Effects of Multiple Stressors on Amphibian Disease Presence and Susceptibility. Savannah River Ecology Lab Seminar Series, Aiken, SC. (Seminar)

Winzeler, M.E. Advised by S. L. Lance. February 2016. Effects of Multiple Stressors on Amphibian Disease Presence and Susceptibility. Master's Defense Presentation, Athens, GA. (Seminar)

Tritium Distribution and Cycling on the Savannah River Site

Funding Entity
NNSA
Start Date and Funding Amount
October 2016; $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 archived fish tissues collected from Fourmile Branch in 2007, and 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.). We continue to have only moderate tritium recovery levels with test standards, i.e., ≈50%. Purchased a Parr Bomb apparatus for extracting OBT to compare recoveries with the combustion furnace.
Conclusions
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 – SREL
Matt Baker, MS Student - SREL
Amna Rana, REU Student - SREL
External Collaborators
Dr. S.B. Kim - Chalk River Laboratories
Dr. Rhett Jackson - UGA
Products
Seaman, J.C. 2016. Tritium Distribution and Cycling on the Savannah River Site: Evaluating Organically Bound Tritium. Report submitted to NNSA June 6, 2016.
Seaman, J.C. A.K. Rana (NSF-REU), F.M. Coutelot, S. Buettner, R.J. Thomas and M. Baker. 2016.

Tritium Distribution and Cycling on the Savannah River Site. Presentation for NNSA June 22, 2016.

H-02 Constructed Wetland Studies—Metal Biogeochemistry

Funding Entity
NNSA - Tritium
Start Date and Funding Amount
October 2016; $377,786
PI and co-PI's
Dr. Gary Mills, Dr. Gene Rhodes and Dean Fletcher (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:(1) assess the efficiency of metal attenuation and determine the biogeochemical processes controlling metal removal;(2) characterize specific substrates that sequester metals within the sediments and assess their geochemical stability;(3) determine the bioavailability of metals that escape sequestration and enter regulated stream waters;(4) evaluate disturbance conditions, including storm events, that facilitate metal remobilization and export from the system;(5) examine the potential transfer of metals to terrestrial food webs via bioaccumulation by aquatic macroinvertebrates that are subsequently preyed upon or emerge from the wetland as adult flying insects and (6) assess the effects of contaminants and stream erosion on macroinvertebrates in Crouch Branch downstream of the H-02 wetland.
Summary of Research Activities
Water Chemistry
We continued monthly monitoring of metal concentrations and water quality parameters in surface water. 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 (UTR). Effluent and influent concentrations of Cu and Zn were consistent with previous years and showed that at normal discharge levels the wetland removes 60-80% of the total metals released from the Tritium Reprocessing Facility discharge waters entering the wetland cells. Monitoring seven water quality parameters with automated samplers began in preparation for stormwater studies to be continued in FY16.

Sediment Chemistry
Seasonal collection and analysis of sediment core samples continue to show increasing concentrations of Cu, Zn, and Pb since operational startup. These increases are consistent with the demonstrated removal of Cu and Zn from influent waters and the engineered design of the system as a metal treatment wetland. Although Pb removal from surface waters was not determined directly, the increase over time in the surface sediments indicates significant removal. As observed in previous years, metal concentrations are highest in the surface sediments (0-5 cm) and decrease rapidly with increasing depth (5-30 cm). This pattern in metal concentration-depth profiles in the wetland cells has remained remarkably consistent in recent years. However, the spatial distribution of metal concentrations in the surface sediments shows considerable heterogeneity. This likely represents the resuspension, movement, and deposition of the metals associated organic flocculent material at the sediment interface that is easily disturbed by maintenance and sampling activity within the wetland cells and perhaps by major storm events.

In addition to sediments in the wetland cells, we conducted a spatially comprehensive analysis of Cu, Zn and organic matter distributions in the retention basin sediments that had previously not been characterized. The basin is deepest in the west end (ca.120 cm) and becomes shallower (ca. 50 cm) toward the east end as a consequence of deposition of suspended material in waters discharged into the basin. Organic matter content was higher along the bank averaging 15% versus an average of 4% in the center points. Copper concentrations in retention basin sediments averaged 165 ppm, but varied greatly (11.7 – 1184; SD = 216). Shoreline sediments had accumulated higher concentrations averaging 289 ppm (11.7 – 1184; SD = 272) versus only 66.0 ppm (19.6 – 344; SD = 60.7) in center locations. Similarly, Zn

concentrations varied greatly across the retention basin (mean = 315; 0.860 – 1280; SD = 364). Again concentration in edge sediments (mean = 547; 24.7 – 1280; SD = 395) averaged four times higher than center locations (mean = 129; 0.860 – 956). Overall, Cu and Zn concentrations appeared to be more strongly influenced by sediment organic matter content than distance to any effluent pipe.

Metal Accumulation in Macroinvertebrates

Analyzing contaminant accumulation in macroinvertebrates is enhancing our assessments by verifying distribution of bioavailable contaminants throughout the system and levels entering wetland communities. Macroinvertebrates are known to accumulate a variety of contaminants and represent trophic links between primary production and higher trophic level vertebrates. The present study is evaluating contaminant accumulation in six genera of nymphs from six sites distributed throughout the H-02 wetland system and from two reference wetlands. We collected from three locations within the retention basin, one in each treatment cell, and one in the effluent pool. A total of 600 composite samples were formed by pooling individuals within size classes. Whole body concentrations of 15 elements were determined for each composite. Copper accumulation in nymphs in all H-02 wetland sites exceeded that of the reference sites. Accumulation of Cu in nymphs inhabiting the effluent pool indicates significant levels of bioavailable Cu immediately downstream of the outfall. Additionally, accumulation differed substantially among genera with differences among genera often exceeding differences among locations. Genera more closely associated with bottom sediments accumulated higher concentrations highlighting the importance of sediment-nymph interactions in contaminant accumulation. Evaluation of whether contaminants are being exported from the H-02 wetland system when dragonflies and damselflies emerge from the water and fly away continued. Collecting was completed from three sites in the retention basin. Identification revealed 17 species of dragonflies and 9 damselfly species. Sample preparation for trace element analyses of adults and shed exuviae continue. Species composition of the dragonfly community appears to have shifted between 2013 and 2105, likely the result of changes in the basin vegetation.

Effects of Contaminants and Stream Erosion on Crouch Branch Macroinvertebrates

Recognizing that a continuum of water runs from the H-02 influent pipes to UTR, we are assessing accumulation of contaminants in macroinvertebrates from two sites in Crouch Branch, downstream of the wetlands. We are using dragonfly nymphs, crane fly larvae, and crayfish to characterized contaminant bioavailability in SRS streams. Crayfish (*Cambarus latimanus*) accumulated over 9 times higher Cu concentrations in reference streams. These elevated contaminant levels indicate passage of biologically available contaminants through the wetland or from another runoff source below the wetland. Accumulation attenuated to lower levels at the downstream Crouch Branch site. Stream assessments are indicating the geomorphology, hydrology, and biology of Crouch Branch to be impaired.

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.
2) Concentrations of Cu, Zn, and Pb in wetland cell sediments continue to increase consistent with the demonstrated removal of Cu and Zn from influent waters and the engineered design of the system as a metal treatment wetland.
3) Biota in the effluent pool and upper reaches of Crouch Branch accumulated elevated levels of Cu and to a lesser degree Zn indicating bioavailable metals passing through the wetland.
4) Erosion of Crouch Branch below H Area has resulted in extensive stream degradation.
5) Complex factors including habitat use and availability can influence contaminant accumulation in aquatic organisms.

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

Angela Lindell, Research Professional – SREL
Dr. Xiaoyu Xu, Postdoctoral Research Associate – SREL
Brooke Lindell, Undergraduate Student, College of Charleston.
Danielle Pitt, Research Technician – SREL
Paul Stankus, Research Professional – SREL

External Collaborators

Dr. Robert Bringolf – UGA

Products

Mills, G.L., R. Philipps, and R. Bringolf. Effect of NOM and water hardness on DGT prediction of bioaccumulation by yellow lampmussel and fathead minnow. *SETAC Annual Meeting, Salt lake City, UT, November 2015.*

Phillips, R.R., Evaluation of Diffusive Gradients in Thin Films for Predicting Bioaccumulation of Copper in Aquatic Animals. M.S Thesis University of Georgia, December 2015.

Harris, S. Metal-Sulfide Dynamics in a Constructed Wetland in the Southeastern U.S. M.S. Thesis. University of Georgia, December, 2015

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 FY16, 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 246 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

Effectiveness of Fe Powders for Removing Radionuclides from Low Quality Groundwater: Phase II Disposition of Spent Materials

Funding Entity
North American Höganäs, Inc.

Start Date and Funding Amount
May 2015; FY16 $37K

SREL Collaborators
Dr. John C. Seaman (SREL)

Objectives
The FY16 objectives of this research were to: 1) determine the effectiveness of standard filter material operation and wash protocols (i.e., repeated standard backwash/acid wash routine) in removing sorbed/immobilized contaminants, restoring filter efficacy and filter bed hydraulic conductivity, 2) characterize spent filter materials, and back-wash/acid-wash water derived from Task 1 to determine final disposal options, and 3) use batch and column methods to compare the efficacy of the prototype LC+ PIC powder (J1) to the commercial LC+ PIC (NF) product in removing several target contaminants (i.e., U, As, NO_3^-, etc.).

Summary of Research Activities
High levels of nitrate (NO_3^-) derived from agriculture and naturally occurring radioactive materials (NORM), primarily uranium (U), thorium (Th) and their natural decay products that have been mobilized by the influx of oxygenated, high-alkalinity water, are a threat to shallow groundwater resources in California. To address this threat, Porous Iron Composite (PIC) materials were evaluated as a water treatment option in a series of laboratory batch and column leaching experiments to evaluate their ability to immobilize U, arsenic (As), strontium (Sr), and rhenium (Re) a non-radioactive surrogate for the nuclear fission product technetium-99 (^{99}Tc). Regulatory extraction tests were also conducted to address concerns regarding the eventual disposal of residual water treatment materials that will include elevated levels of radioactive and non-radioactive contaminants.

Conclusion

1) The commercial Fe Powders were just as effective as the prototype at immobilizing U and As, regardless of pH and in the presence of high levels of NO_3^-, common limitations to the application of zero-valent iron materials to remediation of U contaminated water.
2) The PIC materials have displayed a very high sorption capacity for ^{99}Tc in the presence of O_2, high NO_3^-, and a wide pH range.

Major Impact of Research

1) The batch and column results clearly demonstrated the potential application of novel PIC materials for the reclamation of poor-quality groundwater containing low levels of naturally occurring radioactive materials and other common groundwater contaminants.

Other Project Personnel

Emily Dorward, MS Student – SREL
Jarad Cochran, Research Professional – SREL

External Collaborators

Dr. Hyun-shik Chang - North American Höganäs, Inc.

Products

This project has just begun, there are no products at this time.

Can We Measure and Achieve Functional Restoration Objectives and Regulatory Standards by Applying Specific Treatments to SRS Streams?

Funding Entity
USDA Forest Service-Savannah River
Start Date and Funding Amount
September 2011; $123,216
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, if appropriate, 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 has been established to characterize SRS streams, identify risks of legacy and recent disturbances, and identify disturbed stream reaches with potential for restoration. Three levels of assessments have been initiated 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 are assessing the effects of stream alterations on physical stream condition in a subset of Phase I identified streams. Level III assessments are further evaluating a selected subset of stream reaches by measuring additional hydrology, physicochemistry, biology, and geomorphology features. This comprehensive stream evaluation will elucidate management options and guide prescriptions for potential restorative actions.

We analyzed data from 47 study sites distributed across the Meyers Branch, Pen Branch, Mill Creek, Tinker Creek, McQueen Branch and Turner Branch drainages as well as smaller direct tributaries of Upper Three Runs. Five primary data sets included 1) Drainage Basin and Valley characteristics (18 variables), 2) Instream Geomorphology (10 variables), 3) Water Chemistry (13 variables), and 4) LiDAR Vegetation Assessment (9 variables). Gully depth was additionally assessed. We evaluated relationships between these data sets and a 5^{th} data set of 8 variables characterizing Landscape Disturbance. Dimensionality of this data was reduced by condensing each data set into a set of principal components. Consequently, five sets of principal components were created including a total of 19 components. Influence of a more open tree canopy and greater industrial area coverage had strong influence on instream geomorphology, gully depth, and water chemistry. Basin and valley characteristics interacted with landscape disturbance to influences stream geomorphology. For example, gully depth and geomorphic variability is also greater in smaller, high gradient basins with deeper valleys and greater elevation relief; small steep drainages were most susceptible to erosion from runoff from impervious surfaces and cleared areas. Greater distance from runoff source can buffer effects of runoff. A greater number of obstructions in the perennial stream produced a wider channel with more variable channel width in low gradient streams. Macroinvertebrate communities colonizing leaf packs (30 metrics) were assessed in a subset of 19 sites. Dimensionality was reduced to seven principal components. Because reducing analyses to a subset of sites changed the distribution of included sites, five new sets of principal components were developed to analyze with the macroinvertebrate data. Overall, greater industrial area coverage and more open tree canopy increases gully depth, geomorphic variability, and reduces

Trichoptera richness, density and relative abundance, reduces EPT richness and reduces total macroinvertebrate richness and diversity.

Conclusions

1) Amount of industrial area in a drainage has a strong influence on instream geomorphology, chemistry, and macroinvertebrate communities.
2) Streams receiving excessive stormwater runoff are generally the most disturbed streams within our study systems.
3) Basin and valley characteristics interact with landscape disturbance to influence level of stream disturbance.

Major Impact(s) of Research

1) We will verify 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 will propose restoration plans including post-treatment monitoring for seven headwater streams.
3) A framework upon which a headwater stream mitigation bank can be built is being developed.

Other Project Personnel

J Vaun McArthur, Senior Research Scientist – SREL
Angela Lindell, Research Professional – SREL
Garrett Stillings, Research Professional – SREL
Hannah Angel, Research Technician – USDA Forest Service-SR
Paul Stankus, Research Professional – SREL

External Collaborators

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

Assessment of terrestrial heavy metal contamination 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, 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.

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. A total of 75 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.

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

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

Other Project Personnel

Zoe Cooper, M.S. Student - UGA

Victoria Andreasen, Undergraduate Student - UGA

External Collaborators

NA

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. Georgia Chapter of the Wildlife Society Meeting. Poster. September 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.

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

Funding Entity
National Science Foundation
Start Date and Funding Amount
September 2006; 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. The FY16 project generally followed last year's protocol, and further investigated incubation temperature as a factor potentially affecting duckling quality as it relates to neonate behaviors necessary for early survival.
Summary of Research Activities
This research project has been a multi-year investigation. In the last year, 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).
Conclusions
1) Data are currently being analyzed and have produced only preliminary results on the FY16 project at this point.
Major Impacts of Research
1) Illustrates the potential importance of incubation as related to offspring quality.
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., M.L. Beck, R.A. Kennamer, and W.A. Hopkins. The effect of incubation temperature on wood duck duckling behavior. The 2016 Society for Integrative and Comparative Biology Annual Meetings, Portland, OR. January 4, 2016. (Poster Presentation).

Kennamer, R.A., G.R. Hepp, and B.W. Alexander. Importance of reproductive costs and quality of female wood ducks on survival and future reproductive success. The 7th North American Duck Symposium and Workshop, Annapolis, MD. February 2, 2016. (Oral Presentation).

Kennamer, R.A., G.R. Hepp, and B.W. Alexander. 2016. Effects of current reproductive success and individual heterogeneity on survival and future reproductive success of female Wood Ducks. The Auk: Ornithological Advances 133: 439–450. doi: 10.1642/auk-15-183.1.

Efficacy of the LRAD weapon system as an avian dispersal tool on airports

Funding Entity
USDA Wildlife Services/Federal Aviation Authority
Start Date and Funding Amount
August 2013; $352,241
SREL Collaborators
Dr. O.E. Rhodes, Dr. J.C. Beasley, A.L. Bryan, R.A. Kennamer and A.E. Holland (SREL)
Objectives
The objective of this research is to test the efficiency of a long range acoustic device (LRAD) on dispersing nuisance birds (e.g., vultures, gulls, waterfowl, blackbirds) from unwanted and/or dangerous locations and to determine whether sound treatments with the LRAD affect avian behavior. Sound treatments will occur either at existing sites where these targeted species naturally congregate (e.g.; roosts, landfill) or created sites (e.g., bait sites) with our goal to "defend" these sites (prevent or limit occupancy).
Summary of Research Activities
We targeted several species of birds with a history of aviation collisions: vultures, waterfowl, blackbirds and gulls.
Vultures –GSM transmitters deployed on black and turkey vultures in years 1 and 2 continue to result in 100-300 locations for each individual bird per day and have provided > 4,000,000 total positions as of September 2016. Analyses are continuing on determining typical flight and movement patterns at extremely fine temporal scales, as well as home ranges and resource selection patterns; data that can be used to estimate risks of bird strikes with aircraft.
Waterfowl – In year one, we determined that marked (transmitters and/or nasal saddles) ring-necked ducks at a bait site on L-lake were largely unaffected by the LRAD treatments. In 2014 and 2015, we had a total of 174 counts of unmarked waterfowl on L-Lake, 87 pre-treatment and 87 post-treatment, and found no significant reduction of waterfowl numbers after acoustic treatments with the LRAD.
Blackbirds – We had conducted several trails on wintering blackbirds at two roost sites during the previous two years. The LRAD was ineffective at keeping birds from roost sites and/or dispersing them from these sites.
Gulls – We had conducted multiple acoustic trials on gull flocks on L-Lake in 2015 and found the LRAD to be effective at dispersing birds from the site.
Conclusions
1) Field aspects of this project are completed, and the data summation/reporting is nearing completion.
2) The LRAD was effective at dispersing certain species (vultures & gulls) but was less effective at dispersing others (blackbirds & waterfowl).

Major Impact(s) of Research
1) The research provided information to assist in the determination of the ability of this device (LRAD) to disperse nuisance birds from unwanted locations as well as suggested new research with this device.
2) From this research we will be able to quantify fine-scale movement patterns of black and turkey
3) vultures for use in elucidating bird strike risks with aircraft.

Other Project Personnel
Dr. Mike Byrne, Postdoctoral Research Associate – SREL
Dr. Peter Schlichting, Postdoctoral Research Associate – SREL
External Collaborators
Dr. Travis DeVault – USDA
Dr. Bradley Blackwell – USDA

Products

Schlichting, P.E., A.E. Holland, J.C. Beasley, A.L. Bryan, R.A. Kennamer, T.L. DeVault, B.F. Blackwell, and O.E. Rhodes. Efficacy of an acoustic hailing device as an avian dispersal tool. Submitted to *Journal of Wildlife Management*, September 2016.

Byrne, M.E., A.E. Holland, A.L. Bryan, and J.C. Beasley. Influence of environmental conditions and animal behavior on performance of solar powered GPS/GSM avian transmitters. Submitted to *Journal of Applied Ecology*, March 2016.

Holland, AE, ME Byrnes, AL Bryan, TL DeVault, OE Rhodes, and JC Beasley. Fine-scale assessment of monthly home ranges and activity patterns for resident Black (*Coragyps atratus*) and Turkey (*Cathartes aura*) Vultures in the southeastern United States. Submitted to *PLOSONE*, September 2016.

Holland, AE. 2015. Spatial Ecology of Black and Turkey Vultures in the southeastern U.S. M.S. Thesis, University of Georgia, Athens, GA, USA.

Rhodes, OE, Jr., JC Beasley L Bryan, RE Kennamer, AE Holland, and PE Schlichting. 2016. Final report: Efficacy of the LRAD weapon system as an avian dispersal tool on airports. Report submitted to USDA-APHIS-WS-NWRC. 29 August 2016.

Testing bioclimatic thresholds of reptiles predicted by maximum entropy theory

Funding Entity
US Department of the Army – ERDC-CERL
Start Date and Funding Amount
April 2014; $90,734.00
SREL Collaborators
Tracey Tuberville and Kimberly Andrews (SREL)
Objectives
The overall goal of this research is identify physiological thresholds to predict which reptile species are more vulnerable to potential climate change, with emphasis evaporative water loss and metabolic rates under different temperatures.
Summary of Research Activities
We conducted evaporative water loss trials for four species of turtles and eight species of snakes to evaluate their relative vulnerability to drought-related desiccation. In addition, we conducted metabolic experiments under three different temperatures for two species of turtles and seven species of snakes.
Conclusions
1) Aquatic turtles lost 4-10% of their initial body mass due to EWL over 24hr periods, with EWL rates varying among species. In addition, within species, EWL rates decreased with increasing size.
2) Species that exhibited higher EWL rates also tended to experience higher metabolic costs with increasing temperature.

Major Impact(s) of Research
2) Mechanistic explanation for differential ecological responses of reptile species to drought and increased environmental temperatures
3) Experimental validation of species-specific temperature thresholds identified by our CERL collaborators in their maximum entropy analysis.

Other Project Personnel
David Haskins, M.S. Student - SREL
External Collaborators
Dr. J.D. Willson – University of Arkansas
Phil Vogrinc – University of Arkansas
Products
Tuberville, T.D., K.M. Andrews, J.H. Sperry, and A.M. Grosse. 2015. Use of NatureServe Climate Change Vulnerability Assessment Tool as a prioritization and planning tool for reptiles and amphibians. Environmental Management 56:822-834.

Murphy, C.M., T.D. Tuberville, J.C. Maerz, and K.M. Andrews. 2016. Evaporative water loss rates of four species of aquatic turtle from the Coastal Plain of the southeastern United States. Journal of Herpetology 50:457-463.

Using genetic mark-recapture techniques to investigate the influence of feral hog carcasses on coyote abundance.

Funding Entity
SC DNR
Start Date and Funding Amount
October 2014; $10,000
SREL Collaborators
Dr. Stacey L. Lance (SREL)
Objectives
1) Use scat transects to collect coyote scat over four seasons before and after altering where feral hog carcasses are left on the Savannah River Site
2) Use genetic methods to identify coyote scat to individuals
3) Use population genetic analyses to estimate the density of coyotes in different areas of the site before and after altering feral hog carcass placement.

Summary of Research Activities
Coyote scats (~1100) were collected over four seasons for "pre-treatment" and "post-treatment" data. In June 2015 the treatment started in which feral hog carcasses would only be left out on one half of the site. We are now collecting scat for the "post-treatment" analysis. 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 and in October of 2016 will discuss whether enough data have been collected.
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. John Kilgo - USFS
Products
Manuscripts will be prepared at a later date.

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

Development of Genetic-Based Mark-Recapture Tools for Wild Pigs

Funding Entity
USDA – Wildlife Services – National Wildlife Research Center
Start Date and Funding Amount
May 2014; $35,000.00
SREL Collaborators
Dr. Olin E. Rhodes, Jr. and Dr. James C. Beasley (SREL)
Objectives
The objectives of this study are to quantify detection rates for wild pig scat and evaluate the effects of survey protocol, scat characteristics, and environmental parameters on scat detection. In addition, through this research we will develop a suite of microsatellite markers that are optimized for fecal sampling in wild pigs as well as assess effects of degradation on DNA viability.
Summary of Research Activities
During July-August 2014 we surveyed 58km of transects established in upland pine and bottomland hardwood habitat on the SRS for pig scat to quantify differences in scat detection rates among habitat types. In addition, at each detected scat we conducted a suite of radial searches (5-20m) as well as an adaptive cluster sampling approach to assess the influence of survey methodology on scat detection rates. We additionally conducted surveys to quantify the influence of scat size, the number of pellets present, weather, and percentage ground cover on scat detection among observers. During summer-fall 2014 we collected fecal samples and ear tissue from culled pigs to conduct laboratory studies in order to characterize a suite of microsatellite markers that are optimized for wild pig scat. All collected for this research have now been analyzed in the laboratory.
Conclusions
Our field scat surveys revealed that density of pig scat differs among habitats in the southeastern U.S. and that radial search approaches are more efficient at surveying for wild pig populations than previous methods developed for this species. In addition, scat size, number of pellets present and the percentage of ground cover were found to influence the scat detection rates. We also have identified a suite of 17 microsatellite loci that perform well in both scat and tissue samples. These markers were used to assess impacts of degradation on DNA amplification. This experiment revealed high levels of genotyping success up to 5 days exposure to warm, humid conditions, exemplifying the utility of these markers in future studies with this species.
Major Impact(s) of Research
1) This research provides a robust assessment of the factors influencing wild pig scat detection and the efficacy of a suite of potential scat survey protocols. These data will be used to establish a framework to advise future population estimation studies and management of wild pigs across their range.
2) From this research we produced a suite of microsatellite markers for wild pigs that are optimized for fecal sampling. Delineation of these markers will be essential for future non-invasive mark-recapture research in this species.

Other Project Personnel
David Keiter, M.S. Student - SREL
Shem Unger, Postdoctoral Research Associate – SREL
Elizabeth Kierepka, Postdoctoral Research Associate – SREL
External Collaborators
Dr. Frederick Cunningham - USDA
Toni Piaggio - USDA
Kim Pepin - USDA
Products
Keiter, D.A., F.L. Cunningham, O.E. Rhodes Jr., B.J. Irwin, and J.C. Beasley. 2015. Evaluation of Scat Detection Rates and Methods of Detection for the Estimation of Wild Pig Abundance. 2015.

Warnell Graduate Student Symposium. (*Oral presentation*). *Awarded 1st place in Masters I oral presentation category.*

Keiter, D.A., F.L. Cunningham, O.E. Rhodes Jr., B.J. Irwin, and J.C. Beasley. 2015. Evaluating Scat Detection Rates and Methods of Detection for the Estimation of Wild Pig (*Sus scrofa*) Abundance. American Society of Mammalogists (ASM) Annual Meeting. Jacksonville, Florida, USA. (*Poster presentation*).

Kierepka, E.M., D.A. Keiter, A.J. Piaggio, F.L. Cunningham, J.C. Beasley, and O.E. Rhodes Jr. 2015. Monitoring wild pigs using fecal DNA. Savannah River Ecology Laboratory's Annual Touch An Animal Day (TAAD). Aiken, South Carolina, USA. (*Poster presentation*).

Keiter, D.A., F. Cunningham, O.E. Rhodes, Jr., and J.C. Beasley. 2014. Evaluation of scat detection rates and methods of detection for quantifying feral pig abundance. Georgia Chapter of the Wildlife Society Annual Meeting. Tifton, GA. (*Oral presentation*).

Kierepka, E.M., S.D. Unger, D.A. Keiter, J.C. Beasley, O.E. Rhodes Jr., F.L. Cunningham, and A.J. Piaggio, 2016. Identification of robust microsatellite markers for wil pig fecal DNA. 2016. ***Journal of Wildlife Management***, 80(6):1120-1128

Dose Titration and Duration of Rhodamine B as a Biomarker in Feral Swine

Funding Entity
USDA – Wildlife Services – National Wildlife Research Center
Start Date and Funding Amount
May 2014; $14,934.00
SREL Collaborators
Dr. James C. Beasley and Dr. Olin E. Rhodes, Jr. (SREL)
Objectives
The objectives of this study are to evaluate the minimum effective dose of Rhodamine B to reliably mark guard hair and vibrissae of wild pigs, as well as determine the duration of marks in these tissues subsequent to Rhodamine B exposure.
Summary of Research Activities
Wild pigs were live-trapped throughout the SRS during spring of 2014 to quantify uptake of Rhodamine B (RB) in vibrissae as a function of dose. Fifteen wild pigs of varying sex, age, and weight were trapped, transported to a captive facility on the SRS, and administered RB orally at a dosage of 30, 15, or 5 mg/kg. Vibrissae and guard hairs were collected prior to the administration of RB as control samples. Pigs were maintained in captivity for 12 weeks and guard hair and vibrissae samples were collected every 2 weeks. All samples collected were subsequently evaluated for the presence of RB using fluorescence microscopy and the number of samples exhibiting marking consistent with Rhodamine B exposure was quantified for each individual.
Conclusions
1) We detected RB in vibrissae of wild pigs at dosages as low as 5 mg/kg, although 15 mg/kg appears to be the optimal dose in this species.
2) RB bands were consistently detected in pigs in the 15 and 30 mg/kg treatment groups through the 12 weeks of the study and regression analyses indicated RB bands are likely visible for up to several months post RB exposure in wild pigs.

Major Impact(s) of Research
1) This research will provide the first data to date on the effective RB dose required to sufficiently mark wild pigs. These data will be highly informative for any future control of wild pigs through use of pharmaceutical baits.
2) From this research we produced a regression model that allowed us to determine the retention of RB markings in wild pigs up to 3 months post exposure.

Other Project Personnel
Sarah Webster, M.S. Student - SREL
James Leaphart, Research Technician - SREL
External Collaborators
Dr. Frederick Cunningham - USDA
Dr. John Kilgo - USFS-Savannah River
Mark. Vukovich - USFS-Savannah River
Products
Webster, S.C., F.L. Cunningham, O.E. Rhodes, Jr., and J.C. Beasley. Evaluation of Rhodamie B as a biomarker for assessing bait acceptance in wild pigs. Starkville, MS. (Poster Presentation).

Beasley, J.C., S.C. Webster, O.E. Rhodes, Jr. and F.L. Cunningham. 2015. Evaluation of Rhodamine B as a biomarker for assessing bait acceptance in wild pigs. ***Wildlife Society Bulletin*** 39: 188-192.

Webster, S.C., F.L. Cunningham, JC Kilgo, M. Vukovich, O.E. Rhodes, Jr., and J.C. Beasley. Minimum effective dose and persistence of Rhodamine B in wild pig (*Sus scrofa*) vibrissae. Manuscript submitted to ***Wildlife Research***, September 2016.

Webster, S.C., F.L. Cunningham, JC Kilgo, M. Vukovich, O.E. Rhodes, Jr., and J.C. Beasley. Efficacy of Rhodamine B as a Biomarker in Wild Pigs. 2016 International Wild Pig Conference, Myrtle Beach, SC. (*Oral Presentation*).

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 trial 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
This research is still ongoing, however, thus far results 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.
Major Impact(s) of Research
1) This is the first study of both nestling bird carrion and use of arboreal carrion by vertebrate scavengers. These data will continue to advance our understanding of the cycling of nutrients (and contaminants) within ecosystems, as well as 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
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

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 (e.g., age of sow, weight of piglet, litter size).
Summary of Research Activities
During fall 2014 through summer 2015 we placed ear tag transmitters on juvenile wild pigs 4-5 weeks of age. During 2015-2016 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.
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, ear tag transmitters 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 implant transmitters 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.
3) Determine cause-specific mortality of juvenile wild pigs as well as the influence of key demographic parameters (e.g., age of sow, weight of piglet, etc.) on survival rates of pigs.

Other Project Personnel
David Keiter, M.S. Student - SREL
External Collaborators
Dr. John Kilgo - USFS – Savannah River Site
Mark Vukovich - USFS – Savannah River Site
Dr. Frederick Cunningham - USDA
Products
Beasley JC. 2016. USDA Wild Pig Research Update. Aiken, SC (*Oral Presentation*)

Post-Translocation Movement Behavior of Wild Pigs

Funding Entity
USDA – Wildlife Services – Veterinary Services
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 second year of a 3 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.
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
David Keiter, M.S. Student - SREL
Dr. Josh Smith, Postdoc - SREL
Kevin Eckert, Research Technician – SREL
External Collaborators
Dr. Ryan Miller - USDA
Dan Grear - USDA
Steve Sweeney - USDA
Products
Keiter, D.A., 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. 2016. USDA Wild Pig Research Update. Aiken, SC (*Oral Presentation*)

Keiter, D.A., 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*).

Comparing methods of estimating wild pig population size in two different habitats

Funding Entity
USDA – Wildlife Services – National Wildlife Research Center
Start Date and Funding Amount
May 2014; $78,815.00
SREL Collaborators
Dr. James C. Beasley and Dr. Olin E. Rhodes, Jr. (SREL)
Objectives
The objectives of this study are to evaluate and contrast several potential and currently used methods for quantifying density of wild pigs, as well as the influence of habitat (a proxy for pig density) on the utility of these methods. In particular, we will contrast estimates produced through genetic mark-recapture surveys, remote camera surveys, and catch per unit effort models, as well as other similar measures of abundance. In addition, we will develop simulation models to evaluate performance of each method to assess the potential utility of evaluated methods at local and large spatial scales.
Summary of Research Activities
During spring 2015 we utilized a series of methodologies to assess wild pig density within 3 study areas on the SRS. These study areas differed in habitat composition, and presumably pig abundance. Specifically, we utilized a genetic mark-recapture approach, remote camera surveys, Rhodamine B capture-recapture surveys, and catch per unit effort methods to estimate density. All field data associated with this research and analyses have been completed. In addition, we have completed all simulation models assessing the performance of each evaluated method.
Conclusions
Field implementation of the data collection techniques revealed specific drawbacks and advantages to each methodology. Simulations revealed that movement parameters had the greatest effect on the accuracy of density estimators. We found Lincoln-Petersen estimators to be relatively imprecise, particularly at low movement and detection rates. Data requirements were highest for SECR models, but these techniques exhibited fairly high accuracy and precision. Removal models were most effective when population density was high and site-specific information was available to estimate the effective area sampled. Results suggest the aptness of a density estimation technique will vary with changes in field conditions. The large influence of movement parameters on accuracy of estimators further emphasizes the importance of effective post-hoc calculation of effective area sampled or use of methods that implicitly take spatial variation into account.
Major Impact(s) of Research
1) This research provides the most robust assessment to date of the comparability and utility of various methods for estimating density of wild pigs.
2) Data derived from this study will be integrated into national-level research by the USDA to assess population size and population dynamics of wild pigs.

Other Project Personnel
David Keiter, M.S. Student - SREL
Elizabeth Kierepka, Postdoctoral Research Associate – SREL
External Collaborators
Dr. Frederick Cunningham - USDA
Toni Piaggio - USDA
Kim Pepin - USDA
Amy Davis - USDA
Dr. John Kilgo - USFS – Savannah River Site
Products
Keiter, DA, AJ Davis, OE Rhodes, Jr., FL Cunningham, JC Kilgo, K Pepin, and JC Beasley. Empirical Comparison of Density Estimators for Wild Pigs. 2016. International Wild Pig Conference, Myrtle Beach, SC. (*presentation*)

Keiter, DA, AJ Davis, OE Rhodes, Jr., FL Cunningham, JC Kilgo, K Pepin, and JC Beasley. Comparison of wildlife population density estimators under field and simulated conditions. Manuscript submitted to ***Ecosphere***, September 2016

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

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. We are currently monitoring movements of pigs post-removal and also conducting additional camera trials to estimate density post-removal to monitor recolonization to the area.
Conclusions
This project has just begun, there are no conclusions at this time.
Major Impact(s) of Research
1) This research will provide extensive data on the home range overlap of neighboring wild pig sounders, data that will provide strong inferences on the degree of territoriality in 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 - SREL
Peter Schlichting, Postdoctoral Research Associate – SREL
Kevin Eckert, Research Technician – SREL
External Collaborators
Kim Pepin - USDA
Amy Davis - USDA
Kurt Vercauteren - USDA
Dr. John Kilgo - USFS – Savannah River Site
Products
Beasley JC. 2016. USDA Wild Pig Research Update. Aiken, SC (*Oral Presentation*)

Collaborations and Externally Funded Research Non - SRS

Experimental Evaluation of Trophic Transfer of Energy from Insular Invasive Species

Funding Entity
USDA – Wildlife Services – National Wildlife Research Center
Start Date and Funding Amount
September 2013; $29,986
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/contaminants through the food chain as scavenging occurs on rodent carcasses resulting from island rodent eradication programs.
Summary of Research Activities
Rodent species commonly targeted for island eradication programs will be placed in conjunction with camera traps to experimentally evaluate the influence of temperature, precipitation, and climatic zone on the time to removal and diversity of species associated with carcass scavenging events on Hilo, HI. In each of two years, 2013 and 2014, two trials of two weeks in duration will be conducted. Each trial will utilize 25 camera traps (13 Rattus sp. and 12 Mus sp.) which will be deployed in a specific climate zone in a particular seasonal period of the annual cycle (e.g., wet vs dry season). In total, two climate zones will be evaluated for each of two seasonal periods over the course of this experiment. Rodents used for each of the four trials will be obtained as donations from ongoing trapping programs for rats and mice in the agricultural production areas of Hilo, HI. No live animals or active trapping of live animals will be conducted by the personnel associated with this research project.

During the experiment, the following data will be recorded for each camera trap trial: Climatic zone, average temperature during the trial, total precipitation during the trial, elevation, GPS coordinate, species of carcass, time to removal of carcass, species of scavenger to remove carcass, camera or trial failure due to missed detection or equipment failure. Subsequent to the collection of this information, data will be analyzed using logistic regression and categorical data modeling to evaluate the influence of climatic zone, temperature, and precipitation on the time to removal and the diversity of scavengers utilizing rodent carcasses. In addition, data will be evaluated relative to the proportional frequency of utilization of rodent carcasses by scavenger species under differing climatic zone and environmental conditions to develop contaminant transfer factors for each species of scavenger encountered during the experiment. These data can be used to parameterize risk models for trophic transfer of contaminants and toxicants associated with island rodent eradication programs in the pacific region.
Conclusions
1) Invasive vertebrates do scavenge upon invasive amphibians and reptiles extensively in HI.
2) Energy flow through island ecosystems can be fundamentally altered by invasive species scavenging.
Major Impact(s) of Research
1) Novel data on scavenging community structure for an island ecosystem
2) Experimental evaluation of competition between invasive and native scavengers in island ecosystems
3) Data for parameterization of transfer factors for toxicants through trophic pathways
Other Project Personnel
Erin Abernathy, MS Student – SREL
External Collaborators
Dr. Will Pitt – Smithsonian Institute
Dr. Travis DeVault – USDA
Products
Abernethy, E.F. 2015. Impacts of invasive species on ecosystem energy transfer on the Big Island of Hawai'i: Are you really going to eat that? M.S. Thesis University of Georgia, 94pp.

Abernethy, E., K. Turner, J. Beasley, T. DeVault, W. Pitt and O.E. Rhodes, Jr. **2016**. Carcasses of invasive species are predominantly utilized by invasive scavengers in an island ecosystem. ***Ecosphere*** *(In Press).*

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 - SREL
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 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 containment impoundments 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 3rd or 4th year of the project. Current samples are considered "control" or pre-contaminant samples to assess potential uptake.
Summary of Research Activities
We completed year 2 winter avian blood collections (December 2015 – February 2016) and completed year 3 summer collections (May – August 2016). We collected a sampling of potential avian prey (insects) and analyzed the prey and all Year 2 samples for cadmium. All Year 3 summer collections have been archived for future analyses.
Conclusions
1) 81% of the avian blood samples collected in Year 2 had cadmium levels below the instrument/method detection limits (MDL: 0.01-0.07 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 Year 1, 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, it suggests they were accumulating it from off-site locations.

Major Impact(s) of Research
Preliminary analyses of avian samples during the second control year indicated that, as in Year 1, only a small proportion of the avifauna is currently exposed to cadmium on the Savannah DMCAs. Analyses of potential avian prey indicate that cadmium is bioavailable at the site in selected potential prey items.
Other Project Personnel
Chris Depkin, Research Technician – SREL
Meghan Oberkircher, Research Technician – SREL
External Collaborators
Dr. Susan Wilde - UGA
Brigette Haram - UGA
Products
Rhodes, O.E., S.B. Wilde, J.C. Seaman, and A.L. Bryan, Jr. 2016. Monitoring Potential Cadmium Levels in Avian Tissues Associated with the Savannah Harbor Expansion Project: Annual Report of Year 2 Monitoring. Annual project report to the U.S. Army Corps of Engineers, Savannah District, Savannah, GA (August 2016).

Kings Bay Rare, Threatened and Endangered Wildlife Surveys: Wood Storks and Wading Birds

Funding Entity
DoD-Navy/USACE
Start Date and Funding Amount
June 2014; $35,745
SREL Collaborators:
A. Lawrence Bryan Jr. and Dr. Olin E. Rhodes (SREL)
Objectives
To monitor the use of aquatic habitats on the Kings Bay Submarine Base for use by wood storks and other wading birds, including the use of the base as a breeding site.
Summary of Research Activities
We surveyed selected habitats for stork use and, due to timing of funding arrival, monitored a small number of nesting storks on the base for the latter half of the breeding season. After the breeding season, we ran a series of monthly surveys of potential roadside aquatic habitats to document timing of stork use. We surveyed the breeding colony (of storks) throughout the entire 2015 summer season (April through August) and wrote the final project report. All surveys and reporting are complete.
Conclusions
Wood Storks and other wading birds continue to forage in Kings Bay aquatic habitats and nest in small numbers in one of the wading bird colonies on the base.
Major Impact(s) of Research
1) Wood storks, a "threatened" species under ESA, used multiple aquatic habitats and nested in smallnumbers (<50 nests) on the base in 2014 and 2015.
2) Many other wading bird species, several considered state-listed species of concern, also utilize base aquatic habitats and nest on the facility.

Other Project Personnel
Chris Depkin, Research Technician - SREL
External Collaborators
NA
Products
Depkin, F.C., and A.L. Bryan, Jr. 2015. Naval Submarine Base Kings Bay rare, threatened and endangered wildlife surveys: Wood Storks and wading birds. Final project report to SUBASE Kings Bay/Natural Resources Division, Kings Bay, GA

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 (SREL)
Objectives
To document habitat use and approximate home range size of Loggerhead Shrikes, a regional species of concern, on Submarine Base Kings Bay 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 are on-going.
Conclusions
Loggerhead Shrikes on Kings Bay used maintained (typically mowed) habitats on the base for foraging. Home range analysis is on-going.
Major Impact(s) of Research
1) Loggerhead Shrikes, a regional species at risk, utilized maintained habitats (golf courses and groundsaround facilities) in 2015 and 2016.
2) Home range/habitat use data may be used to estimate current and potential shrike population size forthe base.

Other Project Personnel
Dr. Peter Schlichting, Postdoctoral Research Associate – SREL
Chris Depkin, Research Technician – SREL
Shawn McMahon, Research Technician - SREL
External Collaborators
Charlie Muise - Private Contractor
Products
No publications, presentations, or reports have yet been prepared.

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 (funding to PI)
SREL Collaborators:
A. Lawrence Bryan Jr. (Co-PI) and Dr. Stacey Lance (Co-PI)
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 tests of genetic structure and mating system in US WOST colonies. Specifically examining the inter-relatedness among US stork colonies and determine if extra-pair copulations and/or brood parasitism are occurring among US storks.
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. Samples are currently being prepared for analyses.
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
Products
No publications, presentations, or reports have yet been prepared.

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. 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 have been 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. Work will continue into 2017.
Major Impact(s) of Research
We are investigating 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
Mr. Neal Darby - National Park Service
Products
None yet available

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, $16,700

SREL Collaborators

Dr. K. 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. Half of each female's hatchlings are directly-released after marking and measuring, while half of the hatchlings are retained for head-starting in collaboration with 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.

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
Emily Scully – Wildlife Intern
Alyssa Frediani – Wildlife Intern
Brian Bastarache - Bristol County Agricultural High School
Brian Zarate - NJDEP
Dan Hannon - Wildlife Intern

Products

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.

Obtaining Baseline Population Demography and Nesting Information for Two Species of Map Turtles On the East Pearl and Mike's Rivers U.S. Navy's Stennis Western Maneuver Area, Mississippi and Louisiana 2014-2015

Funding Entity
US Navy DOD
Start Date and Funding Amount
August 2014, $ 45,000
SREL Collaborators
Dr. K. Buhlmann (SREL)
Objectives
1) 1). Determine relative population size and demography (adult females, males, juveniles) of Federally threatened Ringed Map Turtles (*Graptemys oculifera*) inhabiting East Pearl and Mike's Rivers.
2) Assess levels of reproduction along stretches of the East Pearl River within Stennis WMA.
3) Assess the level of potential population recruitment from successful nesting within the Stennis WMA.
4) Provide recommendations for habitat restoration and/or enhancement that will assist the U.S. Navy in its responsibility to maintain populations of threatened species.

Summary of Research Activities
The Stennis Western Maneuver Area (WMA) is located on the East Pearl and Mikes Rivers, on the Mississippi/Louisiana border. The property is operated by NASA and the U.s. Navy trains Boat-operating missions on site. Although the operation of large boats on the rivers may have disturbance impacts to threatened turtles, the target areas established by the Navy along the riparian floodplain provide opportunities for turtle nesting. Wildlife Camera arrays were established at select target areas and natural sandbars in 2016 to monitor turtle nesting activity, as well as nest predation.

Conclusions
We determined that endangered map turtles are nesting successfully on Navy target beaches, both documented in 2015 and 2016. Predation of nests by raccoons and fish crows was unacceptably high. We have also determined that invasive plants are invading nesting habitat. We have expanded the project partnership in 2016 to involve wildlife personnel from Louisiana Wildlife Resources Department to restore natural sandbar habitat.

Major Impact(s) of Research
The U.S. Navy requires riverine areas to train personnel. There may be opportunities to mutually benefit federally-listed threatened species through creation of open-canopy nesting habitats in otherwise closed riparian forests along the East Pearl and Mikes Rivers. Open canopy areas are needed by the U.S. Navy as target-training areas, and open habitats are required for turtle nesting. We are seeking collaborative ways to help recover a threatened turtle species, while helping the U.S. Navy meet its military mission.

External Collaborators
Marion Fanaly- US Navy
Robby Smith - U.S. Navy
Will Selman – Louisiana Department of Fish and Wildlife
Keri Landry - Louisiana Department of Fish and Wildlife
Grover Brown - Southern Mississippi University

Products
Buhlmann, K.A. 2014. Assessment of Ringed Map Turtle (*Graptemys oculifera*) and Pearl Map Turtle (*Graptemys pearlensis*) Abundance and Habitat on the U.S. Navy's Stennis Western Maneuver Area (WMA) East Pearl and Mike's Rivers, Mississippi: With Recommendations for Habitat Enhancement. Report submitted to NAVFAC Southeast, Stennis Western Maneuver Area, Mississippi. 21 February 2014. 34 pp.

Buhlmann, K.A. Evaluation of Wildlife Cameras to Detect Prevalent of Nesting in Endangered Map turtles (genus *Graptemys)* along the East Pearl and Mikes Rivers, Mississippi. Draft report submitted to Stennis NASA, September 2015.

Long-term Management and Persistence of Flatwoods Salamanders (Ambystoma bishopi) at the U.S. Navy's OLF Holley Airfield

Funding Entity
U.S. Navy, DOD
Start Date and Funding Amount
July 2014; $ 45,000
SREL Collaborators
Dr. K. Buhlmann (SREL)
Objectives
1) Monitor known and historic Flatwoods Salamander breeding sites on OLF Holley for continued use. Seek to document arrival of adult salamanders during the usual breeding migration
2) Identify environmental factors that contribute to use of breeding ponds by adult salamanders in any given year. In prior years of survey, not all the known breeding sites successfully recruit larval salamanders into the adult population.
3) Identify nesting habitat and locations of Flatwoods salamanders within the breeding wetlands at Holley OLF. Determine the terrestrial distribution of the adult Flatwoods Salamander population on OLF Holley. There is a need to understand which terrestrial habitats are they using and in which ones are they most abundant.
4) Provide recommendations for habitat restoration and/or enhancement that will assist the U.S. Navy in its responsibility to maintain populations of threatened species.

Summary of Research Activities
We have assisted with design and implementation of invasive plant removal from two wetland basins used by flatwoods salamanders (*Ambystoma bishopi*). We have implemented of prescribed burns, both winter and growing season. Sampling of breeding salamander response commenced in 2015.
Conclusions
Holley OLF airfield represents a remnant population of Federally-Endangered Flatwoods Salamanders and our habitat restoration work has been effective at restoring the habitat. It remains to be seen as to whether the salamander population can respond to this restored habitat.
Major Impact(s) of Research
We have sought collaborative ways to help maintain an endangered salamander, while helping the U.S. Navy met its military mission needs.
Other Project Personnel
NA
External Collaborators
Ron Cherry- US Navy
Robby Smith - U.S. Navy
Kylie Stackis - US Navy
Products
Buhlmann, K.A. 2016. Habitat Restoration, Persistence, and Recovery of Flatwoods Salamander (*Ambystoma bishopi*) on the U.S. Navy's Holley OLF, Santa Rosa County, Florida. Final Report submitted to Naval Facilities Engineering Command ,NAVFAC Southeast, Public Works Department, Whiting Field BLDG 1416, 7183 Langley Street, Milton, Florida. 30 March 2016. 36pp.

Role of Terrestrially Derived Organic Matter in the Ecology of Rocky Intertidal Communities

Funding Entity
No external funding provided
Start Date and Funding Amount
January 2013; (NFP)
SREL Collaborators
Dr. J Vaun McArthur (SREL)
Objectives
The overall objectives of these studies are to determine the role and importance of terrestrial organic matter in the bioenergetics of rocky intertidal organisms.
Summary of Research Activities
To date we have conducted three independent experiments and have one currently in the field. These studies have been controlled replicated experiments to determine the importance of red alder in the diets of urchins, snails, and crabs. The studies contrasted the decomposition of red alder, kelp and sea grass. Treatments included coarse and fine meshed enclosures to tease apart the effects of wave action and biological feeding. In addition the composition of beach wrack was determined. The importance of e3ach food type was examined using stable isotope analysis.

No previous studies have ever examined the role of terrestrial organic matter in the int4ertidal. All previous studies have assumed that inputs from the subtidal region provide the energy basis for organisms in the rocky intertidal. Given that terrestrial environments have been importing organic matter into these cove bays for millennia it seems that some organisms should be able to utilize the rich source of energy and nutrients.
Conclusions
Up to 30% of the carbon and energy requirements of rocky intertidal organisms comes from the terrestrial environment
Major Impact(s) of Research
1) Have determined the importance of terrestrial organic matter in intertidal energetics
2) Proposal sent to NSF- Biological Oceanography
Other Project Personnel
NA
External Collaborators
Dr. Russell B. Rader - Brigham Young University
Dr. Craig Young - University of Oregon
Dr. Aaron Galloway - University of Oregon
Douglas Fairbanks - Brigham Young University
Products
This project has just begun, there are no products at this time.

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 2015; $115,893
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 I - SREL
External Collaborators
D. Allen Saxon, Jr. - Augusta, GA Utilities Department
Tim Weegar - Augusta Regional Airport
Products
Kennamer, R. A., I. L. Brisbin, Jr., and C. S. Eldridge. 2015. Abundance, Distribution, and Movement Patterns of Avifauna in the Vicinity of Bush Field Airport: 2014–2015 Report. Final report submitted to Augusta Utilities Department, 154pp.

Kennamer, R. A. A review of Augusta Regional Airport wildlife strike records and wildlife activity from the previous year. Wildlife Hazard Group Meeting, Augusta Regional Airport, GA. November 19, 2015. (Oral Presentation).

Kennamer, R. A. Bird activity at AGS and constructed wetlands during fall 2015-spring 2016.Wildlife Hazard Group Meeting, Augusta Regional Airport, GA. May 19, 2016. (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
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 one, 9 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 17, 2015 and March 15, 2016, during which nearly 2,200 waterfowl, representing 9 species, were documented using the Monticello Reservoir and over 4,900 waterfowl, representing 11 species, were recorded using Parr Reservoir.
Conclusions
1) A greater diversity of dabbling ducks was seen on Parr Reservoir than on Monticello Reservoir. However, the same three diving duck species, including ring-necked ducks (*Aythya collaris*), lesser scaup (*Aythya affinis*), and buffleheads (*Bucephala albeola*), were seen on both reservoirs.
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.
3) There was more late-season (particularly late February and March) waterfowl use of the Enoree WMA than had been the case earlier in the fall/winter while the waterfowl hunting season was active.

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 eight of nine surveys of Parr Reservoir and three of nine surveys of Monticello Reservoir. Bald eagle sightings included both adults (8) and immature (11) 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. 2016. Waterfowl Aerial Surveys of Monticello and Parr Reservoirs, South Carolina: 2015–2016 Report. Interim project report to Kleinschmidt Associates. Savannah River Ecology Laboratory Report, Aiken, SC, 17pp.

Ecology of juvenile gopher tortoises

Funding Entity

Riverbanks Zoo Conservation Fund, Friends of Georgia Department of Natural Resources, St. Catherines Island Research Foundation

Start Date and Funding Amount

May 2011; NFP

SREL Collaborators

Dr. Tracey Tuberville (SREL)

Objectives

Characterize the ecology of juvenile gopher tortoises in terms of survivorship, spatial ecology and growth rates and inform management of this critical but poorly understood lifestage.

Summary of Research Activities

We investigated the ecology of juvenile gopher tortoises using a variety of techniques, including radiotelemetry, mark-recapture, and automated temperature dataloggers affixed to tortoises.

Conclusions

Temperature loggers revealed a surprising level of surface activity during winter months. Growth rates we observed are among the highest reported for any juvenile tortoises, even at more southerly locations where activity season is presumably longer.

Major Impact(s) of Research

1) Ours will be only the second study to investigate the spatial ecology of juvenile gopher tortoises, a candidate species for federal listing.
2) Growth data will provide useful data for evaluating the suitability of ruderal habitats (such as that at our study site), to which gopher tortoises are increasingly being confined to throughout their range.

Other Project Personnel

Bess Harris, M.S. Student - SREL

External Collaborators

Dr. Nathan Nibbelink – UGA

Dr. Terry Norton - St. Catherines Island / Georgia Sea Turtle Center

Products

Harris, B.B., T.M. Norton, N.P. Nibbelink, and T.D. Tuberville. 2015. Overwintering ecology of juvenile gopher tortoises (*Gopherus polyphemus*). Herpetological Conservation and Biology 10:645-653.

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

Nov 2010; $450,000 (NPS), $313,000 (CEC)

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.

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.

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 - SREL

External Collaborators

Dr. Brian Todd - University of California - Davis
Mark Peaden - University of California - Davis
Max Kern - University of California - Davis
Jacob Daly - UGA

Products

Nafus, M.G., B.D. Todd, K.A. Buhlmann, and T.D. Tuberville. 2015. Consequences of maternal effects on offspring size, growth, and survival in the desert tortoise. Journal of Zoology 297:108-114

Todd, B.D., B.J. Halstead, L.P. Chiquoine, J.M. Peaden, K.A. Buhlmann, T.D. Tuberville, and M.G. Nafus. 2016. Habitat selection by juvenile Mojave desert tortoises in the eastern Mojave Desert. Journal of Wildlife Management 80:720-728.

Daly, J.A., K.A. Buhlmann, B.D. Todd, J.M. Peaden, M.M. Kern, and **T.D. Tuberville**. Evaluating indoor-rearing as a component of head-starting the Mojave desert tortoise: methods and preliminary results. Desert Tortoise Council Annual Meetings, Las Vegas, NV. 19-21 Feb 2016. ORAL PRESENTATION

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. .
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.

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; $124,100
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 Whiting Field Naval Air Station (NAS) and associated Holley Outlying Field (OLF) using remote wildlife cameras at 20 active gopher tortoise burrows. We initiated a similar project at Kings Bay Naval Submarine Base, FL. As part of the remote camera monitoring, we have also characterized the non-tortoise species that used tortoise burrows.

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
Nicole White, Research Technician – SREL
Katrina Woods, Research Technician – SREL
Kimberly Price, Research Technician – SREL

External Collaborators
NA

Products
White, K.N, and T.D. Tuberville. 2015. Evaluation of gopher tortoise populations on NAS Whiting Field and Holley OLF: characterization of threats affecting population viability. Final report to Department of Navy.

White, K.N., and T.D. Tuberville. Temporal patterns of visitation by commensals at gopher tortoise burrows. Gopher Tortoise Council Meetings, Albany, GA. October 2014. ORAL PRESENTATION

Head-starting as a population recovery tool for Blanding's turtles

Funding Entity

USFWS, Disney Worldwide Conservation Fund

Start Date and Funding Amount

September 2013; $49,900 (Disney), $20,000 (USFWS)

SREL Collaborators

Dr. Kurt Buhlmann and Dr. Tracey Tuberville (SREL)

Objectives

1) Evaluate the effectiveness of head-starting as a means of establishing viable populations of Blanding's turtles
2) Compare survivorship of head-started vs. directly-released hatchling Blanding's turtles

Summary of Research Activities

We conducted radio-telemetry on a subset of both directly-released and head-started hatchlings and monitored movement and survivorship. In addition, we also conducted intensive trapping to estimate survival of non-telemetered animals released in previous years and to document their distribution throughout the study site wetland.

Conclusions

Survivorship of head-started hatchlings is significantly higher than those directly-released into the wetland shortly following hatching. In addition, survivorship has been significantly higher than values reported in the literature for wild populations, suggesting that fewer head-starts may be needed than originally anticipated based our preliminary population viability analyses.

Major Impact(s) of Research

This work is among the first to experimentally evaluate the effects of head-starting freshwater turtles on post-release survival and growth. We hope that this research will provide information useful for determining whether head-starting is an appropriate management technique for other species of freshwater turtles.

Other Project Personnel

Jared Green, M.S. Student – SREL

External Collaborators

Dr. Stephanie Koch - USFWS
Brian Bastarache - Bristol County Agricultural High School
Brian Butler - Oxbow Associates
Dr. Richard Chandler - UGA

Products

Buhlmann, K.A., S. Koch, B. Butler, T.D. Tuberville, V. Palmero, and B. Bastarache. 2015. Reintroduction and head-starting: Tools for Blanding's turtle (*Emydoidea blandingii)* conservation. Herpetological Conservation and Biology 10(Symposium):436-454.

Green, J.M. 2015. Effectiveness of head-starting as a management tool for establishing a viable population of Blanding's turtles. M.S. thesis, University of Georgia.

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 - SREL
Kimberly Price, Temporary 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., K. Buhlmann, T. Norton, J. Jensen, V. Greco, and T. Tuberville. Head-starting gopher tortoises (*Gopherus polyphemus*) to augment depleted populations in managed areas: preliminary results. Gopher Tortoise Council Meetings, Albany, GA. October 2014. ORAL PRESENTATION

Quinn, D., K. Buhlmann, T. Norton, J. Jensen, V. Greco, E. Kment, and T. Tuberville. Site fidelity and survivorship of head-started gopher tortoises (*Gopherus polyphemus*) used to augment depleted populations in managed areas. Joint Meeting of Society for Study of Amphibians and Reptiles / Partners in Amphibian and Reptile Conservation, Lawrence, Kansas. July 2015. ORAL PRESENTATION

Social isolation and social disruption in a long-lived colonial reptile occurring at high densities: habitat-mediated effects

Funding Entity

Riverbanks Zoo Conservation Fund, Disney Worldwide Conservation Fund, Archbold Biological Station, Cornell University

Start Date and Funding Amount

March 2014; $8,500

SREL Collaborators

Dr. Tracey Tuberville (SREL)

Objectives

Our overall objective is to characterize the social dynamics of a gopher tortoises, a long-lived colonial reptile, under high density scenarios associated with declining habitat conditions.

Summary of Research Activities

We have conducted continuous monitoring of social interactions at gopher tortoise burrows using remote wildlife cameras. We have also collected DNA samples from all resident adults in the populations, genotyped them at 24 microsatellite loci, and calculated pairwise relatedness. This year continued camera monitoring and have also genotyped offspring from nests collected at the study site, genotyped them at 22 microsatellite markers, and will conduct parentage analysis.

Conclusions

This project is ongoing and we are still in the process of reviewing camera monitoring data to record social interactions in the database. Thus, no conclusions are available at this time.

Major Impact(s) of Research

1) Greater understanding of social behavior derived from this study will inform translocation protocols and support our long-term goal to investigate habitat factors influencing social structure.
2) Provide data for comparison with previously conducted social interaction monitoring in populations at low densities.

Other Project Personnel

Nicole White, M.S. Student - SREL

External Collaborators

Dr. Betsie Rothermel - Archbold Biological Station

Dr. Kelly Zamudio - Cornell University, Ithaca

Products

Yuan, M.L., S.H. Dean, A.V. Longo, B.B. Rothermel, T.D. Tuberville, and K.R. Zamudio. 2015. Age, inbreeding, and fine-scale spatial structure—not kinship—influence gut microbiota in a hindgut-fermenting tortoise. Molecular Ecology 24:2521-2536. Doi: 10.1111/mec.13169 (IF: 6.494)

K.N. White, B.B. Rothermel, and T.D. Tuberville. 2015. Patterns of social behavior in a high-density population of gopher tortoises (*Gopherus polyphemus*). Report to Riverbanks Zoo.

White, N., B. Rothermel, and T.D. Tuberville. Patterns of social behavior in a high-density population of gopher tortoises (*Gopherus polyphemus*). Joint Meeting of Society for Study of Amphibians and Reptiles / Partners in Amphibian and Reptile Conservation, Lawrence, Kansas. July 2015. ORAL PRESENTATION

Combining genetic and sociological techniques to evaluate the status of shark populations in Costa Rica

Funding Entity

Rufford Small Grants for Nature Conservation, Explorers Club Grant, George Mason University

Start Date and Funding Amount

January 2013; $6,000

SREL Collaborators

Dr. Stacey L. Lance (SREL)

Objectives

The objective of this project are to determine the quantities and types of shark species being landed at docks and sold in local markets on Costa Rica's Pacific coast and to determine how fishermen's knowledge of sharks and their fishery impacts shark conservation.

Summary of Research Activities

All data have now been collected and analyzed and full drafts of five manuscripts have been written. Two have been published, one is in review and two will be submitted in fall of 2016.

Conclusions

1) The vast majority of filets labeled as "shark" and sold in the central markets are silky sharks, a threatened species.
2) The majority of sharks being caught by artisanal fishermen are juvenile scalloped hammerheads, an endangered species.
3) Artisinal fishermen in Costa Rica have basic knowledge of sharks and are aware of their declines but do not relate their fishing practices to the declines. They are open to altering the gear they use if it is provided to them.
4) All species of sharks sold in the central markets have Hg levels exceeding EPA consumer guidelines.

Major Impact(s) of Research

It is clear that the sharks being caught in the coastal waters of Costa Rica represent juvenile scalloped hammerheads. This species is not a target of the fishermen but rather is a product of bycatch. The fishing grounds appear to represent nursing grounds for this endangered species. The market data clearly indicate that off shore commercial fishermen are primarily catching silky sharks, a species experiencing dramatic population declines globally. Mercury levels are quite high in the sharks off the coast of Costa Rica and an education program concerning the dangers of Hg consumption is needed. A policy recommendation paper will be written to address the impacts of the research.

Other Project Personnel

Jason O'Bryhim, Ph.D. Student – George Mason University

External Collaborators

Dr. Chris Parsons - George Mason University

Products

O'Bryhim, J.R. The shark trade in Costa Rica: Genetic, Mercury Contamination and Human Dimensions and the Implications for Conservation. PhD Thesis.

O'Bryhim, J.R., E.C.M. Parsons, M.P. Gilmore, and S.L. Lance. 2016. Evaluating support for shark conservation among artisanal fishing communities in Costa Rica. *Marine Policy* 71:1-9.

O'Bryhim, J.R., E.C.M. Parsons, and S.L. Lance. 2017. Forensic species identification of elasmobranch products sold in Costa Rican markets. *Fisheries Research* 186:144-150.

O'Bryhim, J.R., D.H. Adams, J.L.Y. Spaet, G. Mills, and S.L. Lance. In review. Relationships of mercury concentrations across tissue types, muscle regions and fins for two shark species. Submitted to: *Environmental Pollution.*

Population genetics of striped newts across Florida

Funding Entity
Florida Fish and Wildlife Commission
Start Date and Funding Amount
Jan 2016; $17,320
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 FWC is currently in the process of a range-wide genetic assessment of the striped newt, which is being funded from a Conserve Wildlife Tag Grant. 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 the spring we extracted DNA from 575 samples and have screened them across 5 markers. The samples still need to be screened across 5 more markers.
Conclusions
The data are still being collected and analyzed.
Major Impact(s) of Research
Until the data are fully acquired and analyzed we will not know the major impacts.
Other Project Personnel
Imogene Davis, Research Technician - SREL
External Collaborators
Anna Farmer - Florida FWC
Kevin Enge - Florida FWC
Eric Hoffmann - University of Central Florida
Products
Manuscripts will be prepared at a later date.

Prevalence of amphibian diseases in constructed and natural ridge-top wetlands of the Daniel Boone National Forest, Kentucky.

Funding Entity
Eastern Kentucky University
Start Date and Funding Amount
May 2016; $2,358
SREL Collaborators
Dr. Stacey L. Lance (SREL)
Objectives
1) Determine the prevalence of chytrid and ranavirus in amphibians inhabiting the Daniel Boone National Forest
2) Compare prevalence of diseases in ranid frogs and ambystomatid salamanders
3) Compare prevalence of diseases in amphibians inhabiting natural wetlands that are either near or distant from wetlands constructed mitigation.

Summary of Research Activities
In the summer of 2015 we collected samples from 22 wetlands. Four natural wetlands are located in the same area as constructed wetlands, while four are in a different part of the forest. The rest represent constructed wetlands built at different times and for different purposes. From each wetland we screened up to 30 Ranid and 30 Ambystomatid samples for both chytrid and ranavirus.
Conclusions
We found ranavirus in all wetlands sampled and no chytrid in any wetlands. Prevalence of ranavirus was higher in natural than in constructed wetlands, which may be due to the presence of wood frogs in these wetlands. Wood frogs are known to be highly susceptible to ranavirus. Overall the community composition differed among wetland types and the constructed wetlands are not serving as suitable habitat for the target species.
Major Impact(s) of Research
Ranavirus is pervasive in this ecosystem and has the potential to cause die-offs and population declines. In addition the short hydroperiod specialists cannot successfully reproduce in the constructed wetlands, thus their available habitat is limited.
Other Project Personnel
Austin Coleman, MS Student - SREL
External Collaborators
Dr. Stephen Richter - Eastern Kentucky University
Audrey McTaggart - Eastern Kentucky University
Products
McTaggart, A.L. 2016. Amphibian community composition and disease susceptibility in ridge-top wetlands of the Daniel Boone National Forest. MS thesis. Eastern Kentucky University.

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. To date all that has been done is prepare and ship 510 sample collection tubes.

Conclusions

The project is just starting in September 2016.

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

Products

Manuscripts will be prepared at a later date.

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

Funding Entity

SC-DNR, The Yawkey Foundation

Start Date and Funding Amount

April 2012; $50,000

SREL Collaborators

Dr. Stacey L. Lance, Dr. Ben Parrott and Joshua Zajdel (SREL)

Objectives

The overall objective in this project is to determine if contaminant loads influence reproductive success in American alligators.

Summary of Research Activities

Ben Parrott (Medical University of South Carolina), Thomas Rainwater (USFWS), and Phil Wilkinson (Yawkey Wildlife Refuge) have been collecting samples from adult alligators and nests at Yawkey Wildlife Refuge in conjunction with the SC DNR. To date they have sampled eggs from >30 clutches from 2011-2016. In addition they have sampled females at nests over several nesting seasons in Yawkey. Together, at SREL we are now analyzing the microsatellite genotypes of over 800 individuals across a panel of loci. Initial screens indicated very low genetic diversity. We have now developed a new set of 10 loci that have more variation and have increased our power. We have screened hatchlings from 2011-2013 and extracted DNA from 2014 and 2015. We also captured additional adults (40) in April 2016 and will repeat that effort in fall of 2016 to increase the number of adults in our database. Joshua Zajdel has come on board as a MS student to lead the remaining analyses and write ups. The goals of the project include identifying maternity, quantifying levels of multiple paternity, and determining whether paternity relates to male phenotype, including contaminant load. The project is expanding to include population genetics of alligator populations along the Atlantic coast.

Conclusions

Data are still being collected, thus there are no conclusions at this time. We have determined that we need to sample a larger proportion of the adult population to identify parents.

Major Impact(s) of Research

1) As long-lived species, alligators have the potential to be exposed to a large variety of contaminants over a long period of time—similar to humans. Sublethal endpoints of contaminant exposure are difficult to measure, but critical for understanding the environmental implications. Our approach will allow us to look at reproductive success in males and females as a function of contaminant loads.

External Collaborators

Dr. Thomas Rainwater - Clemson University

Dr. Jason O'Bryhim - George Mason University

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.

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.

Sub-lethal effects of chronic exposure to radiation in gray wolves (Canis lupus) at Chernobyl

Funding Entity
National Geographic Society; Institute for Radiological Protection and Nuclear Safety (IRSN), SREL
Start Date and Funding Amount
June 2012; $60,781
SREL Collaborators
Dr. James C. Beasley and Dr. Stacey L. Lance (SREL)
Objectives
The overall objectives in this project are to measure the spatial and temporal variation in radiation dose that individual wolves experience throughout the Chernobyl exclusion zone (CEZ), quantify the relationship between dose and sub-lethal effects, and quantify the distribution and density of carnivores throughout areas of the CEZ varying widely in radionuclide contamination.
Summary of Research Activities
During fall 2014 and spring 2015 we travelled to the CEZ and deployed 9 GPS-dosimetry collars on wolves. We collected samples from captured wolves and other wildlife and also conducted remote camera and scat surveys for various wildlife species. We are currently analyzing data collected on these research trips and are preparing various publications from this work. Additional travel to the CEZ to expand this work is anticipated during fall 2016.
Conclusions
This research is not completed. However, we have validated the GPS/dosimetry technology in the laboratory and in the field on three wild pigs at the SRS and have produced a manuscript detailing these experiments. We also have completed a manuscript that demonstrates that the distribution of carnivores and wild boar within the CEZ is not negatively influenced by radiation contamination level. Preliminary data suggest wolves fit with GPS-dosimeter collars varied widely in radiation exposure and future analyses are ongoing to quantify spatio-temporal variability in dose received. A manuscript detailing these findings as well as the spatial ecology of wolves in the CEZ is in preparation. Preliminary data also suggest that parasite loads of wolves do not vary across the landscape. We also developed microsatellite markers for raccoon dogs and optimized existing markers for gray wolves which we are using to estimate the density of wolves in the CEZ. Laboratory analyses of blood, scat, and other tissue samples will be ongoing through the next FY.
Major Impact(s) of Research
1) For the first time use coupled GPS-dosimetry to directly measure radiation dose rates for free-ranging animals in the CEZ.
2) Use our telemetry/dosimetry data to directly examine the relationship between sub-lethal effects (e.g., disease, immunosuppression, stress) and exposure.
3) Conducted the first remote camera survey for carnivores in the CEZ, showing carnivores are not negatively impacted by the activity concentration of radionuclides in local soil.
4) This research has produced 2 publications to date that have achieved Altmetric attention scores in the top 1% of all research articles ever tracked and for the first time provide robust scientific data demonstrating large mammals are abundant throughout the CEZ.

Other Project Personnel
Sarah Webster, M.S. Student - SREL
Cara Love, Ph.D. Student - SREL
Mike Byrne, Postdoctoral Research Associate – SREL
External Collaborators
Dr. Thomas Hinton - IRSN
Dr. Yuri Bondar - Polesye State Radioecological Reserve
Dr. Dima Shamovich - Researcher and Wildlife Tour Guide

Products

Hinton, T.G., M. Byrne, P. Fort, P. Martin, R. Schuman, S. Webster, and J.C. Beasley. 2015. Quantifying the spatial and temporal variation in dose from external exposure to radiation: A new tool for use on free-ranging wildlife. ***Journal of Environmental Radioactivity*** 145:58-65

Webster, S.C., M.E. Byrne, S.L. Lance, C.L. Love, T. Hinton, D. Shamovich, and J.C. Beasley. 2016. Where the wild things are: Influence of radiation on the distribution of mammalian species within the Chernobyl Exclusion Zone. ***Frontiers in Ecology and the Environment*** 14(4): 1-6

Webster, S.C., M. Byrne, C. Love, S. Lance, T. Hinton, and J.C. Beasley. 2015. Occupancy, Abundance, and Distribution of Mammalian Carnivores within the Chernobyl Exclusion Zone. American Society of Mammalogists. Jacksonville, Florida, USA. *Oral Presentation*

Beasley J.C., T.G. Deryabina, S.V. Kuchmel, L.L. Nagorskaya, T.G. Hinton, A. Lerebours, and J.T. Smith. 2015. Long term census data reveal abundant wildlife populations at Chernobyl. The 22nd Annual Wildlife Society Conference, Winnipeg, Manitoba. *Oral Presentation*

Beasley, J.C. 2015. Ecological adaptations of wildlife to human-disturbed ecosystems. Clemson University. Clemson, SC. *Oral Presentation*

Beasley, J.C. 2015. Biomagnification of Cs^{137} and Population Responses of Wildlife in Radioactive Lands: Case studies at SRS and Chernobyl. Fukushima, Japan. *Oral Presentation*

Webster, S.C., M. Byrne, C. Love, S. Lance, T. Hinton, D. Shamovich, and J.C. Beasley. 2015. Where the Wild Things Are: Influence of Radiation on the Distribution of Mammals within the Chernobyl Exclusion Zone. The Wildlife Society Annual Meeting. Winnipeg, Manitoba, Canada. *Poster Presentation*

Love, C.N., S.C. Webster, J.C. Beasley, T.G. Hinton, M.E. Byrne, D. Shamovich, and S. Lance. 2015. Parasite prevalence and radiation exposure in gray wolves (*Canis lupus*) from the Chernobyl Exclusion Zone. Society of Ecological Toxicology and Chemistry. Salt Lake City, Utah, USA. *Poster Presentation*

Deryabina, T.G., S.V. Kuchmel, L.L. Nagorskaya, T.G. Hinton, J.C. Beasley, A. Lerebours, and J.T. Smith. 2015. Long term census data reveal thriving mammal populations at Chernobyl. ***Current Biology*** 25:R811-R826

Webster, SC. 2016. Occupancy, distribution, and density of carnivores within the Chernobyl Exclusion Zone. M.S. Thesis. University of Georgia, Athens, GA.

Beasley, JC. 2016. Radioactive Wildlife: Effects of chronic radiation exposure on wildlife populations. SREL REU Summer Program, Aiken, SC.

Love, C.N., S.C. Webster, J.C. Beasley, T.G. Hinton, M.E. Byrne, D. Shamovich, and S. Lance. 2016. Gastrointestinal parasite and disease prevalence in gray wolves (*Canis lupus*) from the radioactively contaminated Chernobyl Exclusion Zone. Ecology and Evolution of Infections and Diseases Conference, Ithaca, NY, USA. *Poster Presentation*

Distribution and relative abundance of wildlife in Fukushima along a gradient of contamination and human land-use intensity

Funding Entity
National Geographic Society; Institute for Radiological Protection and Nuclear Safety (IRSN), SREL
Start Date and Funding Amount
June 2016; NFP
SREL Collaborators
Dr. James C. Beasley (SREL)
Objectives
The overall objectives in this project are to quantify the distribution and relative abundance of mammals 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 we will return to Fukushima to conduct an additional 120 camera trials and attach GPS transmitters to mammals in the exclusion zone.
Conclusions
This research has just begun; there are no conclusions at this time.
Major Impact(s) of Research
This research has just begun; there are no impacts at this time.
Other Project Personnel
Sarah Webster, Ph.D. Student – SREL
Phillip Lyons, M.S. Student – SREL
Matt Hamilton, Research Technician – SREL
External Collaborators
Dr. Thomas Hinton - Fukushima University
Dr. Kei Okuda - Fukushima University
Products
This research has just begun; there are no products available at this time.

External (non-SRS) Funding Received in FY16

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 1, 2015; $115,893
SREL Investigators and Roles
R. A. Kennamer, and Dr. I. L. Brisbin, Jr.
Co-Investigators, Roles, and Affiliations
D. A. Saxon, Jr. (Collaborator) Augusta, GA Utilities Department

Monticello Reservoir and Par Reservoir Waterfowl Survey
Funding Entity
Kleinschmidt Associates/South Carolina Electric and Gas Company
Start Date and Funding Amount
November 1, 2015; $21,628
SREL Investigators and Roles
J. C. Beasley and R. A. Kennamer
Co-Investigators, Roles, and Affiliations
Shane Boring (Collaborator) Kleinschmidt Associates

Efficacy of the LRAD weapon system as an avian dispersal tool on airports
Funding Entity
USDA Wildlife Services/Federal Aviation Authority
Start Date and Funding Amount
August 2014; $387…
SREL Investigators and Roles
Dr. O.E. Rhodes, Dr. J.C. Beasley, A.L. Bryan, R.A. Kennamer and A.E. Holland
Co-Investigators, Roles, and Affiliations
Dr. Travis DeVault (Co-PI) – USDA
Dr. Bradley Blackwell (Co-PI) – USDA

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 Investigators and Roles
Dr. Olin E. Rhodes and A. Lawrence Bryan, Jr.
Co-Investigators, Roles, and Affiliations
Dr. Susan Wilde (Co-PI) - UGA

A Survey of NAS Whiting Field and associated properties for gopher tortoises and burrow commensals.
Funding Entity
US Department of Navy
Start Date and Funding Amount
June 2015; $49,100
SREL Investigators and Roles
Dr. Tracey Tuberville (PI)
Co-Investigators, Roles, and Affiliations
none

Kings Bay Rare, Threatened and Endangered Wildlife Surveys: Wood Storks and Wading Birds
Funding Entity
DoD-Navy/USACE
Start Date and Funding Amount
June 2014; $35,745
SREL Investigators and Roles
A. Lawrence Bryan Jr. and Dr. Olin E. Rhodes
Co-Investigators, Roles, and Affiliations
None

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 Investigators and Roles
A. Lawrence Bryan Jr. and Dr. Olin E. Rhodes
Co-Investigators, Roles, and Affiliations
None

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)
Co-Investigators, Roles, and Affiliations
Dr. Brian Todd, University of California-Davis (co-PI)

Effects of road fencing on desert tortoises
Funding Entity
Bureau of Land Management
Start Date and Funding Amount
July 2013; $230,000
SREL Investigators and Roles
Dr. Tracey Tuberville (co-PI), Dr. Kurt Buhlmann (co-PI)
Co-Investigators, Roles, and Affiliations
Dr. Brian Todd, University of California-Davis (PI)

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; $212,806
SREL Investigators and Roles
Dr. Kimberly Andrews (PI), Dr. Tracey Tuberville (co-PI)
Co-Investigators, Roles, and Affiliations
none

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)
Co-Investigators, Roles, and Affiliations
Dr. Terry Norton, Georgia Sea Turtle Center, Jekyll Island, GA; John Jensen, GADNR

Head-starting as a population recovery tool for Blanding's turtles
Funding Entity
Disney Worldwide Conservation Fund
Start Date and Funding Amount
September 2013; $49,900
SREL Investigators and Roles
Dr. Tracey Tuberville (co-PI), Dr. Kurt Buhlmann (co-PI)
Co-Investigators, Roles, and Affiliations
Dr. Stephanie Koch, USFWS, Sudbury, MA

Identifying threats to viability of gopher tortoise populations on Kings Bay Naval Submarine Base, Georgia.
Funding Entity
US Department of Navy
Start Date and Funding Amount
April 2015; $40,000
SREL Investigators and Roles
Dr. Tracey Tuberville (PI)
Co-Investigators, Roles, and Affiliations
none

Thermal regulation and habitat use of black rat snakes (Pantherophis obsoletus) in the southeastern Coastal Plain.
Funding Entity
ERDC-CERL
Start Date and Funding Amount
March 2015; $45,000
SREL Investigators and Roles
Dr. Tracey Tuberville (PI)
Co-Investigators, Roles, and Affiliations
none

Mating system and male reproductive success in a high-density gopher tortoise population.
Funding Entity
Riverbanks Zoo Conservation Fund
Start Date and Funding Amount
May 2015; $3,700
SREL Investigators and Roles
Dr. Tracey Tuberville (co-PI), Nicole White (student)
Co-Investigators, Roles, and Affiliations
Dr. Betsie Rothermel (PI), Archbold Biological Station, Venus, Florida; Dr. Kelly Zamudio (co-PI), Cornell University, Ithaca, New York

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)
Co-Investigators, Roles, and Affiliations
Dr. Melissa Pilgrim (co-PI), University of South Carolina-Upstate, Spartanburg, SC

Characterizing social interactions among gopher tortoises in a viable population: a pilot study with implications for translocation and long-term conservation

Funding Entity
Riverbanks Zoo Conservation Fund
Start Date and Funding Amount
March 2014; $4,800
SREL Investigators and Roles
Dr. Tracey Tuberville (co-PI)
Co-Investigators, Roles, and Affiliations
Dr. Betsie Rothermel (PI), Archbold Biological Station, Venus, Florida; Dr. Kelly Zamudio (co-PI), Cornell University, Ithaca, New York

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. Michael Chamberlain (co-PI), UGA
Dr. Tracey Tuberville (co-PI)
Co-Investigators, Roles, and Affiliations
none

Population genetics of striped newts across Florida

Funding Entity
Florida Fish and Wildlife Commission
Start Date and Funding Amount
January 1, 2016; $17,320
SREL Investigators and Roles
S. Lance (Co-PI)
Co-Investigators, Roles, and Affiliations
Dr. Anna Farmer (PI), Florida Fish and Wildlife Commission
Dr. Kevin Enge (Co-PI), Florida Fish and Wildlife Commission
Dr. Eric Hoffmann (Senior Personnel), 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
Start Date and Funding Amount
January 1, 2016; $14,800
SREL Investigators and Roles
Stacey Lance (Co-PI);
Co-Investigators, Roles, and Affiliations
Dr. Ben Parrott (Co-PI), Medical University of South Carolina and UGA.
Dr. Thomas Rainwater (Co-PI), Clemson University

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

Funding Entity
White Buffalo
Start Date and Funding Amount
September 1, 2016; $15,000
SREL Investigators and Roles
S. Lance (Co-PI)
Co-Investigators, Roles, and Affiliations
Dr. Anthony DeNicola (PI), White Buffalo

Survival and Cause-Specific Mortality of Juvenile Feral Swine

Funding Entity
USDA – Wildlife Services – National Wildlife Research Center
Start Date and Funding Amount
September 30, 2014; $25,300.00
SREL Investigators and Roles
Dr. James C. Beasley
Co-Investigators, Roles, and Affiliations
Dr. John Kilgo, Collaborator, USFS – Savannah River Site, ; Mark Vukovich, Collaborator, USFS – Savannah River Site, Aiken, SC
Dr. Frederick Cunningham, Collaborator, USDA, WS, NWRC

Sub-lethal effects of chronic exposure to radiation in gray wolves (Canis lupus) at Chernobyl

Funding Entity

National Geographic Society; Institute for Radiological Protection and Nuclear Safety (IRSN)

Start Date and Funding Amount

June 1, 2012; $60,781 in total funding

SREL Investigators and Roles

Dr. James C. Beasley (PI) and Dr. Stacey L. Lance (PI)

Co-Investigators, Roles, and Affiliations

Dr. Thomas Hinton, Collaborator, Fukushima University, Japan; Dr. Dima Shamovich, Researcher and Wildlife Tour Guide, Belarus

Dose Titration and Duration of Rhodamine B as a Biomarker in Feral Swine

Funding Entity

USDA – Wildlife Services – National Wildlife Research Center

Start Date and Funding Amount

May 1, 2014; $14,934.00

SREL Investigators and Roles

Dr. James C. Beasley (PI) and Dr. Olin E. Rhodes, Jr. (Co-PI)

Co-Investigators, Roles, and Affiliations

Dr. Frederick Cunningham, Collaborator, USDA, WS, NWRC

Development of Genetic-Based Mark-Recapture Tools for Feral Swine

Funding Entity

USDA – Wildlife Services – National Wildlife Research Center

Start Date and Funding Amount

May 1, 2014; $35,000.00

SREL Investigators and Roles

Dr. Olin E. Rhodes, Jr. (PI) and Dr. James C. Beasley (Co-PI)

Co-Investigators, Roles, and Affiliations

Dr. Frederick Cunningham, Collaborator, USDA, WS, NWRC; Dr. Toni Piaggio, Collaborator, USDA, WS, NWRC; Dr. Kim Pepin, Collaborator, USDA, WS, NWRC

Post-Translocation Movement Behavior of Feral Swine

Funding Entity

USDA – Wildlife Services – Veterinary Services

Start Date and Funding Amount

September 5, 2014; $108,350.00

SREL Investigators and Roles

Dr. James C. Beasley (PI), David Keiter, Dr. Josh Smith

Co-Investigators, Roles, and Affiliations

Dr. Ryan Miller, Collaborator, USDA, VS
Dr. Dan Grear, Collaborator, USDA, VS
Dr. Steven Sweeney, Collaborator, USDA, VS

Development of Genetic-Based Mark-Recapture Tools for Feral Swine

Funding Entity

USDA – Wildlife Services – National Wildlife Research Center

Start Date and Funding Amount

May 1, 2014; $35,000.00

SREL Investigators and Roles

Dr. Olin E. Rhodes, Jr. (PI) and Dr. James C. Beasley (Co-PI)

Co-Investigators, Roles, and Affiliations

Dr. Frederick Cunningham, Collaborator, USDA, WS, NWRC; Dr. Toni Piaggio, Collaborator, USDA, WS, NWRC; Dr. Kim Pepin, Collaborator, USDA, WS, NWRC

Comparing methods of estimating feral swine population size in two different habitats

Funding Entity

USDA – Wildlife Services – National Wildlife Research Center

Start Date and Funding Amount

May 1, 2014; $78,815.00

SREL Collaborators

Dr. Olin E. Rhodes, Jr., Dr. James C. Beasley, David Keiter, Dr. Liz Kierepka

Co-Investigators, Roles, and Affiliations

Dr. Frederick Cunningham, Collaborator, USDA, WS, NWRC; Dr. Toni Piaggio, Collaborator, USDA, WS, NWRC; Dr. Kim Pepin, Collaborator, USDA, WS, NWRC
Amy Davis, USDA, WS, NWRC

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

May 1, 2014; $70,852.00

SREL Collaborators

Dr. James C. Beasley, David Keiter, Dr. Peter Schlichting

Co-Investigators, Roles, and Affiliations

Dr. Frederick Cunningham, Collaborator, USDA, WS, NWRC; Dr. Toni Piaggio, Collaborator, USDA, WS, NWRC; Dr. Kim Pepin, Collaborator, USDA, WS, NWRC
Amy Davis, USDA, WS, NWRC

Habitat suitability models and use of head-starting techniques as planning and mitigation tools for ensured persistence of Mojave desert tortoises to offset solar energy projects

Funding Entity

California Energy Commission

Start Date and Funding Amount (If no funding involved indicate No Funding Provided (NFP))

Nov 2010; $313,000

SREL Investigators and Roles

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

Co-Investigators, Roles, and Affiliations

Dr. Brian Todd, UC-Davis (PI)

Technical Expertise Requests in FY16

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
2016; ongoing
Requesting Entity
National Park Service, Gulf Coast Monitoring Network
Nature of Request
Help design and conduct population monitoring of Texas tortoises at Palo Alto National Battlefield in order to inform management of the park.

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
October 2015
Requesting Entity
British Broadcasting Company (BBC)
Nature of Request
Provided information to BBC for upcoming Public Broadcasting program on the North American Deserts, with specific references to Desert Tortoise biology and population recovery

SREL Investigator
Dr. K. Buhlmann
Date of Request
February 2016; August 2016
Requesting Entity
Turtle Conservation Fund
Nature of Request
Review, evaluate, and rank 21 proposals (February 2016) and 16 proposals (July 2016) for potential funding support by this non-profit conservation group. Attended Executive Board meetings in Moncks Corner, SC (March 2016) and New Orleans, LA, (August 2016).

SREL Investigator
Dr. K. Buhlmann
Date of Request
April 2016, on-going
Requesting Entity
Jeykll Island Authority and Georgia Sea Turtle Center
Nature of Request
Assist with implementation of diamondback terrapin conservation program to reduce road mortalities on the Jekyll Island Causeway, Brunswick, Georgia.

SREL Investigator
Dr. K. Buhlmann, Dr. T. Tuberville
Date of Request
May 2016
Requesting Entity
Bristol County Agricultural High School, Dighton, Mass
Nature of Request
Taught a powerpoint presentation to the junior class that was be responsible for head-starting threatened wood turtles.

SREL Investigator
Dr. K. Buhlmann
Date of Request
September 2016
Requesting Entity
Louisiana State University Press
Nature of Request
Provide photographs of turtles for upcoming book, "Guide to the Amphibians and Reptiles of Louisiana" (Boundy and Carr)

SREL Investigator
Dr. K. Buhlmann, Dr. T. Tuberville
Date of Request
May 2016
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
June 2016
Requesting Entity
Partners in Amphibian and Reptile Conservation (PARC) and National Park Service (NPS)
Nature of Request
Taught a 1-hr Webinar on habitat management for amphibians and reptiles in the Northeastern U.S.

SREL Investigator
Dr. K. Buhlmann
Date of Request
June 2016
Requesting Entity
Reporter with the Des Moines Register newspaper, Iowa
Nature of Request
Provided information on the impact of commercial turtle harvest on native turtle species, with data being used to develop new state harvest regulations

SREL Investigator
Dr. K. Buhlmann
Date of Request
July 2016
Requesting Entity
IUCN- World Conservation Union
Nature of Request
Provide information for an IUCN conference on the reintroduction of Kihansi Spray Toads in Tanzania.

SREL Investigator
Dr. K. Buhlmann, Dr. T. Tuberville
Date of Request
August 2016
Requesting Entity
SCDNR
Nature of Request
Recorded a taped video explanation of the Aiken Gopher Tortoise Heritage Preserve tortoise reintroduction project for SCDNR to stream on their Facebook webpage.

SREL Investigator
Dr. K. Buhlmann
Date of Request
September 2016
Requesting Entity
Friends of the Great Swamp National Wildlife Refuge, NJ.
Nature of Request
Provided a poster exhibit and manned a table display at the Fall Festival, celebrating the Migratory Bird Treaty Centennial, 1916-2016, held at the Great Swamp Refuge on 10 Sept 2016.

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

SREL Investigator
R. A. Kennamer
Date of Request
October 2015
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.

SREL Investigators
Larry Bryan, Dr. Gary Mills, Dr. Xiaoyu Xu
Date of Request
June 2016
Requesting Entity
SRNS-ACP
Nature of Request
To determine the continued existence of a mercury hot-spot on SRS

SREL Investigator
Dr. Tracey Tuberville
Date of Request
FY2016 (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
FY2015 (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
February 2016
Requesting Entity
Eglin Air Force Base
Nature of Request
Long-term conservation plan for viability of gopher tortoise populations

SREL Investigator
Dr. Tracey Tuberville
Date of Request
March 2016
Requesting Entity
Department of Navy
Nature of Request
Disease and genetic issues associated with gopher tortoises displaced from training sites

SREL Investigator
Dr. Tracey Tuberville
Date of Request
April 2016
Requesting Entity
Rotating Planet Television Company
Nature of Request
Information regarding aging and senescence in turtles

SREL Investigator
Dr. Tracey Tuberville
Date of Request
June 2016
Requesting Entity
The Wildlife Society / The Wildlifer Magazine
Nature of Request
Habitat requirements and management for gopher tortoises and associated commensals

SREL Investigator
Stacey L. Lance
Date of Request
October 2015
Requesting Entity
Faculty member, University of Richmond
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
October 2015
Requesting Entity
Faculty Florida Institute of Technology
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
October 2015
Requesting Entity
Angels Hatchery, Florida
Nature of Request (one-two lines)
Develop genetic markers (microsatellites)

SREL Investigator
Stacey L. Lance
Date of Request
December 2015
Requesting Entity
Faculty member, University of Southern Mississippi
Nature of Request
Develop genetic markers (microsatellites).

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

SREL Investigator
Stacey L. Lance
Date of Request
January 2016
Requesting Entity
Researcher, USDA
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
January 2016
Requesting Entity
Faculty member, Stevenson University
Nature of Request
Develop genetic markers (microsatellites).

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

SREL Investigator
Stacey L. Lance
Date of Request
June 2016
Requesting Entity
Faculty member, Georgia Southern University
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
August 2016
Requesting Entity
Faculty member, University of Houston-Clear Lake
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
May 2016
Requesting Entity
Faculty member, Eastern Kentucky University
Nature of Request (one-two lines)
Disease testing of amphibians

SREL Investigator
Dr. James C. Beasley
Date of Request
December 2015
Requesting Entity
International Atomic Energy Association
Nature of Request
Consult with Fukushima Prefecture, Japan

SREL Investigator
Dr. James C. Beasley
Date of Request
July 2016
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 FY16. Below we provide examples of specific activities that SREL personnel have conducted in FY16 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 a presentation to the Citizens Advisory Board on the results of the SREL Technical Review requested by DOE in response to CAB Recommendation 317
- SREL Director participated in meetings with EM1, representatives from EPA Headquarters, and various community leaders to provide information on the planned Radiological Education, Monitoring and Outreach Program
- SREL personnel participated in site visits with UGA and USDA personnel to evaluate potential research on feral 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 ~ 1.9 million dollars in new external funding during the FY16 fiscal year
- SREL personnel hosted multiple DOE personnel to tour SREL's analytical capabilities that might be used in support of SRS missions
- SREL Director hosted the National Rabies Program Manager for discussions of rabies mitigation research to be conducted on the SRS
- SREL personnel provided input to DOE on potential strategies for education and outreach concerning radiation risks to local communities in GA

Department of Energy – NNSA

- SREL personnel provided presentations to personnel from NNSA Tritium to discuss ongoing and future research in support of tritium production on the SRS
- 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 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 personnel gave tours of the SREL Low Dose Facility to multiple regulators to support the SRNS ACP program
- 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 continued to provide support to SRNL towards the development of business in Japan
- 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 met with Dr. John Blake of the USFS and researchers from USDA to discuss potential collaborations on feral swine control on the SRS
- 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
- SREL Personnel worked the USFS-SR to explore ways to make historical rare species data easily accessible to SRS Forest Managers.
- SREL personnel continues to inform USFS-SR of habitat conditions at the Gopher Tortoise (*Gopherus polyphemus*) reintroduction 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 FY16, 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 84 graduate students (Table 2) from universities across the country in FY16. 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 FY16 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 FY16.

- SREL leveraged SRS site assets to acquire external resources to conduct UGA Maymester courses in wildlife ecology and genetics in May 2016

- SREL leveraged UGA funding against project specific funding from DOE and other sources to cost share over 25 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 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 second cohort of 13 students were funded to participate in this program during the summer of FY16. 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 and Dr. Tracey Tuberville (SREL), 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 second summer of funding we hosted 10 students using NSF funds and an additional 3 students from internal SREL funds or from South Carolina State University. These students were chosen from 61 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) Two of the students have been hired as technicians at SREL or accepted for graduate studies.
2) We nominated one student, Kyle Brown (USC-Upstate), to represent SREL at the National REU symposium in Washington, DC and he was selected to be one of 120 students presenting. These students were selected from a pool of over 600 students. Dr. Melissa Pilgrim will accompany Kyle to the symposium.
3) External evaluation of this first summer indicated that the program had a major impact on the students desire to continue in science.

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, David Scott, Larry Bryan, and Dean Fletcher. In addition two graduate students Wes Flynn and Cara Love mentored two students this summer.

External Collaborator

Dr. Melissa Pilgrim - USC-Upstate

Products

Each student was required to give a presentation and to prepare a poster of his or her work at SREL. All students traveled to USC-Columbia and participated in a summer undergraduate research symposium poster session. The following are the titles of each presentation. In addition several of these students have presented at their home institution.

1) **Sarah A. Abercrombie –** Bioaccumulation of radiocesium and mercury in diving and dabbling ducks on Four Mile Creek at the Savannah River Site.
2) **Jill S. Banach –** Contaminant leaching from reducing cementitious materials
3) **M. Kyle Brown –** Bioaccumulation of ^{137}Cs in Florida green watersnakes (*Nerodia floridana*) from three wetlands on the Savannah River Site.
4) **Deonte Burston—**Influence of long-term environmental contamination and parental body burden on metal tolerance in southern toads (*Anaxyrus terrestris*)
5) **C. Sheldon David—**Multiple stressors in larval anurans: Ranaviris and chronic copper exposure.
6) **Christian A. Dicks—**The interactions of radiation and copper on the incidence of antibiotic resistance.
7) **Emily Edwards—**Internal CO_2 change in response to reduced photosynthetic availability.
8) **Christina M. Fulghum—**Bioaccumulation and biomagnification of radiocesium in littoral zone biota from a cooling reservoir on the Savannah River Site
9) **Michaela M. Lambert—**Sublethal effects of ^{137}Cs and Hg contamination in Florida green watersnakes (*Nerodia floridana*)
10) **Brooke E. Lindell—**Distribution of trace elements and Cs-137 in sediments of a Coastal Plan stream impacted by industrial activities.
11) **Nia A. Peek—**Effects of parental and early life exposure to metals on genome methylation in two anuran species.
12) **Awmna K. Rana—**Tritium portioning in the biosphere
13) **Amelia L. Russell—**Mercury bioaccumulation in Florida green watersnake (*Nerodia floridana*) among three wetlands on the Savannah River Site.

In addition, two 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 16

Undergraduate	University	Faculty Advisor
Sarah A. Abercrombie	Purdue University	Beasley
Jill S. Banach	University of Mass. Amherst	Seaman
M. Kyle Brown	USC-Upstate	Pilgrim/Tuberville
Deonte Burston	Fort Valley State	Lance
C. Sheldon Davis	Clemson	Lance/Scott
Christian A. Dicks	Claflin University	McArthur
Emily Edwards	Univ. of Georgia	Aubrey
Christina M. Fulghum	USC-Aiken	Bryan
Michaela M. Lambert	University of Kentucky	Pilgrim/Tuberville
Brooke E. Lindell	College of Charleston	Fletcher/Seaman
Nia A. Peak	Claflin University	Scott/Lance
Awmna K. Rana	Florida International Univ.	Seaman
Amelia L. Russell	USC-Upstate	Pilgrim Tuberville

Table 10.2. SREL Graduate Student Program Participants, FY16

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
Justin Vining	M.S.	University of Georgia	Aubrey	Committee
Jinyan Yang	Ph.D.	University of Georgia	Aubrey	Committee
Tyler Reeves	M.S.	University of Georgia	Aubrey	Committee
Amanda Holland	M.S.	University of Georgia	Beasley	Advisor
Kelsey Turner	M.S.	University of Georgia	Beasley	Advisor
Sara Webster	M.S	University of Georgia	Beasley	Advisor
Ricki Oldencamp	M.S.	University of Georgia	Beasley	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
Jacob Hill	PhD.	Mississippi State University	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
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	Host
Mark Peaden	M.S.	University of California-Davis	Buhlmann	Committee
Jacob Daly	M.S.	University of Georgia	Buhlmann	Committee
Dan Quinn	M.S.	University of Georgia	Buhlmann	Committee

Student	Degree	University	SREL Faculty	Role
Max Kern	M.S.	University of California-Davis	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
Rachel Gauer Will	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
Laura Early	M.S.	University of Georgia	Capps	Committee
Eric Moody	Ph.D.	University of Georgia	Capps	Committee
Sydney Hope	M.S.	Virginia Tech	Kennamer	Host
Wesley Flynn	Ph.D.	University of Georgia	Lance	Advisor
Caitlin Rumrill	M.S.	University of Georgia	Lance	Advisor
Joshua Zajdel	M.S.	University of Georgia	Lance	Advisor
Megan Winzeler	M.S.	University of Georgia	Lance	Advisor
Austin Coleman	M.S.	University of Georgia	Lance	Advisor
Sara Webster	M.S.	University of Georgia	Lance	Committee
Eric Goolsbey	Ph.D.	University of Georgia	Lance	Committee
Jason O'Bryhim	Ph.D.	George Mason University	Lance	Committee
Schyler Nunziata	Ph.D.	University of Kentucky	Lance	Committee
Rebecca Philips	M.S.	University of Georgia	Lance	Committee
Liyun Zhang	Ph.D.	University of Georgia	Lance	Committee
Sarah Heisel	Ph.D.	University of Georgia	Lance	Host
Zoe Cooper	M.S.	Niversity of Georgia	Martin	Advisor
Douglas Fairbanks	M.S.	Brigham Young University	McArthur	Committee
Jesse Thomas	Ph.D.	University of Georgia	McArthur	Committee
Rebecca Philips	M.S.	University of Georgia	Mills	Co-Advisor
Savannah Harris	M.S.	University of Georgia	Mills	Co-Advisor
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
Erin Abernathy	M.S.	University of Georgia	Rhodes	Advisor
Jesse Thomas	Ph.D.	University of Georgia	Rhodes	Co-Advisor
Wes Flynn	Ph.D.	University of Georgia	Rhodes	Committee

Student	Degree	University	SREL Faculty	Role
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
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
Cam Nix	M.S.	Eastern Illinois University	Seaman	Host
Marcus Zokan	Ph.D.	University of Georgia	Sharitz	Committee
Bryan Nuse	Ph.D.	University of Georgia	Sharitz	Committee
Tad Dallas	Ph.D.	University of Georgia	Sharitz	Host
Matt Hamilton	M.S.	University of Georgia	Tuberville	Advisor
Dan Quinn	M.S.	University of Georgia	Tuberville	Advisor
David Haskins	M.S.	University of Georgia	Tuberville	Advisor
Nicole White	M.S.	University of Georgia	Tuberville	Advisor
Jacob Daly	M.S.	University of Georgia	Tuberville	Advisor
Lance Peadan	Ph.D.	University of CA-Davis	Tuberville	Committee
Rebecca Cozad	M.S.	University of Georgia	Tuberville	Committee
Mark Peaden	M.S.	University of CA-Davis	Tuberville	Committee
Chris Leaphart	M.S.	University of Georgia	Tuberville	Committee
Max Kern	M.S.	University of Georgia	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 ten 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).

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 FY16, DOE provided significant additional funds to allow SREL the opportunity to begin the process of bringing its facilities up to the standards of health and human safety and operating parameters necessary to conduct its mission on the SRS.

Our most significant infrastructure project this year was focused toward the ongoing renovation of our research laboratories. Our master renovation plan called for the complete renovation of 16 laboratories and this year we completed this undertaking with an overall project completion time of just less than two years. In FY 16 we completed the last 9 of the 16 laboratories scheduled for renovation.

The renovation of these laboratories was an intensive process that required the following series of steps:

- Cleaning the laboratory slated for renovation and properly disposing of, reallocating, or excessing any surplus chemicals, supplies, or equipment.
- Removing all laboratory furniture and fixtures. (cabinets, drawers, fume hoods, benches)
- Conducting a non-friable asbestos abatement. (floor tiles, mastics, and some counter tops and fume hood panels)
- Repainting lab and replacing acoustical tile ceiling.
- Installing new laboratory furniture and hoods.
- Reestablishing electrical and plumbing service to new laboratory furniture.
- Installing new LVT (luxury vinyl tile) flooring.
- Incorporating new fume hoods into ventilation system and certifying that the hoods deliver proper air flows.

We also have four laboratories that while not completely renovated, received significant upgrades this year. These upgrades included painting, new floor tile, and new acoustical ceilings.

This year we also began extensive repairs and renovations to our greenhouse complex. This complex includes eight greenhouses, a drying oven and plant grinding room, as well as a climate controlled 10x12 laboratory space. Most of these spaces were in a "moth-balled" state due to lack of available funds to correct non-working controls, broken infrastructure components, and other operational issues. DOE provided us funding to address these issues and renovations were begun this year with the goal of bringing these facilities back on line. The first step was a cleaning and removal of trash, unneeded supplies, and the excessing of surplus or broken research equipment. The greenhouses exterior was cleaned and painted, and broken glass panes were replaced. The most significant renovation step in this process involved the installation of six HVAC units to maintain the climates in four of the greenhouses. These greenhouses will now be capable of being used for a number of research endeavors where climate control is a critical factor. Our ongoing renovation plan for this complex is about 50 percent complete and we will continue these efforts into the next year.

To better accommodate our NSF funded REU undergraduate program, we also worked this year to totally renovate one of our office buildings. This facility received three new HVAC units last year, and this year we worked to completely update the building's interior. All of the carpet was replaced, all the interior spaces were painted, and we furnished eight of the fourteen office spaces with new furniture. We created a large conference space complete with large screen HD monitor, 12 person meeting table, and other collaborative furniture and fixtures. Our University of Georgia wireless network was extended to the building, and a small computer room with sharable computers was also added. To complete the renovation effort, we updated the building's break room with new cabinetry and appliances. This re-vamped facility will not only support our undergraduate program, but will give us the needed extra office capacity for our growing research staff.

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 six offices. This included re-carpeting, painting, furnishing, and making any other necessary repairs. These renovations marked our 26th office renovation over the last three years.
- **Renovation of two of our research aviaries:** We were able to bring two of these research facilities back to an operational status. To do this we carried out an extensive amount of cleaning, painting, pruning, and general repairs to these facilities.
- **Renovation of all three SREL conference rooms:** The carpet in these spaces was replaced along with re-painting the rooms and stripping down poor condition vinyl wall coverings.
- **Installation of portable storage sheds:** In an effort to insure that supplies, tools, and other research equipment is properly housed and kept in an orderly condition, we installed four 12x20 wood constructed storage sheds on SREL Property behind our main building. These spaces were then assigned to the appropriate research groups.

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, and we are

continuing to plan for a number of renovations and improvements that we hope to carry out in the coming year. Some of these projects include continued renovations of our greenhouse complex, continued laboratory improvements, and improvements to our animal holding facilities.

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 one, full-time position (SREL EH&S Manager) dedicated to the support of the SREL EH&S Program. 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 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 **14 (fourteen)** targeted lessons learned and safety notices in FY2016 to specific worker groups at SREL. Additionally, in excess of **50 (fifty)** 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 **1 (one)** work related recordable injury/illness during FY16. This represents a decreased injury/illness rate over the previous FY15 reporting period (total of two injuries). The single FY16 recordable injury was a back injury due to improper lifting technique in an indoor laboratory work environment. The worker was advised on proper lifting to prevent recurrence.

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 **40 (forty)** SREL personnel received this required training during FY15. Additionally, SREL personnel received EH&S related training during FY16 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 **480 (Four hundred and eighty)** pounds of hazardous wastes in FY16. **100 (one-hundred)** percent of the hazardous wastes generated was from disposal of laboratory research process generated wastes. 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 FY16 as the result of external or internal reviews, inspections, or assessments. During FY16, 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.

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 FY16 was $203,095.

Table 11.1. SREL Equipment Purchases in FY16.

Description	Total Cost	Category	Programs Served
XRF	$65,000	Detect major trace elements	Ecotoxicology, Biogeochemistry
qPCR	$23,795	Gene Expression	Ecotoxicology Disease Ecology Population Genetics
LAI Canopy Analyzer	$13,500	Leaf Area Index	Plant Physiology
XRD	$87,800	Measure crystalline minerals	Ecotoxicology Biogeochemistry
Ultra Low Freezer	$13,000	Store Biological Samples	Ecotoxicology; Environmental Chemistry Wildlife Ecology
Totals	**$203,095**		

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 FY16. See Task 11 (above) for summary of facilities upgrades.

SECTION III. Cost Status Report

Provided to DOE-SR budget office monthly and final FY16 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 FY16.

SECTION V. Changes in Approach or Goals

In FY16 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
- Leveraged funding for postdoctoral researchers with UGA main campus units to increase the numbers of Ph.D. level staff conducting research in collaboration with SREL faculty to address SRS research needs
- Cost sharing facilities costs such as laboratory renovations for new faculty hires with the Office of the Vice President for Research at UGA to increase the quality of SREL occupied federal facilities for cutting edge research

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 FY16, external funding (non-SRS or UGA dollars) totaled 29% of the laboratories budget, up 5% from FY15 (Section I; Section II-Task 8). 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 FY16, despite these delays.

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

Administrative
Retired – Cherie Summer

Support Staff
Hired – Marsha Wilburn

Tenure-track Faculty
Hired – Benn Parrott

Research Faculty
Hired – Guha Dahrmarajan

Postdoctoral Researchers
Hired – Dr. Xiayou Xu
Hired – Dr. Peter Schlicting

Research Professionals
Separated – Brian Croft
Separated – K. Fouts

Research Technicians
Separated – C. Burkhalter
Separated – J. Cochran
Separated – I. Davis
Separated – F. Depkin
Separated – A. Korotasz
Separated – A. Lavere
Separated – S. Mcmahon
Separated – A. Rana
Separated – A. Russell
Separated – Z. Smith
Separated – K. Woods
Separated – J Zajdel
Hired – A. Korotasz
Hired – A. Lavere
Hired – S. Mcmahon
Hired – A. Rana
Hired – A. Russell
Hired – Z. Smith
Hired – J. Zajdel
Hired – C. Boyce
Hired – C. Candal
Hired – M. Dix
Hired – C. Fulghum
Hired – B. Lindell
Hired – P Lyons
Hired – C. Roberts

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

SREL faculty and staff added 42 new publications to the SREL reprint list in FY16

3334 Dorcas, M. E. and J. D. Willson (2013). Hidden Giants: Problems Associated with Studying Secretive Invasive Pythons. Chapter 19. *Reptiles In Research: Investigations of Ecology, Physiology, and Behavior from Desert to Sea*. W. I. Lutterschmidt (ed.). New York, Nova Science Publishers, Inc.: 367-385.

3335 Nafus, M. G., B. D. Todd, K. A. Buhlmann and T. D. Tuberville (2015). "Consequences of maternal effects on offspring size, growth and survival in the desert tortoise." Journal of Zoology 297(2): 108-114.

3336 Nunziata, S. O., D. E. Scott and S. L. Lance (2015). "Temporal genetic and demographic monitoring of pond-breeding amphibians in three contrasting population systems." Conservation Genetics 16(6): 1335-1344.

3337 Pruett, C. L., L. Wan, T. Li, C. Spern, S. L. Lance, T. C. Glenn, B. C. Faircloth and K. Winker (2015). "Development and characterization of microsatellite loci for common raven (*Corvus corax*) and cross species amplification in other Corvidae." BMC Research Notes 8(655): 1-4.

3338 Graham, C. F., T. C. Glenn, A. G. McArthur, D. R. Boreham, T. Kieran, S. L. Lance, R. G. Manzon, J. A. Martino, T. Pierson, S. M. Rogers, J. Y. Wilson and C. M. Somers (2015). "Impacts of degraded DNA on restriction enzyme associated DNA sequencing (RADSeq)." Molecular Ecology Resources 15(6): 1304-1315.

3339 Finger Jr., J. W., R. J. Williams, M. T. Hamilton, R. M. Elsey, V. A. Oppenheimer, S. D. Holladay and R. M. Gogal Jr. (2015). "Influence of Collection Time on Hematologic and Immune Markers in the American Alligator (*Alligator mississippiensis*)." Journal of Immunoassay and Immunochemistry 36(5): 496-509.

3340 Fletcher, D. E., A. H. Lindell, G. K. Stillings, G. L. Mills, S. A. Blas and J. V. McArthur (2015). "Trophic Variation in Coastal Plain Stream Predatory Fishes." Southeastern Naturalist 14(2): 373-396.

3341 Hamilton, M. T., J. W. Finger Jr., M. E. Winzeler and T. D. Tuberville (2016). "Evaluating the effect of sample type on American alligator (Alligator mississippiensis) analyte values in a point-of-care blood analyser." Conservation Physiology 4(1): 1-7.

3342 Vukovich, M., K. L. Turner, T. E. Grazia, T. Mims, J. C. Beasley and J. C. Kilgo (2015). "Wintering Golden Eagles on the coastal plain of South Carolina." Journal of Field Ornithology 86(4): 337-344.

3343 Luhring, T. M., G. M. Connette and C. M. Schalk (2016). "Trap characteristics and species morphology explain size-biased sampling of two salamander species." Amphibia-Reptilia 37(1): 79-89.

3344 Kennamer, R. A. (2003). "Recoveries of Ring-Necked Ducks Banded on the U.S. Department of Energy's Savannah River Site, South Carolina." The Oriole 68(2003): 8-14.

3345 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(8): 650-659.

3346 Graham, C. F., R. L. Eberts, T. D. Morgan, D. R. Boreham, S. L. Lance, R. G. Manzon, J. A. Martino, S. M. Rogers, J. Y. Wilson and C. M. Somers (2016). "Fine-Scale Ecological and Genetic Population Structure of Two Whitefish (Coregoninae) Species in the Vicinity of Industrial Thermal Emissions." PLos ONE 11(1): 1-20.

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

- Dr. J Vaun McArthur was named Outstanding Teacher of the Year in the Odum School of Ecology
- SREL graduate students won over 14 awards for presentations at regional, national or international meetings
- SREL research was highlighted in print, TV, and web-based media hundreds of times, particularly for radioecological research in Belarus and Japan
- Numerous SREL faculty were asked to serve as peer reviewers on national funding panels for NSF, USDA, and other entities