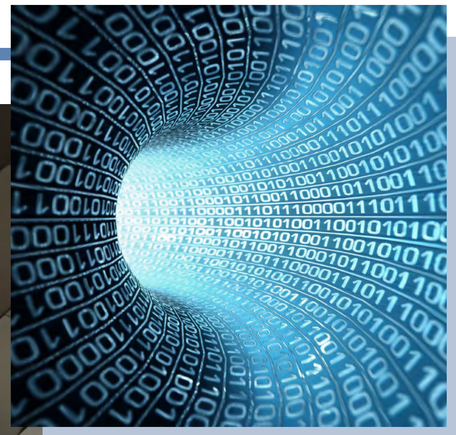
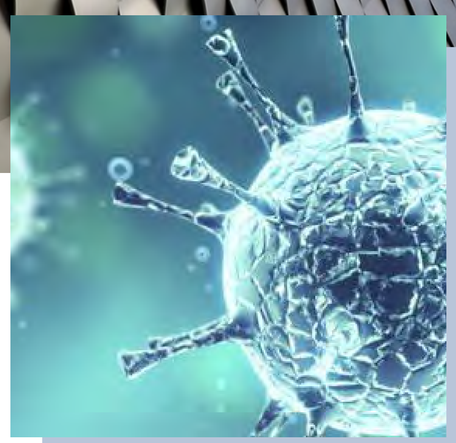




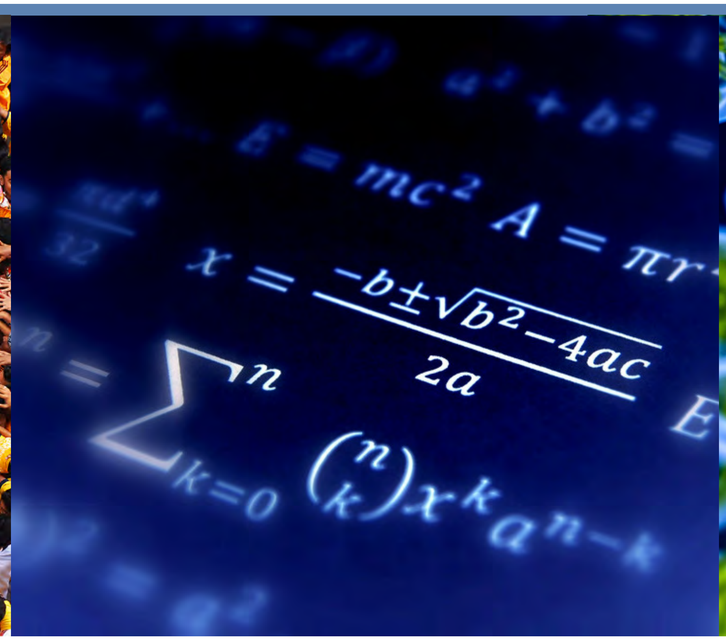
NIMBioS

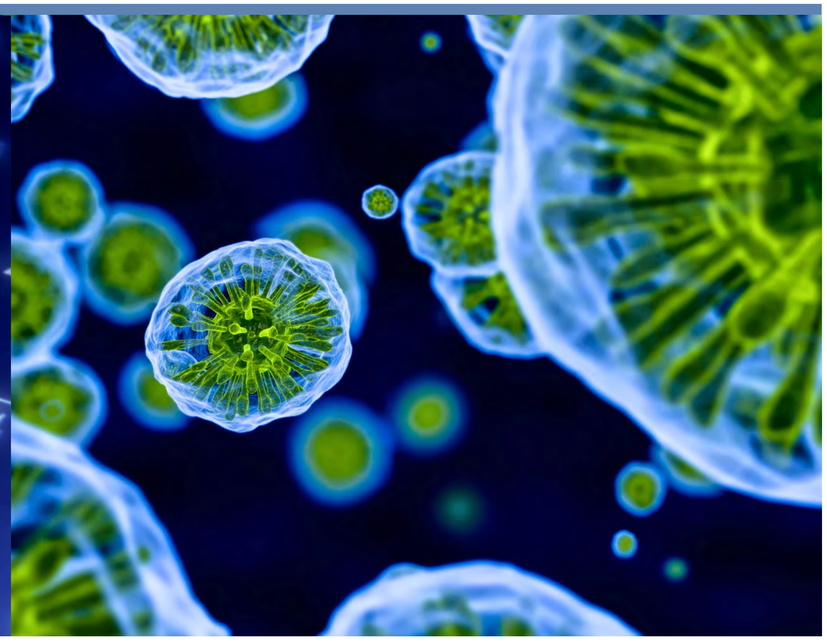
National Institute for Mathematical and Biological Synthesis

at The University of Tennessee, Knoxville

syn·the·sis

> Observation serves to assemble the data, reflection to synthesize them and experimentation to test the results of the synthesis. The observation of nature must be assiduous, just as reflection must be profound, and experimentation accurate.
>
> --John Dewey





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MISSION

THE PRIMARY GOALS OF NIMBioS ARE TO:

- Foster the maturation of cross-disciplinary approaches in mathematical biology

- Develop researchers who can conceive and engage in creative, collaborative connections across disciplines to address fundamental and applied questions in the life sciences

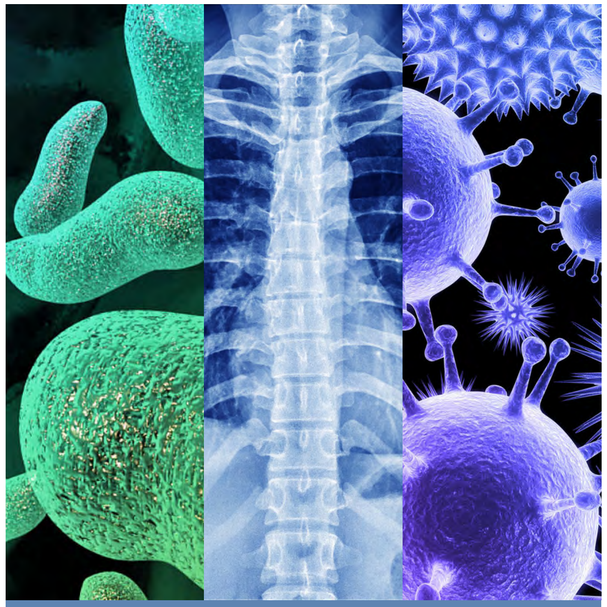
From the Director

These are fascinating times of tension and change in science. Enormously important new opportunities have arisen as diverse fields across the natural, physical and social sciences intersect and converge. Concurrently, new experimental and observational methods that generate large quantities of data have encouraged a different perspective, focusing on “letting the data tell its story” and not at all on the abstraction and hypothetico-deductive approach that has driven much of science for decades.

Over the years of its existence, NIMBioS has transitioned its emphasis in line with shifts in science, contributing to the development of what is known as “quantitative biology,” an amalgam of approaches that in the past were referred to as mathematical biology, theoretical biology, computational biology and systems biology. The success of NIMBioS in fostering novel results across the amalgam is evident from the diverse collection of significant research products that have arisen, the many new collaborations that have flowered, and the opportunities NIMBioS has offered to encourage new researchers to appreciate the potential for benefit to science and society of work at the interface of mathematics, life science, computational science and social science.

This booklet summarizes the diverse array of activities NIMBioS has led with support from the National Science Foundation and other agency partners. We at the University of Tennessee have been very proud of the major contributions by our Advisory Board, government partners, Working Group and Workshop organizers and the over 6,000 participants in our activities. The synthesis that has resulted demonstrates not only the wonderful new science that has been developed through the use of quantitative approaches in biology, but also the tremendous dedication and altruism of our many leaders and participants. NIMBioS is developing new programs, including a Spatial Analysis Lab to offer spatial data collection, visualization and analysis for cross-disciplinary efforts on biological, geographic, and socio-economic processes, and a Mathematical Modeling Center that provides expertise on model development, simulation and analysis linking models to data.

As you read through these pages, we encourage you to consider additional ways that the expertise demonstrated at NIMBioS might assist your research and education efforts. Please contact us to discuss what benefits we can bring to your enterprise as we continue to expand the opportunities we foster in interdisciplinary science and education.



NIMBioS has contributed significantly to investigating numerous questions of direct public policy concern, particularly the analysis of the potential spread, impact and control of infectious diseases of zoonotic origin, including West Nile virus, anthrax, swine flu and mad cow disease, among others.

To Meet, Greet or Retreat During Influenza Outbreaks

The **NIMBioS Working Group: Synthesizing and Predicting Infectious Disease While Accounting for Endogenous Risk (SPIDER)** developed a better model for understanding the role of adaptive human behavior in the spread of disease.

The new model accounts for tradeoffs that people make when weighing the risk of exposure to illness versus the benefits of interacting with others. The benefit of good health is only one part of an overall index of well-being. This is especially true when most people don't expect any permanent side-effects from illness.

In the study's simulated outbreak, a small increase in the price of interpersonal contact lowers the peak prevalence of the disease slightly. Fewer people become infected and social utility is increased. Further increase in the price of contact, which causes individuals to make even fewer contacts, can prevent even more people from getting sick; however, this can decrease the overall benefits to society due to lack of social interaction.

Citation: *Fenichel EP et al. 2011. Adaptive human behavior in epidemiological models. Proceedings of the National Academy of Sciences 108(15): 6306-6311.*

Questioning What We Know About Ocean Viruses

For years, estimates have suggested that a single liter of seawater typically contains more than ten billion viruses. To better understand this population, researchers conducted a meta-analysis of ocean microbial and virus abundance data that had been collected over multiple decades and found that viral populations vary dramatically from location to location and at differing depths in the sea.

In the datasets examined by the researchers, the ratio of viruses to microbes varied from approximately 1-to-1 to 150-to-1 in surface waters, and from 5-to-1 to 75-to-1 in the deeper ocean. For years, scientists had utilized a baseline ratio of 10 to 1— ten times more viruses than microbes—which may not adequately represent marine ecosystems.

The study, which was initiated as part of the **NIMBioS Working Group on Ocean Viral Dynamics**, challenges the notion of a uniform ecosystem role for viruses in the ocean and highlights uncertainty governing climate models and other biogeochemical measures.

Citation: *Wigington CH et al. 2016. Re-examination of the relationship between marine virus and microbial cell abundances. Nature Microbiology 1, Article number: 15024.*

Contact, Competition Count in Parasitic Disease

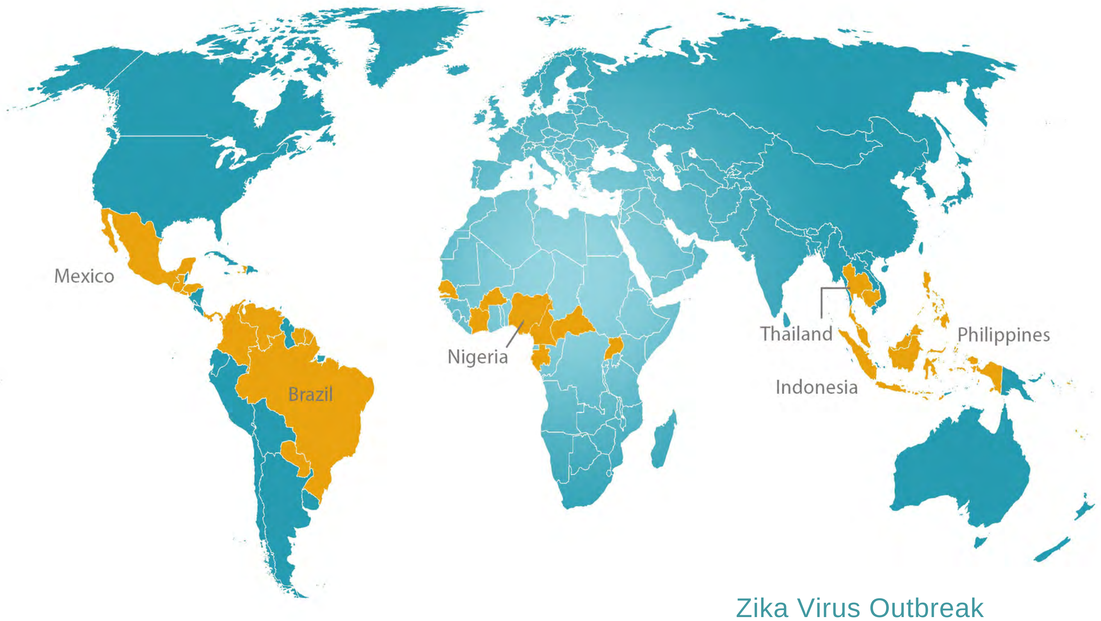
Contact and competition among different animals within a community matters when it comes to the possibility of parasitic disease outbreak.

This study, co-authored by **NIMBioS Postdoctoral Fellow Suzanne O'Regan**, shows how disease risk is either amplified or diluted depending upon the ecological context.

A novel finding of the study is that depending on the degree of contact between different species in the animal community and the traits of the hosts in that community, amplification of transmission can occur in frequency-dependent systems. In density-dependent systems, dilution can occur, especially in situations where competition between different species is sufficiently strong.

Because increased disease risk in multispecies communities may have different drivers, the study underscores the importance of including contact patterns and competition in models.

Citation: *O'Regan SM, Vinson JE, Park A. 2015. Interspecific contact and competition may affect the strength and direction of disease-diversity relationships for directly transmitted microparasites. American Naturalist 186(4): 480-494.*



Zika Virus Outbreak

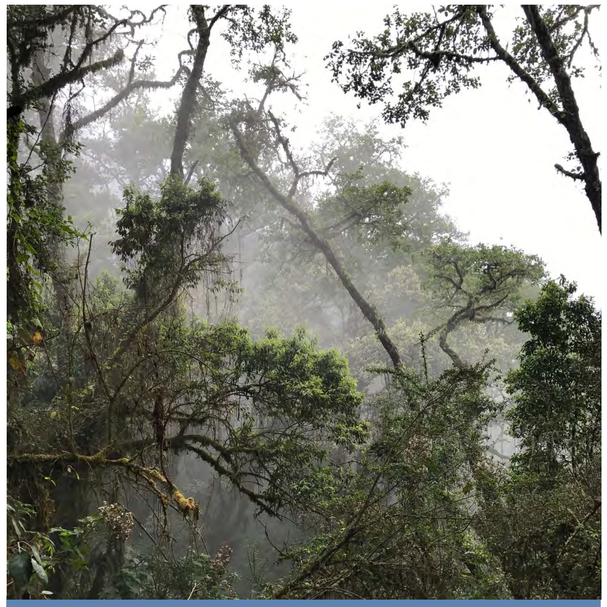
Avoiding a Cartography Catastrophe

In this systematic mapping review of all clinically important infectious diseases known to humans, more than half showed a strong rationale for mapping, yet less than 5 percent of those have been mapped reliably.

An online, open-access database included in the study provides a quantitative scheme for evaluating the quality of data available for each infectious disease as well as specific mapping recommendations.

Unreliable mapping makes it difficult to fully understand the geographic scope and threat of disease and therefore make informed policy recommendations for managing it. The study was initiated as a part of a **NIMBioS Workshop on Infectious Disease Modeling**, co-organized by the National Center for Medical Intelligence.

Citation: *Hay SI et al. 2013. Global mapping of infectious disease. Philosophical Transactions of the Royal Society B. 368(1614): 20120250.*



Mathematical modeling has made important contributions to our understanding of ecosystems. Models can clarify underlying assumptions, make predictions, suggest control strategies, and answer fundamental questions about complex ecological processes and how real ecosystems might change over time.

Divining Patterns in Tropical Rainforests

Tropical rainforests play a vital role in the well-being of our planet, soaking up carbon dioxide and helping stabilize the global climate. Understanding the science of rainforests—the "lungs" of the planet—is critical to maintaining the fragile balance of Earth's ecosystems.

Despite differences in climate and species composition, tropical rainforests worldwide typically exhibit a consistent size structure. However, researchers have not yet found a simple biological explanation for the pattern.

Verifying the mechanism with a mathematical model, **NIMBioS Postdoctoral Fellow Caroline Farrior** and colleagues found that the consistent pattern appears to be driven by trees that lose in competition with other trees for light. The findings have significant implications for how tropical rainforests are modeled, especially important now as modelers try to predict the sustainability of forests' carbon sink – a service provided by tropical forests that slows the rate of atmospheric increase in carbon dioxide by about one-sixth.

Citation: *Farrior CE, Bohlman SA, Hubbell S, Pacala SW. 2016. Dominance of the suppressed: Power-law size structure in tropical forests. Science 351(6269): 155-157.*

Linking Organisms and Their Environments

All species interact with their environments. But how do species that are able to engineer their environments affect the way a community is assembled? This study, co-authored by **NIMBioS Postdoctoral Fellow Jiang Jiang** quantifies what happens when "ecological engineers" or species modify the environment to their own benefit and how this affects the diversity of the competitive community that they inhabit.

This theoretical study found that in the presence of immigration from a regional species pool, strong feedback can increase local species richness, while in the absence of continual immigration, species richness is a declining function of the strength of species-environment feedback. The study's novel results are likely to foster further theoretical research and generate new hypotheses for experimental and field studies. The paper won the 2014 best paper award from the Ecological Society of America and was a "Recommended" paper by Faculty of 1000.

Citation: *Jiang J, DeAngelis DL. 2013. Strong species-environment feedback shapes plant community assembly along environmental gradients. Ecology and Evolution 3(12): 4119-4128.*

Coral Reefs Suffer With Warmer Oceans

In a study exploring the short- and long-term consequences of environmental changes to Australia's Great Barrier Reef, **NIMBioS Sabbatical Fellow Matthew Spencer** and collaborators determined coverage of living corals on the reef could decline to less than 10 percent if ocean warming continues.

The researchers found moderate warming of 1-2 degrees Celsius would cause the decline. With increasing temperatures as well as coastal development, pollution, and over-fishing, the study also found that corals would be over-run by seaweed which would, in effect, suffocate them. Eventually, interactions among reef organisms would lead to dominance by other groups like sponges and soft corals.

The study, which aims to project the composition of the future Great Barrier Reef, uses a multivariate statistical model and includes quantitative surveys of 46 reef habitats from 1996-2006.

Once thought to be one of the more pristine global reefs, the Great Barrier Reef has lost half of its coral cover in only the last 27 years.

Citation: *Cooper JK, Spencer M, Bruno JF. 2015. Stochastic dynamics of a warmer Great Barrier Reef. Ecology 96(7): 1802-1811.*

Complex Social Rules for the Networked Hyena

This study, co-authored by **NIMBioS Postdoctoral Fellow Amiyaal Ilany**, considered the structural factors affecting the social network of spotted hyenas and found that cohesive clustering such that an individual bonds with friends of friends was the most consistent factor to influence the long-term dynamics of the animal's social structure.

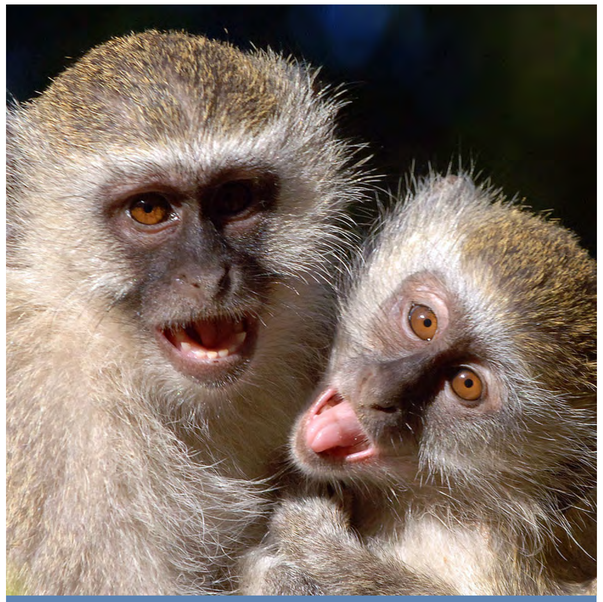
Individual traits, such as sex and social rank, and environmental effects, such as the amount of rainfall and the abundance of prey, also matter, but the ability of individuals to form and maintain social bonds in these triads was key. The study found that hyenas follow a complex set of rules when making social decisions. Males follow rigid rules in forming bonds, whereas females tend to change their preferences over time. For example, a female might care about social rank at one time, but then later choose based on rainfall amounts.

The researchers collected more than 55,000 observations of social interactions of spotted hyenas over a 20 year period in Kenya, making this one of the largest studies to date of social network dynamics in any non-human species.

The researchers used mathematical modeling to evaluate the simultaneous effects of multiple factors—environmental, individual, genetic and structural—on network dynamics. It also gave the researchers a peek into how or why the social structure changes over time and to isolate the factors that shape the structure. The method represents a major advance over methods used in previous studies of animal social networks where more static approaches have typically been applied.

Knowing why and how these animals form lasting relationships can help scientists better understand cooperation patterns and the consequences of sociality in other species.

Citation: *Ilany A, Booms A, Holekamp K. 2015. Topological effects of network structure on long-term social network dynamics in a wild mammal. Ecology Letters 18(7): 687-695.*



The complexity of population-level processes and long time scales over which evolutionary biological processes occur can be elucidated through mathematical models, from simple models that test the soundness of verbal logic to fully-parameterized models that make quantitative predictions directly applicable to empirical systems.

Exploring the Origin and Evolution of Play

In a series of meetings from 2011 to 2013, the **NIMBioS Working Group on Play, Evolution and Sociality** brought together mathematicians, anthropologists, zoologists, neuroscientists, ecologists, psychologists and other top experts to examine play as a window into cognitive evolution and the rules of sociality.

The research culminated in a special issue of the journal *Adaptive Behavior*. The papers represent the first systematic use of computational and mathematical models to investigate the theoretical and empirical origins of play.

Until the Working Group was established, the field lacked mathematical and computational approaches for understanding how play evolves. Using mathematical tools, the group aimed to uncover factors predicting the dynamics, occurrence and trajectory of play in the animal kingdom, as well as to explore the ecological, psychological and life history factors that facilitate and maintain play.

***Citation**: Schank JC. Ed. 2015. Special Issue: The Evolution and Function of Play. Adaptive Behavior 23: 329-330.*

Mating Success in Sex-Role-Reversed Pipefish

Several factors including male size appear to play a role in determining mating success in sex-role-reversed pipefish in which males undergo a long pregnancy and care for the young.

Co-authored by **NIMBioS Postdoctoral Fellow Sarah Flanagan**, the study found that in larger males who bred first, their offspring had a better chance of survival. The researchers used data collected from a population of broad-nosed pipefish (*Syngnathus typhle*) at the beginning of the breeding season in shallow eelgrass beds in Kyllaj, Gotland, Sweden.

Large males with larger embryos invested more energy per embryo than smaller males, produced more newborn offspring, and their offspring survived predation better as compared to the offspring from small males.

The study suggests that larger males have a clear reproductive advantage in the wild over smaller males. And timing is important too – if they breed earlier, they increase their chances of being able to have more pregnancies before the end of the breeding season.

***Citation:** Flanagan SP, Rosenqvist G, Jones AG. 2017. Mate quality and the temporal dynamics of breeding in a sex-role-reversed pipefish, S. typhle. Behavioral Ecology and Sociobiology 71:28*

Surviving Parasites: Advantage Host

When a host and its parasite each have multiple traits governing their interaction, the host has a unique evolutionary advantage that helps it survive, this study found.

Evolutionary theory suggests that parasites and pathogens should evolve more rapidly than their hosts because they tend to have shorter generation times and often experience strong selection. But having multiple attack and defensive mechanisms may help prey species to evolve and maintain low interaction rates with their predators, according to the paper. In addition, the finding suggests that coevolution of multiple traits may help plants to limit the damage they receive from herbivores, and so may help to explain why the world is green.

The researchers, including **NIMBioS Postdoctoral Fellows Tucker Gilman and Tony Jhwueng**, used quantitative genetics and individual-based simulations to analyze a model of a victim-exploiter system. The results could help explain how humans as well as plants and animals evolve to withstand parasitic onslaught.

Citation: *Gilman RT, Nuismer SL, Jhwueng DC. 2012. Coevolution in multidimensional trait space favours escape from parasites and pathogens. Nature 483(7389): 328-330.*

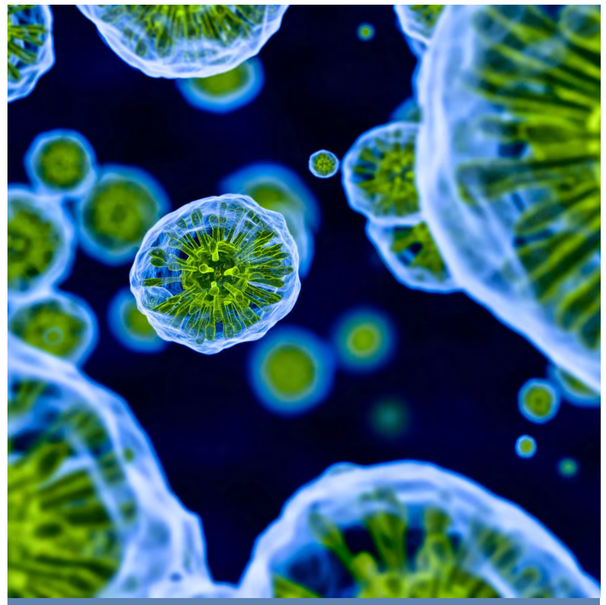
Tails May Have Helped Vertebrates to Walk on Land

When early terrestrial animals began moving about on mud and sand 360 million years ago, the powerful tails they used as fish may have been more important than scientists previously realized. That's one conclusion from this study of African mudskipper fish and a robot modeled on the animal.

The research, which involved a multidisciplinary team of scientists including **NIMBioS Postdoctoral Fellow Sandy Kawano**, examined the mudskipper's locomotive techniques and the robot's flow and drag conditions in representative granular materials. Researchers then applied a mathematical model incorporating new physics based on the drag research.

The study's results could help designers create amphibious robots able to move across granular surfaces more efficiently and with less likelihood of getting stuck in the mud.

Citation: *McInroe B et al. 2016. Tail use improves performance on soft substrates in models of early vertebrate land locomotors. Science 353(6295): 154-158.*



Mathematical and computational approaches can lead to fundamental insights at the molecular and cellular level of biology. Modeling can help untangle biological signaling pathways and feedback loops, elucidate molecular structures, functions and interactions, clarify cellular responses, and lead to greater understanding of larger multicellular systems.

Multi-scale Analysis of Cortical Networks

Activity from the **NIMBioS Working Group on Multi-scale Analysis of Cortical Networks** led to this special topics issue in Frontiers of Neural Circuits, "Towards an Integrated Approach to Measurement, Analysis and Modeling of Cortical Networks."

The collection takes a network-centric approach, matching the physical structure of the brain, and all approaches are interdependent. "Measurement" encompasses the range of neural activity from multi-electrode recordings to whole-brain measurements using imaging. "Analysis" involves creating estimations of network structures from the measurements, and "modeling" covers topics encompassing the relationship between network structure and phenomena, such as stability and synchrony.

Overall, network-based measures better capture the dynamics of brain processes, leading to new understanding and better treatment for brain-related disorders, such as schizophrenia, Parkinson's disease, drug addition, and autism spectrum disorders.

***Citation**: Rao AR, Cecchi GA, Kaplan E. Eds. 2016. Special Topics Issue of Frontiers of Neural Circuits.*

Tracking Genetic Patterns in Invasive Monk Parakeets

The monk parakeets that have invaded Europe and North America over the last half century fortifying their massive communal nests atop utility poles in many urban areas appear to have originated from the same area in South America.

This study found that the North American and European monk parakeets have lower genetic diversity in their invasive populations compared to the genetic diversity in native populations. This is unusual because invasive species with greater genetic diversity often have a greater chance at survival—a more diverse gene pool means more variety in traits of individuals for natural selection to act upon and allow the species to survive and thrive in a new area. Better understanding of the genetic linkages could shed light on the potential success of an invasion. The research team, which included **NIMBioS Postdoctoral Fellow Elizabeth Hobson,** used mitochondrial DNA and microsatellite genotypic data to investigate the levels of genetic variation and to reconstruct the history of the invasions.

***Citation:** Edelaar P et. al. 2015. Shared genetic diversity across the global invasive range of the monk parakeet suggests a common restricted geographic origin and the possibility of convergent selection. Molecular Ecology 24(9): 2164-2176.*

Predicting the Scent of a Molecule

This study's authors organized an international crowd-sourced competition in which teams tried to solve how the smell of a molecule will be perceived by humans. Using a large olfactory psychophysical data set, teams developed machine-learning algorithms to predict sensory attributes of molecules based on their chemoinformatic features. The best models that emerged from this challenge could accurately predict how a new molecule would smell. The top model could accurately identify a molecule's "pleasantness" and "intensity."

Discussion about human olfaction, machine-learning and dynamical systems approaches at the **NIMBioS Investigative Workshop on Olfactory Modeling** provided valuable insight for the research.

The research shines new light on the complex biology of smell perception. No one fully understands what happens when odor molecules waft into the nose and are converted into electrical signals that travel to the brain.

Citation: *Keller A et al. 2017. Predicting human olfactory perception from chemical features of odor molecules. Science 355(6327): 820-826.*

Decoding the Mass of the Human Brain

This study found that as across mammals, human brain mass associates significantly, although weakly, with fat-free mass (FFM) and not fat mass (FM).

A product of the **NIMBioS Investigative Workshop on Mathematical Models of Metabolism and Body Weight Regulation**, the study applied advanced imaging methods to specifically examine the relationships between adult human brain mass and body size-composition. Observations were also extended to examine the corresponding relationships between liver mass and body size-composition. Evaluating liver mass allowed the researchers to generalize the research to other organs and tissues.

The study shows for the first time in healthy adults that prior links between brain mass, body weight, and height are based largely on fat-free mass. The study also concluded brain mass is not a stable fraction of FFM, but brain/FFM is larger in short subjects compared with their tall similar age counterparts. The liver showed much stronger correlations with FFM compared with brain mass; it was also associated with FM. It also confirmed the century old observation that men have a larger absolute total brain mass than do women.

The findings have important implications for understanding the basis of individual differences in adult human energy expenditure and firmly establish that the sexual dimorphism in brain mass cannot be fully explained by sex differences in either body size or composition.

Citation: *Heymsfield SB et al. 2012. Human brain mass: Similar body composition associations as observed across mammals. American Journal of Human Biology 24(4): 479-485.*

Cultural change over time can impact social structure and create new social rules of interaction. Mathematical models have become increasingly central to understanding socio-cultural evolution, both in biology and the social sciences. NIMBioS has been at the forefront of supporting research in this arena.

Human Groups Key to Saving the Environment

Learning between human social groups may be key to sustaining the environment, according to this study that uses mathematical modeling to understand what factors most influence societies to conserve natural resources.

Researchers from the **NIMBioS Working Group on the Evolution of Sustainability** developed a model to simulate how societies with different social structures and institutions manage resources. In the model, societies that over-exploited their environment went extinct; societies survived when individuals cooperated by limiting their personal consumption. But the researchers went further: they wanted to understand what factors influenced individual cooperation, enabling survival. The key appeared to be social groups. In the model, societies that were divided into multiple groups were four times more likely to conserve resources and survive than societies that had no sub-group divisions.

***Citation**: Waring TM, Goff SH, Smaldino PE. 2017. The coevolution of economic institutions and sustainable consumption via cultural group selection. Ecological Economics 131: 524–532.*

What Makes a Leader? Animals Have Answers

This review of leadership in mammalian societies revealed more similarities than previously appreciated between leadership in humans and non-humans.

The research team, comprised of biologists, anthropologists, mathematicians, and psychologists from the **NIMBioS Working Group on Hierarchy and Leadership**, reviewed empirical and theoretical work on leadership in four domains: movement, food acquisition, within-group conflict mediation, and between-group interactions.

The study found that leadership is generally achieved as individuals gain experience, in both humans and non-humans, with some exceptions where leadership is inherited.

The researchers speculate that the human and non-human similarities probably reflect shared cognitive mechanisms governing dominance and subordination, alliance formation, and decision-making, while differences may be explained in part by humans' tendency to take on more specialized roles within society.

***Citation:** Smith et al. Leadership in mammalian societies: Emergence, distribution, power, and payoff. Trends in Ecology & Evolution 31(1): 54-66.*

Prehistoric Conflict Helped Human Brain Evolution

Warfare not only hastened human technological progress and vast social and political changes, but may have greatly contributed to the evolutionary emergence of humans' high intelligence and ability to work together toward common goals, according to this study by **NIMBioS Associate Director for Scientific Activities Sergey Gavrilets.**

How humans evolved high intelligence, required for complex collaborative activities, despite the various costs of having a big brain has long puzzled evolutionary biologists. This study, which uses mathematical modeling to answer its questions, found that intelligence and cooperative behavior can co-evolve.

The research points to the types of collective actions that are most effective at hastening collaboration. According to the model, collaborative ability evolves easiest if there is direct conflict or warfare between groups. In contrast, collective activities, such as defending against predators or hunting for food are much less likely to result in a significant increase in collaborative abilities.

Citation: *Gavrilets S. 2015. Collective action and the collaborative brain. Journal of the Royal Society Interface 12: 20141067.*

Why Do We Follow Unspoken Group Rules?

Following norms can sometimes be costly for individuals if norms require sacrifice for the good of the group. This study, co-authored by Sergey Gavrilets, explores this question, shedding light on the origins of human cooperation. The results show that the ability of humans to internalize social norms is expected to evolve under a wide range of conditions, helping to forge a kind of cooperation that becomes instinctive.

The researchers used computer simulations to model both individual behavior in joint group actions and underlying genetic machinery controlling behavior. In addition to answering theoretical questions about the origins of human cooperation, the study may have a variety of practical applications, such as in social and economic policymaking.

Citation: *Gavrilets S, Richerson PJ. 2017. Collective action and the evolution of social norm internalization. Proceedings of the National Academy of Sciences 114: 6068–6073.*

Founded in 2016 at NIMBioS, the **National Institute for STEM Evaluation and Research (NISER)** provides quality program evaluation to the Science, Technology, Engineering and Mathematics (STEM) research and education sectors. NISER has collaborated on grant proposals with multiple institutions in the United States and abroad and manages a diverse evaluation portfolio of STEM-related projects.

NISER
NATIONAL INSTITUTE FOR STEM EVALUATION AND RESEARCH

Helping define program goals and evaluate outcomes

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.

Many projects focus on improving postsecondary STEM education, including curriculum improvement, student recruitment and retention practices, and faculty education. A particular focus has been expanding the inclusion of underrepresented students in STEM education.

A unique aspect of the Institute is its commitment to expanding evaluation science. Through peer-reviewed publications, NISER generates and disseminates new knowledge about the ways in which integrated STEM programs function successfully. Results of NISER's evaluations of NIMBioS activities, more than 150 to date, are published openly on the NIMBioS website.

Services

Planning and Development
Proposal development · Formative and summative evaluation design and implementation · Strategic planning · Needs assessment · Project mapping

Data Collection
Developing and tailoring instruments · Survey design and administration · Interview and focus group facilitation · Collection and analysis of observational data · Review of program documentation

Analyses
Descriptive and inferential statistical analyses · Bibliometrics · Network analyses · Qualitative and quantitative data analysis · Data visualization

Reports
Utilization-focused reporting · Dashboards · Presentations · Publications

Contact:

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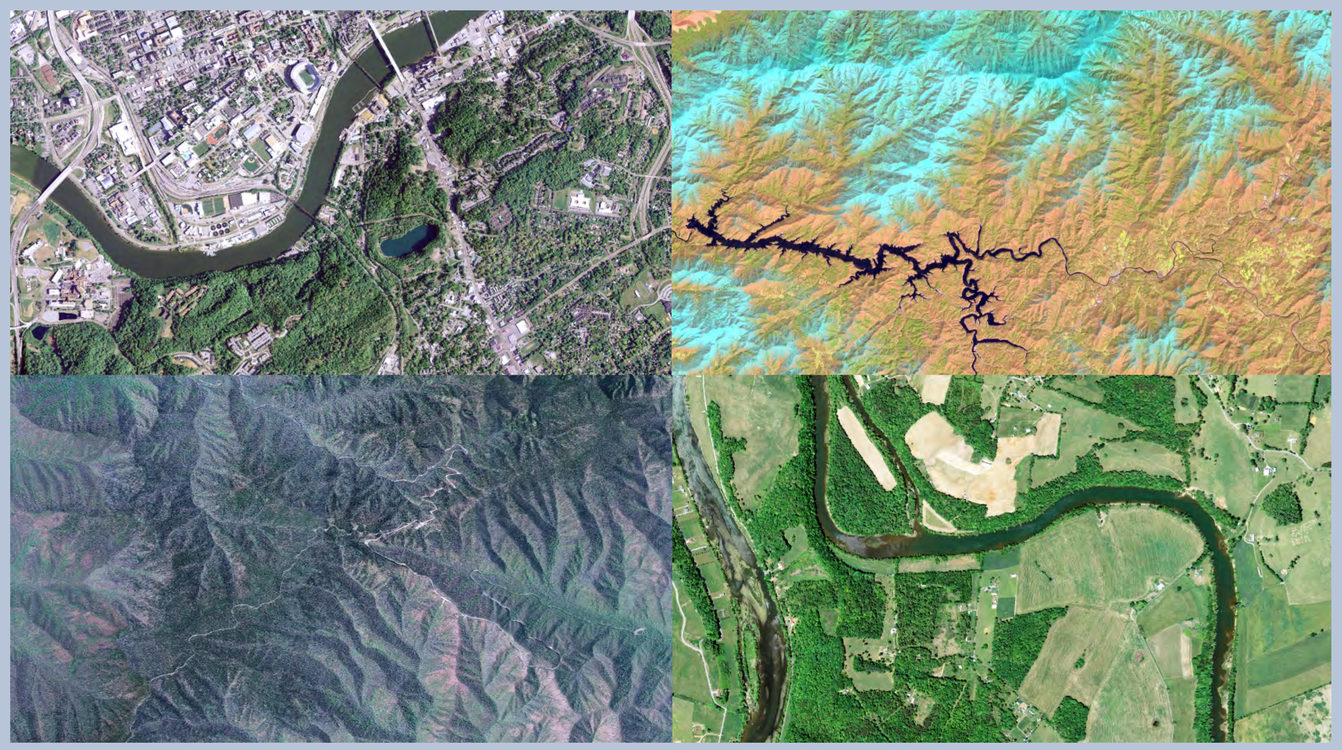
www.stemeval.org

The **Spatial Analysis Lab (SAL)** at NIMBioS offers state-of-the-art spatial analysis capabilities to researchers interested in understanding biological, geographic, and socio-economic processes. SAL enables cross-disciplinary research for those in academia, government and industry who are engaged in biogeographical modeling, spatial statistics, data acquisition and mapping.



How to Work with the Spatial Analysis Lab Now:

- Current Project Engagement: Enhance your project by working with us on a spatial analysis component.
- Grant Facilitation: Add SAL capabilities to strengthen and expand the scope and impact of a grant or contract proposal.
- Education and Outreach: Develop a tutorial or workshop with us that combines your research area with the capabilities of SAL and NIMBioS.

Services

Analytical Lab Capabilities

- Large-scale spatial data capture and collection
- Data visualization and analysis (ArcGIS, ENVI, Trimble Pathfinder Office, FARO SCENE)
- Training and outreach

Field Instrumentation

- Terrestrial laser scanner
- Unmanned Aerial System (max. payload: 5kg)
- Visual, multispectral & hyperspectral sensor packages
- Trimble Juno handheld GPS units

FAA Small Unmanned Aircraft Certified Pilot and Insured Operation
(documentation available upon request)

Contact:

Mona Papeş, Director
Eric Carr, Science Coordinator
SAL@nimbios.org
www.nimbios.org/sal

The NIMBioS Education and Outreach program 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. NIMBioS initiatives focus on the enhancement of education at the interface between mathematics and biology and promote cross-disciplinary approaches to science at all levels.

Extending Learning for Undergraduates

The annual eight-week **Summer Research Experience for Undergraduates** has provided more than 160 undergraduate students from around the country a unique research experience engaging in team science and collaborating across disciplines with faculty and postdocs. Projects have covered a variety of topics, from mating patterns in birds' evolution to modeling the spread of La Crosse virus to developing computer games for teaching biology, and more.

The annual **Undergraduate Research Conference at the Interface of Mathematics and Biology** has hosted more than 800 undergraduate students from around the country. A unique aspect of the conference is the focus on students presenting their research in talks to hundreds of attendees. Each conference includes a panel discussion on career opportunities, graduate school showcase, and networking opportunities.

Virtual Learning Space

Hosting more than 250 educational and outreach activities with more than 1,000 participants since the institute was established in 2008, NIMBioS reaches learners of all ages in a variety of ways. Via live streaming, more than 800 participants have joined tutorials and workshops and webinars. NIMBioS' vast video library hosts more than 400 videos with thousands of regular subscribers. To enhance learning, NIMBioS has also developed online shared communities via WordPress and BaseCamp.

Whether online or in person, NIMBioS tutorials cover a variety of topics, from evolutionary quantitative genetics to stochastic modeling and more. Faculty workshops include curriculum development for computational biology and integrating data intensives into the classroom. Modules with biology and math applications for classroom use at the middle and high school levels are available.

A Strong Commitment to Promoting Diversity

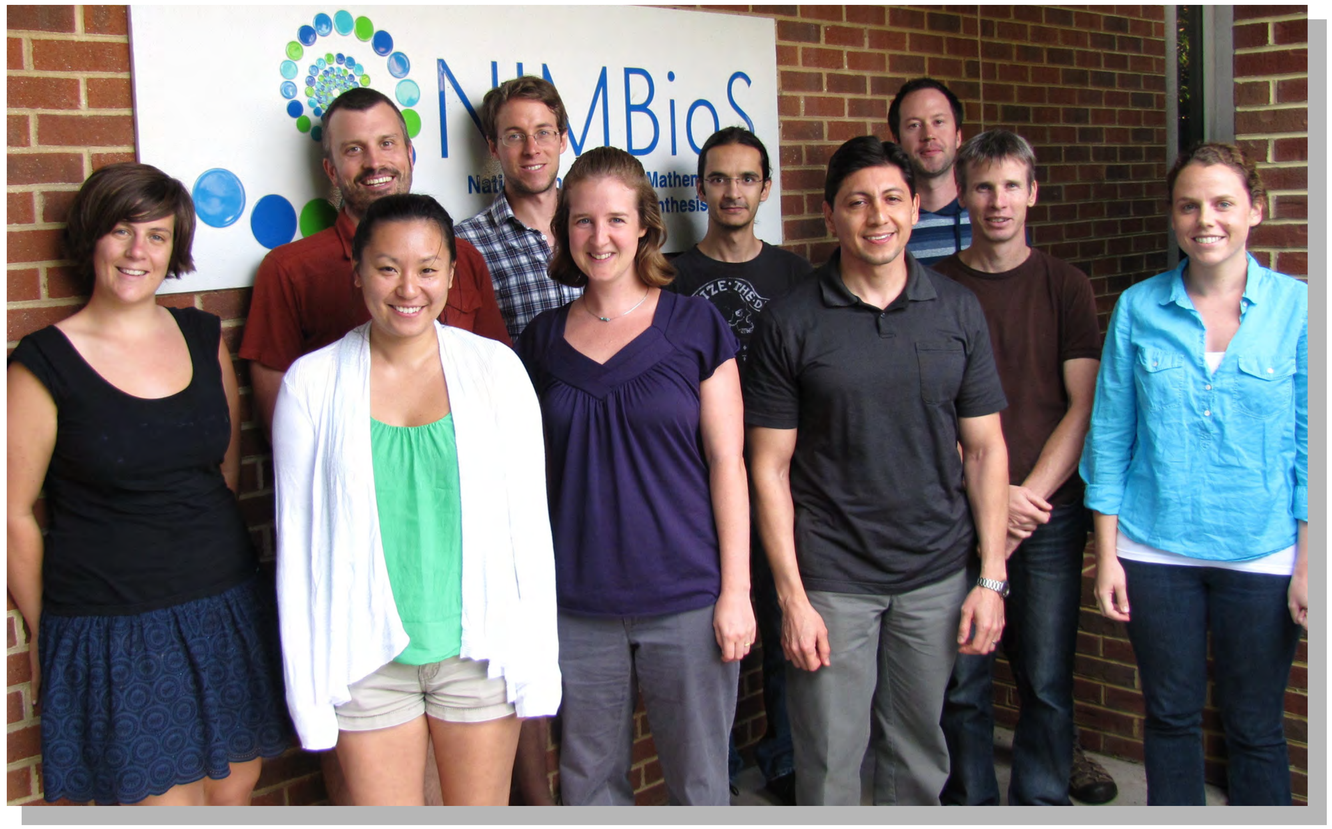
"The pursuit of knowledge and understanding is enriched by an environment in which people of diverse backgrounds learn together and from each other, and participate in free and genuine exchanges of views." (University of Tennessee Diversity Action Plan)

NIMBioS is committed to promoting diversity in all its activities. Diversity is considered in all its aspects, social and scientific, including gender, ethnicity, scientific field, career stage, geography and type of home institution. All applications for proposed NIMBioS activities are required to report the diversity features of their planned activities.

NIMBioS has signed joint agreements with five Minority-Serving Institutions with the primary goal to cultivate a more diverse group of researchers capable of conducting research at the math/biology interface. NIMBioS organizes and facilitates numerous activities to increase the involvement of girls and women in the STEM fields. NIMBioS also helped establish the UT-NIMBioS STEM Alliance, which aims to improve the success of students with disabilities in the STEM disciplines.

For full details, visit http://www.nimbios.org/education/diversity

Postdoctoral Scholarship



"Working at NIMBioS was very much like having a junior faculty position. I had mentors I could consult, but the decisions about what research to conduct and how to do it were mine alone…this was excellent preparation for a 'real' faculty position."

--Former Postdoctoral Fellow

Since 2009 when the program was established, NIMBioS has supported 47 postdoctoral fellows for two-year fellowships. The NIMBioS Postdoctoral Fellowship program is top-of-the-line, designed to help Fellows succeed in future endeavors, whether as a faculty member at a R1 institution or liberal arts college, a position in government, or conducting research in industry. More than 85% of NIMBioS postdoctoral fellows accept faculty positions at the world's top institutions (Top 500, Shanghai Rankings), a far higher success rate than most postdoctoral programs. Find out where our postdocs are today on page 18.

NIMBioS Postdoctoral Fellows: Where Are They Now?

Dr. Clemente Aguilar, Postdoctoral Fellow at MD Anderson Cancer Center

Dr. Folashade Agusto, Assistant Professor of Ecology & Evolutionary Biology, University of Kansas

Dr. Erol Akçay, Assistant Professor of Biology, University of Pennsylvania

Dr. Jeremy Beaulieu, Assistant Professor of Biological Sciences, University of Arkansas

Dr. Sharon Bewick, Postdoctoral Researcher and Lab Manager, Bill Fagan Lab, University of Maryland

Dr. JJ (Chai) Crosskey, Data Scientist, Quantamental Technologies

Dr. Julia Earl, Assistant Professor of Aquatic Ecology, Louisiana Tech University

Dr. Caroline Farrior, Assistant Professor of Integrative Biology, University of Texas at Austin

Dr. Jake Ferguson, Postdoctoral Researcher, Fisheries, Wildlife and Conservation Biology, University of Minnesota

Dr. Orou Gaoue, Assistant Professor of Ecology & Evolutionary Biology, University of Tennessee, Knoxville

Dr. Tucker Gilman, Lecturer of Environmental Biology, University of Manchester, United Kingdom

Dr. Will Godsoe, Lecturer, Bio-Protection Centre, Lincoln University, New Zealand

Dr. Sean Hoban, Tree Conservation Biologist, Morton Arboretum, Chicago

Dr. Elizabeth Hobson, Postdoctoral Fellow, Arizona State University-Santa Fe Institute's Center for Biosocial Complex Systems

Dr. Amiyaal Ilany, Senior Lecturer, Mina and Everard Goodman Faculty of Life Sciences**,** Bar-Ilan University, Israel

Dr. Tom Ingersoll, Computational Biologist, US Department of Defense

Dr. Tony Jhwueng, Associate Professor of Statistics, Feng-Chia University, Taichung, Taiwan

Dr. Jiang Jiang, Professor of Soil and Water Conservation, Nanjing Forestry University, China

Dr. Nels Johnson, Mathematical Statistician, US Forest Service, Pacific Southwest Research Station

Dr. Andrew Kanarek, Population Biologist/Ecological Modeler, US Environmental Protection Agency

Dr. Sandy Kawano, Assistant Professor of Comparative Physiology, California State University, Long Beach

Dr. Arik Kershenbaum, Herchel Smith Research Fellow, Department of Zoology, University of Cambridge

Dr. A. Michelle Lawing, Assistant Professor of Ecosystem Science and Management, Texas A&M University, College Station

Dr. Maud Lélu, Java Developer, AxYus, Paris, France

Dr. Keenan Mack, Assistant Professor of Biology, Illinois College

Dr. Gesham Magombedze, Assistant Investigator, Baylor Institute for Immunology Research

Dr. Yi Mao, (post-fellowship) Senior Fellow, Department of Genome Sciences, University of Washington-Seattle

Dr. Ryan Martin, Assistant Professor of Biology, Case Western Reserve University

Dr. Nick Matzke, Discovery Early Career Researcher Award Fellow, Ecology, Evolution, & Genetics, Research School of Biology, Australian National University

Dr. Emily Moran, Assistant Professor of Plant Ecology & Evolution, University of California, Merced

Dr. Calistus Ngonghala, Assistant Professor of Mathematical Biology, University of Florida

Dr. Suzanne O'Regan, Assistant Professor of Mathematics, North Carolina A&T State University

Dr. Angela Peace, Assistant Professor of Mathematics and Statistics, Texas Tech University

Dr. Chris Remien, Assistant Professor of Mathematics, University of Idaho

Dr. Megan Rúa, Assistant Professor of Biological Sciences, Wright State University

Dr. Daniel Ryan, Chief Information Officer, Mary Mahoney Enterprises

Dr. Ioannis Sgouralis, Postdoctoral Associate, Center for Biological Physics, Arizona State University

Dr. Zavier Thibert-Plante, Senior Lecturer, Department of Ecology and Environmental Science, Umeå University

Dr. Oyita Udiani, National Science Foundation Postdoctoral Fellow, University of Tennessee, Knoxville

Dr. Matt Zefferman, Postdoctoral Fellow, School of Human Evolution and Social Change, Arizona State University

NIMBioS Graduate Research Assistants: Where Are They Now?

Dr. Anna Jo Auerbach
Postdoctoral Fellow, University of Georgia

Jeremy Auerbach, Ph,D. Student, Geography

Dr. Jason Bintz, Assistant Professor of Mathematics, Houghton College

Dr. Erin Bodine, Associate Professor of Mathematics, Rhodes College

Dr. Yuzhuo Chu, Postdoctoral Fellow, Louisiana State Univ.

Blaise DeCotes, Software Engineer, PhishLabs

Dr. Edgar Duenez-Guzman, Senior Software Engineer, DeepMind

Dr. Christine Dumoulin, Postdoctoral Fellow, University of Georgia

Dr. Pelagie Favi, Process Engineer, Intel

Boloye Gomero, Math Instructor, Bullis School

Dr. Mauricio Gonzalez-Forero, Marie Currie Fellow, University of St. Andrews, UK

Dr. Gwen Iacona, Postdoctoral Fellow, University of Queensland

Dr. Elizabeth Johnson, Ph.D. graduate in spring 2017

Dr. Michael Kelly, Assistant Professor of Mathematics, Transylvania University

Dr. Rachel Leander, Assistant Professor of Mathematics, Middle Tennessee State University

Dr. Ben Levy, Mathematics Faculty, Fitchburg State University

Dr. John Martin, Senior Vice President and Chief Technology Officer, VortexT Analytics

Dr. Marco V. Martinez, Assistant Professor of Mathematics, North Central College

Dr. Kathryn Massana, Analytical Training Consultant, SAS

Dr. Austin Milt, Postdoctoral Fellow, Center for Limnology, University of Wisconsin-Madison

Dr. Eric Numfor, Assistant Professor of Mathematics, University of Augusta

Dr. Buddhi Pantha, Assistant Professor of Mathematics, Abraham Baldwin Agricultural College

Dr. Premal Shah, Assistant Professor of Genetics, Rutgers University

Dr. Adam Sullivan, Senior Director, Artificial Intelligence at Change Healthcare

Dr. Ashutosh Wadhwa, Research Assistant Professor, Center for Global Safe Water, Sanitation and Hygiene, Emory University

Dr. Henian Xia, Cofounder, Zywie

Dr. Lakmal Walpitage, Research Analyst, Kansas Department of Health and Environment

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