NIMBioS

National Institute for Mathematical
and Biological Synthesis

Emerging Risks, Measured Responses

A NIMBioS

Synthesis Incubator Event

Friday, March 24, 2017

THE UNIVERSITY OF
TENNESSEE
KNOXVILLE

NSF

The Genius of Synthesis

As defined by the Oxford dictionary, *synthesis* is "the combination of ideas to form a theory or system." For over eight years, NIMBioS has been active in driving community-driven initiatives that have brought to the University of Tennessee numerous experts to promote the *combination of ideas* to address important biological problems. To solve complex biological problems, NIMBioS has embraced fostering synthesis of biology with mathematical and computational modeling. Building on the success of the past eight years, NIMBioS is hosting our first Synthesis Incubator event. In the spirit of synthesis, we bring together participants to discuss a diverse, yet unified set of problems that represent **Emerging Risks** to forge synthetic paths that create **Measured Responses**.

"There are serious needs everywhere-hunger, homelessness, preventable disease, illiteracy-that require volunteers to help alleviate immediate suffering and innovative thinkers to bring about lasting solutions." ~President Jimmy Carter

NIMBioS Synthesis Incubator 2017
Friday, March 24

Agenda

Friday, March 24, 2017	
11:45 am	Welcome- Colleen Jonsson, Director, NIMBioS, Claxton Room 206
12:00 pm to 1:30 pm	Lunch, Claxton Room 104
1:30 pm to 3:00 pm	Roundtable Sessions
	Roundtable 1: *Active Learning for the "M" in STEM: Preparing Students for Emerging Risks.* Moderators: Suzanne Lenhart, Lynn Hodge, Sondra LoRe Meet in Claxton Room 103
	Roundtable 2: *Building Adaptive Capacity into Conservation and Natural Resource Management Plans.* Moderator: Paul Armsworth Meet in Claxton Room 205
	Roundtable 3: *Big Data in Spatial Biology and Emerging Interdisciplinary Actions.* Moderators: Monica Papeș, Agricola Odoi, Liem Tran Meet in Claxton Room 206
	Roundtable 4: *Modeling Biological and Evolutionary Dimensions of Host-Pathogen Interactions.* Moderator: Colleen Jonsson Meet in Claxton Room 105
3:00 pm to 3:05 pm	Group Photo, Claxton 206
3:05 pm to 3:15 pm	Coffee Break, Claxton 104
3:15 pm to 4:45 pm	Roundtables Sessions (continued)
7:00 pm to 8:00 pm	Evening Networking Mixer & Social, The Foundry 747 Worlds Fair Park Dr, Knoxville
	Music by UT School of Music Students: Shelley Armer, viola; Ashlee Booth, cello; Kie Uabamrungjit, violin
8:00 pm to 9:00 pm	Dinner
8:30 pm	Keynote Presentation: Dr. James LeDuc, Director, Galveston National Laboratory, University of Texas Medical Branch
9:00 pm to 10:00 pm	Dessert and Networking

Roundtable 1. Active Learning for the "M" in STEM: Preparing Students for Emerging Risks

Active learning is the process of engaging students in their own learning through teaching strategies that go beyond directing students to take notes and follow directions, placing the responsibility for learning on students' shoulders. Group learning, inquiry-based learning, and problem-based learning are all examples of active teaching strategies with a proven track record of increasing student engagement and academic success.

In August, the White House Office of Science and Technology Policy (OSTP) issued a national Call to Action to improve STEM education through the use of active learning. In an announcement following, OSTP highlighted the challenges specifically related to the community of math learners. "So often, STEM education discussions do not explicitly address challenges in math, even though the mathematics-preparation gap is a known barrier to later success in STEM disciplines, limiting a student's opportunities at a level below their aspirations." -- OSTP blog post, Sept. 9, 2016.

In this roundtable, education leaders will discuss the opportunities that emerging risks, such as Zika virus, Ebola, climate change, and other topics, can provide as a problem space for students to explore the usefulness of math for making well-informed choices when responding to emerging threats. We will also discuss the emerging potential of technology, such as creating online virtual communities of learners to connect geographically isolated schools, such as those in Appalachia. Increasing access to high speed Internet and mobile devices is presenting opportunities for innovation in building active learning communities of both students and teachers.

The overarching goal of this discussion is to brainstorm possible projects that we could collaborate on together around the theme of "emerging risks, measured responses." We could, for example, coordinate support for the creation and/or sharing of active learning teaching resources and professional development for both in-service and pre-service teachers. These activities could be for both the mathematics classroom as well as for better integrating the "M" in STEM across the curriculum.

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Suzanne Lenhart (Moderator)	lenhart@math.utk.edu	UTK Mathematics and NIMBioS
Sondra LoRe (Moderator)	sondra@utk.edu	NIMBioS/NISER
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Christopher Wilson	cwilson@bcbs.org	BSCS (Biological Sciences Curriculum Study)

Roundtable 2: Building Adaptive Capacity into Conservation and Natural Resource Management Plans

Species and ecosystems are already responding to global environmental change, which is projected to become more rapid and extensive. These shifts will impact both the future of biodiversity and of important ecosystem services on which society depends. While our capacity to project future changes has greatly improved, projections are still very limited. We do better at large scales and coarse grains. We also likely miss many feedbacks and drivers that will ultimately mediate the impacts of climate and other global changes on natural systems (e.g. changes due to human adaptation in other sectors). Guidance on just how conservation and natural resource management planning can best utilize projections remains limited. While much has been written about management actions that potentially could be employed in light of changing conditions, little clarity exists over what we should do where and how best we can evaluate trade-offs between different possible actions we might undertake. Finally, a substantial disconnect exists between scientific recommendations regarding adaptation and actual implementation of such measures.

For this roundtable discussion, a panel of ecologists, economists, and engineers spanning academia and key practitioner organizations will discuss future research questions focused on how we build better adaptive capacity into conservation and natural resource management plans.

The discussion will focus on identifying priority research topics and strategies and opportunities to address them. Specifically, we will discuss i) the suitability of available climate projections as well as how biological projection models can make better use of current down-scaling techniques in both space and time from climate science; ii) how best to account for land use changes and feedbacks linked to other human adaptations to a changing climate, with a particular focus on shifting energy development; iii) the suitability of ecological data on species, ecosystems and ecosystem services to support projection models of responses; iv) modeling strategies that acknowledge limitations in available data; and v) the optimization of management intervention strategies that are both robust to uncertainty in projections and are formulated in a way that makes implementation by practitioners more likely.

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Paul Super	paul_super@nps.gov	Great Smoky Mountains National Park

Roundtable 3: **Big Data in Spatial Biology and Emerging Interdisciplinary Actions**

Society is increasingly challenged to solve problems that require broad geographic extent, long-term data and collaborations between researchers from various disciplines and stakeholders. In the last five years, Ecological Society of America has promoted *action ecology*, or research that has socio-ecological implications and that moves ideas from lab and field experiments to implementation through collaborations among researchers and stakeholders. Placing this concept in a broader context, interdisciplinary actions identify urgent issues, engage wide communities, make use of wealth of data available, and translate research into actions that benefit the society. The convergence of ideas, tools, and technologies from various fields has been identified by NSF as one of the 10 Big Ideas for the coming decades. Convergent research is possible through collaborations of universities with state and federal agencies, industry, and private foundations.

The accumulation of large, spatially explicit datasets (big data) and the development of new technologies, e.g., Unmanned Aerial Systems, allow expanding the scope of analyses and bridging across disciplines. To address current societal problems, diverse data have to be leveraged and the tools to analyze them are interdisciplinary in nature. With the participation of key representatives of the broad community of East Tennessee, we will determine a set of current problems that require interdisciplinary actions and large datasets that cannot be collected by a single working group or lab. We will discuss available data resources for the region and new data collection initiatives such as the NSF-funded National Ecological Observatory Network.

The spatial biology roundtable will connect diverse groups of researchers and stakeholders in East Tennessee with the aim of identifying a set of societal issues in the region that could be addressed by leveraging large, spatially explicit datasets and by adopting the interdisciplinary action approach. For each priority issue identified, we will create an outline with the following information: working group tentative members, data needs, possible benefits to the society (policy, management), and funding opportunities, including through partnerships with stakeholders.

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Roundtable 4. **The Biological and Evolutionary Dimensions of Host-Pathogen Interactions**

From hijacking the highways into host cells to disarming the host's internal network of defense barriers to pathogen invasion, pathogens have an impressive collection of tools to guarantee their survival in reservoirs and vectors. While these tools are similar, generally, across pathogens, evolution of pathogens with their reservoirs and vectors has selected for an endless variety of receptors used to enter cells and protein components targeted to disrupt mounting an immune response. Moreover, the large size of microbial populations and short doubling times during the course of an infection provide the microbe endless opportunities to evolve and thereby become resistant to therapeutic treatment. The complexity of pathogen-host interactions and pathogen ecosystems across species, genera and families present an opportunity for transdisciplinary studies of host-pathogen coevolution, evolution of drug resistance and escape from vaccines, microbial population structure as it relates to phenotype, and gene-regulatory networks.

    For this roundtable discussion, a multidisciplinary cohort of academic researchers from the University of Tennessee-Knoxville, UT-Memphis and St. Jude Children's Research Hospital to discuss current problems in host-pathogen interactions. Importantly, the group will discuss how we can leverage the convergence of research talent across biology, computer science, genomics, mathematics, and engineering to tackle these importance problems.

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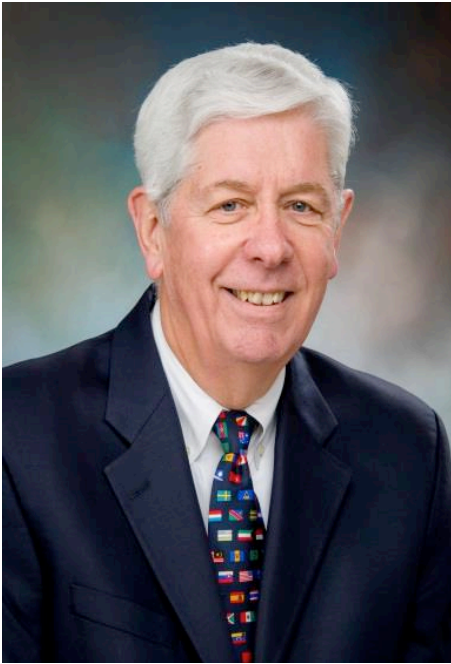
Keynote Speaker

Dr. James LeDuc
Director, Galveston National Laboratory
University of Texas Medical Branch

Dr. James LeDuc is an expert in public health and international biosecurity, a professor in the UTMB School of Medicine and director of the Galveston National Laboratory at the University of Texas Medical Branch in Galveston, Texas.

The Galveston National Laboratory is recognized around the world as a state-of-the-art biocontainment facility where scientists study the world's most dangerous pathogens and emerging infectious diseases. Research is focused on adding to the scientific understanding of infectious diseases and developing important medical counter measures. Work includes the development of vaccines, therapeutics and diagnostics for emerging infectious diseases and agents of potential use in bioterrorism.

Prior to joining UTMB, Dr. LeDuc worked at the US Centers for Disease Control and Prevention where he served in various leadership roles, including director of the division of viral and rickettsial diseases, associate director for global health, and coordinator for pandemic influenza preparedness. Prior to the CDC, he was a medical officer in communicable diseases at the World Health Organization from 1992-1996 and was instrumental in implementing the WHO program in emerging infectious diseases. He is also a retired U.S. Army officer who held leadership roles in government research programs and public health initiatives around the world.

Dr. LeDuc currently serves as a member of the Global Outbreak Alert and Response Network steering committee for the World Health Organization, he serves on the Texas Governor's Task Force on Infectious Disease and Emergency Response, and he is a member of the National Academies of Sciences, Engineering and Medicine's Committee on Science, Technology and Law's study committee on Dual Use Research of Concern. Most recently, Dr. LeDuc was honored with a lifetime appointment as a National Associate of the National Research Council by the National Academy of Sciences. He is a Fellow of the Infectious Diseases Society of America, and a member of several other professional societies.

Evening Networking Tables

NIMBioS

Since its inception in 2008, NIMBioS has hosted more than 6,600 participants from 915 institutions in 56 countries and all 50 US states. Activities have led to the publication of more than 700 journal articles on a variety of topics at the interface of mathematics and biology.
Hosted by Chris Welsh and Catherine Crawley

NISER

The National Institute for STEM Evaluation and Research (NISER) provides evaluation services to the Science, Technology, Engineering and Mathematics (STEM) research and education sectors, including academic communities, not-for-profit organizations, and government entities. A partner with NIMBioS, NISER is currently collaborating on nine proposals that have secured nearly $6.8 million in funding. NISER's staff has experience in systems-level evaluation, a deep understanding of interdisciplinary team science, a professional collaborative approach to program evaluation and research, and the ability to untangle the complexity of large-scale STEM programs.

Hosted by Pam Bishop and Sondra LoRe

Education & Outreach at NIMBioS

The Education & Outreach table will feature 3-D printing of cell organelle and flower models designed by middle school students, just one of the many innovative outreach activities at NIMBioS to enhance understanding of the interface of biology and mathematics. The Education and Outreach program at NIMBioS offers a diverse array of activities to meet the educational needs for learners of all ages including K-12 students and teachers, university and college students and faculty, professional industry audiences, and the general public. The table will also have information describing these programs and details on how to get involved. NIMBioS has hosted more than 250 educational and outreach programs since its inception.
Hosted by Suzanne Lenhart and Michael Peek

Biology in a Box

Since 1993, under the guidance of Dr. Susan Riechert, *Biology in a Box* has afforded more than 100 school districts in Tennessee and surrounding states with fun and challenging educational resources. Students and teachers engage in discovery learning from the 11 thematic-based units in the boxes ranging from fossils to genes to biomechanics. Constructed to align science and math standards with student inquiry, *Biology in a Box* has earned significant positive feedback. In addition, teachers who have participated in *Biology in a Box's* Summer Institutes and who have incorporated its units in their pedagogy report increases in positive student test performance. The *Biology in a Box* table will have several *Biology in a Box* units available for visitors to explore along with the Finding Fossils computer

game. Details on how to get involved or support the program will also be provided. Suggestions from previous participants and interested educators are welcomed as we collect ideas and continue development. Our goal is to broaden the awareness of this incredible resource, so it may reach more learners.

Hosted by Reuben Pine

Spatial Analysis Lab

Located at NIMBioS, the new core facility enables cross-disciplinary research within the broader community of biologists and geographers engaged in bio-geographical modeling, spatial statistics, and anthropogenic dimensions of biodiversity conservation. The lab expands UT research activities that collect and synthesize large-scale spatial data to understand biological, geographic, and socio-economic processes, especially in the areas of biodiversity, disease ecology, and human-environment interface. Data storage and analysis; data visualization; new data collection; and training and outreach are the four main focal areas of the lab.

Hosted by Mona Papes and Eric Carr