



# 2009 Annual Report

National Institute for Mathematical and Biological Synthesis

Reporting Period, September 2008 – August 2009  
Submitted to the National Science Foundation, May 2009

**Annual Report for Period:**09/2008 - 08/2009**Submitted on:** 05/30/2009**Principal Investigator:** Gross, Louis J.**Award ID:** 0832858**Organization:** U of Tennessee Knoxville**Submitted By:**

Gross, Louis - Principal Investigator

**Title:**

National Institute for Mathematical and Biological Synthesis (NIMBioS)

### Project Participants

#### Senior Personnel

**Name:** Gross, Louis**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Louis Gross supervised and coordinated all activities of NIMBioS. This included: hiring all NIMBioS staff, coordinating activities of the Associate Directors, organizing meetings of the Advisory Board, communicating with potential participants in NIMBioS activities, communicating the NIMBioS mission to numerous institutions through formal and informal presentations, communicating activities with leaders of other NSF BIO Centers, coordinating the renovations of NIMBioS facilities with University officials, chairing the search committee for six new faculty to be associated with NIMBioS, and communicating regularly with NSF Program Officers regarding NIMBioS plans.

**Name:** Gavrilets, Sergey**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Dr. Gavrilets is the NIMBioS Associate Director for Scientific Activities and member of the NIMBioS Leadership Team. He leads the assessment of requests for support in conjunction with the rest of the Leadership Team and Board of Advisors. He is also the primary organizer for a NIMBioS working group investigating processes of coalition formation.

**Name:** Lenhart, Suzanne**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Dr. Lenhart is the NIMBioS Associate Director for Outreach, Education, and Diversity and member of the NIMBioS Leadership Team. She oversees all outreach and education activities, supervises the Outreach and Education Coordinator, and works with the Board of Advisor's Committee to Promote Diversity to ensure opportunities at NIMBioS are available to diverse students and researchers. She is also an organizer for a NIMBioS working group investigating modeling and management of disease in feral swine within Great Smoky Mountains National Park (GSMNP) and a NIMBioS investigative workshop evaluating optimal control/optimization questions for individual-based and agent-based models.

**Name:** Hickling, Graham**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Dr. Hickling is the NIMBioS Associate Director for Partner Relations and member of the NIMBioS Leadership Team. He leads contact with industry partners (i.e., ESRI, IBM), government partners (i.e., Great Smoky Mountains National Park), and other supporting organizations. He is also an organizer for a NIMBioS working group investigating modeling and management of disease in feral swine within Great Smoky Mountains National Park (GSMNP) and an instructor for the NIMBioS REV program.

**Name:** Peterson, Cynthia**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Dr. Peterson is the NIMBioS Associate Director for Graduate Education and member of the NIMBioS Leadership Team. She leads evaluation of applicants for NIMBioS graduate research assistantships and oversees administration of the graduate research program. She also coordinates NIMBioS connections to graduate recruitment programs at UTK including an NSF-funded IGERT and NIH-funded PEER award.

**Name:** Welsh, Christopher

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Dr. Welsh is the NIMBioS Deputy Director and member of the NIMBioS Leadership Team. He oversees the day-to-day operations of NIMBioS, supervises NIMBioS staff, and acts as the point of contact for post-doctoral fellows and short- and long-term visitors.

**Post-doc**

**Graduate Student**

**Undergraduate Student**

**Technician, Programmer**

**Name:** Comiskey, Jane

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Jane is a Senior Analyst for NIMBioS. She developed and maintains the NIMBioS website, provides IT support, provides coding support for scientific activities, and supports web-communications for activity participants.

**Other Participant**

**Name:** Peek, Michael

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Mike is the NIMBioS Information Technology (IT) Manager. He provides all IT support, basic hardware and connectivity, software and applications for collaborative services. He oversees the IT staff, which includes a high-performance computing specialist and a senior analyst.

**Name:** Carr, Eric

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Eric is the NIMBioS high-performance computing (HPC) specialist. He provides support for participant HPC needs as well as IT support. He organized the NIMBioS HPC Training the Trainers Tutorial.

**Name:** Duncan, Sarah

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Sarah is the NIMBioS Outreach and Education Coordinator. Working with the Associate Director for Outreach and Education, she has developed and managed the outreach and education activities described under Section II.

**Name:** Bishop, Pamela

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Pam is the NIMBioS Program Evaluation Coordinator. She has developed evaluation instruments for NIMBioS activities both to support NSF reporting requirements and for internal assessment of the success of activities and ways to improve them.

**Name:** Crawley, Catherine

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Dr. Crawley is the NIMBioS Communications Coordinator. She is the main point of administrative contact for media, writes press releases on NIMBioS activities, and consults with other staff on strategies to increase awareness of NIMBioS opportunities in the scientific community.

**Name:** Koosman, Toby

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Toby is the NIMBioS Business Manager. She handles all accounting, inventory, contracting, and personnel procedures and has primary responsibility for all purchasing and financial management of participant support activities.

**Name:** Thomas, Jennifer

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Jennifer is the NIMBioS Event and Travel Coordinator. She is responsible for coordinating logistics of all NIMBioS activities. This includes establishing contracts for lodging and meals, making travel arrangements for activity participants and NIMBioS staff, and ensuring all needs are met during activities.

## Research Experience for Undergraduates

### Organizational Partners

#### **IBM**

IBM is a formal organizational partner with NIMBioS and has pledged the full support of the IBM Deep Computing team and continued collaborations with projects in computational biology.

#### **BioQuest Curriculum Consortium**

BioQuest and NIMBioS collaborated to conduct two workshops at NIMBioS: the NUMB3R5 Count workshop providing data, tools, and curricular materials for teachers and faculty and the SCALE-IT Curriculum Development workshop titled 'Integrating Bioinformatics and Molecular Visualization into the Curriculum' devoted to applying biological problem solving strategies to problems in medicine, epidemiology, forensics, agriculture, and conservation.

#### **Great Smoky Mountains National Park**

GSMNP is a formal organizational partner with NIMBioS. GSMNP staff collaborated with NIMBioS to develop outreach and education programs and as participants in NIMBioS working groups. A presentation on opportunities for GSMNP/NIMBioS collaboration was given at this year's GSMNP's annual science conference.

#### **California State University San Marcos Foundation**

NIMBioS staff are working with CSUSM faculty and staff to increase underrepresented individuals in science careers, with particular connections through the NIH-funded MARC Phase II award at CSUSM.

#### **Environmental Systems Research Institute, Inc.**

ESRI is a formal organizational partner with NIMBioS prepared to provide expertise in enhancing the connection between mathematical models, computational simulation, and GIS visualization and analysis in application to biological problems.

#### **Fisk University**

NIMBioS staff are working with Fisk University faculty and staff to increase underrepresented individuals in science careers.

#### **IPlant Collaborative**

IPlant is an NSF Center with which NIMBioS is collaborating on outreach and education projects including co-sponsoring a session at the 2009 National Assoc. of Biology Teachers Meeting. Along with the other NSF BIO Centers, we are sharing information on projects and potential research collaborations.

#### **Nat. Ctr for Ecological Analysis and Syn**

NIMBioS initiated communication between NESCent, NEON, NCEAS, and IPlant to talk about possible avenues of collaboration between the institutions and centers. An education and outreach meeting is planned at NESCent for a more in depth discussion. There are also discussions ongoing between BIO Center Directors regarding potential collaborations on research and communication.

#### **Nat. Evolutionary Synthesis Center**

NIMBioS initiated communication between NEScent, NEON, NCEAS, and iPlant to talk about possible avenues of collaboration between the institutions and centers. An education and outreach meeting is planned at NEScent for a more in depth discussion, and the Bio Center Directors are in regular discussions concerning collaborations.

#### **National Ecological Observatory Network, Inc**

NIMBioS initiated communication between NEScent, NEON, NCEAS, and iPlant to talk about possible avenues of collaboration between the institutions and centers in February. An education and outreach meeting is planned at NEScent for a more in depth discussion. The Directors of these Centers are in communication to share resources and encourage new collaborations.

#### **National Institute for Computational Sci**

NICS staff collaborated with NIMBioS in development of the HPC Tutorial held in March and has consulted with NIMBioS staff on high-performance computing needs. Time on the KRAKEN super-computer operated by NICS was provided during the Tutorial and arrangements are in place for use of KRAKEN as appropriate for activities based at NIMBioS.

#### **North Carolina Agricultural & Technical State University**

NIMBioS staff are working with NC A&T faculty and staff to increase underrepresented individuals in science careers. NC A&T faculty are participating in activities at NIMBioS, and two NC A&T students are participating in the NIMBioS REU program.

#### **Scalable Computing and Leading Edge Inno**

Scalable Computing and Leading Edge Innovative Technologies (SCALE-IT) is an Integrative Graduate Education and Research Training (IGERT) program funded by the National Science Foundation. It is an interdisciplinary graduate fellowship program at the University of Tennessee designed to train scientists to apply appropriate computing tools to solve quantitative problems at all scales of biology (from atom to ecosystems). NIMBioS is a co-sponsor of the SCALE-IT Curriculum Development workshop devoted to applying biological problem solving strategies to problems in medicine, epidemiology, forensics, agriculture, and conservation. NIMBioS and SCALE-IT also co-sponsored a series of speakers on computational biology challenges over the Spring term at UTK.

#### **Mathematical Biosciences Institute (MBI)**

MBI and NIMBioS are collaborating on a project, PUMP (also sponsored by the Society for Mathematical Biology and SIAM) to survey undergrad and graduate programs in mathematical biology around the US. The leadership teams of NIMBioS and MBI are in regular contact regarding potential collaborations.

#### **Program for Excellence and Equity in Res**

Program for Excellence and Equity in Research (PEER) is an NIH-funded graduate students support program at UTK. NIMBioS faculty and staff have collaborated in development of this 'program of excellence' designed to increase numbers of under-represented minority Ph.D.s in science, technology, engineering, and mathematics (STEM) fields. PEER has an emphasis on quantitative biology.

#### **USDA-APHIS-WS-National Wildlife Research Center**

USDA is a formal organizational partner with NIMBioS. USDA-APHIS personnel initiated the forthcoming NIMBioS Bovine Tuberculosis Workshop, and are participating in the Feral Hog / Pseudorabies Working Group. NIMBioS contributed to Foreign Animal Disease outbreak training for USDA staff, and NIMBioS and APHIS staff are presently planning future Working Groups on Cattle Tick fever, and Wildlife Tuberculosis.

#### **Howard Hughes Medical Institute**

HHMI, through its HHMI Professor Program, sponsored the efforts of BioQuest and Dr. Claudia Neuhauser to lead the NIMBioS co-sponsored 'Curriculum Development Workshop: Integrating Bioinformatics and Molecular Visualization into the Curriculum'. HHMI support provided funding for attendance by faculty at this Workshop, for which NIMBioS provided facilities and staff support.

#### **University of Texas - El Paso**

UTEP and NIMBioS are collaborating to enhance the participation of under-represented minorities in STEM disciplines. These efforts are underway through the NIH-funded MARC Phase II award at UTEP and the Bioinformatics MS program at UTEP, with formal partnership arrangements currently under development.

#### **Amer. Assoc for Advancement of Science**

NIMBioS is involved in the AAAS-led and NSF-funded Conference on Transforming Undergraduate Education in Biology: Mobilizing the Community for Change. NIMBioS organized a group of UTK undergraduate math and biology students to consider questions posed by AAAS for this Conference.

### **Project Kaleidoscope**

PKAL coordinated with NIMBioS a Webinar on undergraduate education for life science students led by the NIMBioS Director, Louis Gross.

### **Other Collaborators or Contacts**

NIMBioS is collaborating with a large number of scientists from many fields. The text below identifies individuals, their affiliations, and how they have interacted with NIMBioS.

#### **NIMBioS BOARD OF ADVISORS**

NIMBioS has a 23-member advisory board that works with the Leadership Team to evaluate requests for support, encourage collaborative research at the interface of mathematics and biology and assist in developing methods to increase the diversity of participants in NIMBioS activities. Members and their institutions are:

Chair: Alan Hastings - University of California at Davis  
 Cheryl Briggs - University of California at Santa Barbara  
 Carlos Castillo-Chavez - Arizona State University  
 Iain Couzin - Princeton University  
 Lisa Fauci - Tulane University  
 James Glazier - Indiana University  
 Gregory Goins - North Carolina A & T State University  
 Christine Heitsch - Georgia Institute of Technology  
 Susan Holmes - Stanford University  
 Peter Hudson - Pennsylvania State University  
 Trachette Jackson - University of Michigan  
 Overtoun Jenda - Auburn University  
 John Jungck - Beloit College  
 Matthew Keeling - University of Warwick  
 Nancy Kopell - Boston University  
 Donna Koslowsky - Michigan State University  
 David Krakauer - Santa Fe Institute  
 Jonathan Mattingly - Duke University  
 George Middendorf - Howard University  
 Gary Smith - University of Pennsylvania  
 DeWitt Sumners - Florida State University  
 John Tyson - Virginia Polytechnic Institute and State University  
 Mariel Vazquez - San Francisco State University

#### **SENIOR PERSONNEL**

The below individuals have been actively involved in NIMBioS activities this year.

Berry, Mike -- Prof. and Assoc. Head, Dept. of Electrical Engineering and Computer Science. Dr. Berry was a co-organizer for the NIMBioS HPC Tutorial, a member of the NIMBioS faculty search committee, and provided advice on HPC opportunities.

Gilchrist, Mike -- Asst. Prof., Univ. Tennessee Department of Ecology & Evolutionary Biology. Dr. Gilchrist is one of the organizers and instructors for the NIMBioS REU and REV program.

Odoi, Agricola -- Asst. Prof., Univ. Tennessee Comparative Medicine, Veterinary College. Dr. Odoi provides expertise in epidemiology, participated in the Modeling Disease in Feral Swine working group, co-organized a NIMBioS Investigative Workshop on Modeling Transmission of Bovine Tuberculosis, was a member of the NIMBioS faculty search committee, and is one of the instructors for the NIMBioS

REV program.

Simberloff, Dan -- Gore Hunger Prof of Environmental Science, Univ. Tennessee Department of Ecology & Evolutionary Biology. Dr. Simberloff participated in the NIMBioS Working Group examining biological problems using binary matrices and has agreed to mentor NIMBioS post-doctoral fellows.

Ubeda de Torres, Francisco -- Asst. Prof., Univ. Tennessee Department of Ecology & Evolutionary Biology. Dr. Ubeda co-organized the NIMBioS Working Group on intragenomic conflict.

#### UT AND ORNL SENIOR COLLABORATORS

The below individuals have participated as noted in NIMBioS activities and are part of a pool of possible post-doctoral mentors as well as providing a variety of local expertise in fields related to NIMBioS working groups:

Kimberly Gwinn, Assoc. Professor, UT Entomology and Plant Pathology Department. Dr. Gwinn is one of the instructors for the NIMBioS REU and REV programs.

Thomas Hallam, Emeritus Professor, UT Departments of Ecology and Evolutionary Biology and Mathematics. Dr. Hallam has co-organized the NIMBioS Investigative Workshop on Modeling White-nose Syndrome in Bats.

Michael Langston, Professor, UT Department of Electrical Engineering & Computer Science - Dr. Langston was a co-organizer of the NIMBioS HPC Tutorial.

John New, Professor and Department Head, UT Comparative Medicine, Veterinary College. Dr. New was involved in the NIMBioS faculty search procedures and provided advice and support in development of the NIMBioS REV program.

Susan Riechert, Distinguished Service Professor, UT Department of Ecology & Evolutionary Biology - Dr. Riechert is assisting with NIMBioS outreach efforts with emphasis on the Biology in a Box program.

Steven Wise, Assistant Professor, UT Department of Mathematics. Dr. Wise is an instructor for the NIMBioS REU and REV programs and discussed NIMBioS in a presentation at the SHANKS conference in May.

#### NIMBioS HPC TUTORIAL INSTRUCTORS

The following individuals were co-instructors in the tutorial designed to 'train the trainers' in use of high-performance computing for biologists:

Dr. Jim Ferguson, Director for Education, Outreach and Training, National Institute for Computational Studies, Univ. Tennessee/ORNL.

Dr. Christian Halloy, Research Leader, JICS UT/ORNL.

Dr. Kwai Wong, Research Scientist, Joint Institute for Computational Science at UT/ORNL.

Michael McLennan, Senior Research Scientist, Purdue University.

Tabitha Samuel, Electrical Engineering & Computer Science, University of Tennessee.

John Eblen, Electrical Engineering & Computer Science, University of Tennessee.

Dr. Scott Duke Sylvester, Post-doctoral Fellow, Department of Biology, Emory University.

Gary Rogers, Department of Computer Science, University of Tennessee.

Stan Tomov, Research Scientist, Computer Science Department, University of Tennessee.

#### R FOR LIFE SCIENCES INSTRUCTORS

Noelia Barrios (Department of Ecology and Evolutionary Biology graduate student) and Marco Martinez (Department of Mathematics graduate student) planned and conducted the NIMBioS-sponsored tutorial on use of R for life sciences.

#### ADDITIONAL COLLABORATORS

John Lounsbury, Professor, Department of Psychology, University of Tennessee has consulted with NIMBioS staff on program assessment and evaluation procedures.

Premal Shah, Univ. Tennessee Department of Ecology and Evolutionary Biology provided computer and audiovisual support for NIMBioS seminars.

Claudia Neuhauser (University of Minnesota- Rochester), Ethel Stanley, Sue Risseuw, and John Jungck (all of BioQuest) collaborated with NIMBioS in planning and carrying out the NUMB3R5 Count Workshop and the BioQuest collaborators also co-sponsored the SCALE-IT Curriculum Development Workshops on Integrating Bioinformatics and Molecular Visualization in the Curriculum.

Tamah Fridman, Joint Institute for Computational Sciences, ORNL, has planned and organized the NIMBioS-cosponsored Summer School in Biophysics: Physics and Computational Challenges in Biology.

#### GRADUATE RESEARCH ASSISTANTS

The following graduate research assistants worked on NIMBioS projects this year: Erin Bodine, Department of Mathematics; Ivan Juric, Ecology and Evolutionary Biology; Rachel Leander, Department of Mathematics - Biology in a Box; and Marco Martinez, Department of Mathematics - R Tutorial for Life Sciences Graduate Students.

#### SHORT-TERM VISITORS

The following individuals have visited (or will visit in July) NIMBioS for collaborative research efforts:

Rene Salinas, Asst. Professor, Appalachian State Univ. Collaborated with Dr. Suzanne Lenhart and Dr. Frank van Manen on Using Dynamic Model Feedback for Optimization of Individual-based Models.

Maria Leite, Department of Mathematics, University of Oklahoma; Zhilan Feng, Department of Mathematics Purdue University; Jorge Velasco-Hernandez, Programa de Matematicas Aplicadas y Computacion Instituto Mexicano del Petroleo.

Dr. Leite, Dr. Feng, and Dr. Velasco-Hernandez are scheduled to meet in July to work on Coupling Within- and Between-Host Dynamics in HIV and on Models for the Characterization and Prediction of Outbreaks of Dengue Fever Based on Spatially Explicit Information.

Renee Fister, Dept. Mathematics, Murray State Univ.; Elsa Schaefer, Dept. Mathematics, Marymount Univ.; Holly Gaff, Virginia Modeling, Analysis and Simulation Center, Old Dominion Univ.; Rachael Miller, Dept. Mathematics, Univ. Tennessee.

These individuals met with Dr. Suzanne Lenhart at NIMBioS in May to collaborate on disease modeling.

#### POST-DOCTORAL FELLOWS

Erol Akcay (Dept. Biology, Stanford Univ.), Sharon Bewick (Material, Aerospace and Biomedical Engineering Dept, Univ. Tennessee), and Yi Mao (Dept. Mathematics, Michigan State Univ.), have accepted NIMBioS post-doctoral fellow positions to begin in July or August 2009.

Folashade Augusto (Dept. Mathematical Sciences, Federal Univ. of Technology Akure) and William Godsoe (Biology Dept., Univ. Idaho) have accepted positions to begin in September 2009.

### Activities and Findings

#### **Research and Education Activities:**

From the beginning of the reporting period through the end of May, 2009, 204 different people (68% male; 32% female) participated in 12 NIMBioS sponsored events. Participants came from 89 cities across 10 countries, including 33 different states in the U.S. Included in these participants were 172 different researchers from 99 institutions, of which there were 9 NIMBioS residents, 12 scientists from the University of



Tennessee, and 151 scientists visiting from other institutions. In addition to these researchers, there were 20 graduate students and 10 undergraduate students participating. The 172 participating researchers came from 82 different colleges or universities, 8 private research institutions, 3 non-profit organizations, and 6 government institutions.

Projected for the month of June, 2009, NIMBioS is scheduled to host approximately 115 different participants during six events, including 72 researchers from 55 different institutes. Visiting researchers are expected to come from 53 cities across 4 countries, including 26 different states in the U.S. Also included are 10 NIMBioS residents, 3 scientists from the University of Tennessee, and 59 scientists visiting from other institutions, 15 4th-8th grade students, 16 undergraduate students, and 2 high school teachers.

Events scheduled for July and August will bring the total of major activities over this first year to seven working groups, three workshops, two tutorials, two advisory board meetings, and five short-term visitors. In addition the NIMBioS Leadership Team has given over 40 talks about NIMBioS since January 1, 2009 at a wide variety of gatherings.

#### Major Research and Educational Activities

Advisory Board Meetings, 1 on-site and 1 virtual. These meetings were held to refine NIMBioS procedures and goals and to evaluate requests for support, including for working groups, workshops, sabbatical visitors, and post-doctoral fellows. 22 participants

#### Working Group on Coalitions and Alliances

Organizers: Sergey Gavrilets, Departments of Mathematics and Ecology & Evolutionary Biology, University of Tennessee, Knoxville; Frans B. M. de Waal, Psychology Department, Emory University

The goal of this working group is to bring together empiricists and theorists to identify the most promising ways for building a testable quantitative theory of coalition formation. 11 participants

#### Working Group on Intragenomic Conflict

Organizers: Francisco Ubeda de Torres, Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville; Andy Gardner, Ashworth Laboratories, Edinburgh, UK; Jon Wilkins, Santa Fe Institute, Santa Fe, NM

This working group brings together biologists working on intragenomic conflict and mathematicians interested in evolutionary theory. The questions to be answered by the working group are related to the differences and commonalities between conflicting genes and what types of models work best for modeling intragenomic conflict. 15 participants

#### Working Group on Feral Swine / Pseudo-rabies in Great Smoky Mountains National Park

Organizers: Graham Hickling, Department of Forestry, Wildlife and Fisheries, Institute of Agriculture, University of Tennessee, Knoxville, and Director, Center for Wildlife Health; Suzanne Lenhart, Mathematics Department, University of Tennessee, Knoxville; Leslie Real, Biology Department, Emory University

This working group focuses on the problem of managing pseudo-rabies virus and other disease agents among feral swine within Great Smoky Mountains National Park. 15 participants

#### Use of Binary Matrices in Biology Working Group

Organizers: Edward F. Connor, Department of Biology, San Francisco State University; Joshua Ladau, Gladstone Institutes, San Francisco

The Binary Matrices working group focuses on null model tests of binary data. The goal of the Binary Matrices Working group is to bring together biologists, statisticians, and mathematicians to address ways to improve quantitative inference from binary data in biology. 10 participants

#### Planned research/educational activities, June 1 - Sept. 1, 2009:

#### Working Group for Synthesizing and Predicting Infectious Disease while Accounting for Endogenous Risk (SPIDER)

Organizers: Eli Fenichel, Arizona State University, School of Life Sciences; Carlos Castillo-Chavez, Arizona State University, Department of Mathematics and Statistics;

Peter Daszak, Consortium for Conservation Medicine, New York, NY; Rick Horan, Michigan State University, Department of Agricultural, Food, and Resource Economics; Charles Perrings Arizona State University, School of Life Sciences

The SPIDER working group will bring together disease ecologists, economists, and mathematicians to facilitate the development of predictive models both to forecast the risks associated with EIDs in humans, livestock, wildlife, and plants, and to assist in the development of risk management strategies.

#### Working Group for Integrating Functional and Evolutionary Dynamics at Multiple Scales

Organizers: Erol Akcay and Joan Roughgarden, Department of Biology, Stanford University

The working group will model the dynamics of biological systems at the functional and evolutionary levels and integrate these two in a unified framework.

**Investigative Workshop for Modeling White Nose Syndrome in Bats at the Individual and Colony Levels: Epizootiology and Management**  
Organizers: Thomas G. Hallam and Gary F. McCracken, Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville

The epizootiology of White Nose Syndrome (WNS) in bats is best described as partially understood. Indeed, there are uncertainties and questions about the pathogenesis of the disease although it is understood that the fungi *Geomyces* sp. play a significant role in the onset and progression of the disease. The purpose of this meeting is to develop modeling directions to help assist in the understanding of the temporal and spatial scales, the pathology, and the physiology of bats during WNS stress and ultimately to lead to managed control of the disease. 30 participants.

**Investigative Workshop on Modeling the Impact of Cattle Movements on Transmission Dynamics of Bovine Tuberculosis**  
Organizers: Colleen Webb, Department of Biology, Colorado State University, Fort Collins; Agricola Odoi, Department of Comparative Medicine, University of Tennessee, Knoxville

This Investigative Workshop will bring together experts from across the globe to discuss cutting-edge approaches to model bovine TB transmission in the United States, with the goal of developing a model that would help inform policy on TB control strategies. 40 participants.

**Working Group on Population and Community Ecology Consequences of Intraspecific Niche Variation**

Organizers: Daniel Bolnick, Section of Integrative Biology, University of Texas at Austin; Volker Rudolf, Department of Ecology & Evolutionary Biology, Rice University; Kevin McCann, Department of Integrative Biology, University of Guelph, Guelph, Ontario, Canada  
The goal of this working group is to use mathematical models to determine whether, and how, niche variation alters the dynamics of classical models of single-species, predator-prey, and community interactions. It will bring together biologists and mathematicians familiar with 1) empirical patterns of niche variation; 2) theoretical quantitative genetics, population genetics, foraging theory, and neural networks; and 3) mathematical models of population, predator-prey, and food web dynamics.

### **Findings:**

It is early yet to report major findings/outputs from the various NIMBioS-sponsored working groups and workshops. The initial meetings of these multidisciplinary groups have developed plans for a variety of products, including publications, but none have appeared yet.

### **Training and Development:**

Major Opportunities for Training, Development, and Mentoring (through June 1, 2009)

#### **R Seminar**

The R Seminar for statistical computing was co-sponsored by NIMBioS and the University of Tennessee's Department of Ecology and Evolutionary Biology. The purpose of the seminar was to help students learn to use the R statistics package in biological research. The format of the seminar was one hour a week for six weeks. 20 participants

#### **High-Performance Computing Tutorial**

Training the Trainers: High-Performance Computing Tutorial for Computational Science Professionals Collaborating with Biologists. This NIMBioS High Performance Computing (HPC) Tutorial focused on disseminating the tools necessary for organizations and individuals to leverage computational resources for research at the interface of biological/computational/mathematical research. 33 participants

#### **PUMP PANEL**

NIMBioS participated in a panel on undergraduate mathematical biology programs called PUMP organized by MBI, SIAM, and SMB at MBI. We are helping to produce a report that will serve as a resource for individuals and institutions developing initiatives in quantitative biology for undergraduate students.

#### **Vision and Change in Undergraduate Biology Education**

Louis Gross is participating in the AAAS Vision and Change Committee on Undergraduate Biology Education. A student mini-conversation was held at NIMBioS on April 28, 2009 to determine which issues the students find most pressing, and how to best use student input for the Vision and Change Steering Committee for Educational Reform reports. 11 participants

Planned training/development opportunities, June 1 - Sept. 1

#### Research Experiences for Undergraduates and Veterinary Students.

Veterinary students (DVM, VMD or MPH) and undergraduates majoring in math, biology, and related fields will live on campus and work in teams with UT professors on state-of-the-art research projects. Two high-school teachers will also participate.

#### Teacher Collaboration Program

The Teacher Collaboration Program intends to provide links between teachers, scientists, and educators with interest in mathematical biology. NIMBioS will pair teachers with interest in mathematics and biology with active researchers in the math biology community. These knowledgeable partners will be faculty, post-docs, and educators from the institute and recruits from the math biology community. NIMBioS will also maintain a website, Wiggio, and electronic mailing service for the purposes of sharing ideas, information, resources and event schedules.

#### Undergraduate Biology Curriculum Workshop

NIMBioS, SCALE-IT, and BioQuest are co-sponsoring an Undergraduate Biology Curriculum Workshop called Integrating Bioinformatics and Molecular Visualization into the Undergraduate Biology Curriculum for faculty on bioinformatics and visualization, which are rapidly developing research approaches throughout the biological, physical, and mathematical sciences curriculum. The emphasis will be on creating teaching units that apply biological problem solving strategies to real problems in medicine, epidemiology, forensics, agriculture, and conservation.

#### Summer School in Biophysics: Physics and Computational Challenges in Biology

Co-sponsored with ORNL, this three-day educational opportunity targets graduate and senior undergraduate students and postdoctoral fellows in physics, computer and materials sciences, mathematics and chemistry who are interested in considering biosciences as a future career direction.

#### **Outreach Activities:**

Outreach and Education are a significant component of NIMBioS activities. These activities cover a broad audience from elementary school (Kids U), middle school (Girls in Science), high school (teacher collaboration and math/biology curriculum programs), and undergraduates (REU program, Biology in a Box, undergraduate math/biology majors conference, Mu Alpha Theta annual meeting) to graduate students and general science population (seminars, presentations). The below describes NIMBioS outreach and education activities completed or scheduled for June-August.

#### Joint Math Meetings

Co-sponsored with NSF Mathematics Institutes, the Joint Mathematics Meetings are held in Washington, D.C., for the purpose of advancing mathematical achievement, encouraging research, and to provide the communication necessary to progress in the field. NIMBioS and the Mathematics Institutes sponsored an open-house with presentations on opportunities available through these NSF-funded Institutes.

#### Computational Biology Seminar Series

Co-Sponsored by the Scalable Computing and Leading Edge Innovative Technologies (SCALE-IT) graduate fellowship program, NIMBioS, Department of Biochemistry, Cellular, & Molecular Biology and Graduate School of Genome Science and Technology (GST), there were a total of 11 seminars presented by researchers in computational biology over the Spring term 2009.

#### NIMBioS Multidisciplinary Seminars (Job Candidate Presentations)

There were a total of 14 job candidate presentations for faculty positions associated with the NIMBioS search with attendance of 30-50 people at each seminar. Seminars were co-hosted by various departments at the University of Tennessee including Biochemistry, Cellular and Microbiology, College of Veterinary Medicine, Ecology and Evolutionary Biology, Electrical Engineering and Computer Science, Forestry, Wildlife, and Fisheries, Mathematics, Microbiology, and Physics,

#### NUMB3R5 Count Workshop

This workshop was for faculty interested in addressing the gap between mathematics and its application in biological problem solving. To support the observation, experimentation and modeling of data, the Numb3r5 Count workshop provided an introduction to data, tools, and

curricular materials for use with undergraduates. Cosponsored by NIMBioS, BioQuest and HHMI.  
17 participants

Webinar: Mathematics and Life Science Education: Promoting Interdisciplinarity

This Webinar led by NIMBioS Director Louis Gross explored the possibilities of a multi-pronged approach to integrate quantitative ideas throughout the biology curriculum. Co-sponsored with Project Kaleidoscope (PKAL).  
28 participants

Earthfest 2009, Knoxville, TN  
Earth Day 2009, Oak Ridge, TN

NIMBioS representatives handed out flyers and talked to the public attending these events.

Biology in a Box

NIMBioS is partnering with Biology in a Box at the University of Tennessee to add math exercises to these amazing boxes. Biology in a Box is a fun and challenging way for entire schools to enhance their life sciences curriculum at all grade levels, and to encourage student interest in STEM (science, technology, engineering, and mathematics) disciplines. The program employs a hands-on, inquiry-based approach to teach the wonders of the living world, as well as introducing the scientific methods and math skills we use to understand that world.

Conference for Undergraduate Biology Majors (UBM)

NIMBioS will be hosting a conference for undergraduates in biology and mathematics. The conference will include student talks and posters, a guest plenary speaker, and a NSF UBM PI meeting will take place at the conference. The conference will feature a panel to take questions about research and careers in math biology. While this event is scheduled for October 2009, the planning and coordination for it has taken place during the period covered by this annual report.

Education and Outreach Biology Center Meeting

NIMBioS initiated communication between NEScent, NEON, NCEAS, and iPlant to talk about possible avenues of collaboration between the institutions and centers in February. An education and outreach meeting is planned at NEScent for a more in depth discussion.

NIMBioS PRESENTATIONS:

Formal talk to University of Tennessee, Math Dept faculty, 28 Aug 2008, S. Lenhart

Discussion with colleagues at the VI International Conference on Ticks and Tick-borne Pathogens, Buenos Aires, Argentina, 24 Sep 2008, G. Hickling

Formal talk to Oak Ridge National Laboratory, Biology and Environmental Sciences Division, 2 Oct 2008, L. Gross, G. Hickling

Formal talk on NIMBioS at AIBS Board of Directors Meeting, 13 Oct 2008, L. Gross

Formal presentations on NIMBioS to Agencies in DC area (NIH, NSF, OSTP and USDA), 14 Oct 2008, L. Gross

Informal presentation to high school teachers at UT Math Contest, 14 Oct 2008, S. Lenhart

Informal presentation to Biomedical Science and Technology Center at Oak Ridge National Laboratory, 16 Oct 2008, S. Lenhart

Formal talk to Univ. Tennessee Deans Council, 17 Oct 2008, L. Gross

Formal talk to Univ. Tennessee Arts and Sciences Department Heads, Oct 2008, L. Gross

Formal talk on NIMBioS at Natural Areas National Meeting, 17 Oct 2008, L. Gross

Informal talk at the 11th International Conference on Lyme Borreliosis and Other Tick-borne Diseases, Irvine CA., 20 Oct 2008, G. Hickling

Formal talk on NIMBioS to UT Board of Trustees, 23 Oct 2008, L. Gross

Formal talk on NIMBioS at NSF UT IGERT Programs kick-off, 23 Oct 2008, L. Gross

Informal presentation at AMS sectional meeting at the University of Alabama at Huntsville, 26 Oct 2008, S. Lenhart

Informal talk with the Wildlife Diseases Working Group, The Wildlife Society 15th Annual Conference, Miami FL., 10 Nov 2008, G. Hickling

Formal talk on NIMBioS at California State University at San Marcos (CSUSM), MARC II, 13 Nov 2008, L. Gross

Formal Talk on NIMBioS to faculty from CSUSM and Palomar and MiraCosta Community Colleges, 13 Nov 2008, L. Gross

Formal talk to CSUSM undergraduates including discussion of NIMBioS, 13 Nov 2008, L. Gross

Formal talk at TIMBER Conference at Appalachian State University , 15 Nov 2008, S. Lenhart

Informal discussions at Biology Summit (NAS) - AAAS - Washington DC, 3-4 Dec 2008, L. Gross

Informal discussions with NRC Board on Life Sciences - Washington DC, 4-5 Dec 2008, L. Gross

Formal talk at NIH-MIDAS Network meeting, Monterrey CA, 5 Dec 2008, S. Lenhart

Presentation: Adaptive radiation: contrasting recent theory and data. U. of Paris, Orsay-Sud, France. Included discussion of NIMBioS with researchers & students in ecology & evolution, 8 Dec 2008, S. Gavilets

Presentation: Dynamics of coalition formation and the egalitarian revolution. U. of Strasburg, France. Included discussion of NIMBioS with researchers & students in biology, 9 Dec 2008, S. Gavilets

Formal talk at Math Institutes Reception of the Joint Math Meetings, Washington DC, 5 Jan 2009, S. Lenhart

Informal presentation at BIO-SIGMAA business meeting (math-biology special interest group of MAA), Joint Math Meetings, Washington DC, 6 Jan 2009, S. Lenhart

Informal discussions at iPlant Collaborative Workshop on Cyberinfrastructure for Plant Science - Arizona, 8 Jan 2009, L. Gross

Formal talk at Belmont University - Nashville, 20 Jan 2009, L. Gross

Informal discussion of NIMBioS opportunities with participants at the Regional Conference to Assess Research and Extension Needs in Integrated Pest Management to Reduce the Incidence of Tick-Borne Diseases in the Southern United States. CDC Atlanta., 20-21 Jan 2009, G. Hickling

Presentations and discussions introducing NIMBioS and exploring partnership with North Carolina A&T University, 26-27 Jan 2009, S. Duncan, S. Lenhart, C. Peterson

Talk to East Tennessee Public Health Forum on NIMBioS and implications for epidemiology and public health, 5 Feb 2009, L. Gross

Meeting with GSMNP Education Staff , 10 Feb 2009, S. Duncan, G. Hickling, S. Lenhart

AAAS Meetings: discuss mini symposium on Biological questions addressed by multiscale mathematical methods; attend symposium on Math in entry-level biology - Chicago, 12-15 Feb 2009, L. Gross

Presentation: NIMBioS informational talk at Tennessee Governor's Academy, Knoxville (honors high school), 19 Feb 2009, S. Lenhart

Presentation: NIMBioS informational talk at Virginia Tech, Blacksburg, 20 Feb 2009, S. Lenhart

HHMI program advising: link Math and Biology for undergrads - Wilkes College, Wilkes Barre, PA, 22-24 Feb 2009, L. Gross

Presentation: Dynamics of ecological speciation: case studies and mathematical models' U. of Fribourg, Switzerland. Included discussion of NIMBioS with researchers & students in ecology & evolution, 24 Feb 2009, Sergey Gavrilets

Presentation: New Opportunities for Graduate Education at UTK. At retreat for BCMB and GST programs coupled with recruiting of new graduate students. 6 Mar 2009, C. Peterson

Presentation: NIMBioS informational talk at MAA Southeastern Section Meeting, Belmont Univ., Nashville, TN, 14 Mar 2009, S. Lenhart

Poster presentation on NIMBioS at Biomedical Science and Engineering Conference at Oak Ridge National Laboratory, 18 Mar 2009, S. Lenhart

Presentation to the 2009 Great Smoky Mountains National Park - Science Colloquium, Gatlinburg. Introducing NIMBioS, The National Institute for Mathematical and Biological Synthesis, in partnership with Great Smoky Mountains National Park. 20 Mar 2009, G. Hicklin, S. Lenhart

Discussion with chair of Biology Department at Florida Institute of Technology, Melbourne, FL, 16 Apr 2009, S. Lenhart

NIMBioS informational welcome to Coalitions and Alliances working group, 16 Apr 2009, L. Gross

University of Tennessee, Knoxville - Undergraduate Mathematics Day - 'What's math got to do with it? Drugs, sex and rock and roll - connections between math and biology at NIMBioS', 18 Apr 2009, L. Gross

NIMBioS informational welcome to Intragenomic Conflict working group, 20 Apr 2009, C. Welsh

NIMBioS informational welcome to Feral Swine/Pseudorabies working group, 26 Apr 2009, C. Welsh

La Selva Biological Field Station, Costa Rica- 'Ecological complexity and Public Policy', 'Quantitative Approaching to Assessing Patterns of Change in Forests', 27-28 Apr 2009, L. Gross

Washington University, St. Louis - 'Space and Control in Natural Systems', 'Mathematics and Life Science Education: Promoting Interdisciplinarity', 4 May 2009, L. Gross

University of Texas, El Paso, TX - 'Mathematics and Life Science Education: Promoting Interdisciplinarity', 11 May 2009, L. Gross

Vanderbilt Shanks Conference, 18 May 2009, Steve Wise

Presentation to Workshop for Emergency Response to Disease at the Wildlife/Livestock Interface, Georgia Center for Continuing Education, University of Georgia, 12-14 May 2009, G. Hickling

NIMBioS informational welcome to Binary Matrices in Biology working group, 26 May 2009, L. Gross

NIMBioS informational welcome to NUMB3R5 Count workshop, 29 May 2009, L. Gross

Washington State University, Pullman, WA - Pacific Northwest Conference on Comprehensive Mathematical Modeling in the Natural and Engineering Sciences Organized in the Spirit of L. A. Segel - 'Space and control in Natural Systems', 3 Jun 2009, L. Gross

Formal talk at the Chinese Society for Math Biology and Society for Math Biology Joint Meeting - China, 15-17 Jun 2009, L. Gross

PLANNED OUTREACH ACTIVITIES, June 1 - Sept. 1

Kids U at UT

NIMBioS is teaching a Kids U course, "Biology by Numbers!" at the University of Tennessee, Knoxville, this summer for students in grades 4-6 to learn about biology using mathematics.

## Mu Alpha Theta National Convention

NIMBioS will contribute to the Mu Alpha Theta National Convention in Knoxville by providing speakers at the convention and by facilitating campus tours for students. Mu Alpha Theta is the national high school mathematics honor society.

## Girls in Science

NIMBioS will participate in the Girls in Science program at the Great Smoky Mountains Institute at Tremont. Created for rising 8th grade girls, Girls in Science Camp promotes conducting hands-on science in the Park. Girls will get up-close and personal with the biodiversity of the Great Smoky Mountains National Park.

## The Smoky Mountains Science Teacher Institute at Tremont

NIMBioS will participate in The Smoky Mountains Science Teacher Institute at Tremont. For one week, teachers will immerse themselves in the biological diversity of the Smokies and return home with exciting new ideas for involving their students in hands-on science.

### Journal Publications

Sergey Gavrillets and Jonathan B. Losos, "Adaptive Radiation: Contrasting Theory with Data", *Science*, p. 732, vol. 323, (2009). Published,

Cheryl B. Travis, Louis J. Gross, Bruce A. Johnson, "Tracking the Gender Pay Gap: A Case Study", *Psychology of Women Quarterly*, p. , vol. , (2009). Accepted,

### Books or Other One-time Publications

### Web/Internet Site

#### **URL(s):**

[www.NIMBioS.org](http://www.NIMBioS.org)

#### **Description:**

The NIMBioS website, NIMBioS.org, became operational October 1, 2008. Visitor traffic is monitored by Google Analytics. For the period ending May 10, 2009, NIMBioS.org received 10,848 visits and 39,316 page views from 5,420 unique visitors, spending an average of 4:20 minutes on site and viewing an average of 3.62 pages per visit. Forty percent of visitors viewed only 1 page; 18 percent viewed more than 5 pages. Visits have originated from 1,134 cities in 79 countries, using 39 languages. Over 55 percent of visits are identifiable as originating from colleges or universities. Direct traffic has accounted for 45 percent of visits, search engines 32 percent, and referring sites 23 percent. The site currently has 104 web pages. Pages with the highest visitor traffic include the front page, personnel pages, calendar, mission page, and pages describing research opportunities for postdoctoral fellows, undergraduates, working groups, and workshops.

### Other Specific Products

### Contributions

#### **Contributions within Discipline:**

NIMBioS is inherently an interdisciplinary institute with cross-cutting activities involving mainly biology and mathematics, with connections to many other disciplines. A primary goal of NIMBioS is to address key biological questions using appropriate mathematical methods. The first set of activities initiated this process in several different areas of both math and biology, involving behavioral biologists, ecologists, evolutionary biologists, anthropologists, geneticists, psychologists, bioinformaticians, veterinarians, epidemiologists and wildlife biologists. Mathematicians and statisticians with expertise in numerous sub-disciplines, as well as computational scientists with particular expertise in high performance computing, were involved in these activities.

#### **Contributions to Other Disciplines:**

An objective of NIMBioS is to bring together individuals from numerous disciplines to collaborate on new research projects, consider new areas which might benefit from contact with various fields of math and biology and foster communication between disciplines. As a few examples from activities held this year, a variety of individuals with mainly background in biology or informatics attended a Tutorial to provide them with the conceptual foundations and skills to utilize the super-computing capabilities available through TeraGrid and other resources. A working group on binary matrices brought together ecologists working on food webs, network biologists, and conservation biologists with statisticians who have expertise in applying emerging statistical methods to field data. A working group on diseases in feral hogs brought together mathematicians with expertise on spatial modeling and control, with veterinarians, epidemiologists and wildlife biologists to analyze potential means to limit the spread of disease from wildlife to livestock.

#### **Contributions to Human Resource Development:**

Several outreach activities this year focused on providing information on how mathematics contributes to biology to various audiences. This included participation in science fairs with mostly children and parents participating, formal presentations to public health officials about NIMBioS, and a variety of talks to undergraduate and graduate student audiences about what NIMBioS is and how the interface between math and biology is important in developing new techniques for significant societal problems as well as investigating basic biology.

Several graduate students were supported through NIMBioS cost-share arrangements to collaborate on activities and expand their own expertise - these students were from both mathematics and biology degree programs. The first year of activities also includes a summer program providing research experiences for an interacting group of undergraduates from biology and mathematics, high school science teachers and graduate students in veterinary medicine.

#### **Contributions to Resources for Research and Education:**

The project supported a short course on the statistical package R designed specifically for graduate students in various biology and agricultural science fields. The materials from this short course are being compiled as a guide that will be posted on the NIMBioS web site. The project is supporting the development of a new text on mathematics for life scientists designed for an entry-level course sequence and being piloted this coming academic year. The project is also supporting the development of quantitative components of the Biology-in-a-Box set of activities, so that these materials and the boxes may be utilized in both biology and mathematics classrooms in middle and high schools.

#### **Contributions Beyond Science and Engineering:**

Several Working Groups at NIMBioS are focused on issues related to public policy, including the Working Group on Feral Swine / Pseudo-rabies in Great Smoky Mountains National Park. This Working Group addressed issues of management of a wild population arising from concerns about the potential for disease spread from the wild population to domestic livestock. An objective is to assist managers in GSMNP in most effectively applying their available resources to limit disease spread.

A NIMBioS Investigative Workshop on Modeling Bovine Tuberculosis has as an objective developing models to exploring control options that could be used as alternatives to whole herd depopulation, which is quite costly. These models are intended to be used to inform public policy decisions by Federal and State agricultural officials.

### Conference Proceedings

### Special Requirements

**Special reporting requirements:** None

**Change in Objectives or Scope:** None

**Animal, Human Subjects, Biohazards:** None

### Categories for which nothing is reported:

Any Book

Any Product

Any Conference