SAVANNAH RIVER
ECOLOGY LABORATORY

ANNUAL TECHNICAL PROGRESS REPORT OF ECOLOGICAL RESEARCH FOR FY15

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SECTION I: Savannah River Ecology Laboratory – FY15 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 the 2015 fiscal year was fulfilled with the publication of 55 journal articles and several book chapters by faculty, technical staff, students, and visiting scientists. One book was also authored by SREL faculty and staff. Additional journal articles and books have been submitted or are in press. Significantly, SREL conducted over 450 outreach events reaching over 38,000 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 104 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 FY15, DOE-SR funding was leveraged to acquire approximately $600,000.00 in new 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 (2 of 3 in place in FY15) and a portion of three new tenure track faculty lines on the main UGA campus (3 of 3 in place in FY15) 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. The current Cooperative Agreement with DOE allows SREL/UGA access to the SRS through 30 November 2016. 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 FY15, 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 35 new and continuing external grants during FY15 and increased non-SRS external funding levels significantly in FY15. 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 FY15 and SREL faculty and staff mentored over a dozen undergraduate students and over 69 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 360 talks, 41 tours, 20 exhibits, and 31 ***Ecologist for a Day*** Programs reaching a total of over 38,000 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 potential for production of biofuels on the SRS to increase energy independence on the SRS, decrease fuel costs for SRS fleet operations and increase the prominence of the SRS in development of green energy alternatives, 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 FY15 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 FY15, the Savannah River Ecology Laboratory received approximately 7 million dollars in funding from a variety of sources (Figure 2.1). These funds supported approximately 105 faculty, staff, and students conducting basic and applied environmental research for at least some portion of FY15 (Table 2.2). In total, University of Georgia funding (both direct and indirect funds returned to the lab) and external dollars received from non-SRS sources were responsible for approximately 38% of the laboratories budget. Laboratory personnel were productive and successful in attracting external funding to the site, and very active in graduate student education and service to their communities and professions (Table 2.2). SREL continues to be a productive, independent partner to DOE on the SRS and an excellent value to both stakeholders on the SRS and taxpayers.

Figure 2.1. Overview of funding received by SREL in FY15. 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).

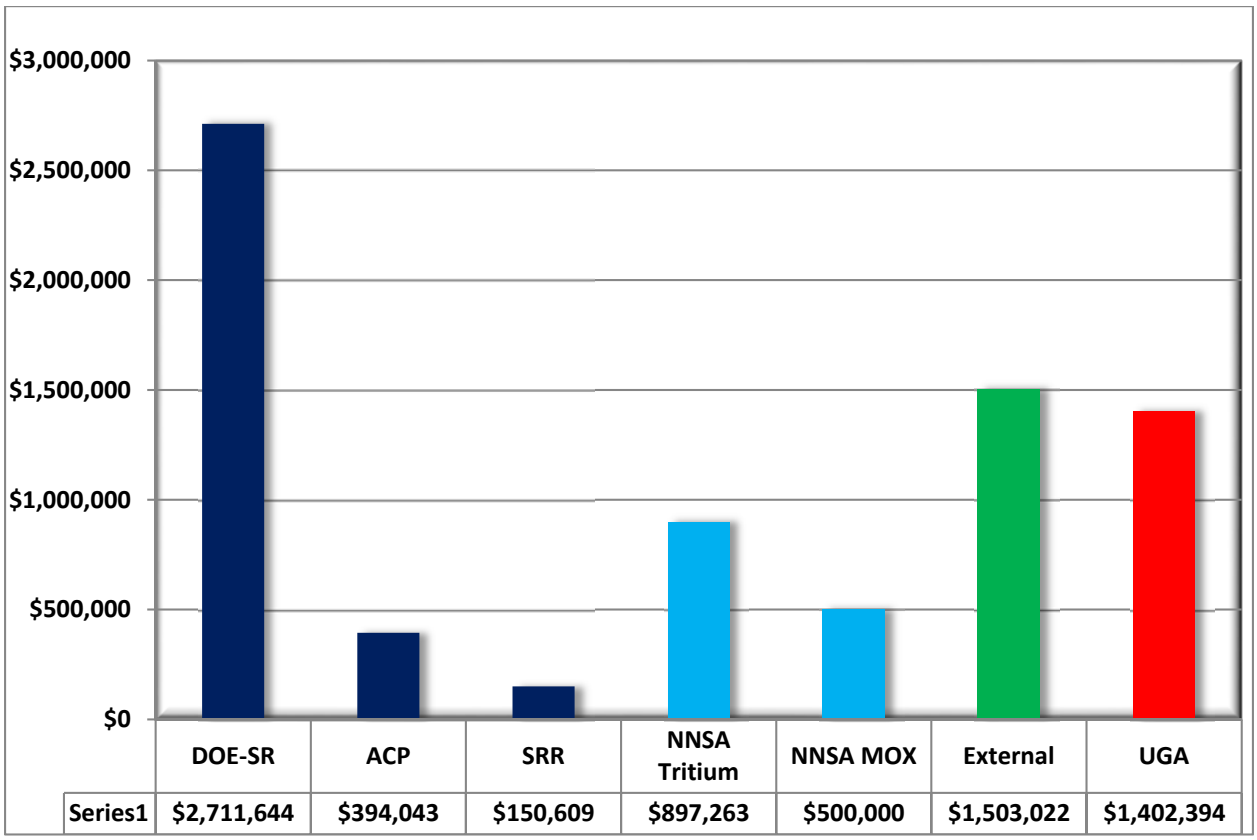

Table 2.2. SREL organizational structure for FY15. This table includes all research faculty, classified staff and Emeritus faculty in residence at the Savannah River Ecology Laboratory for any portion of the FY15 fiscal year.

SREL ORGANIZATIONAL CHART – FY14	
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 **Tenure Track Faculty** Dr. J. Beasley Dr. D. Aubrey Dr. James Martin Dr. Dalia Abbas Dr. Krista Capps **Emeritus Faculty in Residence** Dr. D. Adriano Dr. I. Brisbin, Jr. Dr. J.W. Gibbons Dr. K. McLeod Dr. R. Sharitz **Post Docs** Dr. M. Byrne Dr. J. Smith Dr. S. Unger Dr. S. Weir Dr. A. Kremer Dr. D. Coyle Dr. F. Coulet Dr. L. Kierepka **Research Professionals** Dr. K. Buhlmann R. Beasley A. Bryan D. Fletcher R. Kennamer L. Lee A. Lindell D. Scott P. Stankus B. Croft K Fouts **Research Technicians** R. Juarez R. Biemiller B. Harris E. Bledsoe S. Dean C. Burckhalter J. Cochran I. Davis K. Eckhart D. Fraser A. Jones C. Kupar J. Leapart B. Lindell A. Mustion L. Paden Z. Ross P Walkup K. Woods S. Weathersbee J. O'Brynim N. Fletcher N Bossenbroek A. Coleman F. Depkin	**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 **Administrative Services** L. LopezdeVictoria M. Roberts B. Giddens C. Summer V. Taylor M. Wead
	(As of 10/1/2015)

Table 2.2. Summary of professional activities and accomplishments by Savannah River Ecology Laboratory research faculty, research professionals, postdocs and students in FY15.

Publications and Reviews	Total
Peer Reviewed Journal Articles	55
Book and Book Chapters	3
Proceedings Articles	2
Primer or Other Scientific Notes	7
Non-Peer reviewed Articles	23
Articles In Press	29
Articles In Review	60
Peer Review of Manuscripts Conducted	58
External Funding (non-SRS)	**Total**
External Grants Submitted as PI or CoPI	49
External Grant Funding Submitted as PI or CoPI	$7,748,625
External Grants Funded as PI or CoPI[1]	35
External Grants Funded Dollars as PI or CoPI	$ 1,503,022
Graduate Education and Postdocs	**Total**
MS Graduate Students Chaired	22
MS Graduate Students Completed	7
PhD Graduate Students Chaired	3
PhD Graduate Students Completed	0
Graduate Student Committee Memberships	47
Graduate Students Hosted at SREL	23
Post Docs Supervised	7
Presentations	**Total**
Invited Presentations	16
Professional Oral Presentations	83
Professional Poster Presentations	59
Extension Presentations	23
Extension Publications	59
Other	**Total**
Awards or Honors	4
Professional Society Committee Memberships	16
Staff Teaching Courses for UGA	9
Technical Research Consultations	44

[1] – includes new grants and contracts, renewals and continuations associated with funding sources external to DOE. Total includes multi-year funding commitments received in FY15 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 FY15 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

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

Funding Entity
SRNS Area Closures Projects
Start Date and Funding Amount
October 1, 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) use new data with 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
In the winter of 2013-14, 34 coots were trapped from L-Lake and transported to Pond B where they were banded, their wing-feathers were scissored (i.e., pinioned), and they were released. Sixteen of these coots with known residency times on Pond B were collected (shot) to determined whole-body, muscle, and liver radiocesium levels. In the winter of 2014-15, 50 coots and 56 ring-necked ducks were trapped at L-lake and transported to Pond B where they were banded, their wing-feathers were scissored, and they were released. Nineteen of the released coots and 36 of the released ring-necked ducks with known residency times were then subsequently collected to determine whole-body, muscle, and liver radiocesium levels. In total, radiocesium concentrations for muscle and liver tissue samples from the 35 coots and 36 ring-necked ducks were determined. In the summer of 2015, a student (Josh King from USC-Aiken) participating in SREL's NSF-sponsored Research Experience for Undergraduates (REU) program collected lower GI content samples from the coots and ring-necked ducks collected in this study, processed and counted these samples for radiocesium, and related ratios of GI content and muscle tissue radiocesium concentrations to known residence times on Pond B to examine the efficacy of using this ratio as a predictor of time spent on Pond B by birds collected with unknown residence times.
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 16.82 years (95% CI=12.91-24.19 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 Joshua King the honor of being one of only 120 REU program participants from around the county to participate in a National REU Symposium.

Major Impact(s) of Research

1) For American coots, long-term radiocesium body burden data were useful to produce estimates of contaminant natural attenuation and will be important for site remediation decision making.
2) Continued periodic waterfowl collections at contaminated SRS reservoirs will be useful to refine estimates of contaminant natural attenuation rates and track progress of the 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 - UGA
Joshua King, REU undergraduate student - USCA
Chris Leaphart, Research Technician - SREL

External Collaborators

N/A

Products

King, J.D., R.E. Oldenkamp, R.A. Kennamer, A.L. Bryan, Jr., and J.C. Beasley. Residence time as a determinant of radiocesium uptake by migratory waterfowl using Pond B on the Savannah River Site. SREL Undergraduate Student Symposium 2015. (Oral Presentation).

King, J.D., R.E. Oldenkamp, R.A. Kennamer, A.L. Bryan, and J.C. Beasley. Radiocesium uptake in ring-necked ducks using a contaminated reservoir on the U.S. D.O.E. Savannah River Site. University of South Carolina 2015 Summer Research Symposium, Columbia, SC, July 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
Due to the timing of receipt of funding for this project, no field work has begun yet. All aspects of this research will be beginning the fall/winter of 2015-16.
Conclusions
1) No conclusions can be drawn at this point since field research on this project does not begin until the fall/winter of 2015-16.
Major Impact(s) of Research
1) None identified yet.
Other Project Personnel
Ricki Oldenkamp, MS Student - UGA
Chris Leaphart, MS Student - UGA
External Collaborators
N/A
Products
No publications, presentations, or reports have yet been prepared.

Contaminant Bioaccumulation and Trophic Relationships in Beaver Dam Creek Biota from the D-Area Coal Combustion Waste Plume

Funding Entity
SRNS Area Closures Projects
Start Date and Funding Amount
September 2009; $290,000
PI and co-PI's
Dean E. Fletcher, Angela H. Lindell, and Dr. J Vaun McArthur – SREL
Objectives
We proposed to establish how and to what extent aquatic organisms in Beaver Dam Creek on the SRS were at risk from contaminant bioaccumulation by documenting inter- and intra-specific variation of levels of a suite of metals and metalloids in species ranging from herbivorous invertebrates (< 2 cm in length) to large predatory fishes (> 1 m in length). We also completed an annotated bibliography of ecological work done in the D Area and Beaver Dam Creek system.
Summary of Research Activities
On the Savannah River Site, coal combustion waste (CCW) had been produced by the D Area Power Plant since the early 1950's and stored in basins that discharged into Beaver Dam Creek (BDC). Beaver Dam Creek is a highly modified system. The headwaters were channelized during the early infrastructure construction of the SRS between 1951 and 1956 to transport effluents from the D Area Power plant and associated ash and coal pile runoff basins to the Savannah River. Flow patterns in the upper three km of BDC were established with field reconnaissance and GIS resources. Field collections were made at two sites in BDC headwaters that differed in hydrologic regimes. Cessation of release of pumped water into BDC has since reduced the perennial stream length. Stable isotope analyses ($\delta^{13}C$ and $\delta^{15}N$) were employed to establish trophic relationships among study organisms. Trace element analyses (As, Ba, Be, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Se, TI, V, Zn, Cs and Sr) assessed contaminant bioaccumulation. Over 500 trace element samples and nearly 400 stable isotope samples were analyzed.

We are comparing taxa that differ in trophic position, feeding habits, habitat use, size, and longevity. Within taxa, the influence of size and ontogenetic trophic shifts are being accounted for. Inclusion of two invertebrate herbivores that differ significantly in habitat use and feeding behavior is exploring a baseline of the introduction of materials into the food web from primary producers and is a critical component of stable isotope studies. Further movement through or introduction of contaminants into the food web is being addressed in a comparison of eight dragonfly genera that differ in habitat use, particularly in reference to their exposure to sediments. Additionally detailed studies are comparing three species of bullhead catfish (*Ameiurus sp.*) that also differ in morphology and habitat use. Inclusion of four top level predatory fish allowed comparison of elements entering the food web with those in the top predators. Large predatory fish included channel catfish (*Ictalurus punctatus*), largemouth bass (*Micropterus salmoides*), longnose gar (*Lepisosteus osseus*) and bowfin (*Amia calva*). Muscle tissue was analyzed for all fish, and liver and gonad tissues were analyzed from a subset of individuals. Data from exploratory contaminant assays were also conducted on biofilm and sediments. Data collection has been completed and work extracting publications from the final report continue.
Conclusions
1) Contaminants were entering and moving through the food web in species and element specific patterns.
2) Some contaminants accumulated to levels sufficient to be of ecological and possibly human health concern, although source of contaminants has not been confirmed.
3) Fish livers effectively sequester some elements preventing accumulation in muscle, whereas others bioaccumulate in muscle.

Major Impact(s) of Research

1) Our detailed comparisons between and within species are establishing an information base that can aid in the design of future studies, interpret existing data and support site-wide risk models.

Other Project Personnel

Garrett Stillings, Research Professional - SREL

David Kling, Research Professional - SREL

External Collaborators

Susan Blas – SRNS-ACP

Products

Fletcher, D.E., A.H. Lindell, G.K. Stillings, G.L. Mills, S.A. Blas, and JV. McArthur. 2015. Trophic variation in coastal plain stream predatory fishes. *Southeastern Naturalist* 14:373-396.

Fletcher, D.E., A.H. Lindell, G.K. Stillings, G.L. Mills, S.A. Blas, and JV. McArthur. 2014. Variation in trace element accumulation in predatory fishes from a stream contaminated by coal combusiont waste. *Archives of Environmental Contamination and Toxicology* 66:341-360.

Fletcher, D.E., A.H. Lindell, G.K. Stillings, G.L. Mills, S.A. Blas, and JV. McArthur. 2014. Spatial and taxonomic variation in trace element bioaccumulation in two herbivores from a coal combustion waste contaminated stream. *Ecotoxicology and Environmental Safety* 101:196-204.

Fletcher, D.E., A.H. Lindell, G.K. Stillings, and JV. McArthur. 2011. Contaminant Bioaccumulation and Trophic Relationships in Beaver Dam Creek, Savannah River Site. Phase I Final report submitted to SRNS-ACP, 177 pp.

Lindell, A.H., C. Tant, D.E. Fletcher, and JV. McArthur. 2011. Annotated Bibliography for the Savannah River Site's Beaver Dam Creek. Report to SRNS-ACP, 54 pp.

Lindell, A.H., D.E. Fletcher, G.L. Mills, and JV. McArthur. Contaminant bioaccumulation and trophic characterization of top-level predatory fishes. Annual Meeting of the American Fisheries Society, Seattle, WA, September 2011 (Poster).

Lindell, A.H., G.L. Mills, G.K. Stillings, JV. McArthur, and D.E. Fletcher. Contaminant bioaccumulation and trophic characterization of top-level predatory fishes. Annual Meeting of the Southeastern Fishes Council, Chattanooga, TN, November 2011 (Poster).

Stillings, G.K., A.H Lindell, G.L. Mills, JV. McArthur, and D.E Fletcher. Contaminant bioaccumulation and trophic characterization of two herbivorous invertebrates. Annual Meeting of the Southeastern Fishes Council, Chattanooga, TN, November 2011 (Poster).

Fletcher, D.E., A.H. Lindell, G.K. Stillings, G.L. Mills, and J V. McArthur. Trophic characterization and differential trace element accumulation in congeneric catfishes (Ictaluridae: *Ameiurus*). Annual Meeting of the Society of Environmental Toxicology and Chemistry, Nashville, TN, November 2013 (Poster).

Lindell, A.H., G.L. Mills, J V. McArthur, and D.E. Fletcher. Taxonomic and spatial variation in trace element bioaccumulation in odonate nymphs in a stream receiving coal combustion waste. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Nashville, TN, November 2013 (Poster).

McArthur, JV., G.L. Mills, A.H. Lindell, and D.E. Fletcher. Taxonomic and spatial variation in trace element bioaccumulation and stable isotope analysis in odonate nymphs in a stream receiving coal combustion waste. Joint Aquatic Sciences Meeting, Portland, OR, May 2014. (Oral Presentation).

Fletcher, D.E., A.H. Lindell, G.L. Mills, and JV. McArthur. Differential accumulation of coal combustion contaminants in stream organisms: effects of trophic level and body size. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Vancouver, BC, November 2014. (Poster).

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
Our objectives are to: 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, we collected biological samples from alligators and aquatic turtles inhabiting contaminated and uncontaminated aquatic habitats on the SRS, focusing this fiscal year primarily on aquatic turtles. In addition, we completed a selenium dietary exposure experiment with yellow-bellied sliders, the most ubiquitous turtle species on the SRS. We also mentored two undergraduate research interns who investigated contaminant levels in blood and nails and sublethal effects on immune system and metabolic rates in mud turtles, an omnivorous turtle common in a number of contaminated and uncontaminated sites on the SRS. We continued monthly population counts of alligators in Par Pond and L-Lake reservoirs. Finally, in collaboration with Dr. Beasley, we administered questionnaire-based surveys to people who hunt or fish in South Carolina and Georgia at two wildlife expositions in South Carolina. The goal of the questionnaires is to characterize hunting and game consumption patterns for game species, including turtles and alligators. In addition, over the life of the grant, we have also: 1) analyzed tissue samples from our initial alligator experiment investigating dietary exposure to coal combustion waste (CCW)-contaminated prey; 2) conducted screening for *Ranavirus* in aquatic turtles on the SRS using archived blood samples from 288 individuals of 8 species collected from 2008-2014; and 3) developed a protocol to successfully extract corticosterone from alligator scutes and alligator and turtle nails for quantifying long-term stress.
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) Although a mud turtle (*Kinosternon subrubrum*) from Risher Road sloughs captured Spring 2014 was documented to have severe Ranaviral infection and to have later died, subsequent screening for Ranavirus in multiple aquatic turtles across the SRS has failed to reveal any other actively infected

individuals. Based on current evidence, Ranavirus does not appear to be a significant threat to aquatic turtle populations on the SRS at this time. However, the screening test only detects actively infected individuals, which may exhibit extreme lethargy and rapid mortality – both of which severely limit detectability of disease.

6) Corticosterone can be successfully extracted from both alligator scutes and alligator and turtle nails, suggesting they should be useful measures of long-term chronic stress in long-lived reptiles.
7) 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) Baseline data regarding prevalance of Ranavirus in populations of aquatic turtles across the SRS.
3) Incorporation of new biological endpoints for evaluating sublethal effects of contaminants on alligators and freshwater turtles.
4) 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

David Scott, Research Professional – SREL
Dr. Stacey Lance, Associate Research Scientist – SREL
Bess Harris, Temporary Research Technician – SREL
Matt Hamilton, MS Student – UGA
David Haskins, MS Student – UGA
Amanda Jones, Temporary Research Technician – SREL
Naya Eady, REU student – Trinity Washington University
Jarad Cochran, REU student – University of South Carolina, Upstate

External Collaborators

John Finger - Interdisciplinary Toxicology Program, UGA
Dr. Terry Norton – Georgia Sea Turtle Center
Dr. Travis Glenn – Environmental Health Science, UGA
Dr. Nicole Stacy – University of Florida
Dr. Elizabeth Howell - College of Veterinary Medicine, 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. *In press*. 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*.

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

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. *In review*. Hepatic and renal concentrations in American alligator (*Alligator mississippiensis*) following chronic dietary exposure to coal fly ash contaminated prey. Submitted to: *Environmental Pollution*.

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

Hamilton, M.T., J.W. Finger, Jr., R.M. Elsey, and T.D. Tuberville. Measuring long-term stress in American alligators (*Alligator mississippiensis*): a validation study. Joint Meeting of Society for Study of Amphibians and Reptiles / Partners in Amphibian and Reptile Conservation, Lawrence, Kansas. July 2015. (*poster*).

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

Funding Entity
SRNS Area Closures Projects
Start Date and Funding Amount
November 2014; $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 FY 2015, 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 2014 based on soil core samples ranged from ≈ 74.3 to 95.5 %, 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 47.2 to 88.7% between plots, with a yearly average of 77.6 ± 12% 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 except for one sampling occasion, March 2014, when the levels of 1, 4 dioxane in the soil water were 3.8 and 6.4 $\mu g\ L^{-1}$ for samples from plots 13 and 19, respectively.
5) Soil water extraction and tritium analysis for soil cores collected as part of the 2015 calendar End-of-Year efficiency report is ongoing.

Other Project Personnel
Matt Baker, Graduate Student - UGA
Jarad Cochran, Research Technician - SREL
External Collaborators
N/A
Products
Beuttner, S.W. and J.C. Seaman. 2015. Estimating Evapo-Transpiration Losses for Tritium at the MWMF: 2014 End of Year Summary Report. Final report submitted to SRNS-ACP January 30, 2015.
Seaman, J.C. 2016. Estimating Evapo-Transpiration Losses for Tritium at the MWMF: 2015 End of Year Summary Report. In Preparation.

Chemical and Physical Properties of Saltstone as impacted by Curing Environment

Funding Entity
Savannah River Remediation (SRR)
Start Date and Funding Amount
December 2014; $125,842
PI and co-PI's
Dr. John C. Seaman - SREL
Objective
The project objective for 2015 was to evaluate the physical and chemical properties of saltstone monoliths, produced utilizing Savannah River Remediation LLC (SRR) prescribed grout formulations, spiked with either non-radioactive contaminant analogs (i.e., Re and ^{127}I) or ^{99}Tc and subjected to a range of curing durations under controlled temperature and humidity conditions chosen to mimic curing conditions within a Saltstone Disposal Unit (SDU).
Summary of Research Activities
Two batches of saltstone were produced utilizing Savannah River Remediation LLC (SRR) prescribed grout formulations. One was spiked with stable iodine-127 (^{127}I) and rhenium (Re) to serve as non-radioactive analogs for iodine-129 (^{129}I) and technetium-99 (^{99}Tc) (hereafter referred to as the I/Re spiked monoliths), and the second batch was spiked with ^{99}Tc for comparison. The relative concentrations of I, Re and ^{99}Tc in the saltwaste simulants were consistent with the average concentrations of ^{129}I and ^{99}Tc in the Tank 50 feed waste at the Saltstone Disposal Facility (SDF). Both batches were subjected to varying curing durations under controlled temperature and humidity conditions chosen to mimic curing conditions within Saltstone Disposal Unit (SDU) Cell 2B.

Contaminant mass transfer rates for the I/Re and the ^{99}Tc spiked monoliths were evaluated using EPA Method 1315, Mass Transfer Rates of Constituents in Monolithic or Compacted Granular Materials Using a Semi-Dynamic Tank Leaching Procedure (USEPA, 2013). For comparison, nitrate (NO_3^-) leaching was also evaluated for the ^{99}Tc spiked saltstone as a poorly retained saltwaste constituent. Given the importance of redox conditions in controlling the mobility of the studied contaminants, the EPA mass transfer test was conducted using an artificial groundwater (AGW) simulant as the leachate in equilibrium with three different test atmospheres: (1) ambient laboratory atmosphere (oxic), (2) Ultra High Purity (UHP) N_2 (99.999% N_2) purged atmosphere (anoxic), and (3) 98% N_2% H_2 atmosphere (anoxic reducing).

Results from EPA Method 1315 were also compared to a novel Dynamic Leaching Method (DLM) developed by SREL in which the flexible-wall permeameter was used to achieve saturated leaching under an elevated hydraulic gradient in an effort to evaluate the persistence of reductive capacity and subsequent changes in contaminant partitioning within the intact saltstone monolith. In the current study, two three-inch diameter ^{99}Tc spiked saltstone monoliths were tested in comparison to earlier tests using two-inch diameter I/Re spiked saltstone monoliths. The larger diameter samples were tested in an effort to increase the rate of leaching and pore solution turnover at reasonable pressure gradients. Tests using the larger diameter monoliths were largely unsuccessful due to cracks that developed under moderate pressure gradients, leading to bypass flow. Subsequent testing using two-inch ^{99}Tc spiked saltstone monoliths were successful with ^{99}Tc leaching rates that were much lower than previous results observed for Re under similar leaching conditions, further supporting the conclusion that ^{99}Tc is immobilized to a greater degree.
Conclusions
1) Based on EPA Method 1315, the cumulative release history for both Re and I conformed to a diffusion controlled mechanism. For Re, the lack of response to extraction atmosphere may reflect the difficulty in achieving reduction, with similar amounts of Re(VII) available for release regardless of the atmospheric conditions.

2) Based on EPA Method 1315, Re, I and NO_3^- displayed similar diffusivities and leachability indices (LIs), indicating very limited immobilization within the saltstone.
3) The effective diffusivities for ^{99}Tc were about two orders of magnitude lower than the values observed for I and Re, ranging from 2.0×10^{-10} to 3.7×10^{-10} cm^2 s^{-1}, with the LIs ranging from 9.7 to 10.0, consistent with values previously reported for ^{99}Tc leaching from low-activity waste Hanford Cast Stone formulations (LI = 9.7-11.2).
4) Tc-99 leaching was also insensitive to the test extraction atmosphere. This suggests that maintaining a high degree of saturation during curing and subsequent leaching serves as a barrier to contaminant oxidation in the case of ^{99}Tc, even when exposed to an oxygenated atmosphere.

Major Impact(s) of Research

1) EPA tests and DLM results indicate that Re is a poor analog for ^{99}Tc behavior in reductive saltstone materials.
2) DLM results suggest that Tc leaching from Saltstone is controlled by the solubility (i.e., Tc ≈ 5×10^{-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

Shea Buettner, Research Professional – SREL

External Collaborators

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

Products

Seaman, J.C. 2015. Chemical and Physical Properties of ^{99}Tc-Spiked Saltstone as Impacted by Curing Duration and Leaching Atmosphere. Submitted to SRR October 1, 2015.

Seaman, J.C. H.S. Chang, S. Buettner, and S. Simner. 2015. Rhenium (Re) As a Surrogate for Technetium (Tc) Partitioning in Radioactive Waste Materials. 2015 Annual ASA/SSSA/CSA Meetings. Minneapolis, MN, Nov. 15-18.

Thomas, R.J., J.C. Seaman, and H.S. Chang. 2015. Rhenium (Re) As an Analog for Technetium (Tc) in Environmental Sorption Experiments. 2015 Annual ASA/SSSA/CSA Meetings. Minneapolis, MN, Nov. 15-18.

Evaluating the Potential for Sulfate Attack at the Saltstone Disposal Facility

Funding Entity
Savannah River Remediation (SRR)
Start Date and Funding Amount
July 2015; $35,853
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 representative of the 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") will be 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. Additional samples are reserved for sectioning and microscopic analysis by Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Analysis (EDXA) to evaluate changes in concrete composition and structure at the microscopic level.
Conclusions
1) A laboratory bench test system was developed and an initial set of 13 SDU 4"x 8" concrete cylinders were immersed in saltwaste test solution to visually evaluate changes in appearance and physical integrity over the next calendar year.
2) SREL is currently developing a test platform for equilibrating SDU test cylinders under elevated temperatures (68 °C) that occur during saltstone curing.

Major Impact(s) of Research
1) In collaboration with SRR and DOE, SREL tested several potential solution recipes 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 is also being used to evaluate the suitability of concrete coatings that may be applied to the SDU concrete structure (ASTM G20).

Other Project Personnel
Jarad Cochran, Research Professional – SREL
External Collaborators
Dr. S. Simner – SRR
Products
Proposed Simulant Salt Solution for Evaluating the Resistance of SDU Concrete to Chemical Attack. G-ESR-Z-00018. Rev 0.

Preliminary Contaminant Analyses in Selected Game Species on the Savannah River Site

Funding Entity
SRNS Area Closure Project (ACP)
Start Date and Funding Amount
December 2014; $39,500
PI and Co-PIs
Larry Bryan, Dr. Jim Beasley, Robert Kennamer and Dr. Gary Mills - SREL
Objectives
We are completing a 2+ year study documenting the levels of contaminants of concern, primarily radiocesium and metals/metalloids (including mercury), in tissues of wild pigs, waterfowl, squirrels and other "game" (e.g.; raccoons & beaver) from various regions of the SRS. Our goal is to generally assess if SRS-associated contaminants are reaching levels of concern in game species that could leave the SRS and potentially be consumed by the hunting public. We also will use manipulative experiments to quantify temporal patterns in uptake of metals/metalloids for waterfowl utilizing the D-area ash basins.
Summary of Research Activities
In the second year of the study, and after discussions with ACP, we limited our new collections (to waterfowl) and expanded our analyses of archived SRS hog samples. We also acquired samples of non-SRS hogs (south-central Georgia) for comparison. At present, all of the collected tissues have been analyzed for metals (including mercury) and radiocesium. Data on tissue concentrations of the various elements is being summarized for the final project report (due in late December, 2015). Additional manipulative experiments to quantify uptake rates of metals/metalloids in waterfowl in the D-area ash basins were completed in 2015 and are being summarized for publication.
Conclusions
1) This research was completed in 2015.
2) Waterfowl muscle and liver samples continue to exhibit the highest concentrations of metals (As, Hg & Se) of the game species, especially those collected from the D-Area ash basins. Waterfowl samples from Pond B exhibited the highest radiocesium levels, with approximately 50% at or exceeding levels of concern for human consumption.
3) Raccoon muscle and liver samples have higher concentrations of selenium and selected other metals compared to other mammalian game species on SRS, possibly due to a more omnivorous diet and the number of samples collected near the D-Area ash basins.
4) Selenium and mercury concentrations in SRS pig samples are greater than the "control" (south central Georgia) samples. Control samples had higher concentrations of chromium than SRS pig samples.

Major Impact(s) of Research
1) The reported concentrations/levels of selected metals and radiocesium in game species collected on the SRS will be incorporated into on-site, IOU-specific ecological and human risk assessments generated by SRNS/SRNL. In a larger sense, these efforts will assist DOE in maintaining an environmental stewardship policy that minimizes the likelihood of public exposure to contaminants of concern.
2) This research will produce the most comprehensive information to date on uptake rates for metals/metalloids of concern in migratory waterfowl utilizing ash settling basins, data that will be used to assess risk to people (typically hunters) and other wildlife potentially consuming contaminated waterfowl.

Other Project Personnel
Ricki Oldenkamp, MS Student – UGA
Chris Leaphart, temporary research technician - SREL
External Collaborators
N/A

Products

Oldenkamp, R.E., A.L. Bryan Jr., R.A. Kennamer, J.C. Beasley. 2015. Arsenic, selenium, and mercury in waterfowl exposed to coal combustion wastes and consumption risks to human hunters. Presented at The 22nd Annual Wildlife Society Conference, Winnipeg, Manitoba.

Oldenkamp, R.E., A.L. Bryan Jr., R.A. Kennamer, J.C. Beasley. 2015. Trace elements in waterfowl exposed to coal combustion wastes and risks. Presented at The Georgia Wildlife Society Conference, Athens, GA.

Oldenkamp, R.E., J.C. Beasley. 2015. Metals/Metalloids in game species of the Savannah River Site, SC. Presentation at the Warnell Graduate Student Association Symposium, Athens, GA. *First place award*.

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

Funding Entity
SRNS Area Closure Project
Start Date and Funding Amount
February 2015; $40,000
PI and Co-PIs
Larry Bryan, Dr. Gary Mills, Angela Lindell - SREL
Objectives
We are in the 2nd 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, whereas the current study (2nd year) is focused on the SRSS region and includes analyses of sediments, biofilms and biota from sites in the Fourmile component of the SRSS as well as up-river "control" wetlands in the SRSS associated with Crackerneck. These control wetlands likely receive potential mercury inputs associated with the Savannah River and/or atmospheric deposition, but should not have any potential input from Fourmile. All samples are to be analyzed for total mercury and a subset will be analyzed for methylmercury.
Summary of Research Activities
In year 2 we collected sediment, biofilm, and fish samples, as well as aquatic invertebrates (e.g.; crayfish and insects) and amphibians (when present), for mercury analysis within 7 sites in the SRSS associated with Fourmile Branch and 8 sites within the SRSS associated with Crackerneck. We deployed DGT probes (diffusive gradient in thin films) at all locations to examine mercury/methylmercury in the water column and sediments. All sampling occurred in late summer as we tried to match the seasonal timing of the monitoring that historically documented the elevated mercury levels. All samples have been prepped for mercury analyses and analyses have just been initiated.
Conclusions
1) We collected 281 biota samples from the Fourmile SRSS sites, including 166 fish (14 total species), 56 amphibians (adult and larval stages), and 59 aquatic invertebrates (primarily crayfish and aquatic beetles). Additionally, we collected sediment and biofilm samples from each site.
2) We collected 263 biota samples from the Crackerneck SRSS sites, including 138 fish (10 total species), 6 amphibians (adult and larval stages), and 119 aquatic invertebrates (primarily crayfish and aquatic beetles). We also collected sediment and biofilm samples from each site.
3) Mercury (total) analysis of all collected samples has just been initiated. Once completed, a subset of these 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 this system. Mercury/methylmercury data from the current samples from the Fourmile SRSS region will be compared to up-river control sites and can be assessed to determine if this portion of the SRSS is still of regulatory concern.

Other Project Personnel
Nick Bossenbroek, research technician – SREL
E.J. Borchert, research technician - SREL
External Collaborators
N/A
Products
No publications, presentations, or reports have yet been prepared.

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 collected samples of sediment, biofilms and biota of varying trophic levels to determine the degree of radiocesium uptake by these components in three aquatic systems on the SRS: Pond A/R Canal (highly contaminated), Pond 2 (less contaminated), and Fire Pond (control). Biological samples in addition to biofilms included aquatic invertebrates (insects and crayfish), amphibians (larval and adult stages), fish, and reptiles (snakes). 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
Over 1,000 biological samples (total) were collected from the three sites in 2015. For all samples, R Canal had higher radiocesium contamination than Pond A and Pond 2, which had higher contamination than Fire Pond, our control. Our initial analysis was focused on amphibian trophic pathway (sediments to biofilms to larval frogs to adult frogs). The preliminary findings for the amphibians suggest that while radiocesium accumulation occurs at all levels, biomagnification along this pathway is not occurring. We are currently analyzing the remaining biota (insects, crayfish, fish, and reptiles) for radiocesium levels to better understand if trophic transfer is occurring along different pathways. We will extend this study into 2016 to collect additional samples (filling data gaps for certain species) and possibly examine radiocesium accumulation over time to determine uptake curves.
Conclusions
1) For all samples analyzed to date (sediments, biofilms, larval and adult frogs), R Canal samples had higher radiocesium contamination than Pond A and Pond 2 samples, which had higher contamination than Fire Pond samples.
2) Within the amphibian trophic pathway, our data suggest that while radiocesium accumulation occurred at all levels, biomagnification is not occurring. It is possible the reduction of accumulation by adult frogs (relative to larval stages) is due to a shift from an aquatic to a more terrestrial diet.

Major Impact(s) of Research
1) When completed, we will have a better understanding of uptake rates in biota from aquatic systems with a range of a radiocesium contamination. These rates can be utilized by ACP to assess potential risks to humans and wildlife. We will also have a better understanding of the potential for biomagnification within these systems.

Other Project Personnel
James Leaphart, MS student –UGA
Alexis Korotasz, REU student – Stetson University
External Collaborators
N/A
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 2013; $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 – UGA
Dr. James Beasley, Assistant Professor – SREL
Erin Abernethy, M.S. Student – UGA
Kelsey Turner, MS Student - UGA
External Collaborators
Dr. Travis Glenn – UGA
Products
No publications, presentations, or reports have yet been prepared.

Potential Production of Oilseed-based Biofuels on the SRS

Funding Entity
DOE-EM Support to SREL
Start Date and Funding Amount
October 2013; $40,000
PI and Co-PIs
Olin Rhodes - SREL
Objectives
To evaluate the potential for production of biofuels from oilseed crops in right-of-ways on the Savannah River Site.
Summary of Research Activities
In year 2, nine 2ha study areas on the SRS were planted with cotton, soybean and peanuts (3 sites each) and herbicide applications were made for each site and crop type. Crops were grown without irrigation and wildlife were allowed access to sites with the exception of 2, 10x10ft exclosures within each site. Crops were evaluated for success relative to wildlife impacts and crop growth and yield.
Conclusions
1) This research identified cotton as promising crop for oilseed production on the SRS.
Major Impact(s) of Research
1) This research will provide insights into the potential for cultivation of oilseed crops for production of diesel biofuels for use on the SRS as well as into the potential challenges that may need to be overcome to achieve this objective.
Other Project Personnel
Linda Lee, Research Professional – SREL
External Collaborators
Dr. Dewey Lee – UGA
Products
No publications, presentations, or reports have yet been prepared.

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 FY15

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 emphasize 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 more than 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 FY15

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. Our main accomplishment this past year was the installation and startup of the University of Georgia's Paws-Secure wireless network inside our main building 737-A. This project required DOE approval and the signal strength had to be mapped and confined to a specified DOE boundary. This Wi-Fi system will not allow connection to our central computing network but will only provide access to the internet and UGA email. Only SREL employees with UGA issued ID numbers are able to access this Wi-Fi network, and this capability will allow us to more cost effectively support our large number of students and technicians with the IT capabilities that their positions require. We also made several other improvements to our IT systems in FY15 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 Primary Backup server.** Replaced a 6 year-old server with a new one for better performance and reliability.

3. U**pgraded Server anti-virus software to Endpoint 2014**. This keeps the anti-virus software up-to-date on our servers.

4. **Installed a new mirror server.** This server mirrors our primary data server to help insure agented data loss.

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

6. **Use Zenworks to deploy R and R Studio to all researches desk top.** This gives all researchers easy access needed statistical software.

7. **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.

We are also in the process of developing a long-range plan for replacing some of our smaller, dated, servers and older operating programs. Our goal is to continually improve our system to effectively protect our valuable data and provide our staff with the IT resources needed to accomplish their objectives.

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.

In 2007 SREL's data archiving system was crippled by loss of the server that supported it. The data were recovered, but were not easily accessible. Technological advances in data management tools provided additional incentives to upgrade. In FY14 SREL began the transition to a modern, full-featured system similar to that in use at the University of Georgia's Sapelo LTER. By the close of FY14, a dedicated server had been set up; databases had been created and populated from a variety of source materials; and processing of legacy files had begun.

Activity in FY15 focused mainly on the addition of project metadata and data files from the legacy system, and web coding. At the close of FY15, migration of metadata and data was nearly complete. Also during FY15, the web application for accessing the data was developed and released within SREL for user testing and feedback. Projects can now be easily retrieved by metadata searches, such as study year or investigator, and most search results have the data files attached. Relevant prints are also attached to the search results. Projects and reprints have also been linked to the database of active personnel, so that they are attached to the researcher's profile. Spatial data for SREL research sites has also been added, though more information is required to link them to the project files. Once linked, the archive will be searchable by location as well.

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 FY15

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 from encroaching 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-Aside Areas are critical to the DOE's Environmental Stewardship mission: they provide for long-term study sites as well as sanctuary and protection to much of the SRS's sensitive flora and fauna, as well as protecting many archaeological sites. They also serve as benchmarks or baseline controls for conducting ecological risk assessments, contaminant transport studies, and site remediation and restoration work. They exist today in strong support of the SRS being a National Environmental Research Park.

Administration and Management of the Set-Aside Areas – Under the existing Cooperative Agreement with the DOE, 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 reintroduction of prescribed fire to some sites, 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.

- Craig's Pond Set-Aside was burned in early October, 2014. The primary objective was to reduce woody growth (primarily loblolly pine and gallberry) in the ecotone and bay margin. Hog rooting created a somewhat patchy burn in the bay interior, but the ecotone on the northeast side burned especially well. Sarracenia Bay was burned at the same time but did not carry as well. Energy Solutions did not participate.

- The Old UGA Lab Site was burned in January, 2015. Many studies were conducted here when a portion of it was maintained as old-field habitat. Since then it had shifted to a less diverse community with heavy fuel loads in some areas. Fuels will be gradually reduced, as at Flamingo Bay, to avoid damaging older pines present on the site. Both in terms of habitat and the presence of occupied buildings nearby, reintroduction of regular prescribed fire is desirable.

- The Mona Bay and Woodward Bay Set-Aside was burned in mid-March, 2015. Standing water in Mona Bay did not prevent the fire from burning additional invading pines along the bay margin that had survived the prescribed fire in 2011.

- Thinning, fire, and boundary expansion of Cypress Bay Set-Aside were discussed as part of this year's MEY Project Plan.

- A portion of the Ginger's Bay boundary line was re-marked.

- For the first time, state-endangered gopher frog egg masses have been observed at Thunder Bay.

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 example, SREL began developing a spatial component to the long-term turtle data that has been collected over several decades on the SRS. Existing GIS data from other sources have been cross-walked with the turtle database to fill in all previously documented locations. The resulting geographic data set has been mapped to provide an easy reference point for digitizing the remaining missing locations. Capturing the spatial component will greatly enhance the value of this important long-term dataset.

Current research in SRS Set-Asides

- Archaeologists with the USC-Savannah River Archaeologist Research Program (SRARP) continued their investigations at Flamingo Bay. Human use of this site is now known to span approximately 13,000 years. This site has yielded important insights into both bay formation processes and patterns of human activity in the early Holocene.

- 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.

- Research on habitat use of state-endangered gopher frogs 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. Craig's Pond, Sarracenia Bay, and Mona Bay, all known as gopher frog breeding sites, held egg masses this year. In addition, two egg masses were found at Thunder Bay, not previously known as a breeding site for this species.

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

- The amphibian community at the Rainbow Bay Amphibian Reserve Set Aside has been monitored for 37 consecutive years, during which time local extinctions, species colonizations,

and dramatic population fluctuations have occurred. Researchers are also investigating genetic changes over time for mole and marbled salamanders to better understand how population size relates to genetic diversity, which is important for conservation efforts. Genetic analyses for Rainbow Bay and Ginger's Bay were published in this year in *Conservation Genetics*.

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

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

- Rainbow Bay Amphibian Reserve, Cypress Bay, Ellenton Bay, Mona and Woodward bays, Flamingo Bay, Craig's Pond and Sarracenia Bay, and Ginger's Bay served as sampling locations for SREL's Research Experiences for Undergraduates (REU) student projects.

- Research on predator-prey interactions between snakes and songbirds in Field 3-412 has been completed and the student received his Ph.D.

- UGA researchers continue to sample zooplankton assemblages in several Set-Asides containing seasonal wetlands. Comparison with existing scientific literature indicates that the SRS zooplankton community is 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.

- 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.

- Thunder Bay served as a reference site for a graduate researcher comparing invertebrate scavenging communities around contaminated and uncontaminated wetlands.

- SREL's Outreach Program continues to use the E.P. Odum Wetland Set-Aside as an outdoor classroom during its enormously 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.

- The E. P. Odum Wetland Set-Aside was used to collect aquatic insects for a stream ecology station at SREL's annual lab-wide outreach event, Touch an Animal Day.

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 FY15 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
February 2015; $286,355
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 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 uses information from SREL research that is ongoing as well as from long-term research efforts to provide training and services to MOX and other SRS employees and to educate the public locally, regionally, and nationally about ecological research findings associated with on-site activities.

NNSA has provided critical funding that has allowed SREL to accomplish the goal of maintaining SRS and public outreach programs in order to enhance the understanding of environmental issues affecting the SRS and to increase general ecological awareness. Consistent with the goals of DOE and NNSA, this past year, SREL provided information and presentations to schools and programs in addition to resource materials demonstrating the ecological health of the SRS, and the importance of environmental stewardship and National Environmental Research Park (NERP) programs on the SRS. Accordingly, the Outreach program

remained available to conduct Lunch and Learn presentations to site personnel at the MOX facility and provide tours for DOE site interns and new MOX employees. SREL developed and distributed literature and developed displays on animals and plants native to the SRS, 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 and community events. Issues as diverse as wildlife safety in the field, wildlife population declines, potential responses of organisms to contamination, distribution and abundance of sensitive 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 communicated information about environmental activities on the SRS for more than two decades based on ecological research conducted on site by SREL scientists. The Outreach program's communication efforts through numerous presentations and exhibits annually, coupled with SREL's credibility with the general public, have greatly aided in raising awareness of the rich ecological diversity of the MOX area on the SRS and the region in general, in order to encourage people to appreciate their setting, engage in environmental stewardship, and protect environmental integrity on and off the site.

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 41 scheduled tours; estimated number of attendees – 1,215 (includes 23 SRS Public Tours, estimated attendees – 869; 18 tours for on-site employees/visitors, estimated attendees – 346)
2) Provided 8 Wildlife Safety talks; estimated number of attendees – 496 (includes 3 talks to SRS employees, estimated attendees – 122; 5 talks to professional groups – estimated attendees 374)
3) Presented 295 classroom education programs for elementary and secondary students; estimated number of attendees –17, 408
4) Provided 33 environmental outreach presentations to college, civic, and professional groups; estimated number of attendees –1,600
5) Provided 20 exhibits at local and regional events; estimated number of attendees – 14,098 (includes 6 career exhibits at schools, estimated attendees – 4,754; 6 science night at schools, estimated number of attendees – 1,218; 1 SRS Info POD in Augusta, Ga., estimated number of attendees – 98)
6) Conducted 31 ***Ecologist for a Day*** programs (school field trips to SREL's Conference Center);
7) estimated number of attendees – 814
8) Conducted 1 ***Touch an Animal Day*** event (August 22, 2015 at SREL's Conference Center); estimated number of attendees – 477
9) Provided 24 presentations at regional library summer reading programs – estimated number of
10) attendees –1,947

***Total Outreach events: 453; total estimated attendance: 38,055**

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

Funding Entity
NNSA - MOX
Start Date and Funding Amount
February 2015; $213,645
PI and co-PI's
Dr. Olin E. Rhodes, Jr, Dr. J Vaun McArthur and Dean Fletcher – 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.

In FY 15, we analyzed a total of 108 composite sediment samples collected from sandy runs and depositional zones in our five study streams. Additionally, a total of 412 dragonfly, 365 crayfish, and 105 crane fly samples were analyzed. From composite samples of each media category, 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. Contaminants stored in bottom sediments were primarily found in depositional zones where finer sediments and organic matter tend to settle out. Positive correlations between most element concentrations and organic matter content reflect this trend. Contaminant levels did not appear particularly high in our samples. Analyzing contaminant accumulation in macroinvertebrates is enhancing our assessments by verifying which contaminants detected in the sediments are bioavailable and actually entering the stream community. Macroinvertebrates are known to accumulate a variety of contaminants and represent trophic links between primary production and higher trophic level vertebrates. Preliminary statistical analyses suggest macroinvertebrates to integrate exposure to contaminants. Extensive macroinvertebrate community surveys conducted in FY15 will further establish the present condition of U8 relative to reference streams and its 2009 condition.
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) Negative relationships with water velocity and positive relationships with organic matter and clay content resulted in higher trace element concentrations in sediments of depositional zones. Sediment clay content was increased in U8 due to scouring down to bed clay.

4) Scouring by excessive flows has reduced organic matter content in the streams, potentially influencing stream energetics and contaminant dynamics.
5) Contaminants did not appear to be accumulating to high levels in sediment of our U8 samples, but pulses of contaminants being flushed from extensive depositional zones have been identified in other systems. In FY 16, such extensive depositional zones will be evaluated in U8.
6) Preliminary analyses suggest macroinvertebrates to be better integrators of biological available contaminants. Contaminant statistical analyses will be completed in FY16.

Major Impact(s) of Research

1) We will assess potential impacts of MOX construction and other activities in the U8 drainage. Condition of physical habitat will be assessed as will the biotic communities.
2) Extensive contaminant analyses combined with the physical characterization will help 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 will propose 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

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 1 2014; $375,829
PI and co-PI's
Dr. Stacey Lance and David Scott – SREL
Objectives
Our research at the H-02 constructed wetland complex focuses primarily on several questions related to these treatment wetlands: 1) Over time, what amphibians, reptiles, and plants have become established in the wetlands? 2) Do the elevated trace metal levels (e.g., copper and zinc) in the wetlands affect amphibian reproductive success, disease ecology, and population dynamics? 3) How do the amphibian diversity and numbers compare to other, more natural, wetlands? and 4) As the constructed wetlands age, how will the amphibian community respond?

Summary of Research Activities
This report summarizes our amphibian studies related to the H-02 treatment wetlands from October 2014 to September 2015. We used aquatic trapping to characterize biota of the treatment wetlands. We followed up on our southern toad mesocosm experiment by rearing metamorphs to five months of age. We completed a second field season examining the influence of wetland hydroperiod on the prevalence of two amphibian diseases, chytridiomycosis and ranavirus, in ambystomatid salamanders. We also expanded that study to include several species of anurans. To more directly examine the effect of copper on disease susceptibility we conducted an experimental challenge. To do this we reared marbled salamander larvae under conditions of no and low levels of copper. After 30 days we exposed them to known concentrations of ranavirus and then reared them fro an additional 30 days. We also finished a population model examining the relative importance of climate change and copper contamination on viability of southern toad and southern leopard frog populations. Rainbow Bay and other isolated wetlands serve as comparison sites for the H-02 amphibian studies. We completed the 37th 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. Finally, along with our summer undergraduates, we examined the bioaccumulation of mercury in amphibians from wetlands across the SRS.

Conclusions
1) Southern toad juveniles exposed to copper as larvae had significantly reduced survival at five months after metamorphosis.
2) Incidence of the fungus that causes chytridiomycosis, *Batrachochytrium dendrobatidis*, decreased from 22% to 0% in the H-02 wetlands, indicating the potential for temporal cycling of disease prevalence.
3) Our population model indicates that for southern leopard frogs, climate change poses a more serious risk than copper exposure. However, copper exposure increases the odds of local extinction.
4) Southern toads can be at risk of local extinction due to either copper exposure or climate change impacts.
5) Copper exposure did not affect susceptibility of marbled salamanders to ranavirus
6) Exposure to ranavirus caused a sharp decline in growth rate.
7) Amphibians inhabiting shorter hydroperiod wetlands accumulate significantly more mercury than those in longer hydroperiod wetlands.
8) 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.

Major Impact(s) of Research

1) Our continued time series of metal concentrations in the H-02 system (in sediments, water, and biota) will enable informed assessment of how this type of constructed treatment wetland functions, and whether it provides suitable wildlife habitat in addition to enhancing water quality.
2) Our mesocosm studies demonstrate the importance of looking a) at multiple stressors, b) beyond the larval period, and c) at multiple source populations. We found significant latent effects that lead to completely different conclusions than the larval study alone—although larval exposure to low-level copper concentrations did not affect larval survival, effects on juvenile survival were apparent five months later, largely due to Cu effects on body size at metamorphosis.
3) Our disease studies are ongoing, but are demonstrating the complexity of variables involved with disease incidence and prevalence in amphibians. The nature of the wetland—metal-contaminated vs. clean, permanent vs. ephemeral, and constructed treatment wetland vs. natural— impacts disease prevalence and variables are confounded with each other.
4) 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

Scott Weir, Postdoctoral scholar, SREL
Wes Flynn, PhD student, UGA
Caitlin Rumrill, MS student, UGA
Megan Winzeler, MS student, UGA
Austin Coleman, research technician, SREL

External Collaborators

N/A

Products

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Love, C.N., Winzeler, M.E., Beasley, R., Scott, D.E., Nunziata, S.O., and S.L. Lance. Patterns of amphibian disease prevalence across contaminated and uncontaminated wetlands on the Savannah River Site, SC. *PlosOne (in review).*

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Lance, S.L., Love, C.N., Winzeler, M., Nunziata, S.O., Beasley, R., Coleman, A. and D.E. Scott. Patterns of prevalence of two amphibian diseases, Ranavirus and Chytridiomycosis, across wetlands on the Savannah River Site. Third International Symposium on Ranaviruses. Gainesville, FL. USA.

Rumrill, C.T., Bringolf, R., Davis, A., and S.L. Lance. Larval and post-metamorphic consequences of aquatic stressors in southern toads (*Anaxyrus terrestris*). Master's Defense. Odum School of Ecology, Athens, GA.

Rumrill, C.T., Scott, D.E., and S.L. Lance. The chronic effects of larval exposure to multiple stressors in southern toads, *Anaxyrus terrestris*. Association of Southeastern Biologists. Chattanooga, TN.

Rumrill, C.T., Scott, D.E., and S.L. Lance. The chronic effects of larval exposure to multiple stressors in southern toads, *Anaxyrus terrestris*. Southeastern Ecology and Evolution Conference. Athens, GA. (Platform)

Rumrill, C.T., Scott, D.E., and S.L. Lance. The chronic effects of larval exposure to multiple stressors in southern toads, *Anaxyrus terrestris*. Odum School of Ecology Graduate Research Symposium. Athens, GA.

Weir, S.M., Scott, D.E., Salice, C.J., and S.L. Lance. 2015. Population-level consequences of copper toxicity and climate variability on southern toads. European meeting of the Society of Environmental Toxicology and Chemistry, Barcelona, Spain.

Weir, S.M., Lance, S.L., and D.E. Scott. 2015. Long-term monitoring of salamander energy subsidies in the Southeast suggests aquatic flux is more common than terrestrial flux and highly dependent on hydroperiod for five salamander species. Annual meeting of the Ecological Society of America, Baltimore, MD, USA.

Weir, S.M., Scott, D.E., Salice, C.J., and S.L. Lance. 2015. Understanding the population-level consequences of copper toxicity and climate variability on amphibians inhabiting contaminated environments. Annual meeting of the Association of Southeastern Biologists, Chattanooga, TN, USA.

Winzeler, M.E., D. E. Scott, and S. L. Lance. Influence of Natural and Anthropogenic Stressors on Amphibian Response to Disease. Odum School of Ecology Graduate Student Symposium, Athens, GA.

Winzeler, M. E., D. E. Scott, and S. L. Lance. Multiple Stressors and Amphibian Disease. Aquatic Ecosystem Health: Third International Symposium on Ranaviruses. Gainesville, FL.

Tritium Distribution and Cycling on the Savannah River Site

Funding Entity
NNSA
Start Date and Funding Amount
November 2015; $93,449
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
Installed the Carbolite MTT 12/38/850 combustion furnace system with associated chemical oxidation unit for OBT extraction from plant and animal tissues. Currently relocating the system to an alternate lab and continuing "method" development and evaluation using traceable ^{3}H-labeled organic compounds (i.e., ^{3}H-labeled glucose). At present sample combustion and moisture recovery is insufficient, requiring excess sample mass for typical ^{3}H analysis. The current system is being modified to improve recovery based on conversations with colleagues (Dr. S.B. Kim et al) at Chalk River Laboratories, Chalk River Canada. We are currently discussing SREL's participation in an inter-laboratory comparison of OBT extraction systems.

We have continued to collect and archive soil and vegetation sample materials, including woody and herbaceous plant tissues, from various locations in the central SRS area, including sites within and adjacent to the tritium phytoremediation plots. We continue to conduct conventional fluid extraction for soil and vegetation samples. We repaired and upgraded the 1200 Quantulus liquid scintillation counter (LSC) located at the Par Pond facility to improve low level ^{3}H analysis capabilities.
Conclusions
Conclusions to date are based on conventional tritium extractions methods.
1) When exposed to a tritium source other than atmospheric deposition, fluid tritium levels in plants and animals increase with increasing exposure level and decrease with precipitation.
2) When the tritium source is removed, the biological half-life of fluid based tritium is relatively short, ≈ 2 days for rodent species.

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
Dr. James Beasley, Assistant Professor – SREL
Robert Thomas, M.S. Student – UGA
Matt Baker, M.S. Student – UGA

External Collaborators

Dr. S.B. Kim - Chalk River Laboratories

Dr. Rhett Jackson - UGA

Products

No publications, presentations, or reports have yet been prepared.

H-02 Constructed Wetland Studies—Metal Biogeochemistry

Funding Entity
NNSA - Tritium
Start Date and Funding Amount
October 1 2014; $302,190
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; and (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.
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 (FY-12 to FY 14) and showed the wetland removes 60-80% of the total metals released from the Tritium Reprocessing Facility discharge waters.
Sediment Chemistry
Analysis of sediment cores collected during summer and winter seasons continue to show that Cu, Zn, and Pb continue to increase in the upper 5 cm of the wetland sediments with little accumulation in the deeper (15-30 cm), sulfide-laden layer. Although sulfide minerals are not visually apparent in the surface sediments, reactive sulfides can accumulate to geochemically relevant concentrations by diffusion from the deeper sulfide mineral layer. Consequently, we initiated a survey of reactive sulfide concentrations, measured as acid volatile sulfides (AVS), in the surface sediments. We coupled this with the analysis of simultaneously extracted metals (SEM) that are co-extracted with the sulfides. When the SEM/AVS ratio, calculated in molar concentrations (μmol/g), exceeds 1.0, metals are considered to be mobile and potentially bioavailable. When SEM/AVS values are less than 1.0, the metals are assessed to be primarily bound to sulfides and, consequently relatively immobile and less bioavailable. This is a well-established approach for assessing mobility and bioavailability in both reducing and suboxic sediments. AVS concentrations in H-02 constructed wetland surface sediments (flocculent and surficial sediments to approximately 5 cm in depth) ranged from 1.0 to 2.4 μmol/g dry sediment. The flocculent layer alone averaged 2.1 ± 0.7 μmol/g and accounted for 64.6% of the total, significantly higher than the underlying mineral surficial layer, which averaged half that amount, with 1.2 ± 0.5 μmol/g. Total SEM (SEM-Cu, Zn, and Pb) in the combined (averaged) sediment layers ranged from 7.7 ± 6.7 to 23.3 ± 2.1 μmol/g dry sediment, with Cu contributing 3.1 ± 2.9 to 7.4 ± 0.5 μmol/g, Zn contributing 4.5 ± 3.8 to 15.8 ± 3.3 μmol/g, and Pb contributing 0.1 ± 0.1 to 0.2 ± 0.1 μmol/g. The flocculent layer accounted for an average of 20.1 ± 5.0 μmol/g total SEM, equivalent to 59.2% of combined flocculent and surficial average total SEM,. Overall, SEM-Cu was significantly higher in the flocculent layer than the surficial layer. There were no significant differences in layer composition regarding SEM-Zn or Pb. For all sampling locations, the surficial sediment SEM/AVS ratio well exceeded 1, with an average ratio of 10.5 ± 2.1 indicating the metals are potentially mobile and bioavailable.

Metal Accumulation in Macroinvertebrates

Analyzing contaminant accumulation in macroinvertebrates is enhancing our assessments by verifying levels of contaminants entering wetland communities. Macroinvertebrates are known to accumulate a variety of contaminants and represent trophic links between primary production and higher trophic level vertebrates. We continued processing samples collected in FY14 in a study evaluating contaminant accumulation in nymphs from six sites distributed throughout the H-02 wetland system and from two reference sites. These analyses will be completed early in FY16.

Conclusions

1) The H-02 constructed wetland effectively reduces Cu and Zn concentrations in the Tritium Facility discharge wastewater to achieve SCDEHC regulatory limits.
2) Metal sulfides are present in the surface sediments and sequester about 10% of the Cu, Zn and Pb. However, most of the metals are associated with organic matter or other minerals that may be mobile or bioavailable.
3) 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
Savannah Harris, Graduate Student – UGA
Rebecca Philipps, Graduate Student – UGA
Brooke Lindell, Undergraduate Student – College of Charleston.

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.

Harris, S.M., Mills, G.L., and R.R. Philipps. Effects of sediment resuspension events on metal sulfide stability in a constructed wetland. Southeastern meeting of the Geological Society of America, Nashville, TN, October, 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 FY15, 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 214 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
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
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 FY15 project specifically 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).
Conclusions
1) Data are currently being analyzed and have produced only preliminary results on the FY15 project.
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 - None in FY15

Effect of Bait Type and Persistence Time on Scent Station Visitation Rates by Carnivores

Funding Entity
SREL
Start Date and Funding Amount
September 2013; NFP
SREL Collaborators
Dr. James C. Beasley
Objectives
The objectives of this study are to 1) evaluate visitation rates of common carnivores in the southeastern U.S. to scent stations baited with fatty acid tablets against a suite of alternative carnivore-based attractants, and 2) evaluate latency to detection of each lure for individual carnivore species as well as the influence of sampling period length on visitation rates and population estimates.
Summary of Research Activities
During fall 2013 we conducted 178 scent station trials across the SRS. Trials were balanced among 5 lure types: fatty acid, synthetic fermented egg, fish oil, beaver castor, and skunk essence. Trials were conducted for 2 weeks and we monitored visitation using Reconyx infrared remote cameras. All camera images from the 2013 trials have been analyzed and additional trials have been planned for fall 2014.
Conclusions
From those experiments conducted to date, coyote, bobcat, and striped skunk all exhibited significant differences in visitation frequencies among bait types. From these preliminary results it appears fish oil and skunk essence, not the commonly used fatty acid tablets are most effective for attracting carnivores to scent stations. Overall synthetic fermented egg had the lowest average latency to detection followed closely by fish oil and skunk essence. These results, although preliminary, suggest fatty acid tablets, which are the most commonly used carnivore attractant for scent station research, may be less efficient than other common lures in attracting carnivores.
Major Impact(s) of Research
1) Scent stations are one of the most common methods used to survey carnivore abundance and thus this research will provide important guidance to refine and improve methodology to survey a suite of carnivore species.
2) This research will determine the optimal lures and survey duration periods necessary to maximize efficiency of carnivore scent station surveys.

Other Project Personnel
Sarah Webster, M.S. Student – UGA
James Leaphart, Research Technician – SREL
External Collaborators
N/A
Products
Webster, S., and J.C. Beasley. 2014. Evaluation of scent lures for carnivore scent station surveys. Warnell Graduate Student Symposium. Athens, GA. (*Poster Presentation*).

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 2014; $35,000.00
SREL Collaborators
Dr. Olin E. Rhodes, Jr. and Dr. James C. Beasley
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.
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 samples have been collected for this research and currently are being 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 microsatellite loci that perform well in both scat and tissue samples and are currently using these markers to quantify rates of scat degradation under natural conditions.
Major Impact(s) of Research
1) This research will provide 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 will produce 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 wild pigs.

Other Project Personnel
David Keiter, M.S. Student - UGA
Shem Unger, Postdoctoral Research Associate – SREL
Dr. Elizabeth Kierepka, Postdoctoral Research Associate – SREL
External Collaborators
Dr. Frederick Cunningham - USDA
Dr. Toni Piaggio - USDA
Dr. Kim Pepin - USDA
Products
D.A. Keiter, 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.*

D.A. Keiter, 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*).

E.M. Kierepka, 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*).

D. Keiter, 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*).

Sub-lethal health effects of chronic exposure to contaminants in raccoons and wild pigs

Funding Entity
SREL, University of Florida
Start Date and Funding Amount
August 2013; NFP
SREL Collaborators
Dr. James C. Beasley
Objectives
The overall goals of this research are to quantify body burdens of contaminants in raccoons from both control and contaminated sites on the SRS and evaluate a suite of potential sub-lethal health effects in those animals. Specifically, we are looking at the effects of contaminants on blood chemistry, parasite burdens, and changes in gut microbiota.
Summary of Research Activities
From August-December 2013, samples (blood, muscle, liver, feces, etc.) were collected from raccoons captured throughout upper three runs and the D-area ash basins on the SRS. Upon collection, samples were frozen or shipped to a diagnostic laboratory for further analysis. Twenty eight raccoons have been collected and necropsied for this research. These data indicate raccoons from contaminated sites have elevated body burdens of selenium in particular, but no differences in blood chemistry (e.g., red blood cell counts, white blood cell counts, etc.) or gut microbiota have been documented. A manuscript detailing these findings is nearly complete. However, raccoons from the ash basins harbored elevated helminth parasite abundance and diversity than the control site.
Conclusions
1) Raccoons sampled from the D-area ash basins had significantly higher burdens of copper, arsenic, and selenium in their liver tissue than individuals sampled from reference locations.
2) Although raccoons with higher copper concentrations had more diverse and higher endoparasite burdens, no other adverse health effects were observed in raccoons exposed to higher levels of contaminants.

Major Impact(s) of Research
1) Raccoons are good sentinels of metal and metalloid pollution.
2) Metal/metalloid levels observed in raccoons sampled in the vicinity of the D-area ash basin are below the threshold believed needed to cause adverse effects in mammals and no adverse effects were observed in comparison with individuals sampled from a nearby uncontaminated site.

Other Project Personnel
Sarah Webster, M.S. Student – UGA
Ricki Oldenkamp, M.S. Student – UGA
External Collaborators
Dr. Samantha Wisely – University of Florida
Felipe Hernandez – University of Florida
Products
Hernandez, F, S. Wisely, and J.C. Beasley. (2014). Are raccoons good sentinels of heavy metal contamination? A wildlife health perspective. Florida Cooperative Fish and Wildlife Research Unit. Gainesville, FL. (*Poster Presentation*).

Hernandez, F, S. Wisely, and J.C. Beasley. (2014). Are raccoons good sentinels of heavy metal contamination? A wildlife health perspective. Ecohealth. Montreal, Canada. (*Poster Presentation*).

Hernandez, F., R. Oldenkamp, S.C. Webster, S. Wisely, J.C. Beasley, and L. Farina. 2015. Are raccoons (*Procyon lotor*) and their intestinal helminths good sentinels of metal contamination - a wildlife health perspective. American Society of Mammalogists. Jacksonville, Florida, USA. (*Poster Presentation*)

Hernandez, F., R. Oldenkamp, S. Wisely, J.C. Beasley, and L. Farina. 2015. Helminths of raccoons: are they sensitive to heavy metal pollution? – a wildlife health perspective. University of Florida Emerging Pathogens Institute. Gainesville, Florida. (*Poster Presentation*)

Hernandez, F., R. Oldenkamp, S. Webster, J.C. Beasley, L.L. Farina, and S.M. Wisely. *Accepted with Revisions.* Are raccoons (*Procyon lotor*) and their intestinal helminths sensitive to trace element contamination? – An ecosystem health perspective. *Ecological Indicators*

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.
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
Analyses are ongoing for this research; there are no conclusions at this time.
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 will produce RB degradation models that will allow 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 - UGA
James Leaphart, Research Technician - SREL
External Collaborators
Dr. Frederick Cunningham - USDA
Dr. John Kilgo - USFS-SR
Mark. Vukovich - USFS-SR
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.

Effect of Carcass Size and Habitat on Vertebrate Scavenging Dynamics

Funding Entity
Joseph Jones Ecological Research Center, SREL
Start Date and Funding Amount
May 2013; $21,665.00
SREL Collaborators
Dr. James C. Beasley and Dr. Olin E. Rhodes, Jr.
Objectives
The objective of this study is to evaluate the influence of 1) carcass size, 2) habitat, 3) season, and the interaction of these variables on the composition and efficiency of vertebrate scavenging communities in the southeastern U.S. In addition, this research will investigate the impact of red imported fire ants and mesopredator exclusion on vertebrate scavenging dynamics.
Summary of Research Activities
For this research, rat, rabbit, and feral pig carcasses were placed within each of 4 habitat types common throughout the SRS: 1) clearcuts, 2) mature pine stands, 3) young pine stands, and 4) bottomland hardwoods. Twelve stands of each habitat type were selected for this study, for a total of 48 trials of each carcass type. In addition, rabbit carcasses were placed in control stands as well as red imported fire and treated stands and stands where mesopredators were excluded. Trials were conducted from 2013-2015For each trial, we placed a single remote camera proximal to the carcass and monitored scavenger activity for up to 1 month, or until the carcass was completely removed.
Conclusions
1) Scavenger community composition differs substantially as a function of carcass size and season, with increased diversity during the winter owing to longer carcass persistence.
2) The proportion of carcasses scavenged by vertebrates increases as a function of carcass size.
3) Vertebrate scavenging communities are incredibly resilient as exclusion of red imported fire ants and mesopredators failed to reduce the efficiency of vertebrate communities at acquiring scavenging resources.

Major Impact(s) of Research
1) This is the most comprehensive study of the effects of habitat and carcass size on scavenging dynamics and nutrient cycling to date and will greatly enhance our understanding of energy flow, and potentially contaminant transport, within food webs.
2) This research will inform our understanding of the effects of forestry practices on the fate of carrion in southeastern landscapes.

Other Project Personnel
Kelsey Turner, M.S. Student – UGA
Erin Abernathy, M.S. Student – UGA
Zachary Smith, Research Technician – SREL
Lincoln Oliver, Research Technician – SREL
External Collaborators
Dr. Mike Conner – Joseph Jones Ecological Research Center
Products
Turner, K, E. Abernethy, O.E. Rhodes, Jr., and J.C. Beasley. The Effects of Carcass size, Habitat Type, and Season on Scavenging Communities in the Coastal Plain of the Southeast. Warnell School of Forestry and Natural Resources Symposium, Athens, GA, February 2014 (*Oral presentation*).
Turner, K., E. Abernethy, O.E. Rhodes, Jr., and J.C. Beasley. 2014. Effects of carcass size and habitat type on the composition and efficiency of vertebrate scavenging communities. The 21st Annual National Meeting of the Wildlife Society. Pittsburgh, PA.
Turner, K., M. Conner, and J.C. Beasley. 2014. The effect of species exclusions on scavenging community dynamics. Georgia Chapter of the Wildlife Society Annual Meeting. Tifton, GA.

Turner, K.L., E.F. Abernethy, O.E. Rhodes, Jr., and J.C. Beasley. 2015. The effects of carcass size, habitat type, and season on scavenging communities. 2015 Warnell Graduate Student Association Annual Symposium, Athens, GA. *2nd Place award*.

Laatsch, L., J.B. Smith, and J.C. Beasley. 2015. What Scavenges the Ultimate Scavenger? The Fate of Black Vulture Carcasses on the Savannah River Site. Savannah River Ecology Laboratory Research Experiences for Undergraduates Symposium, Aiken, SC

Turner, K.L., E.F. Abernethy, L.M. Conner, O.E. Rhodes, Jr., and J.C. Beasley. 2015. How do carcass size, habitat type, and season influence scavenging community dynamics? Georgia Chapter of The Wildlife Society Annual Meeting, Athens, GA. *1st Place award*.

Laatsch, L., J.B. Smith, and J.C. Beasley. 2015. What Scavenges the Ultimate Scavenger? The Fate of Black Vulture Carcasses on the Savannah River Site. University of South Carolina Summer Research Symposium, Columbia, SC

Sub-lethal reproductive effects of chronic exposure to contaminants in free-ranging small mammals on the SRS

Funding Entity
U.S. Army Center for Health Promotion and Preventative Medicine
Start Date and Funding Amount
September 2013; $9,000
SREL Collaborators
Dr. James C. Beasley
Objectives
The objective of this research is to determine whether small mammals residing in habitats contaminated with radionuclides, metals, or a combination of these contaminants exhibit impaired reproductive parameter thresholds in comparison with individuals captured at uncontaminated sites.
Summary of Research Activities
All trapping for this research was conducted during March-May 2014. Sampled sites included Pond B, Tim's Branch, Upper 3 runs, and the D-area ash basins on the SRS. All captured individuals were necropsied and various organs and tissues were collected for future determination of body burden assessments of contaminants and determine if elevated exposures have contributed to altered reproductive parameters (e.g., sperm counts, sperm morphology, ovarian follicle counts). Reproductive tissues were sent out for examination and all analyses have been completed.
Conclusions
Small mammals were trapped at three contaminated sites on the SRS (Tim's Branch, D-Area Ash Basins, and Pond B), and a reference site (Upper Three Runs Creek). Sperm count and ovarian follicle count analyses failed to identify significant differences in these parameters among sites, suggesting small mammals inhabiting these sites are not reproductively compromised.
Major Impact(s) of Research
1) This research has demonstrated that small mammals residing in selected contaminated habitats on the SRS do not exhibit suppressed reproductive function consistent with levels that could impede long-term sustainability of populations.
Other Project Personnel
Lincoln Oliver, Research Technician – SREL
External Collaborators
Dr. Lawrence Tannenbaum – U.S. Army Center for Health Promotion and Preventative Medicine
Products
Tannenbaum, L.V., and J.C. Beasley. *In Review*. Validating mammalian resistance to stressor-mediated reproductive impact using rodent sperm analysis. *Environmental Pollution*

Spatio-Temporal Shifts in Coyote Spatial Ecology and Home Range Overlap in Response to Supplemental Food Provisioning

Funding Entity
SREL
Start Date and Funding Amount
September 2014; NFP
SREL Collaborators
Dr. James C. Beasley
Objectives
The objective of this study is quantify the effects of resource availability on coyote movement behavior, home range overlap, and social interactions through manipulation of carrion food resources. Despite the importance of carrion to carnivores, few studies have evaluated how these resources influence their movement behavior or intraspecific interactions. Moreover, I am not of aware of any studies that have assessed the influence of resource availability and predictability on coyote spatial ecology. Collectively, these questions have important implications to disease transmission dynamics, food web ecology, and management of carrion and other food resources.
Summary of Research Activities
During winter/spring 2015 we attached GPS transmitters to free-ranging coyotes on the SRS and additional coyotes on nearby properties outside SRS boundaries to serve as controls. Movement behavior of all individuals was monitored during spring 2015 and beginning 1 June 2015 we established multiple sites baited with wild pig carcasses within the general home range boundaries of collared coyotes on the SRS. Carcasses are being maintained at sites for several months and we will subsequently quantify shifts in coyote spatial ecology in response to carcass placement. Off-site coyotes will serve as controls without manipulation of food resources.
Conclusions
This project is still ongoing and GPS collars have not been recovered; there are no conclusions at this time.
Major Impact(s) of Research
1) This research will have important implications to the management of carrion resources as well as the impact of carrion on potential shifts in disease transmission dynamics in wild carnivores.
2) Despite the large number of wild pigs culled throughout the U.S. during efforts to manage this invasive species, disposition of carcasses following culling operations currently do not take potential impacts to food-web or disease transmission dynamics into consideration. This research will elucidate potential ecological impacts of wild pig carrion on the spatial ecology of apex carnivores in southeastern ecosystems.

Other Project Personnel
Sarah Webster, M.S. Student – UGA
Dr. Michael Byrne, Postdoctoral Research Associate – SREL
Ernest Borchert, Research Technician – SREL
External Collaborators
Dr. John Kilgo - USFS-SR
Products
No publications, presentations, or reports have been prepared yet.

Survival and Cause-Specific Mortality of Juvenile Feral Swine

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
Objectives
The objective of this study is to quantify survival and cause-specific mortality of juvenile wild pigs. 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 we placed ear tag transmitters on juvenile wild pigs 4-5 weeks of age. We are currently evaluating the performance of several VHF transmitter attachment methods for monitoring piglets <1 week of age when mortality is expected to be highest. During spring 2016 we will deploy additional transmitters on 30-60 newborn wild piglets and monitor survival through summer 2016.
Conclusions
This study has just begun, there are few conclusions at this time. Survival of 4-5 week old juvenile wild pigs has been high thus far, with few mortalities recorded.
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 transmitters 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 - UGA
External Collaborators
Dr. John Kilgo - USFS-SR
Mark Vukovich - USFS-SR
Dr. Frederick Cunningham - USDA
Products
No publications, reports, or presentations have been prepared to date.

Post-Translocation Movement Behavior of Feral Swine

Funding Entity
USDA – Wildlife Services – Veterinary Services
Start Date and Funding Amount
September 2014; $108,350.00
SREL Collaborators
Dr. James C. Beasley
Objectives
The objective of this study is to quantify the movement behavior of wild pigs pre- and 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 first 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. Additional transmitters will be collected in fall 2015 and an additional 12-24 individuals will be fit with collars beginning in spring 2016.
Conclusions
This study is in the beginning of the second year of a 3+ year study; thus, conclusions are limited at this time. Thus far, home ranges of translocated pigs are nearly 19 times larger than those of in situ pigs revealing that translocated pigs move extensive distances subsequent to their introduction.
Major Impact(s) of Research
1) This research will produce the first 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.

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

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 2014; $78,815.00
SREL Collaborators
Dr. Olin E. Rhodes, Jr. and Dr. James C. Beasley
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 quantify the cost and relative precision 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 have been collected and we currently are analyzing the various datasets to determine density.
Conclusions
This project has just begun, there are no conclusions at this time.
Major Impact(s) of Research
1) This research will provide 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 of wild pigs.

Other Project Personnel
David Keiter, M.S. Student - UGA
Elizabeth Kierepka, Postdoctoral Research Associate – SREL
External Collaborators
Dr. Frederick Cunningham – USDA
Dr. Toni Piaggio – USDA
Dr. Kim Pepin – USDA
Dr. Amy Davis – USDA
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
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.

Efforts to date have focused on comparing stream characteristics of disturbance categories to those of reference sites. Disturbance categories included streams affected by excessive runoff from both present and past land use, abandoned floodplain obstructions and channelized reaches. We used these analyses to select the optimal headwater streams within each of the disturbance categories that could be efficiently and effectively improved by enhancement efforts and be suitable for compensatory mitigation. The seven selected headwater streams lie within the Upper Three Runs and Meyers Branch drainages. Several selected streams have sustained multiple categories of disturbance. Stormwater runoff is a prominent disturbance force on the SRS that has led to varying levels of disturbance of headwater streams adjacent to industrial areas. The disturbance gradient extends from relatively minor to near complete obliteration. Indeed, categorical analyses identified streams currently receiving runoff to be the most disturbed of any included in our work. Moreover such disturbance triggers long term impacts as evidence of continued impairment of streams degraded by pre-SRS era land use. Previous surveys documented numerous abandoned structures crossing the floodplain of most larger-streams and many headwater streams on the SRS. Streams have generally reached a new equilibrium, but remain susceptible to extreme beaver impoundment. Channelized reaches considered for restoration area associated with other disturbances. Canebrake management was also identified as an improvement option. Additionally, data was screened and raw data processed in preparation to broaden the analyses to include basin and valley characters, disturbance variables, hydrology, geomorphology, and biology to be conducted in FY16. Site-specific restoration/enhancement prescriptions will be completed in FY16.

Conclusions

1) Analyses identified streams receiving excessive stormwater runoff to be the most disturbed streams within our study systems.
2) Even though streams have often stabilized from pre-SRS legacy impacts, some risks can persist.

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, Temporary Research Technician – USFS-SR

External Collaborators

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

Products

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

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

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

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

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

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

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

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

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

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

Paller, M.H., B.A. Prusha, E. Kosnicki, S.A. Sefick, M.S. Jarrell, D.E. Fletcher, S.C. Sterrett, A.M. Grosse, T. D. Tuberville, and J. W. Feminella. 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* (in press).

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
Dr. Tracey Tuberville and Dr. Kimberly Andrews
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
Physiological characteristics play an important role in shaping activity patterns, habitat use, and ultimately, species distribution—particularly for ectothermic vertebrates. For example, evaporative water loss has been shown to be correlated with degree of terrestriality in lizards and snakes, with species with higher evaporative water loss rates presumably constrained in their ability to survive drought and travel overland between aquatic habitats. Individual metabolic rate is another physiological characteristic that can have important consequences at higher levels of organization. In reptiles, approximately 85% of an individual's energy budget is allocated to maintenance. Standard metabolic rates increase with increasing temperatures in reptiles; therefore, assuming equal rates of energy acquisition, a higher proportion of an individual's energy budget is required for basic maintenance at higher temperatures than lower temperatures, with less energy available for growth and reproduction. Thus, both evaporative water loss and standard metabolic rate are physiological attributes influenced by bioclimatic conditions and, in turn, are likely to shape species distribution patterns via their ability to occupy or persist at locations near their bioclimatic thresholds.
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. Efforts to collect additional individuals and additional species are ongoing, thus we present only preliminary conclusions below.
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
1) Mechanistic explanation for differential ecological responses of reptile species to drought and increased environmental temperatures
2) Experimental validation of species-specific temperature thresholds identified by our CERL collaborators in their maximum entropy analysis.

Other Project Personnel
Bess Harris, Temporary Research Technician – SREL
Samantha Dean, Temporary Research Technician – SREL
David Haskins, M.S. Student - UGA
Chris Murphy, Undergraduate Student - UGA
External Collaborators
Dr. Jinelle Sperry – ERDC-CERL and University of Illinois
Dr. James Westervelt – ERDC-CERL
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. In press. Evaporative water loss rates of four species of aquatic turtle from the Coastal Plain of the southeastern United States. *Journal of Herpetology*

Effectiveness of Fe Powders for Removing Radionuclides from Low Quality Groundwater

Funding Entity

North American Höganäs, Inc.

Start Date and Funding Amount

May 2015; $36,315

SREL Collaborators

Dr. John C. Seaman

Objectives

The objectives of this research were to: (1) characterize a low-quality groundwater source in terms of contaminant concentrations and chemical factors that influence contaminant partitioning; (2) utilize dynamic leaching protocols to evaluate the effectiveness of three distinct Fe Powder materials in removing the major contaminants of concern from the low-quality water source, including U and other radionuclides that may be present; (3) evaluate the composition of the spent Fe Powder materials in terms of contaminant partitioning mechanisms and loading rates to determine the final disposition of the used material; and (4) conduct a batch sorption study to evaluate the sorption capacity of the three Fe Powders for U, Th, and Sr.

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 Fe Powders were effective 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.

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, Summer REU Student - SREL
Brian Croft, Research Professional – SREL
Jarad Cochran, Research Professional – SREL

External Collaborators

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

Products

Seaman, J.C., E. Dorward, and J. Cochran. 2015. Effectiveness of Porous Iron Composite (PIC) Materials for Removing Radionuclides from Low Quality Groundwater: Batch and Column Test Results. Submitted to North American Höganäs. October 23, 2015.

Seaman, J.C. and E. Dorward. 2015. Effectiveness of Porous Iron Composite (PIC) Materials for Removing Radionuclides from Low Quality Groundwater: Interim Report. Submitted to North American Höganäs. August 18, 2015.

Monitoring Natural Attenuation Using Microbial Biosensors to Detect Hotspots of Bioavailable Toxic Metals/Radionuclides and Characterization of Bioremediating Subsurface Microbiome Involved in Environmental Restoration

Funding Entity

DOE-EM Minority Serving Institutions Partnership Program

Start Date and Funding Amount

October 2015; $49K

SREL Collaborators

Dr. John C. Seaman

Objectives

The objectives of this research are to: 1) use newly designed whole cell bacterial biosensors with the ability to precisely identify the dominant metals and radionuclides such that hotspots of bioavailable contamination can be identified and correlated to the total chemical fraction to bin contaminated samples as high (H), medium (M) and low (L) levels; 2) obtain 16S gene based functional metagenomics information from H, M and L samples to identify and isolate the dominant bacterial-fungal communities, and correlate with concentrations and genes for metals resistance and U bioconversion such that predictions on Ni and U bioremediation across sites using predictive relative metabolic turnover can be obtained; 3) delineate factors that limit Ni and U bioremediation using lab controlled microcosms; and 4) train a steady stream of under-represented undergraduate and graduate students in the field of environmental monitoring and rehabilitation using rigorously intertwined research objectives.

Summary of Research Activities

Metals and radionuclides have been released into the environment as a function of nuclear energy activities, accidental spills from nuclear power plants, and the production of nuclear weapons and their testing, posing a serious threat to both environmental and human health. Environmental pollutants are generally monitored by chemical analyses that provide total concentrations without addressing the more relevant aspects of chemical speciation and bioavailability. Microbial biosensors that are genetically engineered to detect a toxic pollutant can be an effective strategy for quantifying the bioavailable fraction of the toxic compound, thus providing a direct estimation of toxicity. Using recently developed biosensors, FAMU and SREL are evaluating natural attenuation processes by evaluating the bioavailable metal(s) (mainly Ni) and radionuclide (U) from Tims Branch/Steed Pond watershed of the SRS. The same techniques for estimating contaminant bioavailability will also be used to determine the efficacy of several in situ remediation methods for addressing SRS contaminants.

Conclusion

1) To date we have sampled and screened over fifty soil and sediment samples from the Tims Branch/Steed Pond watershed to identify a select set of suitable test materials reflecting a range of contaminant concentrations. Based on XRF analysis we selected five soils for further study.

Major Impacts of Research

1) The development of efficient methods for evaluating contaminant bioavailability.
2) The application of biosensors to evaluate the efficacy of contaminant immobilization strategies for addressing SRS contaminants.

Other Project Personnel

N/A

External Collaborators

Dr. Ashvini Chauhan - Florida Agricultural and Mechanical University

Dr. Charles Jagoe - Florida Agricultural and Mechanical University

Products

No publications, presentations, or reports have yet been prepared.

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; In Kind
SREL Collaborators
Dr. Stacey L. Lance
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 (~500) were collected over four seasons for "pre-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 "pre" scats and are currently genotyping them across a suite of microsatellite markers.
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-SR
Products
No publications, presentations, or reports have yet been prepared.

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; $164,331
SREL Collaborators
Dr. O.E. Rhodes, Dr. J.C. Beasley, A.L. Bryan, R.A. Kennamer and A.E. Holland
Objectives
The overall goal 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 of individual birds per day and have provided > 2,800,000 total positions as of November 2015. 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 years 1(2014) and 2 (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 conducted several additional trails on blackbirds (in addition to the three from the previous year) at winter roosts. The LRAD was ineffective at keeping birds from roost sites and/or dispersing them from these sites.
Gulls – We 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) Through the reported trials, the LRAD appears effective at dispersing certain species (vultures & gulls) but not others (blackbirds & waterfowl).

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

Other Project Personnel
Dr. Mike Byrne, Postdoctoral Research Associate – SREL
Chris Leaphart, Temporary Research Technician – SREL
Zach Ross, Temporary Research Technician - SREL
External Collaborators
Dr. Travis DeVault – USDA
Dr. Bradley Blackwell – USDA

Products

Holland, A. E., M. E. Byrne, A. L. Bryan, T. L. DeVault, O. E. Rhodes, and J. C. Beasley. Fine-Scale Assessment of Seasonal Home Ranges for Resident Black and Turkey Vultures in the Southeastern U.S. Oral Presentation. Warnell College of Forestry & Natural Resources Graduate Student Symposium. University of Georgia, Athens, GA. 18-20 February 2015.

Holland, A. E., M. E. Byrne, A. L. Bryan, T. L. DeVault, O. E. Rhodes, and J. C. Beasley. Fine-Scale Spatial Ecology of Resident Black and Turkey Vultures in the Southeastern United States. Student Research-in-Progress Poster Presentation. The Wildlife Society's Annual Conference. Winnipeg, Manitoba, Canada. 25-30 October 2015.

Wickson, A., J. C. Beasley, A. E. Holland, A. L. Bryan, C. Cleveland, S. M. Hernandez, and M. J. Yabsley. Identifying Avian Haemosporidians in Turkey Vultures and Black Vultures from South Carolina. Population Biology of Infectious Diseases REU Poster Symposium. University of Georgia, Athens, GA. 23 July 2015.

Effects of Chemical Contaminants on Coleopteran Carrion Assemblages

Funding Entity
SREL
Start Date and Funding Amount
May 1 2014; NFP
SREL Collaborators
Dr. James C. Beasley and Dr. Olin E. Rhodes, Jr.
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. Insect traps were placed at each carcass and all beetles colonizing carcasses were collected. Beetles captured are currently being characterized to species. In addition, sample testing to determine trace element and radiocesium burdens is currently ongoing.
Conclusions
This study has just begun, there are no conclusions at this time.
Major Impact(s) of Research
1) This research is amongst the first studies to quantify responses of invertebrate carrion communities to chemical contamination in the U.S. and will allow us to determine whether population-level effects exist to invertebrates inhabiting landscapes contaminated with radionuclides or metals.
2) This research will contribute greatly to our understanding of the fate and transport of contaminants within ecosystems, as well as the body burden levels of contaminants in invertebrate carrion communities.

Other Project Personnel
Kelsey Turner, M.S. Student – UGA
Erin Abernathy, M.S. Student – UGA
Ansley Silva, M.S. Student – UGA
Dr. David Coyle, Postdoctoral Research Associate – UGA
Dr. Kamal Gandhi, Associate Professor – UGA
External Collaborators
Dr. Jeffery Tomberlin - Texas A&M
Products
Silva, A., D. Coyle, E. Abernethy, K. Turner, J. Beasley, and K. Gandhi. 2014. Effects of contamination on invertebrate Scavenging communities. Southern Forest Insect Work Conference, Charleston, SC
Silva, A., D. Coyle, E. Abernethy, K. Turner, J.C. Beasley, K. Gandhi. Effects of Contaminants on Scavenging Beetles. Entomological Society of America. Minneapolis, MN. 2015.
Silva, A., D. Coyle, E. Abernethy, K. Turner, J.C. Beasley, K. Gandhi. Death and destruction: effects of pollution on carrion beetles. 2015. Georgia Entomological Society. Jekyll Island, GA.
Silva, A., D. Coyle, E. Abernethy, K. Turner, J. Beasley, K. Gandhi. Death and Destruction: Effects of contamination on Coleopteran scavengers. Georgia Entomological Society. Jekyll Island, GA. 2014.
Silva, A., D. Coyle, E. Abernethy, K. Turner, J. Beasley, K. Gandhi. Effects of chemical contamination on Coleopteran scavenging communities. Warnell Graduate Student Association Annual Symposium, Athens, GA.

Collaborations and Externally Funded Research Non - SRS

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 2014; $111,742
SREL Collaborator
Robert Kennamer and Dr. Lehr Brisbin, Jr.
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
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. Identifying and mitigating bird-strike risk at Augusta Regional Airport (AGS). Wildlife Hazard Group Meeting, Augusta Regional Airport, GA. November 2014. (Oral Presentation).
Kennamer, R. A. Testing of the Acoustic Hailing Device (AHD) as an avian dispersal tool: the results. Wildlife Hazard Group Meeting, Augusta Regional Airport, GA. May 2015. (Oral Presentation).

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
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 – UGA
External Collaborators
Dr. Will Pitt – Smithsonian Institute
Dr. Travis DeVault – USDA Wildlife Services
Products
Abernathy, E.F., K.L. Turner, J.C. Beasley, T.L. DeVault, W.C. Pitt and O.E. Rhodes, Jr. 2015. Impacts of invasive species on ecosystem energy flow on the big island of Hawai'i: Excuse me but are you going to eat that cane toad? Odum School of Ecology Defense Seminar. Athens, GA.

Abernathy, E.F., K.L. Turner, J.C. Beasley, T.L. DeVault, W.C. Pitt and O.E. Rhodes, Jr. 2015. Contributions of invasive species to island energy flow: What you gon' do with all that junk? Odum School of Ecology Graduate Student Symposium. Athens, GA.

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
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 has just been initiated
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, MS Student - SREL
External Collaborators
Dr. Will Pitt – USDA Wildlife Services
Dr. Travis DeVault – USDA Wildlife Services
Products
Smith, J.B., K. Turner, T.L. DeVault, W.W. Pitt, J.C. Beasley, and O.E. Rhodes, Jr. (*Submitted*) Carcass locations of brown treesnakes (Boiga irregularis) on Guam following exposure to acetaminophen. *Ecotoxicology*

Risk Assessment Models for Avian Species in Hawai'i

Funding Entity
US Fish and Wildlife Service
Start Date and Funding Amount
August 2014; $43,341.00
SREL Collaborators
Dr. Olin Rhodes, Jr.
Objectives
The overall goal of this research is to utilize published data to develop and parameterize risk assessment models for transfer of rodenticides to threatened and endangered avifauna on the island of Hawai'i.
Summary of Research Activities
Rodents are very successful invaders and adaptable colonizers of island ecosystems worldwide and have severely impacted the native floral and faunal resources of the Hawaiian Islands. Broadscale control of introduced mammals is considered a necessary and standard practice in other countries such as New Zealand to protect small populations of critically rare birds, native plants, and invertebrates. To effectively manage rodents over large areas, the use of rodenticides is often necessary, whether by aerial or hand-broadcast, or bait station application. Two rodenticide products, both containing diphacinone, are currently approved for use to manage rodent populations in natural areas in Hawaii. Most insular rodent eradication projects have used brodifacoum, a second generation anticoagulant, because of its higher toxicity against rodents. Although brodifacoum (EPA Reg. No. 56228-36) is registered in the United States (Section 3) for conservation purposes, its use in Hawaiian natural areas is currently not allowed. Increased awareness of direct and secondary non-target poisoning of brodifacoum use in terrestrial ecosystem recovery programs has restricted its use in many areas in favor of first generation chemicals such as diphacinone which are considered less-toxic to birds. However, recent research suggests that sublethal effects from diphacinone may be observed in some birds of prey. A third rodenticide, chlorophacinone, is being considered for use in Hawaii in natural areas to protect native species.

Before any of these rodenticides are applied on a broad scale, it is critical that the potential effects on native birds be investigated. Of greatest concern are species that are federally listed as endangered, and whose diet could place them at risk of exposure to rodenticide baits. The risk assessment of potential exposure animals will include the federally-listed Nene (*Branta sandvicensis*), 'Io (*Buteo solitarius*), and 'Alala (*Corvus hawaiiensis*). The state of Hawaii-listed short-eared owl, pueo, could also be considered at risk. Once the risks to these birds have been quantified, control programs using toxicants will be designed in a way to minimize non-target effects with a large safety margin.
Conclusions
1) This project is ongoing and the development of risk assessment models has not yet been completed.
Major Impact(s) of Research
1) The development of risk assessment data for endangered and threatened species.
2) Management recommendations for future species recovery programs for avifauna in Hawai'i.
Other Project Personnel
Dr. Scott Weir, Postdoc – SREL
External Collaborators
Dr. Will Pitt – Smithsonian Institute
Dr. Travis DeVault – USDA Wildlife Services
Products
Final Report Submitted

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 2012; $60,781
SREL Collaborators
Dr. James C. Beasley and Dr. Stacey L. Lance
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
In October 2012, we participated in a workshop at the Polesye State Radioecological Reserve (PSRER) in Belarus. The purpose of this workshop was to identify common research interests between SREL, IRSN, and Belarus scientists and develop proposals to submit to funding agencies to begin collaborative research in the Belarus portion of the CEZ. 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.
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 is In Press 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. 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. 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.

Other Project Personnel
Sarah Webster, M.S. Student – UGA
Cara Love, Ph.D. Student – UGA
Dr. Mike Byrne, Postdoctoral Research Associate – SREL
External Collaborators
Dr. Thomas Hinton - IRSN, France
Dr. Yuri Bondar - Polesye State Radioecological Reserve, Belarus
Dr. Dima Shamovich - Belarus
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. *In Press*. 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*

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. 2014. 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*

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

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 - UGA

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

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

SREL Collaborators

Dr. Tracey Tuberville and Dr. Kurt Buhlmann

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 - UGA

External Collaborators

Dr. Brian Todd - University of California, Davis
Mark Peaden - University of California, Davis
Max Kern - University of California, Davis

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. *In press*. Habitat selection by juvenile Mojave desert tortoises in the eastern Mojave Desert. *Journal of Wildlife Management*.

Buhlmann, K.A., T.D. Tuberville, M.G. Nafus, M. Peaden, L. Chiquoine, J. Daly, V. Johnson, and B.D. Todd. Survivorship and growth of predator-protected vs. free-ranging released juvenile desert tortoises in the Mojave National Preserve. Desert Tortoise Council, Las Vegas, NV. February 2015. (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
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. In press. Delimiting road-effect zones for threatened species: implications for mitigation fencing. *Wildlife Research*. http://dx.doi.org/10.1071/WR15082

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 and Larry Bryan

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

Nicole White, Temporary Research Technician – SREL

Katrina Woods, Temporary Research Technician – SREL

External Collaborators

N/A

Products

K.N. White, 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.

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
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 - UGA
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; $93,335
SREL Collaborators
Dr. Tracey Tuberville, Dr. Kurt Buhlmann,
Objectives
Evaluate the effectiveness of head-starting as a means of establishing viable populations of gopher tortoises on protected lands in Georgia.
Summary of Research Activities
We protected and hatched nests from three donor sites in Georgia. We have released head-starts from 2013 and 2014 cohorts as well as hatchlings from the 2015 cohort, and are monitoring them using radio-telemetry post-release. We are also head-starting animals from the 2015 cohort for release in 2016.
Conclusions
Head-starting appears to be an effective way of increasing juvenile survivorship, although site-specific predator pressures from raccoons and fire ants can exert strong influence on outcome.
Major Impact(s) of Research
This work is among the first to evaluate post-release site fidelity and survival of released head-started gopher tortoises. Our results will help determine whether head-starting can be used as a potential recovery tool for the species.
Other Project Personnel
Dan Quinn, M.S. Student - UGA
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. *In press*. Gopher tortoise egg and hatching data from predator-excluded nests at three sites in Georgia. *Herpetological Review*.

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. (TALK)

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. (TALK)

Quinn, D., K. Buhlmann, T. Norton, J. Jensen, V. Greco, and T. Tuberville. Site fidelity and survivorship of head-started gopher tortoises on a managed site. 2015 Georgia Chapter of the Wildlife Society Meeting, Athens, GA. Sept 2015. (TALK)

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 (Riverbanks Zoo)

SREL Collaborators

Dr. Tracey Tuberville

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 - UGA

External Collaborators

Dr. Betsie Rothermel - Archbold Biological Station

Dr. Kelly Zamudio - Cornell University

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.

K.N. White, B.B. Rothermel, and T.D. Tuberville. 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. TALK

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
Start Date and Funding Amount
October 2015, $ 5,000
SREL Collaborators
Dr. Tracey Tuberville
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
One preliminary visit has been made to the proposed reintroduction site. Initial summary report is been prepared.
Conclusions
No conclusions are currently available. Work will continue into 2016.
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
N/A
External Collaborators
Neal Darby - National Park Service
Products
No publications, presentations, or reports have yet been prepared.

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

Start Date and Funding Amount

March 2012, $ 53,500

SREL Collaborators

Dr. Kurt Buhlmann

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

N/A

External Collaborators

Colin Osborn – USFWS
Dorothy Fescke - USFWS
Emily Scully – Great Swamp National Wildlife Refuge
Alyssa Frediani –Great Swamp National Wildlife Refuge
Brian Bastarache - Bristol County Agricultural High School
Brian Zarate - NJDEP Division of Nongame and Endangered Wildlife
Dan Hannon - Great Swamp National Wildlife Refuge

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. Kurt Buhlmann
Objectives
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 have been established at select target areas and natural sandbars to monitor turtle nesting activity, as well as nest predation.

Conclusions
1) Endangered map turtles are nesting successfully on Navy target beaches. Predation of nests by raccoons is unacceptably high.

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 met its military mission needs.

Other Project Personnel
N/A
External Collaborators
Marion Fanaly – U.S. 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. Kurt Buhlmann
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
No conclusions are currently available, but seasonal rainfall affects the probability of breeding events by these salamanders. Work will continue into 2016.
Major Impact(s) of Research
We are seeking collaborative ways to help maintain an endangered salamander, while helping the U.S. Navy met its military mission needs.
Other Project Personnel
N/A
External Collaborators
Ron Cherry - US Navy
Robby Smith - US Navy
Kylie Stackis - US Navy
Products (Publications, Presentations, Technical Reports)
No publications, presentations, or reports have yet been prepared.

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
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)
1) Have determined the importance of terrestrial organic matter in intertidal energetics
2) Proposal sent to NSF- Biological Oceanography
Other Project Personnel
N/A
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
Fairbanks, D., C. Young, J V. McArthur and R. B. Rader. Consumption of Red Alder Leaves in the Rocky Intertidal Zone. Western Society of Naturalist's annual meeting in Sacramento. November 2015

Mercury bioaccumulation in newts from California wetlands with differing hydroperiods.

Funding Entity
NFP
Start Date and Funding Amount
June 2015; NFP
SREL Collaborators
Dr. Stacey L. Lance
Objectives
1) Determine whether newts are accumulating significant burdens of mercury in California wetlands
2) Determine if newts in shorter hydroperiod wetlands accumulate more mercury

Summary of Research Activities
In the summer of 2015 we collected 10 newts from each of 10 wetlands. Five of the wetlands are permanent ponds while five are ephemeral. We have dissected each sample to remove gut contents and freeze dried the specimens. Mercury analyses will be conducted in December 2015.
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
Imogene Davis – Temporary Research Technician - SREL
External Collaborators
Dr. Pieter Johnson - University of Colorado.
Products
No publications, presentations, or reports have yet been prepared.

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

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. After Jason's PhD defense in November, 2015 we will begin submitting manuscripts for publication.

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 are needed. A policy recommendation paper will be written to address the impacts of the research.

Other Project Personnel

Jason O'Bryhim, PhD Student – George Mason University

External Collaborators

Dr. Chris Parsons - George Mason University
Dr. Ingo Whertman - University of Costa Rica
Dr. Randall Arauz - PRETOMA
Taylor Clark - University of Costa Rica

Products

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

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

Funding Entity
SC-DNR
Start Date and Funding Amount
April 2012; $10,000
SREL Collaborators
Dr. Stacey L. Lance
Objectives
The overall objective in this project is to determine if contaminant loads influence reproductive success in American alligators.
Summary of Research Activities
Lou Guillette and 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 2011-2014. 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. 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.

Other Project Personnel
Jason O'Bryhim, PhD Student – George Mason University
External Collaborators
Dr. Lou Guillette - Medical University of South Carolina
Dr. Ben Parrott - Medical University of South Carolina
Dr. Thomas Rainwater – USFWS
Products
Lance, S.L. and B. Parrott. Population Genetics of Yawkey Alligators. Alligator Workshop, Medical University of South Carolina, Charleston, SC, April 2015 (*oral presentation*).

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 2015; $4,500
SREL Collaborators
Dr. Stacey L. Lance
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 have 30 Ranid and 30 Ambystomatid samples. To date, we have screened animals from 16 wetlands and all were found positive for ranavirus and negative for chytrid.
Conclusions
The data are still being collected but it is clear that ranavirus is widespread in the area.
Major Impact(s) of Research
Until the data are fully acquired and analyzed we will not know the major impacts.
Other Project Personnel
Austin Coleman, M.S. Student - SREL
External Collaborators
Dr. Stephen Richter - Eastern Kentucky University
Audrey McTaggart - Eastern Kentucky University
Products
No publications, presentations, or reports have yet been prepared.

Examining the effects of thermal emissions from industry on populations of lake and round whitefish in the Great Lakes

Funding Entity
Bruce Power
Start Date and Funding Amount
January 2011; $19,000
SREL Collaborators
Dr. Stacey L. Lance
Objectives
The overall objective in this project is to examine whether thermal emissions from industry affect unique populations of lake and round whitefish on the Great Lakes.
Summary of Research Activities
Whitefish are of special economic and ecological significance in Lake Huron. Numerous industries are located on the banks of Lake Huron, including Bruce Power, Canada's first private nuclear energy generator. Bruce Power has funded several groups to examine the potential impact of their operations on whitefish populations. In collaboration with Chris Somers at the University of Regina we have developed and optimized microsatellite loci for the lake whitefish (*Coregonus clupeaformis*) and the round whitefish (*Prosopium cylindraceum*). We have genotyped ~500 lake whitefish and ~550 round whitefish.
Conclusions
Microsatellite analyses of genetic population structure indicated that fish captured at all locations in the vicinity of the power plant were part of a larger population extending beyond the study area. In concert, ecological and genetic markers do not support the presence of an evolutionarily significant unit in the vicinity of the power plant.
Major Impact(s) of Research
Whitefish populations near Bruce Power do not appear to be fragmented from neighboring areas of Lake Huron and can be managed as a single population.
Other Project Personnel
Jason O'Bryhim, PhD Student – George Mason University
External Collaborators
Dr. Christopher Somers - University of Regina.
Carly Graham - University of Regina
Thomas Morgan - University of Regina
Dr. Sean Rogers - University of Calgary
Products
Graham, C.F., Eberts, R.L., Morgan, T.D., Boreham, D.R., Lance, S., Manzon, R.G., Martino, J.A., Rogers, S.M., Wilson, J.Y., and C.M. Somers (*In review*) Fine scale ecological and genetic population structure of two whitefish (Coregoninae) species in the vicinity of industrial thermal emissions. *PLoS ONE.*

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

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.
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 second or third year of the project. Current samples are considered "control" or pre-contaminant samples to assess potential uptake.
Summary of Research Activities
We completed year 1 winter avian blood collections (December 2014 – February 2015) and completed year 2 summer collections. We collected a sampling of potential avian prey (insects) and analyzed the prey and all year 1 samples for cadmium. Year 2 summer collections have been archived for future analyses (after year 2 winter collections are complete).
Conclusions
1) 89% of the avian blood samples 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 greater the MDL were collected from summer avian species, possibly due to increased consumption of insect prey.
3) Analysis of a sample of potential insect prey for cadmium was highly variable, but certain species (e.g.; Potato Beetles) had relatively high concentrations (> 10 ppm Cd dry wt) of cadmium.
4) Analyses of kidney and liver tissues of lethally-collected waterfowl on the DMCAs indicated that the birds were accumulating cadmium, but since all the blood samples from these watefowl were < MDL, it suggests they were accumulating it from off-site locations.

Major Impact(s) of Research
Preliminary analyses of avian samples during the first control year indicate that 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.
Other Project Personnel
Frank C. Depkin, Research Technician - SREL
External Collaborators
Dr. Susan Wilde - UGA
Brigette Haram - UGA
Products
Rhodes, O.E., S.B. Wilde, and A.L. Bryan, Jr. 2015. Monitoring Potential Cadmium Levels in Avian Tissues Associated with the Savannah Harbor Expansion Project: Year 1 Annual Report. Annual project report to the U.S. Army Corps of Engineers, Savannah District, Savannah, GA.

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
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
In our initial year, 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 are currently summarizing data and writing the final project report. We extended the project funding through December 2015 to allow time for a more thorough summarization of the data.
Conclusions
Wood Storks and other wading birds continue to forage in Kings Bay aquatic habitats and a small number nest in one of the wading colonies on the base.
Major Impact(s) of Research
1) Wood storks, a "threatened" species under ESA, used multiple aquatic habitats and nested in small numbers (<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
Frank C. Depkin, Research Technician - SREL
External Collaborators
N/A
Products
No publications, presentations, or reports have yet been prepared.

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
Objectives
To document habitat use and approximate home range size of Loggerhead Shrikes, a regional species of concern, by use of radio telemetry.
Summary of Research Activities
We employed a contractor to capture 8 shrikes and attach transmitters to them in April of 2015. We monitored their locations during a series of visits to the base, acquiring > 50 locations per bird before the transmitter batteries expired. Approximately half of the tagged birds nested during this period. One bird departed the base (> 5 miles one way) for two days before returning to the base. After discussions with Kings Bay personnel, we decided to use the remaining funds to deploy additional transmitters in 2016 and thus are seeking a contract extension for this project.
Conclusions
Loggerhead Shrikes on Kings Bay used maintained (typically mowed) habitats on the base for foraging. Home range sizes have yet to be determined.
Major Impact(s) of Research
1) Loggerhead Shrikes, a regional species at risk, utilized maintained habitats (golf courses and grounds around facilities) in 2015.
2) Home range/habitat use data may be used to estimate current and potential shrike population size for the base.

Other Project Personnel
Frank C. Depkin, Research Technician – SREL
Charlie Muise, Shrike Trapper - Private Contractor
External Collaborators
N/A.
Products
No publications, presentations, or reports have yet been prepared.

External (non-SRS) Funding Received in FY15

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, 2014; $111,742
SREL Investigators and Roles
R. A. Kennamer, and Dr. I. L. Brisbin, Jr. (co-PIs)
Co-Investigators, Roles, and Affiliations
D. A. Saxon, Jr., Collaborator, Augusta, GA Utilities Department

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 – Wildlife Services – National Wildlife Research Center

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 – Wildlife Services – National Wildlife Research Center

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 – Wildlife Services – National Wildlife Research Center
Dr. Toni Piaggio, Collaborator, USDA – Wildlife Services – National Wildlife Research Center
Dr. Kim Pepin, Collaborator, USDA – Wildlife Services – National Wildlife Research Center

Effect of Carcass Size and Habitat on Vertebrate Scavenging Dynamics
Funding Entity
Joseph Jones Ecological Research Center, SREL
Start Date and Funding Amount
May 1, 2013; $21,665.00
SREL Investigators and Roles
Dr. James C. Beasley (PI) and Dr. Olin E. Rhodes, Jr. (Collaborator)
Co-Investigators, Roles, and Affiliations
Dr. Mike Conner, Collaborator, Joseph Jones Ecological Research Center

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)

Co-Investigators, Roles, and Affiliations

Dr. Ryan Miller, Collaborator, USDA – Wildlife Services – Veterinary Services

Dr. Dan Grear, Collaborator, USDA – Wildlife Services – Veterinary Services

Sub-lethal reproductive effects of chronic exposure to contaminants in free-ranging small mammals on the SRS

Funding Entity

U.S. Army Center for Health Promotion and Preventative Medicine

Start Date and Funding Amount

September 1, 2013; $9,000

SREL Investigators and Roles

Dr. James C. Beasley (PI)

Co-Investigators, Roles, and Affiliations

Dr. Lawrence Tannenbaum, Collaborator, – U.S. Army Center for Health Promotion and Preventative Medicine

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 – Wildlife Services – National Wildlife Research Center

Dr. Toni Piaggio, Collaborator, USDA – Wildlife Services – National Wildlife Research Center

Dr. Kim Pepin, Collaborator, USDA – Wildlife Services – National Wildlife Research Center

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. James C. Beasley (PI), Dr. Olin E. Rhodes, Jr. David Keiter, Dr. Liz Kierepka (co-PI's)

External Collaborators

Dr. Frederick Cunningham, USDA – WS – NWRC

Toni Piaggio, USDA – Wildlife Services – NWRC

Kim Pepin, USDA – Wildlife Services – NWRC

Amy Davis, USDA – Wildlife Services – NWRC

Examining the effects of thermal emissions from industry on populations of lake and round whitefish in the Great Lakes

Funding Entity

Bruce Power

Start Date and Funding Amount

March 2014; $19,000

SREL Investigators and Roles

S. Lance (Co-PI)

Co-Investigators, Roles, and Affiliations

Dr. Chris Somers, (PI), University of Regina

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

July 10 2014; $9,900

SREL Investigators and Roles

Stacey Lance (Co-PI);

Co-Investigators, Roles, and Affiliations

Dr. Ben Parrott (Co-PI), Medical University of South Carolina

Dr. Thomas Rainwater (Co-PI), Clemson University

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 Investigators and Roles
Tracey Tuberville (PI) and Kimberly Andrews (co-PI)
Co-Investigators, Roles, and Affiliations
Dr. James Westervelt
Dr. Jinelle Sperry

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)

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, University of California-Davis (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; $124,060
SREL Investigators and Roles
Dr. Kimberly Andrews (PI)
Dr. Tracey Tuberville (co-PI)
Co-Investigators, Roles, and Affiliations
N/A

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
N/A

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
N/A

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

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; $93,335
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

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

Kings Bay Rare, Threatened and Endangered Wildlife Surveys: Loggerhead Shrikes
Funding Entity
DoD-Navy/USACE
Start Date and Funding Amount
June 18, 2014; $46,000
SREL Collaborators
A. Lawrence Bryan Jr. and Dr. Olin E. Rhodes
Co-Investigators, Roles, 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

Kings Bay Rare, Threatened and Endangered Wildlife Surveys: Wood Storks and Wading Birds
Funding Entity
DoD-Navy/USACE
Start Date and Funding Amount
June 18, 2014; $35,745
SREL Collaborators
A. Lawrence Bryan Jr. and Dr. Olin E. Rhodes
Co-Investigators, Roles, Affiliations
None.

Technical Expertise Requests in FY15

SREL Investigator
R. Kennamer
Date of Request
October 2014
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 Investigator
Dr. James C. Beasley
Date of Request
December 2014
Requesting Entity
International Atomic Energy Association
Nature of Request
Consult with Fukushima Prefecture, Japan

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

SREL Investigator
Stacey L. Lance
Date of Request
October 2014
Requesting Entity
Faculty member, University of Missouri-St. Louis
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
October 2014
Requesting Entity
Faculty member, University of Calgary
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
November 2014
Requesting Entity
Faculty member, Murray State University
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
November 2014
Requesting Entity
Faculty member, Amherst College
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
December 2014
Requesting Entity
Researcher, Instituto Politecnico Nacional
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
December 2014
Requesting Entity
Researcher, Fairchild Botanical Garden
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
December 2014
Requesting Entity
Faculty member, Middle Tennessee State University
Nature of Request
Develop genetic markers (microsatellites).

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

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

SREL Investigator
Stacey L. Lance
Date of Request
February 2015
Requesting Entity
Researcher, Fisheries and Ocean Canada
Nature of Request
Develop genetic markers (microsatellites).

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

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

SREL Investigator
Stacey L. Lance
Date of Request
April 6, 2015
Requesting Entity
Researcher, Sam Noble Museum
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Stacey L. Lance
Date of Request
April 2015
Requesting Entity
Faculty member, New Mexico State University
Nature of Request
Develop genetic markers (microsatellites).

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

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

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

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

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

SREL Investigator
Stacey L. Lance
Date of Request
July 2015
Requesting Entity
Faculty member, Friedrich-Alexander University Erlangen Nuremberg
Nature of Request
Develop genetic markers (microsatellites).

SREL Investigator
Dr. Tracey Tuberville
Date of Request
FY2015 (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
November 2014
Requesting Entity
NPS
Nature of Request
Participate in workshop on Texas tortoise monitoring, conservation and ecology

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
October 2014
Requesting Entity
Gopher Tortoise Council
Nature of Request
Participate in workshop on use of waif tortoises as a conservation strategy

SREL Investigator
Dr. Tracey Tuberville
Date of Request
September 2015
Requesting Entity
Sierra Club
Nature of Request
Advisement regarding effects of solar development threats on gopher tortoise habitat

SREL Investigator
Dr. Tracey Tuberville
Date of Request
Summer 2015
Requesting Entity
National Park Service
Nature of Request
Advisement regarding translocation of desert tortoises

SREL Investigator
Dr. K. Buhlmann
Date of Request
2015; 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
2015; 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
2015; 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
February 2015
Requesting Entity
Turtle Conservation Fund
Nature of Request
Review, evaluate, and rank 19 proposals for potential funding support by this non-profit conservation group.

SREL Investigator
Dr. K. Buhlmann
Date of Request
March 2015
Requesting Entity
USFWS
Nature of Request
Discussed recovery plan actions for Federally-listed Flatwoods Salamanders

SREL Investigator
Dr. K. Buhlmann
Date of Request
April 2015
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 Jeykll Island Causeway, Brunswick, Georgia.

SREL Investigator
Dr. K. Buhlmann
Date of Request
June 2015
Requesting Entity
University of Dar es Salaam
Nature of Request
Review graduate student's thesis (2nd time). Results from reintroduction of Kihansi Spray Toads in Tanzania.

SREL Investigator
Dr. K. Buhlmann
Date of Request
August 2015
Requesting Entity
USFWS
Nature of Request
Discussed recovery plan actions for Federally-listed Bog Turtles

SREL Investigator
Dr. K. Buhlmann
Date of Request
December 2015
Requesting Entity
U.S. Forest Service-SR
Nature of Request
Provide USFS-SR with input regarding prescribed burning of wetlands for 2016

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 FY15. Below we provide examples of specific activities that SREL personnel have conducted in FY15 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 Radiological Environmental Monitoring Program on the results of the SREL Technical Review requested by DOE in response to CAB Recommendation 317
- 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 ~ 1.5 million dollars in new external funding during the FY14 fiscal year
- SREL personnel hosted multiple DOE personnel to tour SREL's analytical capabilities that might be used in support of SRS missions
- 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 met with 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 met with Sam Wisdom of NNSA to discuss SREL activities and research in support of MOX
- 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 report to SRR on impacts to the watershed associated with ongoing activities at the Salt Waste Processing Facility utilizing baseline reference data and analyses of recent samples of sediment, water and biota conducted by SREL personnel
- SREL personnel renewed a contract with SRR to perform work scope related to derivation of Kd values for cementitious materials

Savannah River Nuclear Solutions

- SREL personnel leveraged funding from ACP to conduct radioecology research programs involving long-lived reptiles, game species, Four Mile Branch, waterfowl and tritium mitigation activities at the Mixed Waste Facilities on SRS
- SREL personnel met with ACP senior management team and representatives from SRNL's environmental programs to discuss data needs related to future IOU remediation activities
- SREL provided support to SRNS Corporate Communications by providing programs for 27 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 personnel gave tours of the SREL Low Dose Facility to multiple visitors to the SRS to support the development of joint research missions with SRNL for future research
- SREL faculty collaborated with various SRNL scientists to accomplish a variety of research projects focused on environmental remediation and monitoring

US Forest Service

- SREL personnel 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

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 FY15, 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 69 graduate students (Table 2) from universities across the country in FY15. 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 FY15 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 FY15.

- SREL leveraged SRS site assets to acquire external resources to conduct UGA Maymester courses in wildlife ecology and genetics in May 2015

- 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 2 research faculty to provide instructional support to UGA departments as a means to maintain critical environmental expertise on the SRS

- SREL personnel successfully acquired a National Science Foundation Grant to develop a *Research Experience For Undergraduates* internship program for undergraduates in radioecology and the first cohort of 13 students were funded to participate in this program during the summer of FY15. 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. 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 first 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 63 applications received over a very short time frame. NSF did not release funding until March and our program began in May. 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 of tours of SREL field sites and special tours of the Saltstone facility and 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, Joshua King (USCA), to represent SREL at the National REU symposium in Washington , DC and he was selected to be one of 120 students. These students were selected from a pool of over 600 students. Dr. Tracey Tuberville accompanied Joshua 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. O. E. Rhodes, Dr. James Beasley, Dr. John Seaman, Dr. Tracey Tuberville, Dr. Stacey Lance, Dr. J Vaun McArthur, David Scott, Larry Bryan, and Robert Kennamer.
External Collaborator

Dr. Melissa Pilgrim - USC-Upstate
Dr. Virginia Shervette - USC-Aiken

Products (Publications, Presentations, Technical Reports)

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) **Shaina Carrington** - Presence of ranavirus and chytrid fungus in *Lithobates sphenocephalus* in long and short hydroperiod wetlands
2) **Jarad Cochran** - Influence of coal ash contamination on metabolic rates of eastern mud turtles
3) **Emily Dorward** - Zero valent iron as a filter for water contaminated with uranium and nitrate
4) **Naya Eady** - Influence of coal ash exposure on eastern mud turtle immune response
5) **Nathaniel Fox** - Investigating the incidence of antibiotic resistance in biofilm bacteria
6) **Joshua King** - Residence time as a determinant of radiocesium uptake by migratory waterfowl using Pond B on the Savannah River Site
7) **Alexis Korotasz** - Comparison of ^{137}Cs accumulation in larval and adult ranid species on the Savannah River Site
8) **Lauren Laatsch** - What scavenges the ultimate scavenger? The fate of black vulture carcasses on the Savannah River Site
9) **Marilyn Mason** - Mercury bioaccumulation in longnose gar (*Lepisosteus osseus*): A preliminary population survey
10) **Demarcus Rainey** - Effect of environmental radiation on the incidence of antibiotic resistance in bacteria isolated from frogs
11) **Morgan Reed** - Evaluation of population size and movement behavior of largemouth bass in Par Pond reservoir
12) **Carlos Tapia** - The effect of wetland hydroperiod and feeding ecology on amphibian mercury concentrations
13) **Mel Thompson** - Use of medaka as a model organism to explore proteomic and glycomic responses to mercury and low dose radiation exposure in fish

Table 10.1. SREL Undergraduate Student Program Participants, FY 15

Undergraduate	University	Faculty Advisor
Shaina Carrington	Virginia Tech	Scott
Jarad Cochran	University of South Carolina-Upstate	Pilgrim
Emily Dorward	Hofstra University	Seaman
Naya Eady	Trinity Washington University	Tuberville
Nathaniel Fox	Kenyon College	McArthur
Joshua King	University of South Carolina - Aiken	Kennamer
Alexis Korotasz	Stetson University	Bryan
Lauren Laatsch	University of Georgia	Beasley
Marilyn Mason	University of South Carolina - Aiken	Shervette
Demarcus Rainey	South Carolina State University	McArthur
Morgan Reed	Clemson University	Rhodes
Carlos Tapia	University of Central Florida	Lance
Melissa Thompson	University of South Carolina-Upstate	Rhodes

Table 10.2. SREL Graduate Student Program Participants, FY15

Student	Degree	University	SREL Faculty	Role
Justin Vining	M.S.	University of Georgia	Aubrey	Committee
Jinyan Yang	Ph.D.	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
Erin Abernathy	M.S.	University of Georgia	Beasley	Committee
Felipe Hernandez	Ph.D.	University of Florida	Beasley	Committee
Charles Evans	M.S.	University of Georgia	Beasley	Committee
Michael Foster	M.S.	University of Georgia	Beasley	Committee
Sarah Sapp	M.S.	University of Georgia	Beasley	Committee
Emily Jolly	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
Mark Peaden	M.S.	University of California-Davis	Buhlmann	Committee
Jared Green	M.S.	University of Georgia	Buhlmann	Committee
Nassor Mohammed	M.Sc.	University of Sares Salaam	Buhlmann	Committee
Jacob Daly	M.S.	University of Georgia	Buhlmann	Committee
Dan Quinn	M.S.	University of Georgia	Buhlmann	Committee
Max Kern	M.S.	University of California-Davis	Buhlmann	Committee
Richard Biemiller	Ph.D.	University of Kentucky	Fletcher	Host
Wesley Flynn	Ph.D.	University of Georgia	Lance	Advisor
Caitlin Rumrill	M.S.	University of Georgia	Lance	Advisor
Cara Love	Ph.D.	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
Student	**Degree**	**University**	**SREL Faculty**	**Role**
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
Katherine Worsley-Tonks	M.S.	University of Georgia	Lance	Committee
Liyun Zhang	Ph.D.	University of Georgia	Lance	Committee
Douglas Fairbanks	M.S.	Brigham Young University	McArthur	Co-Advisor
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
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
Erin Cork	Ph.D.	University of Georgia	Scott	Host
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
Savannah Harris	M.S.	University of Georgia	Seaman	Committee
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
Jared Green	M.S.	University of Georgia	Tuberville	Advisor
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
Student	**Degree**	**University**	**SREL Faculty**	**Role**
Lance Peadan	Ph.D.	University of CA.-Davis	Tuberville	Committee
Rebecca Cozad	M.S.	University of Georgia	Tuberville	Committee
Nassor Mohammed	M.S.	University of Sares Salaam	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 two full time technicians, four 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 FY15, 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 calls for the complete renovation of 11 laboratories, and this year we completed four laboratories with three more undergoing renovations at the end of FY15. Our projected renovation timetable calls for all of the remaining laboratories to be completed in FY16. These renovations are a detailed process which includes the following steps:

- Relocating any current researchers and projects in a laboratory slated for renovation to an alternative suitable work space.
- 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 six laboratories that while not completely renovated, received significant upgrades this year. These upgrades included painting, new floor tile, and new acoustical ceilings.

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 two offices. This included re-carpeting, painting, and making any other necessary repairs. These renovations marked our 20th office renovation over the last three years.

- **The installation of nine HVAC units in SREL maintained facilities:** These included two 10 ton roof top units on our main 737-A building. Four 5 ton units on our Student Annex building, and three units (two 5 ton and one 3 ton) on our Par Pond laboratory. All of the units that were replaced were between twenty to twenty- five years old and all had significant maintenance issues. Replacement of the Par Pond units allowed us to regain research capabilities due to enhanced climate control and also helped with humidity and mold issues.

- **Replacement of our number two Air handler:** We replaced the air handler that is largely responsible for the conditioning of our laboratory wing. This unit had lost its chill water coil during the extreme freeze event two years ago and we were only able to marginally repair it. We had a new unit designed and installed in place, and the increase in overall efficiency from the new unit has resulted in a great improvement to the balancing and performance of all of our steam/chilled water air handlers.

- **Renovation of office wing women's restroom:** This restroom is the one that is primarily used by guests and visitors to SREL, particularly visitors associated with the SRNS public tours. We completely renovated this space including new tile, carpet, paint, cabinetry and new acoustic tile grid ceiling.

- **Replacement of carpet in office wing at Par Pond laboratory**: This carpet was over twenty years old and had issues with mold and permanent staining. We replaced it with a high quality commercial carpet.

We also continued our emphasis on cleaning and proper organization this year, as this is one of our key institutional standards. To achieve this goal, we hired a new property coordinator and tasked that position with the goal of spearheading our efforts to clean our laboratories and storage facilities, and dispose or excess any clutter and unneeded supplies. 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 are continuing to plan for a number of renovations and improvements that we hope to carry out in the coming year. These projects include renovation of our greenhouse complex, continued laboratory renovations, 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 **10 (ten)** targeted lessons learned and safety notices in FY15 to specific worker groups at SREL. Additionally, in excess of **45 (forty-five)** 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 **2 (two)** work related recordable injury/illness during FY15. This represents a decreased injury/illness rate over the previous FY14 reporting period (total of four injuries). One FY15 worker illness was the result of work place stress aggravating a pre-existing anxiety related psychological condition for a summer worker. Accommodations were made in the worker's tasks to prevent recurrence. The second FY15 incident was a work related injury which resulted from a trip and fall while in the field. Attention to detail and awareness of field conditions were reinforced for all SREL research personnel.

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 **30 (thirty)** SREL personnel received this required training during FY15. Additionally, SREL personnel received EH&S related training during FY15 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 **838 (Eight hundred and thirty-eight)** pounds of hazardous wastes in FY15. Approximately **60 (sixty)** percent of the hazardous wastes generated was from disposal of excess laboratory chemicals. The balance of hazardous wastes was generated as the result of active laboratory research operations. An increase in the proportion of hazardous waste generation from excess chemicals from the previous reporting year is attributable to ongoing renovations of SREL's laboratory facilities and subsequent evaluation of chemical laboratory chemical inventories. 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 **110 (one hundred and ten)** separate chemical purchase orders made by SREL personnel.

SREL received no Notices of Violation in FY15 as the result of external or internal reviews, inspections, or assessments. During FY15, 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 FY15 was $198,459.

Table 11.1. SREL Equipment Purchases in FY15.

Description	Total Cost	Category	Programs Served
Microbalance	$31,600	Weight determination of samples	Ecotoxicology
Freeze Drier	$14,450	Bench top freeze drier	Ecotoxicology Disease Ecology Population Genetics
Autosampler for ICP-OES	$8,800	High thoroughput metal analyses	Ecotoxicology; Environmental Chemistry
GPS Collars	$47,273	Spatially explicit studies of animal movement	Population Genetics Wildlife Ecology Ecotoxicology
Me-Hg Analyzer	$29,921	Analysis of Methyl Mercury	Ecotoxicology; Environmental Chemistry Wildlife Ecology
DMA 80 Hg Analyzer	$39,075	Analysis of total Mercury	Ecotoxicology; Environmental Chemistry Wildlife Ecology
UV/Vis Spectrophotometer	$7,500	Analytical Chemistry	Ecotoxicology; Environmental Chemistry
GPS Transmitters	$10,000	Spatially explicit studies of animal movement	Population Genetics Wildlife Ecology Ecotoxicology
Sonicator	$9,840	General laboratory	Population Genetics Wildlife Ecology Ecotoxicology
Totals	**$198,459**		

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 FY15. See Task 11 (above) for summary of facilities upgrades.

SECTION III. Cost Status Report

Provided to DOE-SR budget office monthly and final FY15 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 FY15.

SECTION V. Changes in Approach or Goals

In FY15 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 FY15, external funding (non-SRS or UGA dollars) totaled 24% of the laboratories budget, up 4% from FY14 (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

Due to delays associated with the FY14 federal budgeting process, the majority of funding from DOE-SR for FY14 was received through the cooperative agreement in April of 2014. The late arrival of funding resulted in carryover of approximately 2/3 of the FY14 allocated funds into FY15. However, SREL managed to spend the majority of these carry over funds and new FY15 funds prior to the start of the FY16 funding cycle.

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 FY15, despite these delays.

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

Administrative
Retired – Marie Roberts

Support Staff
Hired – Beth Giddens
Hired – Brian Morton
Hired – Chad Cooper
Hired – Dennis Fraser

Tenure-track Faculty
Hired – Doug Aubrey
Hired – Krista Capps

Postdoctoral Researchers
Separated – Dr. Michael Byrne
Separated – Dr. Shem Unger
Separated – Dr. Scott Weir
Separated – Dr. David Coyle
Hired – Dr. Josh Smith
Hired – Dr. Elizabeth Kierepka
Hired – Dr. Fanny Coulet

Research Professionals
Separated – Brian Croft
Separated – K. Fouts

Research Technicians
Separated – Jason O'Brynim
Separated – M. Baker
Separated – E. Beechuk
Separated – C. Burton
Separated – J. Daly
Separated – D. Haskins
Separated – K. Hinkson
Separated – D. Keiter
Separated – S. Mannix
Separated – C. Murphy
Separated – A. Mustion
Separated – L. Oliver
Separated – Z. Smith
Separated – S. Taylor
Separated – S. Yu
Hired – R. Juarez
Hired – J Cochran
Hired – K Ekhart
Hired – A. Jones
Hired – K Woods
Hired – R. Biemiller
Hired – E. Bledsoe
Hired – C. Burkhalter
Hired – I. Davis
Hired – D. Fraser
Hired – C. Kupar
Hired – B. Lindell
Hired – A. Mustion
Hired – L. Paden
Hired – P. Walkup

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

SREL faculty and staff added 38 new publications to the SREL reprint list in FY15

3296 Kennamer, R.A. (1997). "Hooded Mergansers Breeding in the Upper Coastal Plain of South Carolina." The Chat 61(2): 117-119.

3297 Winans, G.A., J.D. Baker and S.L. Lance (2014). "Twenty-five novel microsatellite markers for English sole, Parophrys vetulus." Conservation Genetic Resources 2014(6): 417-419.

3298 Beasley, R. R., S.L. Lance, J.A. Ruskey and E.B. Taylor. (2014). "Development and characterization of twenty-five microsatellite markers for the longnose dace (Cyprinidae: Rhinichthys) using paired-end Illumina shotgun sequencing." Conservation Genetic Resources 6: 1011-1013.

3299 Bryan Jr., A. L., J.W. Snodgrass, H.A. Brant, C.S. Romanek, C.H. Jagoe, G.L. Mills and I.L. Brisbin Jr. (2014). "Precipitation Influences on Uptake of a Global Pollutant by a Coastal Avian Species." Environmental Toxicology and Chemistry 33(12): 2711-2715.

3300 Rabeling, C., M. Bollazzi, M. Bacci Jr., R.R. Beasley, S.L. Lance, K.L. Jones and N.E. Pierce. (2014). "Development and characterization of twenty-two polymorphic microsatellite markers for the leafcutter ant, Acromyrmex lundii, utilizing Illumina sequencing." Conservation Genetic Resources 6: 319-322.

3301 Rabeling, C., C.N. Love, S.L. Lance, K.L. Jones, N.E. Pierce and M. Bacci Jr. (2014). "Development of twenty-one polymorphic microsatellite markers for the fungus-growing ant, Mycocepurus goeldii (Formicidae: Attini), using Illumina paired-end genomic sequencing." Conservation Genetic Resources 6: 739-741.

3302 Ramos, A. G., S.O. Nunziata, S.L. Lance, C. Rodriguez, B.C. Faircloth, P.A. Gowaty and H. Drummond. (2014). "Interactive effects of male and female age on extra-pair paternity in a socially monogamous seabird." Behavioral Ecology and Sociobiology 68: 1603-1609.

3303 Fletcher, D. E., A.H. Lindell, G.K. Stillings, G.L. Mills, S.A. Blas and J V. McArthur. (2014). "Variation in Trace-Element Accumulation in Predatory Fishes from a Stream Contaminated by Coal Combustion Waste." Archives of Environmental Contamination and Toxicology 66(3): 341-

3304 Witczak, L. R., J.C. Guzy, S.J. Price, J.W. Gibbons and M.E. Dorcas. (2014). "Temporal and Spatial Variation in Survivorship of Diamondback Terrapins (Malaclemys terrapin)." Chelonian Conservation and Biology 13(2): 146-151.

3305 Bryan Jr., A. L., C.N. Love, G.L. Mills, R.R. Borkhataria and S.L. Lance. (2015). "Testing for Associations between Hematozoa Infection and Mercury in Wading Bird Nestlings." Journal of Wildlife Diseases 51(1): 222-226.

3306 DeGregorio, B. A., J.D. Willson, M.E. Dorcas and J.W. Gibbons. (2014). "Commercial Value of Amphibians Produced From an Isolated Wetland." The American Midland Naturalist 2014(172): 200-204.

3307 Gaines, K. F., C.S. Boring and D.E. Porter. (2005). "The development of a spatially explicit model to estimate radiocaesium body burdens in raccoons (Procyon lotor) for ecological risk assessment." Science of the Total Environment 341(2005): 15-31.

3308 Graves, G. R., C.S. Romanek and A. R. Navarro. (2002). "Stable isotope signature of philopatry and dispersal in a migratory songbird." Proceedings of the National Academy of Sciences 99(12): 8096-8100.

3309 Harden, L. A. and M. E. Dorcas (2008). Using Thermal Biology to Investigate Habitat Use and Activity of Mud Turtles (Kinosternon subrubrum) on a Golf Course. Urban Herpetology. J. C. Mitchell, R. E. Jung Brown and B. Bartholomew. Salt Lake City, UT, Society for the Study of Amphibians and Reptiles: 321-323.

3310 Collins, B. (2005). Thresholds of Disturbance: Land Management Effects on Vegetation and Nitrogen Dynamics. 1-56.

3311 Flynn, R. W., D.E. Scott, W. Kuhne, D. Soteropoulos and S.L. Lance. (2015). "Lethal and Sublethal Measures of Chronic Copper Toxicity in the Eastern Narrowmouth Toad, Gastrophryne carolinensis." Environmental Toxicology and Chemistry 34(3): 575-582.

3312 Li, D., D.I. Kaplan, H. Chang, J.C. Seaman, P.R. Jaffé, P. Koster van Groos, K.G. Scheckel, C.U. Segre, N. Chen, D. Jiang, M. Newville and A. Lanzirotti. (2015). "Spectroscopic Evidence of Uranium Immobilization in Acidic Wetlands by Natural Organic Matter and Plant Roots." Environmental Science and Technology 49(5): 2823-2832.

3313 Scott, D. E., Y. Yanes, B.B. Rothermel, M. Pilgrim and C. S. Romanek. (2015). "Efficacy of Labeling Wetlands with Enriched 15N to Determine Amphibian Dispersal." Wetlands 35(2): 349-356.

3314 Seaman, J. C., Buettner, S.W. and H. Chang. (2015). Phosphate-Uranium Interactions in Soils. Phosphate in Soils - Interaction with Micronutrients, Radionuclides and Heavy Metals. H. M. Selim (ed.). Boca Raton, FL, CRC Press: 59-96.

3315 Beck, J. B., Semple, J.C., Brull, J.M., Lance, S.L., Phillips, M.M., Hoot, S.B., and G.A. Meyer. (2014). "Genus-wide Microsatellite Primers for the Goldenrods (Solidago: Asteraceae)." Applications in Plant Sciences 2(4): 1300093.

3316 Yuan, M. L., Dean, S.H., Longo, A.V., Rothermel, B.B., Tuberville, T.D., and K.R. Zamudio. (2015). "Kinship, inbreeding and fine-scale spatial structure influence gut microbiota in a hindgut-fermenting tortoise." Molecular Ecology 24(10): 2521-2536.

3317 Winzeler, M. E., Hamilton, M.T., Tuberville, T.D., 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(1): 77-81.

3318 Price, K. A., O'Bryhim, J.R., Jones, K.L., and S.L. Lance. (2015). "Development of polymorphic microsatellite markers for the bonnethead shark, Sphyrna tiburo." Conservation Genetics Resources 7(1): 69-71.

3319 Piñeros, V. J., Gutiérrez-Rodríguez, C., and S.L. Lance. (2015). "Development and characterization of 29 microsatellite markers for the sergeant major damselfish (Abudefduf saxatilis) using paired-end Illumina shotgun sequencing." Conservation Genetics Resources 7(1): 103-105.

3320 O'Bryhim, J. R., Spaet, J., Hyde, J.R., Jones, K.L., Adams, D.H., and S.L. Lance. (2015). "Development of microsatellite markers for globally distributed populations of the threatened silky shark, Carcharhinus falciformis." Conservation Genetics Resources 7(2): 463-465.

3321 Grosse, A. M., B.A.Crawford, J.C. Maerz, K.A. Buhlmann, T. Norton, M. Kaylor, and T.D. Tuberville. (2015). "Effects of Vegetation Structure and Artificial Nesting Habitats on Hatchling Sex Determination and Nest Survival of Diamondback Terrapins." Journal of Fish and Wildlife Management 6(1): 19-28.

3322 Buhlmann, K. A., S.L. Koch, B.O. Butler, T.D. Tuberville, V.J. Palermo, B.A. Bastarache and Z.A. Cava. (2015). "Reintroduction and Head-starting: Tools for Blanding's Turtle (Emydoidea blandingii) Conservation." Herpetological Conservation and Biology 10(Symposium): 436-454.

3323 Luhring, T. M. and R. M. Holdo (2015). "Trade-offs between growth and maturation: the cost of reproduction for surviving environmental extremes." Oecologia 178(3): 723-732.

3324 Tuberville, T. D., T.M. Norton, K.A. Buhlmann, and V. Greco. (2015). "Head-starting as a Management Component for Gopher Tortoises (Gopherus polyphemus)." Herpetological Conservation and Biology 10(Symposium): 455-471.

3325 Robinson, G.L., G.L. Mills, A.H. Lindell, S.H. Schweitzer and S.M. Hernandez. (2015). "Exposure to mercury and Aroclor 1268 congeners in least terns (Sternula antillarum) in coastal Georgia, USA." Environmental Science Processes and Impacts 17(8): 1424-1432.

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

- Kurt Buhlmann received the Partners in Amphibian and Reptile Conservation Visionary Leader Award
- Gene Rhodes was elected as a Fellow of The Wildlife Society
- David Scott received the Conservation Hero award from Partners in Amphibian and Reptile Conservation
- Over twenty SREL graduate students won awards for presentations at regional, national or international meetings
- John Seaman was elected as Treasurer of the International Society of Trace Element Biogeochemistry
- SREL research was highlighted in print, TV, and web-based media hundreds of times, particularly for radioecological research in Belarus and Japan as well as for research on Antibiotic resistance
- Numerous SREL faculty were asked to serve as peer reviewers on national funding panels for NSF, USDA, and other entities