02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS

Submit only ONE copy of this form **for each PI/PD and co-PI/PD** identified on the proposal. The form(s) should be attached to the original proposal as specified in GPG Section II.C.a. Submission of this information is voluntary and is not a precondition of award. This information will not be disclosed to external peer reviewers. ***DO NOT INCLUDE THIS FORM WITH ANY OF THE OTHER COPIES OF YOUR PROPOSAL AS THIS MAY COMPROMISE THE CONFIDENTIALITY OF THE INFORMATION.***

PI/PD Name: Louis J Gross

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☐

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.
Race Definitions:
American Indian or Alaska Native. A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.
Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
Black or African American. A person having origins in any of the black racial groups of Africa.
Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
White. A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

WHY THIS INFORMATION IS BEING REQUESTED:

The Federal Government has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity, or disability of its proposed PIs/PDs. To gather information needed for this important task, the proposer should submit a single copy of this form for each identified PI/PD with each proposal. Submission of the requested information is voluntary and will not affect the organization's eligibility for an award. However, information not submitted will seriously undermine the statistical validity, and therefore the usefulness, of information recieved from others. Any individual not wishing to submit some or all the information should check the box provided for this purpose. (The exceptions are the PI/PD name and the information about prior Federal support, the last question above.)

Collection of this information is authorized by the NSF Act of 1950, as amended, 42 U.S.C. 1861, et seq. Demographic data allows NSF to gauge whether our programs and other opportunities in science and technology are fairly reaching and benefiting everyone regardless of demographic category; to ensure that those in under-represented groups have the same knowledge of and access to programs and other research and educational oppurtunities; and to assess involvement of international investigators in work supported by NSF. The information may be disclosed to government contractors, experts, volunteers and researchers to complete assigned work; and to other government agencies in order to coordinate and assess programs. The information may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records", 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records", 63 Federal Register 268 (January 5, 1998).

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 11-1

NSF 11-1

FOR NSF USE ONLY

NSF PROPOSAL NUMBER

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

DBI - RESEARCH RESOURCES

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				003387891	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)

626001636

SHOW PREVIOUS AWARD NO. IF THIS IS
☒ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

0832858

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

University of Tennessee Knoxville

AWARDEE ORGANIZATION CODE (IF KNOWN)

0035303000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

University of Tennessee Knoxville
1 Circle Park
Knoxville, TN. 379960003

NAME OF PRIMARY PLACE OF PERF

University of Tennessee Knoxville

ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE

University of Tennessee Knoxville
1122 Volunteer Blvd
Knoxville ,TN ,379163410 ,US.

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS ☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS

☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **NIMBioS: National Institute for Mathematical and Biological Synthesis**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ **18,600,000**	**60** months	**09/01/13**	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ EAGER* (GPG II.D.2) ☐ RAPID** (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____
PHS Animal Welfare Assurance Number _____

☐ HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number _____
Exemption Subsection _____ or IRB App. Date _____
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
_____
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT

Ecology & Evolutionary Biology

PI/PD FAX NUMBER

865-974-9461

PI/PD POSTAL ADDRESS

Nat. Inst. for Math. and Biol. Synthesis
1122 Volunteer Blvd. - Suite 106
Knoxville, TN 379963410
United States

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **Louis J Gross**	**PhD**	**1979**	**865-974-4295**	**gross@NIMBioS.org**
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, lobbying activities (see below), responsible conduct of research, nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 11-1). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:
(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.
(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:
(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:
(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

Certification Regarding Responsible Conduct of Research (RCR) (This certification is not applicable to proposals for conferences, symposia, and workshops.)

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that, in accordance with the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.B., the institution has a plan in place to provide appropriate training and oversight in the responsible and ethical conduct of research to undergraduates, graduate students and postdoctoral researchers who will be supported by NSF to conduct research.
The undersigned shall require that the language of this certification be included in any award documents for all subawards at all tiers.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME		

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER

* EAGER - EArly-concept Grants for Exploratory Research
** RAPID - Grants for Rapid Response Research

Directorate for Biological Sciences
Division of Biological Infrastructure
Research Resources

Proposal Classification Form
PI: Gross, Louis

CATEGORY I: INVESTIGATOR STATUS (Select ONE)

- ☐ Beginning Investigator - No previous Federal support as PI or Co-PI, excluding fellowships, dissertations, planning grants, etc.
- ☐ Prior Federal support only
- ☐ Current Federal support only
- ☑ Current & prior Federal support

CATEGORY II: FIELDS OF SCIENCE OTHER THAN BIOLOGY INVOLVED IN THIS RESEARCH (Select 1 to 3)

- ☐ Astronomy
- ☐ Chemistry
- ☑ Computer Science
- ☐ Earth Science
- ☑ Engineering
- ☑ Mathematics
- ☐ Physics
- ☐ Psychology
- ☐ Social Sciences
- ☐ None of the Above

CATEGORY III: SUBSTANTIVE AREA (Select 1 to 4)

- ☐ BIOMATERIALS
- ☐ BIOTECHNOLOGY
- ☐ Animal Biotechnology
- ☐ Plant Biotechnology
- ☐ Environmental Biotechnology
- ☐ Marine Biotechnology
- ☐ Metabolic Engineering
- ☐ CHROMOSOME STUDIES
- ☐ COMMUNITY ECOLOGY
- ☑ COMPUTATIONAL BIOLOGY
- ☐ CONSERVATION & RESTORATION BIOLOGY
- ☐ CORAL REEFS
- ☐ CURATION
- ☐ DATABASES
- ☐ ECOSYSTEMS LEVEL
- ☐ GENOMICS (Genome sequence, organization, function)
- ☐ Viral
- ☐ Microbial
- ☐ Fungal
- ☐ Plant
- ☐ Animal
- ☐ INFORMATICS
- ☐ MARINE MAMMALS
- ☐ Molecular Evolution
- ☐ Methodology/Theory
- ☐ Gene/Genome Mapping
- ☐ Natural Products
- ☐ NANOSCIENCE
- ☐ PHOTOSYNTHESIS
- ☐ PLANT BIOLOGY
- ☐ Arabidopsis-Related Plant Research
- ☐ POPULATION DYNAMICS & LIFE HISTORY
- ☐ POPULATION GENETICS & BREEDING SYSTEMS
- ☐ REPRODUCTIVE ANIMAL BIOLOGY
- ☐ Plant Pathology
- ☐ Coevolution
- ☐ Biological Control
- ☑ STATISTICS & MODELING
- ☐ Methods/ Instrumentation/ Software
- ☐ Modeling (general)
- ☑ Modeling of Biological or Molecular Systems
- ☑ Computational Modeling
- ☐ Statistics (general)
- ☐ STRUCTURAL BIOLOGY
- ☐ SYSTEMATICS
- ☐ Phenetics/Cladistics/ Numerical Taxonomy
- ☐ NONE OF THE ABOVE

CATEGORY IV: INFRASTRUCTURE (Select 1 to 3)

- ☐ COLLECTIONS/STOCK CULTURES
- ☐ Collection Enhancement
- ☐ Collection Refurbishment
- ☐ Living Organism Stock Cultures
- ☐ Natural History Collections
- ☐ DATABASES
- ☐ Database Initiation
- ☐ Database Enhancement
- ☐ Database Maintenance & Curation
- ☐ Database Methods

FACILITIES

- ☐ Controlled Environment Facilities
- ☐ Field Stations
- ☐ Field Facility Structure
- ☐ Field Facility Equipment
- ☐ LTER Site
- ☐ GENOME SEQUENCING
- ☐ Other Plant Genome Sequencing
- ☐ INDUSTRY PARTICIPATION
- ☐ INSTRUMENTATION
- ☐ Instrument Development

☐ Instrument Acquisition	☐ Technique Development	☑ Multi-, Cross-, Interdisciplinary Training
☐ Computational Hardware Development/Acquisition	TRACKING SYSTEMS	☑ Undergraduate Training
☐ TOOLS DEVELOPMENT	☐ Geographic Information Systems	☐ Predoctoral Training
☐ Analytical Algorithm Development	☐ Remote Sensing	☑ Postdoctoral Training
☐ Other Software Development	☐ TRAINING	☐ NONE OF THE ABOVE
☐ Informatics Tool Development		

CATEGORY V: HABITAT (No selection required)

CATEGORY VI: GEOGRAPHIC AREA OF THE RESEARCH (No selection required)

CATEGORY VII: CLASSIFICATION OF ORGANISMS (Select 1 to 4)

☐ VIRUSES	☐ PLANTS	☐ Chondrichthyes (Cartilaginous Fishes) (Sharks, Rays, Ratfish)
☐ Bacterial	☐ N0N-VASCULAR PLANTS	☐ Osteichthyes (Bony Fishes)
☐ Plant	☐ VASCULAR PLANTS	☐ AMPHIBIA
☐ Animal	☐ GYMNOSPERMS	☐ REPTILIA
☐ PROKARYOTES	☐ ANGIOSPERMS	☐ AVES (Birds)
☐ Archaebacteria	☐ Monocots	☐ MAMMALIA
☐ Cyanobacteria	☐ Dicots	☐ Primates
☐ Eubacteria	☐ ANIMALS	☐ Humans
☐ PROTISTA (PROTOZOA)	☐ INVERTEBRATES	☐ Rodentia
☐ FUNGI	☐ ARTHROPODA	☐ Marine Mammals (Seals, Walrus, Whales, Otters, Dolphins, Porpoises)
☐ LICHENS	☐ Hexapoda (Insecta) (Insects)	☐ TRANSGENIC ORGANISMS
☐ SLIME MOLDS	☐ VERTEBRATES	☑ NO ORGANISMS
☐ ALGAE	☐ FISHES	

CATEGORY VIII: MODEL ORGANISM (Select ONE)

☑ NO MODEL ORGANISM	FUNGAL	☐ Fruitfly (Drosophila melanogaster)
MODEL ORGANISM (Choose from the list or input up to 9 characters)	PLANT	[Enter your own model organism - up to 9 characters]
☐ Escherichia coli	☐ Mouse-Ear Cress (Arabidopsis thaliana)	

NIMBioS Summary

Vision:

The mission of NIMBioS is to foster the maturation of cross-disciplinary approaches at the interface of mathematics and biology. NIMBioS encourages the development of a cadre of researchers who are capable of conceiving and engaging in creative and collaborative connections across disciplines to effectively use appropriate and necessary mathematics to address fundamental and applied biological questions. The methods that NIMBioS has developed to address this mission are summarized in its strategic plan. A key element of this plan is that NIMBioS is ***community-driven***, in that it relies upon requests from researchers and educators from around the world to suggest appropriate activities. These requests are vetted by an external Advisory Board who provide recommendations to the NIMBioS Leadership Team on how well the requests align with the NIMBioS mission. The Advisory Board comprises individuals from a broadly diverse collection of institutions, fields of expertise and experiences, thus assuring that diverse perspectives are taken into account in the process of allocating NIMBioS resources.

Biological science is an immense and rapidly changing field which relies upon diverse methods to interpret and synthesize data obtained at many different scales of biological organization. Mathematical, statistical and computational methods play a critical role in this process by providing means to succinctly describe responses, infer the implications of hypotheses about biological processes and their interactions, and project the response of biological systems to conditions not observed. Though it is often the case that similar quantitative methods are useful in application to biological questions in diverse sub-disciplines, it is also sometimes necessary to develop new mathematical approaches and computational toolsets. NIMBioS provides the infrastructure of a national center that allows researchers to effectively collaborate in synthesizing biological data and models, both in applying existing methods and in developing new ones. Many of the central issues of national and international concern related to the environment, public health, ecosystem functioning, and natural resources require the scientific knowledge that arises from connections between data and models at multiple scales of biological organization that NIMBioS fosters.

The NIMBioS strategic plan describes the variety of routes NIMBioS has developed to achieve its mission. These routes were developed based upon the successes of our leadership team in developing new interdisciplinary collaborations nationally and internationally, and on the successful efforts of other Synthesis Centers supported by NSF BIO Division and the Mathematics Institutes supported by the NSF MATH Division. These routes may be classified as (1) Collaborative Intensive Research Activities; (2) Investigative Research Activities; (3) Education Activities; and (4) Outreach Activities. Though listed here as distinct activities, by intention there are connections between these and their methods to contribute to reaching the goals of NIMBioS.

A key component of the NIMBioS strategic plan has been to carry out extensive evaluations of all activities in order to assess their impact on meeting the mission of NIMBioS. These evaluations, for which there are over 60 reports posted on the NIMBioS web site, provided important confirmation of the impacts of NIMBioS activities. This conclusion is based upon the very high response rates to the evaluations by participants in NIMBioS activities, and their extremely positive views of NIMBioS. These evaluations therefore provide extensive evidence that the methods NIMBioS has employed have been highly successful. Other indications of success are the highly positive comments of the two external site reviews that have been carried out. Although the reviews provide some suggestions of ways that NIMBioS may be even more

effective in meeting some of its goals, this proposed plan for continuation of NIMBioS does not include major changes to the existing activities. We are proposing a variety of modifications and expansions of activities, methods to attract higher topical and participant diversity, and have already incorporated some management team changes to allow this to proceed. We have already responded to a concern raised in the latest site review by adding an Associate Director position focused on enhancing participant diversity. Our plans for the renewal period include a more formal emphasis on research and training opportunities for graduate students and several methods to attract activities from the broad spectrum of biological subdisciplines. Due in part to a change in the sponsoring agencies, although we propose to continue our successful efforts to support activities related to animal infectious disease, the magnitude of emphasis in this area will be reduced in favor of enhancing connections to areas such as biological engineering, molecular biology, cell biology and microbiology. Building upon our ongoing efforts with an array of other national centers, we propose to further enhance collaborations with these entities.

Intellectual Merit:

The scientific activities NIMBioS has fostered have been highly interdisciplinary. Many of the significant scientific challenges of today involve the convergence of fields and efforts at the interstices between disciplines[45]. The argument is that taking perspectives from multiple disciplines "permits the emergence of new scientific principles and opportunities". Convergence is arising across all of biology, with direct feed-back between knowledge from the genome to the individual to the ecosystem level. Major contributions to science depend upon our capacity to draw upon physical science and engineering as well as the wealth of biological science that may have been traditionally viewed as far afield from the purview of the field in question. Thus NIMBioS has fostered collaborations between researchers with quite diverse expertise in essentially every Working Group supported. This has included anthropologists and psychologists, game theorists and economists, biophysicists and statisticians, experts on partial differential equations and control theory, and those from across the spectrum of the biological hierarchy. As a means to foster these new connections, NIMBioS requires every Working Group or Investigative Workshop to have organizers from different backgrounds, typically in some area of biology and some area of quantitative science. The expectation is that the collaborations these activities foster will provide new insight into long-standing issues, as well as provide opportunities for entirely new areas to be advanced.

This approach has led to a wide array of papers published in the most prestigious scientific journals. The reference list includes example products of NIMBioS activities annotated by the type of activity which generated the product, and includes papers published in the top-tier multidisciplinary journals Science[8, 19, 23, 47], Nature[6, 25], and PNAS[4, 17, 21, 22, 29, 40, 43, 52] and many additional high-impact specialty journals. The topical areas covered by these high-impact journal products range broadly across biology. An area particularly emphasized in the NIMBioS Collaborative Research Activities (Working Groups and short-term visitors) and Investigative Research Activities (Investigative Workshops and Postdoctoral and Sabbatical Fellows) has been animal infectious disease, with approximately 25% of the Working Groups and 40% of the Investigative Workshops in this area. The results from these activities have established NIMBioS as a leading center fostering modeling of infectious disease. This emphasis has contributed significantly to national needs in analyzing potential spread, impacts and control of zoonotic disease. Some activities in this general area will be continued throughout the renewal period, but we propose to significantly expand the breadth of activities at NIMBioS in biological areas which have had less development of general theory and modeling methods. This plan contributes directly to our mission to broaden the connections of mathematical approaches across all of biology.

Broader Impacts:

NIMBioS has supported a diverse array of education and training activities including: establishment of a high-impact ***educational program for K-12***, with elaboration of mathematical content for the Biology-in-a-Box project that incorporates math in the science component of the curriculum and biology in the math part of the curriculum; establishment of a ***Research Experiences for Undergraduates*** program with teams of math and biology undergraduates, mentored by UT faculty, NIMBioS postdocs and collaborators, working together to carry out research in modern biology using mathematics; an annual ***Undergraduate Research Conference*** at the Interface of Mathematics and Biology featuring undergraduate student talks and posters, keynote speakers, career panels, and networking opportunities; ***Tutorials*** that encourage biologists and quantitative scientists to develop an appreciation for new mathematical and computational approaches, particularly including high performance computing, to address biological questions in their own research fields; and ***Postdoctoral opportunities*** for individuals capable of independent research at the interface of math and biology who develop the skills and experience to go on to be the mentors for the students of the future.

NIMBioS has provided the essential infrastructure to foster these educational activities linked to research and thus has provided opportunities for students at every level of education to experience some of the thrill of connecting mathematics to everyday biological experience. This effort to encourage the relevant connections of mathematics is central to the enhanced national efforts to encourage STEM education and workforce development. Interdisciplinary education, emphasizing quantitative methods to model observations and evaluate hypotheses, is an ongoing focus across all of the NIMBioS educational initiatives. Connected directly with this are evaluation methods that take a scientific approach to determining what methods are most effective in encouraging collaborations across disciplines. NIMBioS has been a leader among national research centers in fostering a center-scale view perspective on evaluation. This effort can have extensive impact by providing the scientific basis to consider how allocations to major centers can be made more effective in reaching the respective goals of these centers.

We propose to continue the above mentioned activities which contribute to broader impacts throughout the renewal period, with some additional emphasis placed particularly on initiatives for graduate students. We propose to offer an opportunity for a limited number of graduate students to spend an extended period in residence as NIMBioS Graduate Fellows. The objective is to encourage participation by those students who have particular interdisciplinary research interests related to NIMBioS personnel and activities, including that of the Postdoctoral Fellows. These students would be provided some financial support to spend periods of a month to several months in order to obtain input and mentoring on their research and career plans external to that available from their home institution. These positions will be available on a competitive basis based upon an application process and would require the approval of their primary mentors and their home institution. As an additional effort to foster interdisciplinary education opportunities, we propose to expand an ongoing collaboration with two other centers by hosting a summer graduate-level short course in an area at the interface of mathematics and biology.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.B.2.

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

NIMBioS Project Description

Vision and Strategic Plan

Background

The National Institute for Mathematical and Biological Synthesis was initiated September 1, 2008 through a Cooperative Agreement between the University of Tennessee, Knoxville and the National Science Foundation, with the US Department of Homeland Security and the US Department of Agriculture as additional sponsoring agencies. The initial Advisory Board meeting was held in November 2008, the first activity was held in March 2009 and NIMBioS moved into its initial facilities in April 2009. NIMBioS moved into its current spacious facilities in April 2012. Through August 31, 2012, a total of 2,759 participants (1,825 different people) attended NIMBioS-sponsored events. Over this time NIMBioS has hosted 50 Working Group meetings, 21 Investigative Workshops, 8 Tutorials, 24 Post-doctoral Fellows, 116 Short-term Visitors, 5 Sabbatical Fellows, and more than 65 Outreach and Education activities. Participants came from 50 countries and all 50 states in the U.S., as well as the District of Columbia and Puerto Rico. A total of 596 different institutions were represented among the participants.

The mission of NIMBioS is to foster new collaborative efforts to investigate fundamental and applied questions arising in biology using appropriate mathematical and computational methods, to enhance the essential human capacity to analyze complex biological questions and develop necessary new mathematics, and to encourage broader public appreciation of the unity of science and mathematics. The methods that NIMBioS has developed to address this mission are summarized in its strategic plan. NIMBioS is ***community-driven***, in that it relies upon requests from researchers and educators around the world to suggest appropriate activities, which are vetted by an external Advisory Board prior to being chosen for support.

Strategic Plan

NIMBioS carried out an initial strategic planning exercise among the Leadership Team and subsequently modified this plan based upon input from the Advisory Board. The plan has served NIMBioS well in meeting its objectives for the initial award period, based upon the very positive reviews from site visits and the large number of participants in NIMBioS activities. Some aspects of NIMBioS activity planning and management have been modified over the course of the initial funding period, and further management changes are described in the management plan. The major components of the strategic plan are described below, and we propose to continue these through the renewal period with some modifications described below.

The general methods that NIMBioS has utilized to meet its mission are:

- Choosing fundamental problems that will benefit from cross-disciplinary collaborations.
- Choosing applied problems of sufficient general interest to be readily extended beyond an initial region/ organism/ system.
- Building appropriate collaborations to address these fundamental and applied problems.
- Developing education and outreach opportunities to diversify participation in these collaborations at all levels
- Developing methods to support and bring about a diverse workforce capable of carrying our new research at the math/biology interface.

As outlined in the Strategic Plan, the specific methods NIMBioS has utilized to meet these general goals are:

- Focused research projects (**Working Groups**) to build collaboration among diverse communities.
- Building collaborations through more open-ended general problems, addressed through multiple approaches (**Investigative Workshops**).
- Skill and methods-based programs (**Tutorials**) that foster a broader understanding of potential applications of modern math and computational science in biology.
- Increasing and diversifying the workforce in cross-disciplinary research through **Postdoctoral Fellowships**
- Visiting researcher programs including **Sabbatical and Short-term** opportunities for visitors to collaborate with postdocs and students, and participate in other activities.
- An expansive set of **education-linked-to-research** endeavors from elementary through post-doctoral level that provide diverse opportunities at the math/biology interface.

A key component of the Strategic Plan has been a formal evaluation process, following the Evaluation Plan approved by our Advisory Board, which provides a mechanism to assess the variety of activities NIMBioS supports in terms of how effectively each activity contributes to meeting the NIMBioS mission. We have been generally very pleased with the success of the programs, and this enthusiasm is justified by the evaluations of our activities, from the vast majority of participants and from the Site Reviews, which have been highly laudatory. We have re-envisioned our evaluation program in part because participant responses have been so highly positive that we gain little additional information by continuing to evaluate each individual activity. Thus, we have been transitioning our evaluation effort toward the science of evaluating collaborative interdisciplinary activities and the effectiveness of centers such as NIMBioS. In coordination with our communication and education staff members, we have been developing methods to assess the effectiveness of interdisciplinary education and collaboration efforts as part of the science of team science. We expect these to be a major component of our evaluation and communication activities during our renewal period.

The Strategic Plan specifically was developed to provide guidelines for the various components of NIMBioS over its first five years of existence. The Plan will be reviewed by the NIMBioS Leadership Team following the renewal, and suggested modifications will be brought to the first Advisory Board meeting in the renewal period. Some Plan modifications are already underway, including focusing efforts on partnerships with Federal agencies and research centers rather than private industry partners. The Associate Director for Partner Relations position is being phased out, with responsibilities for enhancing relations with various research and education centers being spread among the other members of the Leadership Team. An Associate Director for Diversity Enhancement has been appointed to develop additional partnerships with minority-serving institutions and broaden participation in NIMBioS activities. The Strategic Plan will be further modified over the renewal period, based upon initiatives of the new Director and the Leadership Team as they consider long-term sustainability options for NIMBioS.

Meeting National Needs

Coincident with several major national initiatives to enhance STEM opportunities and educational initiatives, are reports that point to the future of biology as being highly interdisciplinary. The NRC report[39] points out how the major areas of Health, Agriculture, Energy and Environment require integration of a wide variety of disciplines, and will benefit from new collaborations across federal agencies. The report encourages initiatives that foster

interdisciplinary education. These ideas are inherent in the National Bioeconomy Blueprint, released in April 2012 by the White House, which among other objectives notes the need for research investments to provide the foundation for the US bioeconomy and the need for updating training programs to support the new bioeconomy. Sharp and Langer[45] similarly point out that multidisciplinary approaches are becoming ever more essential in biomedical science, but this argument transcends biomedical science since "convergence" across fields is arising in all of biology. The NIMBioS mission aligns directly with the needs identified in these national reports regarding interdisciplinary research and education.

Inherent in the sponsoring agency structure for NIMBioS over its initial support period has been a unique collaboration of federal agencies, and by design therefore NIMBioS has been contributing to the Bioeconomy Blueprint objective to coordinate and integrate research efforts across federal agencies. Independent of whether there is formal sponsorship of multiple agencies in the renewal period, NIMBioS has successfully engaged researchers from numerous Federal and State agencies in its many research activities. NIMBioS has developed a flexible support structure, accounting for the variety of agency requirements for their employees to participate in activities funded by NSF, to encourage participation by employees from diverse agencies. This will continue to provide an effective means to foster inter-agency collaborations along with fostering connections to researchers from academia and the private sector.

NIMBioS research activities have been specifically designed to foster activities that align with the national initiatives for modern biology to encourage interdisciplinarity. The requirement for activities to arise from the community, rather than from directives of the NIMBioS leadership, allows for a diverse collection of novel connections between various biology subdisciplines and mathematics to be brought forward for consideration. Evaluation of these community-derived requests by the Advisory Board provides assurance that the scientific research that NIMBioS supports is appropriate to the mission. The Board also may recommend that NIMBioS support projects that respond to a national need separate from any requests received from the community. The requirement by NIMBioS that each activity include individuals who bring diverse perspectives to the underlying research question provides new opportunities for "convergence". Requests for participation in NIMBioS activities are assessed based upon the applicants' research and education productivity as well as our objective to promote diversity in gender, ethnicity, scientific field, career stage, geography and type of institution. Perusal of the backgrounds of participants in any NIMBioS Investigative Workshop or Working Group illustrates the interest across fields in the topics that NIMBioS addresses. As just one example, the Investigative Workshop on Mathematical Modeling of Intracellular Movements included participants from departments of bioinformatics, biochemistry, pathology, mathematics, computer science, environmental science, physics, electrical engineering, botany and from NIST.

Education and outreach activities at NIMBioS have directly aligned with national initiatives to encourage cross-disciplinary education and to broaden participation in scientific research to those individuals from under-represented groups. NIMBioS education and outreach activities have been expansive, including K-12 initiatives, teacher training, undergraduate research opportunities, and tutorials oriented towards graduate students. Outreach has included formal partnerships to minority-serving institutions, leadership of activities at numerous professional society events, and a songwriter-in-residence program to broaden exposure of unsuspecting concert audiences across the country to the inherent connections between math and biology. Concurrently, we developed extensive electronic communication approaches, using a range of media, to broaden the exposure of NIMBioS activities and research beyond those who attend activities in person or read the scientific literature.

Center Activities

The range of NIMBioS scientific research activities is illustrated in Figure 1. Scientific activities at NIMBioS typically involve an array of connections between various methods. Postdocs are often involved in collaborations with visitors and participate and assist in organizing Working Groups and Investigative Workshops. Although not illustrated in this graphic, there are direct connections between these research activities and educational ones. For example, many postdocs have served as mentors for summer undergraduate research experience students, in collaboration with NIMBioS senior personnel and other faculty.

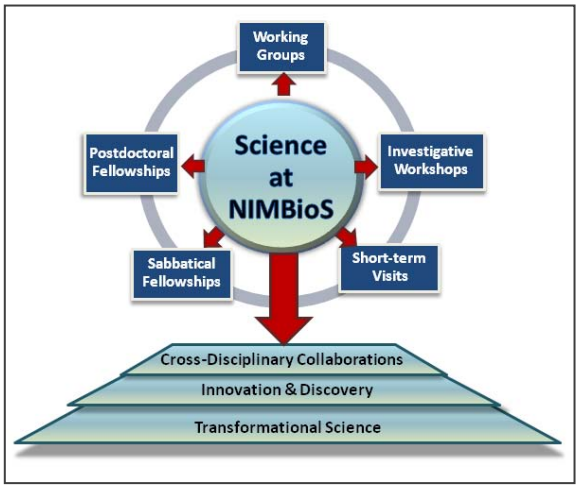


Figure 1. Science at NIMBioS

Scientific Activity Innovations Developed at NIMBioS

- ***Working Groups*** combine the expertise of diverse quantitative and biological researchers to address current issues in fundamental and applied biology. Such Working Groups, consisting of 10-15 researchers with appropriate expertise to address a particular biological issue, have been a major component of the activities at the previous NSF Biology Synthesis Centers. They are not part of the tradition of the NSF Mathematics Institutes, and NIMBioS has been encouraging the formation of the diversity of expertise in these Working Groups and fostering the common vocabulary necessary for the transformational research that these Working Groups are designed to address. Metrics of success for Working Groups include the production of new research, the development of new cross-disciplinary collaborations and encouraging inclusion of those from groups typically underrepresented in research in math biology.
- ***Investigative Workshops*** build connections between researchers at different career stages to address significant biological areas that could benefit from new collaborations across disciplines and encourage the development of new Working Groups. Unlike workshops that are designed to mainly transmit information concerning a particular research topic, these Investigative Workshops are designed to include a mixture of presentations to develop a shared vocabulary and set of conceptual foundations for current research questions, as well as significant small-group sessions to encourage collaborations following the activity itself. Metrics of success for Investigative Workshops include the development of new research collaborations, including the formation of potential new Working Groups.
- ***Tutorials*** encourage biologists and quantitative scientists to develop an appreciation for new mathematical and computational approaches, particularly including high performance computing, to address biological questions in their own research fields. Several Tutorials have been developed in collaboration with other NSF-supported projects, utilizing the NIMBioS infrastructure to efficiently broaden education and outreach efforts.
- Development of procedures for ***community-driven suggestions*** for science activities that are vetted by an external advisory board. While the ecological and evolutionary biology communities had experience through other NSF BIO Synthesis Centers (NCEAS and NESCent) with the opportunity to suggest activities, this approach was novel for the broader biology and mathematics communities. The breadth of potential areas of requested support required developing a highly diverse external Advisory Board.

- Development of research activities in ***animal infectious disease***. NIMBioS has encouraged requests in this research area, and will continue to do so in the renewal period at a somewhat reduced expected level of activity than during the initial support period.
- Offering ***postdoctoral opportunities*** for individuals capable of independent research at the interface of math and biology who can carry out self-directed research with advice, rather than direction, from established mathematicians and biologists. NIMBioS postdocs are chosen because of their demonstrated capacity for independent research and their competency at the math/biology interface. The selection process is expected to continue to be quite rigorous, consistent with past history of the Advisory Board recommending only about 15% of the applicants.
- Development of ***spousal/partner accommodations for postdoctoral fellows*** to provide opportunities for spouse/partners to continue their own career trajectories. This program was established, with UTK support, due to the acknowledged need to address partner/spouse issues and has been part of regular discussions with many of the postdoctoral fellows. We are unaware of any similar effort at any other NSF-supported Center.
- ***Fostering interactions between NSF-supported Centers*** and projects, in biology and mathematics, to develop shared activities and collaborations in science, education, outreach and communications. NIMBioS has actively sought to reinforce connections between the BIO Synthesis Centers, the Math Institutes, NEON, and several other NSF-supported projects by encouraging and hosting activities that bring together the staffs of these Centers.

Requests for support for activities at NIMBioS are evaluated based upon an explicit set of criteria that are defined in the application procedures posted on the NIMBioS website. In general these include whether the request will advance biological understanding, has an interdisciplinary perspective, will create new mathematics or involve novel applications of existing mathematics, will address particular national needs and will foster the development of a cadre of researchers capable of conceiving and engaging in creative and collaborative connections across disciplines. For Working Groups and Investigative Workshops criteria also include the potential scientific impact and inclusion of participants with a diversity of backgrounds and expertise that match the scientific needs of the effort. For Postdoctoral Fellows, criteria focus as well on the applicant's demonstrated capacity for independent research at the math/bio interface and how NIMBioS will expand the scholar's previous education. For Visitors and Sabbatical Fellows, additional criteria are how NIMBioS will enhance the capacity for the proposed research to be completed in an efficient and timely manner, and how the proposed visit will mesh with ongoing activities, in particular the research interests of the postdocs in residence.

Metrics of success are discussed with all participants at the start of each activity by one of the members of the Leadership Team. Although these metrics vary somewhat across activity type, a common metric is the production of new knowledge determined through the publication of peer-reviewed scientific articles. NIMBioS activities have successfully generated numerous articles in top-tier multidisciplinary journals, and a sampling of these are identified in the reference list by NIMBioS activity type from which the article arose. An example of an exemplary activity is the Working Group on Synthesizing and Predicting Infectious Disease while accounting for Endogenous Risk (SPIDER). This Group included mathematicians, disease ecologists, and economists and developed theoretical and empirical approaches to understand and analyze feedbacks between behavior and spread of infectious disease. The Group has published 15 papers that either emerged from or were enhanced by SPIDER meetings. The Group also organized a well-attended special session at the World Congress on Environmental and Resource Economics in 2010. Many members of the group have continued to work together and some have successfully collaborated on a $1.6M grant from NIH to continue and expand the SPIDER

research program. NIMBioS Postdoctoral Fellows success must be determined based upon their individual career goals, and to date of the nine postdocs who have completed their tenure at NIMBios, two have moved to tenure-track faculty positions in mathematical sciences departments, two to tenure-track positions in biological sciences units, one is a research fellow at a genomics center and three are in postdoc positions.

For the renewal period, we propose to continue to support requests for each of the activities noted in Figure 1. Based upon the history of approved requests, we are requesting funding for an average of nineteen Working Group meetings, four Investigative Workshops, two Tutorials and ten postdocs a year. These funds are for activities that we expect will be approved to start after the renewal, while we propose to utilize remaining participant support from the initial award period to support activities that are continuing and were begun prior to the renewal. This includes a continuing collaboration with the NSF-supported Remote Data and Visualization project, supported through a supplement award to NIMBioS, to develop high performance computing toolsets of use in biological applications.

We have requested funding for a new program of NIMBioS Visiting Graduate Fellows who will be in residence for periods of several weeks to months. This program signifies our continued commitment to graduate education and will support students from diverse institutions to come work and interact with NIMBioS faculty, post-docs and students. This will build upon our previous efforts, which have focused primarily on supporting graduate students to participate in Investigative Workshop and Tutorial activities and as Short-term Visitors.. We have and will continue to cooperate with MBI and CAMBAM on the Summer Graduate Student Workshops and have requested support to host one of these at NIMBioS.

Topical Diversity

A major objective of NIMBioS is to encourage a very broad enhancement of the use of mathematical and computational methods across areas of biology. While NIMBioS has been successful in encouraging research initiatives across much of biology, as illustrated in Figure 2, an objective for the renewal period is to further broaden the impacts of mathematical methods across biology. To meet this goal, we propose further methods to reach out to the biological sciences community working in fields with lesser representation.

Though it is not immediately apparent from Figure 2, there has been a trend of enhancing the breadth of NIMBioS research activities across the first four years. We have assessed this using a diversity index. To characterize the diversity of scientific topics covered by NIMBioS Working Groups and Workshops, we used the inverse Simpson index S^{46}, which is widely used in ecology,

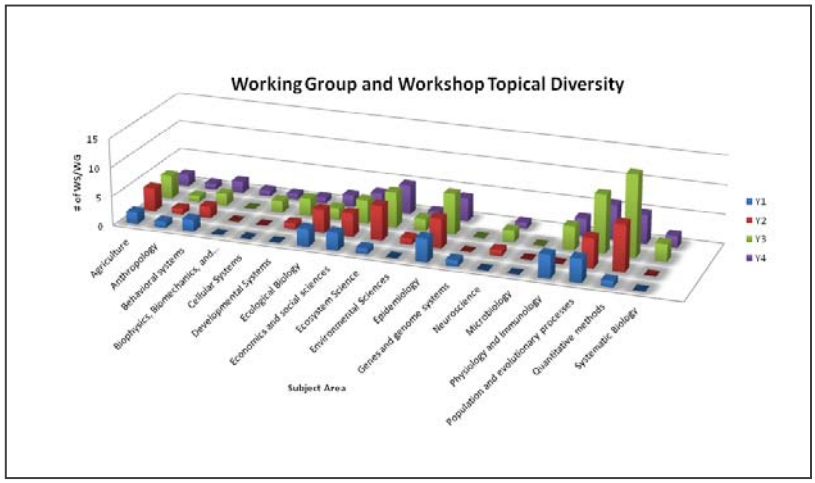


Figure 2. Temporal chart of the topical diversity of NIMBioS research activities

demography, and information science. During the submission process, each request for support is assigned three subject categories by the organizers (out of 13 different subject categories chosen from those used by the Directorate for Biological Sciences at NSF for classifying research proposals). For each year, we first computed the vector of frequencies p_i at which each subject category was linked to requests for support. Then index S is computed as $S = \frac{1}{\sum p_i^2}$. The value of S shown in Figure 3 gives an effective number of different subject categories represented in requests for support. Although we have only 4 data points, the data do demonstrate a trend towards increased diversity (Figure 3 shows the linear regression). We will use this methodology to assess the overall impact of our proposed efforts to enhance topical diversity of NIMBioS research activities.

We have begun a process to broaden the impact of NIMBioS Working Group and Workshop activities across biology and propose to enhance these throughout the renewal period. We plan to contact directly different researchers in the under-represented research areas with the goal of stimulating their interest in organizing a NIMBioS activity. Recently, prior to the September 4, 2012 deadline for requests for support, we conducted a pilot investigation of the potential for enhancing topical diversity, in which we contacted via email: 1) about 25 people suggested by current or incoming Advisory Board members, and 2) about 60 recent recipients of NSF grants at the math/bio interface, in areas outside of environmental biology. The results are encouraging: due to these contacts, by the deadline we received one request for support for a Working Group and one request for support for an Investigative Workshop, both in areas not previously well-represented by NIMBioS activities. We propose to continue this "direct email marketing" approach with the help of our Advisory Board members, personal connections, NSF grantees databases, subscribers to the NIMBioS newsletter, and by further expanding our efforts to publicize our activities in professional society publications in areas such as molecular and cell biology. The NIMBioS Communication Manager will assist in determining which of these methods are most effective in attracting broader participation in both requests for support and applications by potential participants. The NIMBioS Associate Director for Diversity Enhancement will collaborate to ensure methods are in place to contact researchers from under-represented groups in conjunction with efforts to broaden topical diversity.

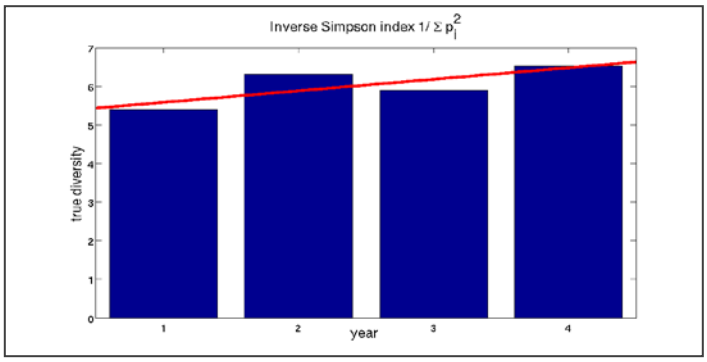


Figure 3. Temporal chart of the Simpson index for topical diversity

To further encourage broader topical diversity among requests for support, we propose to sponsor activities such as symposia at professional society meetings in subdisciplines we wish to enhance at NIMBioS. We propose to provide limited support for activities at such society gatherings requested by organizers of Working Groups or Workshops who desire to expand the connections of their organized activity to a broader audience in their subdiscipline. We have piloted this by supporting an activity by the Cortical Network Working Group at the annual Society of Neuroscience meeting. Assessing the impact of NIMBios-sponsored activities at society gatherings is non-trivial, however we will use this as a means to expand our database of "potential organizers", track of the dates they have been contacted, and resulting outcomes.

Participant Diversity

NIMBioS is committed to promoting diversity in all aspects of its activities including gender, ethnicity, scientific field, career stage, geography and type of home institution. The diversity goals are clearly stated in application guidelines for organizers of potential activities, and the statements on diversity in requests for support of activities are an essential component of the selection process. The Board of Advisors, and particularly its Committee to Promote Diversity, along with the Leadership Team, assist potential organizers to increase the diversity of invited participants and ensure that diversity is a criteria for selection of those to support from the open application pool for Workshops and Tutorials. The Leadership Team is often contacted by potential organizers prior to submission of a request for support to obtain suggestions to enhance diversity of those named in the request. The Leadership Team relies upon their own contacts, the database of prior participants, online searches and suggestions from the Board of Advisors to make suggestions to potential organizers.

Following a suggestion from the 2010 Site Review, NIMBioS established a group of benchmarks for participant and organizer diversity. For Working Group and Workshop participants, the benchmarks are 30% female, 10% international, no more than 15% local, and an increase of 10% per year in participation by those from under-represented groups (URG). For activity organizers, the benchmarks are 30% female and no more than 25% from UT faculty. NIMBioS has met the gender and international benchmarks each year, but participation by URG has increased only slightly over the four years and local organizers make up about 30% of all organizers. The 2012 Site Review made explicit suggestions regarding the benchmarks, noting that they were not sufficiently ambitious, and encouraged hiring both a full-time staff member as a Diversity Manager as well as a faculty member as an Associate Director focused explicitly on enhancing diversity. Another recommendation is to further increase the number of Advisory Board members from underrepresented groups.

With the support of UTK, in response to the Site Review suggestion, we have proceeded to add an Associate Director for Diversity Enhancement (Dr. Ernest Brothers) to reinforce our efforts in meeting our benchmarks and to consider, in conjunction with our Advisory Board, feasible means to make these benchmarks more ambitious. Dr. Brothers holds the position of Assistant Dean of the Graduate School with an explicit responsibility to broaden participation from URG in graduate programs. Dr. Brothers has extensive experience with minority-serving institutions (MSIs), has significant background in broadening participation, and has begun the process of mapping out methods that can extend and enhance the NIMBioS Diversity Plan. He has also begun a program to enhance cross-cultural mentoring for NIMBioS postdocs and students[14,51]. His efforts will build upon those ongoing by Associate Director Suzanne Lenhart to enhance NIMBioS participation in activities that have attracted large participation from URG. Dr. Lenhart serves on the Math Sciences Institutes Diversity Committee. NIMBioS is the lead organizer of the Modern Math Workshop at the SACNAS meeting in October 2012. We have built collaborations with several MSI partners, focusing on those that have already made a commitment to fostering efforts at the math/biology interface. We propose to expand this initiative, under guidance from Dr. Brothers, to not only expand the number of MSI partners, but to reach out more broadly to faculty at MSIs to encourage participation as organizers for NIMBioS activities.

Broader Impacts

NIMBioS activities related to education and outreach are illustrated in Figure 4, but these should not be viewed as independent of the research activities. Innovations at NIMBioS related to

Broader Impacts include:

- Establishment of a high-impact ***educational program for K-12***, including elaboration of mathematical content for the Biology-in-a-Box project that incorporates math in the science component of the curriculum and biology in the math part of the curriculum. This is in place in over 90 school systems in Tennessee and surrounding States. NIMBioS has carried out a vast array of additional activities oriented toward K-12 education.

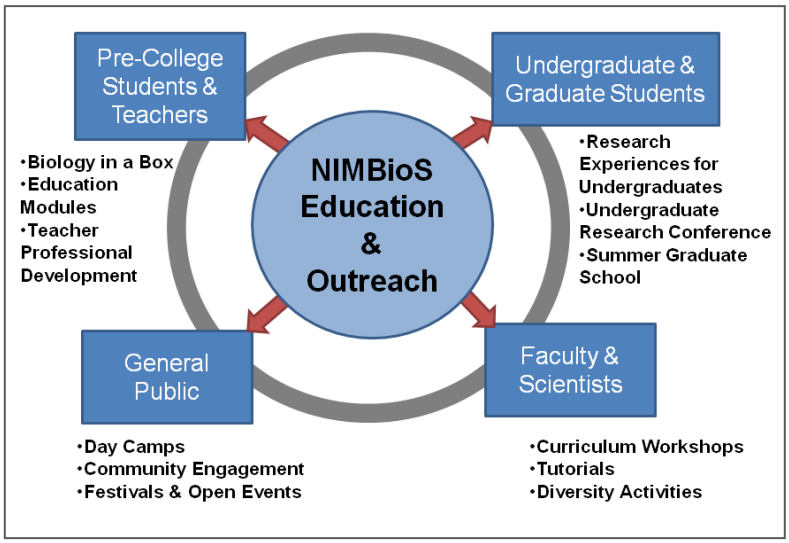


Figure 4. Education and Outreach at NIMBioS

- Establishment of a ***Research Experiences for Veterinary Students*** program that provided summer projects, particularly focused on diseases of animal origin with public health significance, linking quantitative approaches to veterinary issues. This arose at the request of the Advisory Board as a means to encourage, particularly for those DVM students interested in epidemiology and public health issues, an appreciation of the utility of quantitative models in animal infectious disease analysis.
- Establishment of a ***Research Experiences for Undergraduates*** program - teams of math and biology undergraduates, mentored by UT faculty, NIMBioS researchers and collaborators, work together to carry out research in modern biology using mathematics. Pre-service and professional teachers are included among the participants.
- An annual ***Undergraduate Research Conference*** at the Interface of Mathematics and Biology has featured undergraduate student talks and posters, keynote speakers, career panels, and networking opportunities. Many of the students attending are supported by NSF projects across the US.
- Partnerships with several ***Minority Serving Institutions*** have been signed to foster collaboration in research and education. The primary goal of these partnerships is to cultivate a more diverse group of researchers capable of conducting research at the math/biology interface. NIMBioS has hosted several undergraduates and faculty from these schools in our activities and events, and NIMBioS researchers regularly visit our partner institutions to discuss their research with faculty and students.
- Development of an ***evaluation program*** that provides very complete evaluations of all NIMBioS activities, centered around the diverse objectives of these programs. This provides quick feed-back to activity organizers as well as the NIMBioS Leadership on participants' perceptions of NIMBioS. This has been expanded to a systems-based approach to evaluation of center-scale effectiveness, with particular emphasis on how to assess the impacts of NIMBioS in developing cross-disciplinary collaborations and research.
- Development of a ***Songwriter-in-Residence*** program to encourage outreach to communities that have little exposure to the interconnections between math and biology. With artists

stipends provided by UT, this has encouraged NIMBioS researchers to expand their range of public interactions and has led to exposure for NIMBioS in several national media formats.

- Establishment of an ***extensive video archive*** of researchers working at the math/biology interface, built around a common set of questions to offer explanations of the importance of quantitative approaches in biology. This is also a means to provide media training, including on-camera interview experience, for NIMBioS participants.
- Establishment of a ***national science blog*** affiliated with a National Public Radio program emphasizing ways of learning about mathematics and biology. This, along with Facebook and Twitter feeds, provides a means to connect NIMBioS with the broad community of social media users. Another innovation has been the development of on-line shared communities, using Wiggio, for each NIMBioS activity.
- A ***postdoctoral mentoring program*** that provides media training, on-camera interview experience, visits to Minority-Serving Institution partners to broaden postdoc exposure to diverse educational institutions, REU (research experience for undergraduates) mentoring opportunities, undergraduate teaching opportunities (when appropriate for postdoc career goals), and the ability for postdocs to be the lead-investigator on grant proposals.

We plan to continue our partnerships with Minority Serving Institutions, which give priority to their students and faculty for participation in our activities. We support visits (with talks) to their campuses by our faculty, staff and postdoctoral researchers and give input on curriculum and proposal submission issues (when asked). Our current partners are Fisk University, Howard University, Tennessee State University, California State University San Marcos, and University of Texas at El Paso. We have supported 17 visits to these partners and we've supported 54 visits to participate in NIMBioS activities by 36 individuals from our partners. Six REU students were from these partners. We are in the process of completing agreements with North Carolina University A & T and the University of the Virgin Islands, and we intend to make an agreement with a college with a large percentage of Native American students.

Through participant funding from an NSF award to the Math Institutes Diversity Initiative, NIMBioS will be hosting a "Spring Opportunities" workshop, which aims to familiarize women in the mathematical sciences with professional opportunities in academia, industry and government. The workshop will provide examples of people and problems from industrial and government laboratory settings, provide discussions of expectations of employers, and enable networking opportunities. The audience will be graduate students and PhDs in the early stages of their careers. Several areas of applied mathematics will be featured, including mathematical biology. SAMSI, an NSF math institute, is cooperating with us on the planning of this event, which will be held in spring 2014.

We will continue to host an REU program for eight weeks each summer and plan to have 20 undergraduate student participants. The students will be math or biology majors, broadly interpreted. Each summer will have about five projects; the students are divided into project groups, with a math mentor and a biology mentor for each group. Mentors are usually UT faculty members or NIMBioS postdocs. This program gives the postdocs a professional development opportunity in mentoring undergraduate research. As in the past, we may have pre-service teachers or high school teachers as participants in our REU projects. The NIMBioS Annual Research Conference at the Interface of Biology and Mathematics will continue to be held each fall. This two-day conference focuses on talks and poster presentations by undergraduates, with two plenary talks, career panel discussion, a graduate school showcase session, and networking opportunities. We expect 120 attendees, including 80 students, for whom NIMBioS provides a limited support for lodging expenses. For the renewal period, after considerable discussion, we have not included funding for the Research Experiences for Veterinary Students (REV) summer

program. We have decided that this program would be most effectively organized as a separate activity from the REU program, due in part to the differences in maturity-level of REV and REU students. Although the evaluations from the limited REV participants were quite positive, we have decided this is an effort better supported directly by Veterinary education units.

The majority of our collaborative activities with other organizations have been with other NSF-supported BIO Synthesis Centers and Math Institutes, several NSF-supported High Performance Computing projects (TeraGrid, and now XSEDE) and with Great Smoky Mountains National Park and Oak Ridge National Laboratory. We have also closely collaborated with two interdisciplinary graduate education programs based at UTK and funded by NSF (the SCALE-IT IGERT) and NIH (the PEER program). In cooperation with other NSF Centers, NIMBioS has co-sponsored activities at the Joint Math Meetings, SIAM annual meetings and at SACNAS. We will continue to cooperate with the BIO Synthesis Center activities at the SACNAS meeting, lead by NESCent. NIMBioS hosted the Society of Mathematical Biology annual meeting in Knoxville in summer 2012 and has held several workshops and tutorials in collaboration with XSEDE projects and the iPlant Collaborative. NIMBioS also continues to lead efforts in collaborating and sharing best practices with education and outreach programs at other centers through regular communication and annual meetings with other center coordinators. In February 2012, NIMBioS hosted the annual meeting which included representatives from the BIO Synthesis Centers, NSF Mathematics Institutes, an Engineering Research Center, museums, universities, and NGOs. We will continue to foster these cross-center activities and propose to hold several Tutorials on the mathematics of continent-scale analysis in conjunction with NEON.

In 2011 and 2012, NIMBioS has cooperated with two math biology institutes, MBI and CAMBAM (McGill University), to sponsor a summer graduate student workshop. These ten-day workshops had lectures, daily computer/analysis labs, and group projects with eight researchers leading the activities and the projects. NIMBioS is hosting this workshop in 2013 on "Connecting Data with Models in Mathematical Biology" for 40 biology and math graduate students. We plan to continue to cooperate on this and have proposed funding for a summer program in 2015 or 2016.

NIMBioS has contributed mathematics activities to all ten existing Biology in a Box K-12 curriculum enrichment units. Biology in a Box now reaches 90+ school systems in Tennessee and surrounding states, and activity booklets are available worldwide via online resources. NIMBioS will continue efforts to share this program broadly, as well as contribute to the development of new units, including the forthcoming units Biomechanics, Cells and Cell Processes, and Climate and Habitats.

NIMBioS will host two-three Tutorials and one-two curriculum development workshops each year. We will continue efforts to focus some Tutorials on High Performance Computing issues for biologists. A combination Tutorial/curriculum development workshop is being planned with the Center for Cell Analysis and Modeling (University of Connecticut) for Spring 2013. We have a successful ongoing collaboration with the BioQuest project in the development and use of software for education and research, including two events in January 2013: an AP Biology high school teacher workshop on quantitative biology and a college faculty curriculum workshop with a focus on cellular and genomic levels of biology, in collaboration with the European Bioinformatics Institute (EBI) and SCALE-IT (UTK NSF IGERT). These are indicative of the collaborative activities we propose for the renewal period.

We propose to augment the existing Teacher Collaboration Program to focus on further development of partnerships between K-12 teachers and members of the math biology community through an annual workshop. This workshop will focus on bringing STEM high

school math and biology teachers together with researchers/college faculty to work on innovative curriculum projects, introducing participants to math-science software and enrichment activities, and encouraging partnerships that will last beyond the end of the workshop.

Evaluation

NIMBioS continues to develop its methods for center-scale evaluation, particularly metrics useful in assessing the impact of the Center on the development of interdisciplinary collaborations. Over its first four years of operation, NIMBioS evaluation procedures have evolved to meet changing needs. During years 1-3, the center employed an evaluation model that was mostly formative and descriptive. The focus was mainly center inputs and processes, such as NIMBioS administrative activities, event formats, numbers of participants and events, and participant demographics. Data sources for evaluation were mostly limited to participant surveys and document analysis. This model not only met the Center reporting requirements, but also worked well to provide feedback to NIMBioS staff, leadership, and event organizers about processes that were working well, and areas in need of improvement. Data from these formative evaluations were used to guide policy creation for day-to-day operations, improve services to participants, and create "best practices" guidelines for event organizers. Evaluation reports for all activities are posted on the website.

Beginning in year 4, NIMBioS responded to a need to incorporate center outcomes more heavily into its evaluation plan by adopting the CIPP systems-based model for evaluation[48]. The CIPP approach considers the Center as a whole, assessing the quality and significance of outcomes while still examining the inputs and processes that lead to these outcomes. Different from years 1-3, the new evaluation approach incorporates multiple data sources, including surveys, document analysis, participant interviews, and Web of Science data. The approach also incorporates new research methods, such as bibliometrics, network analysis, and mapping of scientific output. In addition, NIMBioS conducts evaluation case studies that examine more closely the changes in participants as a result of their participation in NIMBioS events. One such longitudinal study of 46 participants of completed Working Groups recently found that during the years in which faculty are affiliated with NIMBioS, they are more likely to collaborate with colleagues and with other institutions, and more likely to form international collaborations. Figure 5 illustrates the ongoing and planned evaluation activities at NIMBioS.

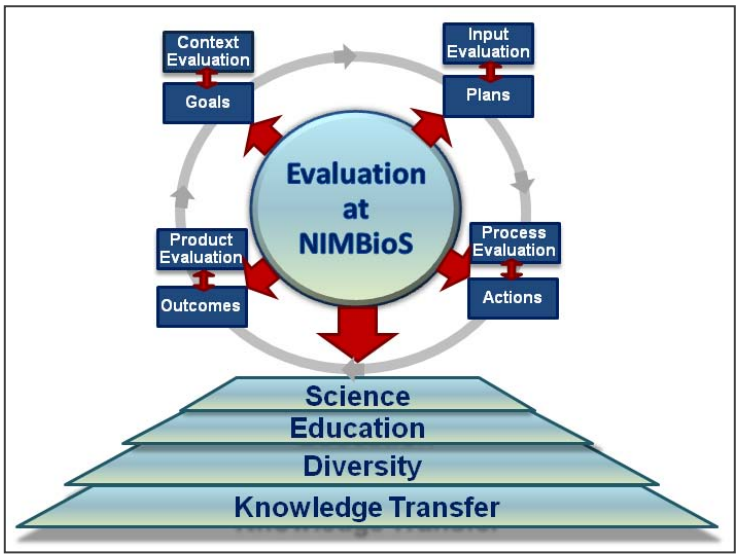


Figure 5. Evaluation at NIMBioS

Proposed growth in the evaluation plan to be implemented in the next five years builds upon our experience, and from program-level NSF evaluations, such as the AAAS review of NSF Science and Technology Centers (STCs)[55], the subsequent AAAS Blue Ribbon Panel review of the same program[34], and the review of NSF IGERT[12]. While NIMBioS lacks the funding and staff resources to carry out an ongoing evaluation of the magnitude of these evaluation studies, our evaluation model in the next five

years will follow an outcomes-based approach similar to the STC evaluations, focusing on "value-added" by the Center in the areas of science, education, diversity, and knowledge transfer[55].

NIMBioS proposes to enhance the NSFs capacity to evaluate major research centers by developing a scientific method to assess impacts that are not adequately captured in standard demographic and publication metrics. We are currently accruing a set of metrics to measure the success of the Center in several areas, including:

- *Science*

(i) Integration and Specialization scores[41] to compare changes in interdisciplinarity of scientific output of participants from before and after affiliation with the center. *(ii)* Simpson's inverse diversity index[46] to measure change in the diversity of scientific topics covered in NIMBioS Working Groups and Workshops year to year.

- *Education*

(i) Long-term tracking of pre-professional participants (postdoctoral, graduate, and undergraduate) to determine the impact NIMBioS has had on recruitment, retention, degree-taking, and transition into the STEM workforce. (ii) Pre and post measurement of knowledge and abilities of REU students

- *Diversity*

(i) Benchmarks to ensure representation of women and under-represented groups, as well as geographic diversity, of organizers and participants in Working Groups and Workshops. (ii) Impacts of the center on underrepresented participants regarding recruitment, retention, degree-taking, and transition into the STEM workforce (if pre-professional), or on career benefits (if professional).

- *Knowledge transfer*

(i) Diffusion scores[11] to measure the spread of NIMBioS-produced publications across multiple disciplines. (ii) Measuring collaboration (and its relationship to productivity) through long-term network studies of Working Group participants using size, density, complexity, and centralization measures[1].

By the end of the renewal period, we will have a set of publications that establish transformative means to evaluate center-scale interdisciplinary science and education using a variety of methods. The first of these publications should appear in 2013. This translational research will impact assessment of science and education activities not only that NSF supports, but will also potentially impact evaluations of the growing number of interdisciplinary centers operated by other government agencies, universities and private industry.

NIMBioS Communication Efforts

Inherent in NIMBioS broader impact objectives is the need to effectively communicate our activities and opportunities, as well as the outcomes of these. This involves a broad spectrum of communication tools to reach multiple audiences. Our chief communications vehicle is the award-winning NIMBioS Web site, which in four years, has grown to 700 html pages and 966 pdf documents. The website currently averages more than 3,700 unique visitors, 7,400 visits, and 22,000 page views per month, an increase over the previous year of 32% for visits and 41% for

page views. In May 2012, the site merited an international award for excellence in technical communication from the Society for Technical Communication.

NIMBioS has issued 52 press releases, and subsequently, received recognition in local, regional, national and international media, including Science, Nature, New York Times, National Public Radio, Time, US News and World Report, Los Angeles Times, and Discover, among others. We actively utilize social media tools, including Twitter (more than 1,000 followers and Klout score of 45), Facebook, YouTube, LinkedIn, Flickr and Storify.

The NIMBioS YouTube channel has 56 videos with a total of more than 25,000 views. NIMBioS videos range from interviews with visiting researchers to brief profiles of postdoctoral fellows' research to videos of NIMBioS' educational efforts and/or general science topics. NIMBioS has a video archive of responses from 24 researchers working at the math/biology interface, which is built around a common set of question to offer explanations of the importance of quantitative approaches in biology. NIMBioS now has webcasting capability using 323link educast technology, so seminars, workshop presentations, and other activities will be recorded and made available to a broader audience via our website. The proposed renewal funding includes effort of a database specialist to edit and maintain the video archive of presentations. NIMBioS also provides media training for postdocs, including on-camera interview experience.

The NIMBioS blog, started in 2011, showcases news at NIMBioS and other math-bio related content of interest to the scientific community. The blog is updated weekly, and currently has 142 posts and 71 registered subscribers. The NIMBioS electronic newsletter, issued bi-monthly, has more than 3,800 registered subscribers and an open and click-through rate of approximately 30%, far higher than industry averages.

Sustainability

The University of Tennessee, Knoxville has made long-term commitments to NIMBioS in consideration of the desire to foster the continuation of research and educational activities at the interface between mathematics and biology that have been an emphasis at UTK for over three decades. UTK has one of the longest standing programs in this interdisciplinary area, with a history of numerous collaborative courses, shared students and research activities between faculty based in Mathematics and those based in several biological science units. The current NIMBioS Leadership Team is representative of how UTK has fostered connections between empirical biologists, theoretical biologists and mathematicians. The addition of six new faculty in conjunction with the initiation of NIMBioS provides strong evidence that UTK views its commitment to excellence in the areas that foster connections between biology, mathematics and computation. These junior faculty have already successfully developed their own research programs in areas previously not emphasized at UTK, such as mathematical immunology, and several have successfully obtained NSF funding for their research. While all have been greatly involved in NIMBioS activities, as junior faculty they have not been asked to take a major leadership role in NIMBioS. However, by the middle of the renewal period, all will have been considered for promotion and tenure, and it is expected that several of these faculty will become part of the NIMBioS Leadership Team and be directly involved in plans for longer-term changes in NIMBioS, in conjunction with the new Director.

Based on the fact that UTK now has one of the largest and most diverse collections of faculty with research interests across the spectrum of mathematical biology, there is no doubt that initiatives at UTK in this area will continue long-after the renewal period for NIMBioS. As

NIMBioS represents a major research strength at the UTK, which is in the process of encouraging significant growth in the UTK research portfolio to further the objective of reaching Top-25 Public University status, it is likely that future faculty positions will be aligned with NIMBioS research initiatives. An expectation of the new Director is that this individual will work closely with the new Vice Chancellor for Research, Dr. Taylor Eighmy, who has extensive background in environmental engineering and environmental microbiology, in enhancing connections of NIMBioS to the variety of engineering fields that have become more biologically focused. NIMBioS already has connections, including involvement of several senior personnel, to the Departments in the UTK College of Engineering which have an explicit connection to biology in their mission. Enhancing the connections between the faculty in these units and NIMBioS will provide additional routes to success for the long-term enhancement of opportunities at UTK in areas supported by NIMBioS. This also directly supports the recommendations of the 2012 Site Review to broaden the topical diversity of activities at NIMBioS.

Concurrent with research initiatives, there is the potential for further expansion of the already significant emphasis at NIMBioS on educational activities. As biological interdisciplinary connections continue to expand in this "Century of Biology", there are numerous opportunities to consider new models for education at disciplinary interstices. Recent reports on the future of biology[38, 39] all point to the need for rethinking education and training initiatives, which has been the focus of several education reports[10, 30, 37]. There is currently no national center providing the infrastructure to foster the development of such new educational initiatives at a variety of educational levels, though NIMBioS has acted in concert with several organizations (BioQuest, AIBS, AAAS, other NSF Centers), in a limited way to assist in this effort. The long-standing programs at UTK in undergraduate and graduate quantitative education for life science students can serve as the basis for new national-scale initiatives. The NIMBioS infrastructure would be beneficial to provide assistance to national efforts on interdisciplinary biology education. This builds upon the curriculum development workshops already held, the ones planned, and the potential to develop in consort with various digital libraries a compilation of carefully vetted modules and activities, along with assessment methods, for quantitative biology. The expectation is that educational activities that reach well beyond the UTK community will continue under the auspices of NIMBioS after the renewal period.

There is a history at UTK within the math biology research group of successfully transitioning an interdisciplinary center through a variety of support mechanisms over two decades. The Institute for Environmental Modeling (TIEM) was established in 1991 with emphasis on fostering connections between modelers and environmental scientists to address problems in theoretical and applied environmental science. The initial focus was mostly on environmental toxicology, but branched out to ecological risk assessment, biotic modeling for Everglades restoration, grid computing for spatial environmental analysis, ecological impacts of bats, and spatial control in natural resource management. TIEM has received financial support from numerous Federal, State and private agencies (totaling over $17M) and has a current focus in ecological and human health risk assessment associated with chemicals and radiation. While we cannot specify now exactly how NIMBioS will transition after the renewal period, it is clear that UTK faculty and staff have demonstrated the experience and knowledge of how to support and maintain interdisciplinary connections, as evidenced by the success of TIEM, and have amassed the broad range of expertise across an excellent faculty to ensure continuation of efforts consistent with the NIMBioS mission.

References

Notation: Products of NIMBioS activities are denoted with a WG (Working Group), WS (Investigative Workshop), P (Postdoctoral Fellow), V (Visitor or NIMBioS Faculty or student).

1. Aboelela SW, Merrill JA, Carley KM. Larson E. 2007. Social network analysis to evaluate an interdisciplinary research center. *Journal of Research Administration*, XXXVIII, 97-108.
2. Akçay E, Roughgarden J. The evolution of payoff matrices: Providing incentives to cooperate. *Proceedings of the Royal Society B.* (published online December 8, 2010). [P]
3. Akçay E, Simms E. 2011. Negotiation, sanctions and context dependency in the legume-rhizobium mutualism. *The American Naturalist*, **178**(1): 1-14 (published online June 2, 2011). [P, V]
4. Akcay E, Van Cleve J, Feldman MW, Roughgarden J. 2009. A theory for the evolution of other-regard integrating proximate and ultimate perspectives. *Proceedings of the National Academy of Sciences*, **106**(45): 19061-19066. [P, V]
5. Araújo MS, Bolnick DI, Layman CA. 2011. The ecological causes of individual specialization. *Ecology Letters*, **14**(9): 948-958. [WG]
6. Barnosky AD, Matzke N, Tomiya S, Wogan GOU, Swartz B, Quental TB, Marshall C, McGuire JL, Lindsey EL, Maguire KC, Mersey B, Ferrer EA. 2011. Has the Earth's sixth mass extinction already arrived? *Nature*, **471**(7336): 51-57. [T]
7. Beaulieu JM, Jhwueng DC, Boettiger C, O'Meara BC. 2012. Modeling stabilizing selection: Expanding the Ornstein-Uhlenbeck model of adaptive evolution. *Evolution*, **66**(8): 2369-2383. [P]
8. Beckage B, Godsoe W, Gross L, Platt W, Simberloff D. July 2010. Individual variation slows competitive exclusion. *Science,* e-letter published online 14 July 2010. [P, V]
9. Bolnick DI, Amarasekare P, Araújo MS, Bürger R, Levine J, Novak M, Rudolf VH, Schreiber S, Urban M, Vasseur D. 2011. Why intraspecific trait variation matters in community ecology. *Trends in Ecology and Evolution*, **26**(4): 183-192. [WG]
10. Brewer C, Smith D (ed.), O'Connor C, Withers M, Donovan S, Hoskins SG, Lopatto D, Varma-Nelson P, White H, Bauerle, Gross L, Labov J, Poston M, Wessner D, Lynn D, Drew S, Tanner K, Wood W, Fry C, Matyas M, DePass A, Anderson A, Ebert-May D, McClatchey W, Pelaez N, Wubah D, Singer S. 2001. *Vision and Change in Undergraduate Education: A Call to Action*. AAAS, Washington, DC.
11. Carley S, Porter AL. 2012. A forward diversity index. *Scientometrics,* **90**(2): 407-427.
12. Carney J, Chawla D, Wiley A, Young D. 2006. Evaluation of the initial impacts of the National Science Foundation's integrative graduate education and research traineeship program. Bethesda, MD: Abt Associates, Inc.
13. Cooper IA, Gilman RT, Boughman JW. 2011. Sexual dimorphism and speciation on two ecological coins: Patterns from nature and theoretical predictions. Evolution, 65(9): 2553-2571. Akçay E, Simms E. 2011. Negotiation, sanctions and context dependency in the legume-rhizobium mutualism. *The American Naturalist*, **178**(1): 1-14 (published online June 2, 2011). [P]
14. Davidson MN, Johnson LF. 2001. Mentoring in the preparation of graduation researchers of color. *Review of Educational Research*, **71**(4): 549-574.

15. DeAngelis DL, Wolkowicz GS, Lou Y, Novak M, Svanback R, Araujo MS, Jo Y, Cleary EA. 2011. The effect of travel loss on evolutionary stable distributions of populations in space. *The American Naturalist*, **178**(1):15-29. [WG]
16. Duenez-Guzman EA, Mavarez J, Vose MD, Gavrilets S. 2010. Case studies and mathematical models of ecological speciation. 4. Hybrid speciation in butterflies in a jungle. *Evolution*, **63**(10): 2611-2626. [V]
17. Fenichel EP, Castillo-Chavez C, Ceddia MG, Chowell G, Gonzalez Parra PA, Hickling GJ, Holloway G, Horan R, Morin B, Perrings C, Springborn M, Velazquez L, Villalobos C. 2011. Adaptive human behavior in epidemiological models. *Proceedings of the National Academy of Sciences*, **108**(15): 6306-6311. [WG]
18. Fenichel EP, Horan RD, Hickling GJ. 2010. Management of infectious wildlife diseases: Bridging conventional and bioeconomic approaches. *Ecological Applications*, **20**(4): 903-914. [WG]
19. Frick WF, Pollock JF, Hicks AC, Langwig KE, Reynolds DS, Turner GG, Butchkoski CM, Kunz TH. 2010. An emerging disease causes regional population collapse of a common North American bat species. *Science*, **329**(5992): 679-82. [WS]
20. Furuta Y, Abe K, Kobayashi I. 2010. Genome comparison and context analysis reveals putative mobile forms of restriction-modification systems and related rearrangements. *Nucleic Acids Research*, **38**(7): 2428-2443. [WS]
21. Gavrilets S. 2012. Human origins and the transition from promiscuity to pair-bonding. *Proceedings of the National Academy of Sciences*, **109**:9923-9928. [V]
22. Gavrilets S. 2012. On the evolutionary origins of the egalitarian syndrome. *Proceedings of the National Academy of Sciences*, **109**:14069-14074. [V]
23. Gavrilets S, Losos JB. 2009. Adaptive radiation: Contrasting theory with data. *Science*, **323**(5915): 732-737. [WG]
24. Gilman RT, Behm JE. 2011. Hybridization, species collapse, and species reemergence after disturbance to premating mechanisms of reproductive isolation. *Evolution*, **65**(9): 2592-2605. [P]
25. Gilman RT, Nuismer SL, Jhwueng DC. 2012. Coevolution in multidimensional trait space favours escape from parasites and pathogens. *Nature*, **483**(7389): 328-330. [P]
26. Giraud T, Gladieux P, Gavrilets S. 2010. Linking the emergence of fungal plant diseases with ecological speciation. *Trends in Ecology and Evolution*, **25**(7): 387-395. [WG]
27. Godsoe W. 2010. Regional variation exaggerates ecological divergence in niche models. *Systematic Biology*, **59**(3): 298-306. [P]
28. Gotelli NJ, Dorazio RM, Ellison AM, Grossman GD. 2010. Detecting temporal trends in species assemblages with bootstrapping procedures and hierarchical models. *Philosophical Transactions of the Royal Society B: Biological Sciences*, **365**:3621-3631. [WG]
29. Gross LJ, Beckage B. 2012. Toward a metabolic scaling theory of crop systems. *Proceedings of the National Academy of Sciences*, **109**:15535-15536. [V]
30. HHMI-AAMC. 2009. *Scientific Foundations for Future Physicians*. Report of the AAMC-HHMI Committee, Washington, DC.
31. Horan RD, Fenichel EP, Melstrom RT. 2011. Wildlife disease bioeconomics. *International Review of Environmental and Resource Economics*, **5**(1): 23-61. [WG]

32. Khan F, Furuta Y, Kawai M, Kaminska K, Ishikawa K, Bujnicki J, Kobayashi I. 2010. A putative mobile genetic element carrying a novel type IIF restriction-modification system (PluTI). *Nucleic Acids Research*, **38**(9): 3019-3030. [WG]
33. Loladze I, Elser JJ. 2011. The origins of the Redfield nitrogen-to-phosphorus ratio are in a homoeostatic protein-to-rRNA ratio. *Ecology Letters*, **14**(3): 244-250. [WG]
34. Mason SM, Gagosian R, Gentile J, Hey T, McGuire S, Melkers J, Moore D, Natalicio D, Noonan N, Peters L, Fawwaz U. 2010. The NSF Science and Technology Centers Integrative Partnership Program, 2000-2009, pp. 22, Washington, DC.
35. Massol F, Gravel D, Mouquet N, Cadotte MW, Fukami T, Leibold MA. 2011. Linking community and ecosystem dynamics through spatial ecology. *Ecology Letters*, **14**(3): 313-323. [WG]
36. Mesterton-Gibbons M, Gavrilets S, Gravner J, Akcay E. 2011. Models of coalition or alliance formation. *Journal of Theoretical Biology*, **274**(1): 187-204. [WG]
37. National Research Council 2003. *BIO2010: Transforming Undergraduate Education for Future Research Biologists.* National Academies Press, Washington, DC.
38. National Research Council. 2008. *The Role of Theory in Advancing 21st-Century Biology: Catalyzing Transformative Research*. National Academies Press, Washington, DC.
39. National Research Council. 2009. *A New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution*. National Academies Press, Washington, DC.
40. Perrings C. 2010. Exotic effects of capital accumulation. *Proceedings of the National Academy of Sciences,* **107**(27): 12063-12064. [WG]
41. Porter AL, Roessner DJ, Heberger AE. 2008. How interdisciplinary is a given body of research? *Research Evaluation*, **17**(4): 273-282.
42. Sadedin S, Hollander J, Panova M, Johannesson K, Gavrilets S. 2009. Case studies and mathematical models of ecological speciation. 3: Ecotype formation in a Swedish snail. *Molecular Ecology*, **18**(19): 4006-4023. [WG]
43. Shah P, Gilchrist MA. 2011. Explaining complex codon usage patterns with selection for translational efficiency, mutation bias, and genetic drift. *Proceedings of the National Academy of Sciences*, **108**(25): 10231-10236. [V]
44. Shah P, Gilchrist MA. 2010. Effect of correlated tRNA abundances on translation errors and evolution of codon usage bias. *PLoS Genetics*, **6**(9): e1001128. [V]
45. Sharp PA, Langer R. 2011. Research Agenda. Promoting convergence in biomedical science. *Science*, **333**(6042): 527.
46. Simpson EH. 1949. Measurement of diversity. *Nature*, **163**: 688.
47. Smith RJ, Okano JT, Kahn JS, Bodine EN, Blower S. 2010. Evolutionary dynamics of complex networks of HIV drug-resistant strains: The case of San Francisco. *Science*, **327**: 697-701. [V]
48. Stufflebeam DL. 2003. The CIPP model for evaluation. In T. Kelleghan & D.L. Stufflebeam (Eds.) *International Handbook of Education Evaluation* (pp. 31-61). London: Kluwer Academic Press.
49. Thibert-Plant X, Hendry AP. 2010. When can ecological speciation be detected with neutral loci? *Molecular Ecology*, **19**(11): 2301. [P]
50. Ubeda F, Gardner A. 2010. A model for genomic imprinting in the social brain: Juveniles. *Evolution*, **64**(9): 2587-2600. [WG]

51. White JL, Altschuld JW, Lee YF. 2006. Cultural dimensions in science, technology, engineering, and mathematics: Implications for minority retention research. *Journal of Educational Research & Policy Studies*, **6**(2): 41-59.
52. Yahara K, Fukuyo M, Sasaki A, Kobayashi I. 2009. Evolutionary maintenance of selfish homing endonuclease genes in the absence of horizontal transfer. *Proceedings of the National Academy of Sciences*, **106**:18861-18866. [WG]
53. Yu Y, Degnan JH, Nakhleh L. 2012. The probability of a gene tree topology within a phylogenetic network with applications to hybridization detection. *PLoS Genetics*, **8**(4): 456-465. [V]
54. Zychaluk K, Bruno JF, Clancy D, McClanahan TR, Spencer M. 2012. Data-driven models for regional coral-reef dynamics. *Ecology Letters*, **15**(2): 151-158. [WS]
55. Chubin, D. E., Derrick, E., Feller, I., & Pallavi, P. (2010). AAAS review of the NSF science and technology centers integrative partnerships (STC) program, 2000-2009. Washington, DC: American Association for the Advancement of Science.

BIOGRAPHICAL SKETCH - LOUIS J. GROSS

(a) Professional Preparation

Drexel University	Mathematics with honors	BS 1974
Cornell University	Applied Mathematics	Ph.D. 1979

(b) Professional Appointments:

2010- present, Alvin and Sally Beaman Professor, University of Tennessee

2009- present, James R. Cox Distinguished Professor, University of Tennessee

2008- present, Director, National Institute for Mathematical and Biological Synthesis

1997- present, Professor, Departments of Ecology and Evolutionary Biology and Mathematics, University of Tennessee, Knoxville, TN

1998 – present, Director, The Institute for Environmental Modeling, University of Tennessee

1992- 1997, Professor, Department of Mathematics and Graduate Program in Ecology, University of Tennessee, Knoxville, Tennessee

1985-1992, Associate Professor, Department of Mathematics and Graduate Program in Ecology, University of Tennessee, Knoxville, Tennessee

1987, Distinguished Visitor (Summer), Mathematics and Botany Departments, University of California, Davis, California

(c) (i)Five Publications Related to the Project:

Hastings, A. and L.J. Gross (eds.). 2012. *The Encyclopedia of Theoretical Ecology*. University of California Press, Riverside, CA.

Gross, L. J. and B. Beckage. 2012. Toward a metabolic scaling theory of crop systems. *Proceedings of the National Academy of Sciences* **109**:15535-15536.

Yin, L., S-L. Shaw, D. Wang, E. A. Carr, M. W. Berry, L. J. Gross and E. J. Comiskey. 2012. A framework of integrating GIS and parallel computing for spatial control problems – a case study of wildfire control. *International Journal of Geographical Information Science* **26**:621-641.

Beckage, B., L. J. Gross, and S. Kauffman. 2011.The limits to prediction in ecological systems. *Ecosphere* **2**(11):125. doi:10.1890/ES11-00211.1

Beckage, B., L. J Gross and W. J. Platt. 2011. Grass feedbacks on fire stabilize savannas. *Ecological Modelling* **222**: 2227-223.

(ii) Five Additional Publications:

Beckage, B., W. J. Platt and L. J. Gross. 2009. Vegetation, fire, and feedbacks: a disturbance-mediated model of savannas. *American Naturalist* **174**(6): 805-818 (2009).

Fuller, M. M., L. J. Gross, S. M. Duke-Sylvester and M. Palmer. 2008. Testing the Robustness of Management Decisions to Uncertainty: Everglades Restoration Scenarios. *Ecological Applications* **18**:711-723.

Bodine, E. N, L. J. Gross and S. Lenhart. 2008. Optimal control applied to a model for species augmentation. *Mathematical Biosciences and Engineering* **5**:669-680.

Gaff, H. D. and L. J. Gross. 2007. Modeling tick-borne disease: a metapopulation model. *Bulletin of Mathematical Biology* **69**:265-288.

Gross, L. J. 2004. Interdisciplinarity and the undergraduate biology curriculum: finding a balance. *Cell Biology Education* **3**:85-87.

(d) Synergistic Activities:

Society for Mathematical Biology. President (2003-2005). Scientific Committee member for Annual Meetings (1999, 2000), Annual Meeting Chair (2002). Education Committee member (1999-2008). President-Elect (2002), Nominating Committee Chair (2010), Okubo Prize Chair (2011), Annual Meeting Chair (2012)

Mathematical Biosciences Institute. Chair, Board of Governors, Ohio State University, 2003-2005.

American Institute for Biological Sciences, 2006 Distinguished Scientist Awardee. Elected at-Large Member of Board of Directors, 2008-2010; Elected Treasurer, 2010-2013.

Ecological Society of America, Annual Meeting Program Chair, 2008; Meetings Committee co-Chair, 2008-2009; Theoretical Ecology Section: Vice Chair, 2000-2001; Chair, 2001-2002.

National Research Council. Chair, Committee on Integrating Education with Biocomplexity Research. 2001-2003. Member, Mathematics and Computer Science Panel for Bio2010: Transforming Undergraduate Education for Future Research Biologists, 2001-2002. Member, Committee on the Selection and Use of Models in Regulatory Decision Making, 2004-2005. Member, Board on Life Sciences, 2008-2013; BLS Liaison to Standing Committee on Emerging Science for Environmental Health Decisions, 2010-2013.

(e) Collaborators and Other Affiliations:

(i) Collaborators, co-editors, and current affiliations:

E. Asano (U South FL), B. Beckage (U VT), M. Berry (UTK), E. Bodine (Rhodes), J. Brown (UIC), N. Buchanan (ESRI), E. Carr (UTK), E. Comiskey (UTK), V. Dale (ORNL), D. DeAngelis (USGS), W. Ding (Mid. TN St.) S. Duke-Sylvester (U. Lousiana), H. Gaff (Old Domin.), W. Godsoe (UTK), A. Hastings (UC Davis), B. Johnson (UTK), H. Joshi (Xavier), S. Kauffman (SFI/U VT), K. Klemow (Wilkes), K. Langston (UTK), S. Lenhart (UTK), B. McGill(U Maine), M. Palmer (UTK), W. Platt (LSU), A. Potochnik (U Cinn), L. Real (Emory), R. Salinas (App. St.), D. Simberloff (UTK), R. Stephenson ((U. Mass-Boston), C. Travis (UTK), D. Wang (ORNL), A, Whittle (Kennesaw St).

(ii) Graduate Advisors: Simon A. Levin (Princeton), Brian F. Chabot (Cornell)

(iii) Ph.D. Students and Post-doctoral Associates Directed: Brian Beckage (U VT), Mark Bevelhimer (ORNL), E. Bodine (Rhodes), John Curnutt (USGS), Wandi Ding (MTSU), Scott Duke-Sylvester (U. Louisiana), Paula Federico (Capital U.), Michael Fuller (U Toronto), Holly Gaff (Old Domin.), O. Gaoue (UTK), Will Godsoe (UTK), Milena Holmgren (Wageningen), Hem Raj Joshi (Xavier), Hang-Kwang Luh (Oregon St.), E. Moran (UTK), Seema Nanda (Bangalore), M. Philip Nott (Inst. Bird Pop.), Larry Pounds (ORNL), Rene' Salinas (Appal. St.), Dali Wang (ORNL), Paul Wetzel (Mt. Holyhoke), Andrew Whittle (Kennesaw St.), Yegang Wu (S FL. Water Manage. District).

Total graduate students directed: 15. Total Post-doctoral associates: 18.

BIOGRAPHICAL SKETCH - ERNEST L. BROTHERS

(a) Professional Preparation

Delta State University	Chemistry	BS	1994
Delta State University	Natural Science	MSNS	1995
Mississippi State University	Public Policy & Admin	MPPA	2003
Jackson State University	Urban Higher Education	Ph.D.	2006

(b) Professional Appointments:

2010- present, Assistant Dean of the Graduate School, Office of Graduate Training and Mentorship, University of Tennessee, Knoxville, TN

2007- 2009, Executive Director, Peach State Louis Stokes Alliance for Minority Participation, University of Georgia, Athens, GA

2000- 2007, Campus Site Coordinator, Louis Stokes Mississippi Alliance for Minority Participation, Delta State University, Cleveland, MS

2006- 2007, Assistant Professor, Department of Biological and Physical Sciences, Delta State University, Cleveland, MS

2000-2006, Instructor of Chemistry, Department of Biological and Physical Sciences, Delta State University, Cleveland, MS

1996- 2000, Research Assistant I, Mississippi State Chemical Laboratory, Mississippi State University, Mississippi State, MS

1995-1996, Research Assistant I/Laboratory Project Director, Analytical Food Support and Food Safety Laboratory, Mississippi State University, Mississippi State, MS

(c) Five Publications Related to the Project:

Brothers, E. L., & Knox, B. (2011). Best practices in retention of underrepresented minorities in science, technology, engineering, and mathematics (STEM) in the Tennessee Louis Stokes Alliance for Minority Participation (Tennessee LSAMP). In Supporting Cultural Differences Through Research; 2011 Monograph Series (pp. 1411-1427) [CD]. Scarborough, ME: National Association of African American Studies and Affiliates.

(d) Areas of professional expertise:

Chemistry, Public Policy and Administration, Diversity Recruitment, Graduate Recruitment, Student Retention in STEM, Mentoring, Higher Education, Graduate Training, Historically Black Colleges and Universities collaborations

BIOGRAPHICAL SKETCH - ALISON BUCHAN

(a) Professional Preparation

James Madison University	Biology	BS 1994
University of Georgia	Microbiology	MSc 1997
University of Georgia	Marine Sciences	Ph.D. 2001

(b) Professional Appointments:

2011- present, Associate Professor of Microbiology, University of Tennessee

2012-present, Associate Director for Graduate Education- present, National Institute for Mathematical and Biological Synthesis

2005-present, Faculty member, UT Center for Environmental Biotechnology

2005-present, Faculty member, ORNL-UTK Graduate Program in Genome Science & Technology

2005-2011, Assistant Professor of Microbiology, University of Tennessee

(c) Five Publications Related to the Project:

Cude, W. N., J. Mooney, A. A. Tavanaei, M. K. Hadden, A. Frank, C. A. Gulvik, A. L. May and A. Buchan (2012). The production of the secondary metabolite indigoidine contributes to competitive surface colonization in the marine roseobacter *Phaeobacter* sp. strain Y4I. *Applied and Environmental Microbiology.* 78:4771-4780

Magalhães, C., R. P. Kiene, A. Buchan, A. Machado, C. Teixeria, W. J. Wiebe, and A. A. Bordalo. (2012) A novel inhibitory interaction between dimethylsulfoniopropionate (DMSP) and the denitrification pathway. *Biogeochemistry.* 107:393-408

Yao, D., A. Buchan and M. T. Suzuki (2011). In situ activity of NAC11-7 roseobacters in coastal waters based on *ftsZ* expression. Environmental Microbiology 13:1032-1041.

Fernández-Guerra, A., A. Buchan, X. Mou, E. O. Casamayor, and J. M. González. (2010) T-RFPred: a nucleotide sequence size prediction tool for microbial community description based on terminal-restriction fragment length polymorphism chromatograms. *BMC Microbiology* 10:262

Buchan, A., B. Crombie, and G. M. Alexandre. (2010) Temporal dynamics and genetic diversity of chemotactic-competent microbial populations in the rhizosphere. *Environmental Microbiology* 12:3171-3184.

(d) Areas of professional expertise:

Microbial ecology, Microbial physiology, Microbial genomics, Microbial secondary metabolite production

BIOGRAPHICAL SKETCH - SERGEY GAVRILETS

(a) Professional Preparation

Moscow State University, USSR	Physics/Biophysics	BS	1982
Moscow State University, USSR	Physics and Mathematics	Ph.D.	1987
INRA Toulouse, France	Theoretical population biology	Postdoc	1991-1992
University of California, Davis	Theoretical population biology	Postdoc	1992-1995

(b) Professional Appointments:

2008- present, Associate Director for Scientific Activities, National Institute for Mathematical and Biological Synthesis (NIMBioS), University of Tennessee

2007- present, Distinguished Professor, Departments of Ecology & Evolutionary Biology and Mathematics, Uniersity of Tennessee

2003-2007, Professor, Departments of Ecology & Evolutionary Biology and Mathematics, University of Tennessee

1999-2003, Associate Professor, Departments of Ecology & Evol. Biology and Mathematics, University of Tennessee

1997-1999, Assistant Professor, Departments of Ecology & Evol. Biology and Mathematics, University of Tennessee

1995-1997, Assistant Professor, Department. of Mathematics, Univ. of Tennessee

1987-1991, Researcher, N.I.Vavilov Institute of General Genetics, Moscow, USSR

(c) Five Publications Related to the Project:

Gavrilets, S. 2012. On the evolutionary origins of the egalitarian syndrome. *Proceedings of the National Academy of Sciences* 109:14069-14074.

Gavrilets, S. 2012. Human origins and the transition from promiscuity to pair bonding. *Proceedings of the National Academy of Sciences* 109:9923-9928.

Mesterton-Gibbons, M., S. Gavrilets, J. Gravner, and E. Akcay. 2011. Models of coalition and alliance formation. *Journal of Theoretical Biology* 274:187-204.

Gavrilets, S., E. A. Duenez-Guzman, and M. D. Vose. 2008. Dynamics of alliance formation and the egalitarian revolution. *PLoS ONE* 3:e3293.

Gavrilets, S. and A. Vose. The dynamics of Machiavellian intelligence. *Proceedings of the National Academy of Sciences* 103:16823-16828.

(d) Areas of professional expertise:

Evolutionary biology, dynamical systems, computational biology

Biographical Sketch-Suzanne Lenhart

(a). Professional Preparation

Ph.D, 1981, University of Kentucky, Lexington, in Mathematics

B.A., 1976, Bellarmine College, Lou., KY, Math.,Secondary Teaching Certificate

(b) Professional Appointments

1981- present: University of Tennessee, Knoxville -Full Professor 1992-, Chancellor's Professor 2011

2008-present: Associate Director for Education, Outreach and Diversity at National Institute for Mathematical and Biological Synthesis, NIMBioS, UT

1987 - 2009: Part-time researcher at Oak Ridge National Laboratory

(c) Five Publications related to this project

1. S. Lenhart and J. T. Workman, Optimal Control applied to Biological Models, Chapman and Hall and CRC Press, book 2007.

2. R. Miller Neilan, E. Schaefer, H. Gaff, K. R. Fister, and S. Lenhart Modeling optimal intervention strategies for cholera, Bulletin of Mathematical Biology 1 (4), 2010, 379-393.

3. H. R. Joshi, L. J. Gross, S. Lenhart, and R. Salinas, UBM and REU: Unique Approaches at Tennessee, Promoting Undergraduate Research in Mathematics, editor J. Gallian, AMS, (2007), 261-266.

4. S. Duncan and S.Lenhart, Preparing the 'New' Biologist of the Future: Student Research at the Interface of Mathematics and Biology, Cell Biology Education and Life Sciences Education 9 (2010) 311-314.

5. S. Reichert, R. Leander and S. Lenhart, A Role Playing Exercise Demonstrating the Process of Evolution by Natural Selection: Caching Squirrels in a World of Pilferers, American Biology Teacher 73 (2011), 208-212 .

(d) Areas of Professional Expertise

mathematical biology, applied mathematics, optimal control, epidemiology, natural resource modeling, undergraduate research, outreach to schools

BIOGRAPHICAL SKETCH - JOHN C. NEW, JR.

(a) Professional Preparation

Texas A & M University	Veterinary Science	BS	1970
Texas A & M University	Veterinary Medicine	DVM	1971
University of Minnesota	Public Health	MPH	1977
American College of Veterinary Preventive Medicine		Diplomate	1977

(b) Professional Appointments:

2012, NIMBioS Associate Director for Postdoctoral Activities

2011-present, Director of Public Health and Outreach, College of Veterinary Medicine, University of Tennessee

2004-2009, Head, Department of Comparative Medicine, University of Tennessee

2002-2003, Head (Acting) Department of Comparative Medicine, University of Tennessee

1999-present, Professor, Department of Biomedical and Diagnostic Sciences, University of Tennessee

1983-1999, Associate Professor, Department of Comparative Medicine, University of Tennessee

1977-1983, Assistant Professor, Department of Environmental Practice, University of Tennessee

1975-1977, Veterinary Research Associate, Large Animal Clinical Sciences, University of Minnesota

(c) Five Publications Related to the Project:

New, Jr., J.C., M.D. Salman, J.M. Scarlett, P.H. Kass, M. King, J.M. Hutchison. 2000. Shelter relinquishment: Characteristics of shelter-relinquished animals and their owners compared with animals and their owners in U.S. pet-owning households. *Journal of Applied Animal Welfare Science* 3(3):179-201.

New, Jr., J.C., W.J. Kelch, J.M. Hutchison, M.D. Salman, M. King, J.M. Scarlett, P.H. Kass. 2004. Birth and Death Rate Estimates of Cats and Dogs in U. S. Households and Related Factors. *Journal of Applied Animal Welfare Science* 7(4):229-241.

Proctor, K.W., Kelch, W.J., New, Jr., J.C. 2009. Estimating the Time of Death in Domestic Canines. *Journal of Forensic Science* (doi: 10.1111/j.1556-4029.2009.01156.x. Available online at: www.blackwell-synergy.com)

Souza,M.J., Ramsay, E.C., Patton, S., New, J.C. 2008. *Baylisascaris procyonis* in Raccoons (Procyon lotor) in Eastern Tennessee. *Journal of Wildlife Diseases* 45(4):1231-1234.

Adams, H., Kennedy, M., van Vuuren, M., Bosman, A., Keet, D., New, J. 2008. The epidemiology of lion lentivirus among a population of free-ranging lions (*Panthera leo*) in Kruger National Park, Republic of South Africa. *Journal of the South African Veterinary Association* 80(3).

(d) Areas of professional expertise:

Epidemiology of infectious and zoonotic diseases of free-living wildlife, Human-animal interactions, Epidemiology/food safety/zoonoses education.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Louis Gross	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Development of Selected Model Components of an Across-Trophic Level Systems Simulation (AtLSS) for the Wetland Ecosystems of South Florida

Source of Support: US Geological Survey

Total Award Amount: $ 354,000 Total Award Period Covered: 01/01/06 - 12/31/12

Location of Project: University of Tennessee

Person-Months Per Year Committed to the Project. Cal: 0.05 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Mammalian Research

Source of Support: Oak Ridge National Laboratory

Total Award Amount: $ 137,979 Total Award Period Covered: 05/17/07 - 12/31/12

Location of Project: University of Tennessee

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: National Institute for Mathematical and Biological Synthesis (NIMBioS)

Source of Support: National Science Foundation

Total Award Amount: $ 16,386,284 Total Award Period Covered: 09/01/08 - 08/31/13

Location of Project: University of Tennessee

Person-Months Per Year Committed to the Project. Cal: 10.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Development of selected model components of an Across-Trophic Level Systems Simulation

Source of Support: US Geological Survey

Total Award Amount: $ 65,000 Total Award Period Covered: 12/01/10 - 10/31/15

Location of Project: University of Tennessee

Person-Months Per Year Committed to the Project. Cal: 0.05 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: UT-Battelle EPA Risk - Environment Assessment and Decision Analysis

Source of Support: Oak Ridge National Laboratory

Total Award Amount: $ 909,822 Total Award Period Covered: 10/09/10 - 09/30/12

Location of Project: University of Tennessee

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Summ: 0.00

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Louis Gross	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Development and application of selected model components of an Across-Trophic Level Systems Simulation(ATLSS) for the Wetland Ecosystems of South Florida to evaluate3 scenarios

Source of Support: US Geological Survey

Total Award Amount: $ 40,000 Total Award Period Covered: 10/01/12 - 09/30/13

Location of Project: University of Tennessee

Person-Months Per Year Committed to the Project. Cal: 0.05 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: UT-Batelle EPA Risk - Environment Assessment and Decision Analysis

Source of Support: Oak Ridge National Laboratory

Total Award Amount: $ 575,796 Total Award Period Covered: 10/01/12 - 09/30/14

Location of Project: University of Tennessee

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: NIMBioS: National Institute for Mathematical and Biological Synthesis

Source of Support: NSF

Total Award Amount: $ 18,600,000 Total Award Period Covered: 09/01/13 - 08/31/18

Location of Project: University of Tennessee, Knoxville

Person-Months Per Year Committed to the Project. Cal: 1.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Shared Facilities available to NIMBioS at the University of Tennessee, Knoxville

Computing Resources at NIMBioS, the University of Tennessee and Oak Ridge National Laboratory

Petaflop-scale supercomputers are available through The National Institute for Computational Sciences (NICS), based at Oak Ridge National Laboratory (ORNL), and at the Joint Institute for Computational Science (JICS), a collaborative center between the University of Tennessee and ORNL. UT-Battelle management of ORNL has resulted in a partnership that provides a unique synergy of resources and experience on a wide array of High Performance Computing (HPC) platforms. The relationship has resulted in bringing leading HPC scientists to UT and ORNL through joint appointments. Two of the major computational resources available to NIMBioS participants, located within NICS and JICS, are supported as part of the NSF-supported XSEDE project. These currently include Kraken, a Cray XT-5, and Nautilus, an SGI Altix UV 1000 system, operated by the Remote Data and Visualization (RDAV) project.

The UTK Joint Institute for Computational Science has received funding under the NSF 05-625, Towards a Petascale Computing Environment for Science and Engineering, for a Mid-Range HPC deployed and supported by The National Institute for Computational Sciences. NICS is delivering a 1.17-petaflops (PF) peak performance Cray XT5 (code-named Baker) system, with 147 terabytes (TB) of memory and 3.3 petabytes (PB) of disk. The XT5 is designed specifically for sustained application performance, scalability, and reliability, and will incorporate key elements of the Cray Cascade system to prepare the user community for sustained, high productivity, petascale science and engineering. The proposed system holds Cray Baker compute blades each with eight "Montreal" AMD Opteron processors with eight cores at 3.0 GHz. The system has 100 TB of memory across the machine. NICS and Cray, in partnership with AMD, will provide and support this system. To deliver this new capability to the science and engineering communities, the team will establish a major new petascale computing environment—fully integrated with NSF XSEDE. As part of XSEDE it will be nationally available to researchers. UT management will allow for priority access to a portion of process time to UT researchers, including participants in NIMBioS, and NIMBioS researchers can benefit from locally available support and workshops.

These large-scale HPC systems supplement a variety of smaller clusters available for research at UT as well as the small-scale development cluster installed at NIMBioS. A proposed visualization and analysis workstation will further extend the computational resources within NIMBioS. Extensive experience is available at UT to allow NIMBioS participants to readily obtain support for HPC implementation on all of the above machines, with an additional advantage that a number of the Senior Personnel on this proposal have utilized these HPC facilities for biological applications and can provide advice for NIMBioS participants, including how to effectively transition models between single processor desktops, multi-core machines, clusters, and HPC. The NIMBioS HPC Specialist has extensive experience in biological applications of HPC and will continue to be readily available to NIMBioS researchers to assist in their computational science needs. \

NIMBioS has utilized Linux workstations for researchers while providing access to both Apple iMacs, laptops, and Dell Windows-based machines. Virtual machines and remote desktop provide access to Windows-based environments as needed. Linux servers with 80 Terabytes of backup and storage, and a 10 gigabit internal network backbone with 1 gigabit connections provide access to many mathematical software packages running on both the Linux servers and a 128-core ROCKS Linux cluster maintained by the NIMBioS HPC Specialist. A machine room with adequate cooling houses the NIMBioS computing infrastructure and provides ample space for expansion. A second offsite backup server is located in the Austin Peay Building for redundancy, providing separate backup services for all NIMBioS users.

Physical Facilities available at NIMBioS

The National Institute for Mathematical and Biological Synthesis is centrally located on the University of Tennessee-Knoxville campus in the Philander P. Claxton Education Building, 1122 Volunteer Boulevard. NIMBioS occupies the entire first (ground-level) floor and part of the second floor. Over 12,000 sq. ft. of space provides offices for all staff and post-doctoral fellows, offices for three or more sabbatical fellows, additional desk space for ten or more visitors, plus two large conference rooms, two classrooms, a tiered auditorium, and a small meeting room.

The layout of the space is designed to facilitate activities and interaction. The Darwin and Fisher Conference Rooms, Kovalevskaya Meeting Room, and the Franklin Classroom flank a large informal break area. These rooms are the primary home of working groups when they visit NIMBioS. Breakfast and lunch for activity participants are served in the break room, making meals much more time efficient and inviting the informal interactions which leads to new collaborations. The tiered Hallam Auditorium, equipped for web-casting, and the Hopper Classroom, equipped for video-conferencing, are immediately upstairs from the other meeting rooms and are the primary home for seminars, workshops, tutorials, and other large classroom events. With this arrangement, NIMBioS can easily host concurrent activities such as a Working Group and a Tutorial without one interfering with the other. Conference rooms and classrooms have digital projectors and retractable screens for presentations; the Darwin Conference Room goes a step beyond that, providing a three-projector and screen system. Teleconferences can be conducted in any of the rooms. Wireless internet access and access to the University of Tennessee library system are provided to all visitors and wired internet connections are available in all meeting rooms.

The administrative offices in Suite 106 are adjacent to the main meeting areas, putting participants in close proximity to business, travel, and event management staff. A second break area just down the hall provides a convenient space for staff and visitors to gather for coffee, lunch, or informal meetings. This break area and the larger participant break area have tile floors depicting a Game of Life cellular automaton model. Offices for post-doctoral fellows, currently 16 spaces designated for post-doc use, are grouped together down the main hallway, keeping them near each other and near numerous 4'x8' whiteboards that line the hall, encouraging hallway interactions. The south wing of NIMBioS' space is devoted to staff and visitor offices, including the offices of the Director and Associate Directors. Three large offices with 4-5 desks each are available for short-term visitors and REU students.

Outdoor space consists of a courtyard with picnic tables and ample seating, as well as additional tables and benches around Blueberry Falls, a landscaped garden with blueberry bushes and an attractive water feature.

The Claxton building complex also houses, on floors just above the main NIMBioS location, the University of Tennessee Innovative Computing Laboratory (ICL), directed by Dr. Jack Dongarra, research personnel of the NSF XSEDE Remote Data and Visualization (RDAV) project, and a Computational Geography Research Group, directed by Dr. Shih-Lung Shaw. This co-location was specifically designed by the University of Tennessee to enhance opportunities for collaborations to develop between NIMBioS visitors and researchers and these world-class computational science research groups.

Shared Educational Facilities

NIMBioS has been collaborating extensively with a major educational initiative, the Biology-in-a-Box project, headquartered at the University of Tennessee, Knoxville for K-12 students. This project now

reaches 90+ school systems in Tennessee and surrounding states, and activity booklets are available worldwide via free access on the internet. The Biology-in-a-Box project utilizes physical facilities separate from NIMBioS to build and maintain these boxes which contain manipulative educational material about biology tied into state learning standards. NIMBioS has added mathematics activities to the Biology-in-a-Box curriculum enrichment units and these additions are managed through the separate facilities on campus, and made available to the many school systems utilizing these.

Other Resources Provided by the University of Tennessee, Knoxville in Support of NIMBioS

The University of Tennessee, Knoxville (UTK) reiterates its ongoing institutional commitment to provide resources to support NIMBioS and its goals over the proposed renewal time period from 2013-2018. The physical facilities described above were extensively renovated and designed explicitly to meet the needs of NIMBioS by UTK. Additional commitments in support of NIMBioS for the proposed renewal period include:

(i) workstations and furniture for all staff and researchers in NIMBioS;

(ii) access to current and upgraded computational software packages at no cost to NIMBioS;

(iii) carrying out a national search for a new Director who will continue to expand NIMBioS as a national resource in diverse areas of biology that benefit from connections to mathematics;

(iv) full funding of the nine-month salary and benefits of the Director of NIMBioS, with no formal classroom teaching responsibilities, thus allowing the Director to focus on enhancing NIMBioS;

(v) providing release-time funding for three full-time equivalents each year for participation in NIMBioS activities by UT and Oak Ridge National Laboratory faculty and staff;

(vi) support for classroom teaching opportunities for those NIMBioS post-docs who desire it;

(vii) continuing to encourage and support spousal/partner accommodations for NIMBioS post-docs, as has been the policy at NIMBioS over the last several years;

(viii) support for four graduate students to be affiliated research assistants at NIMBioS.

(ix) authorizing the release from other responsibilities of Dr. Ernest Brothers, Assistant Dean of the Graduate School, for 3 months of the calendar year to assist NIMBioS as Associate Director for Diversity Enhancement.

NIMBioS Data and Information Policy

Introduction:

NIMBioS is committed to making the data, models and software derived from NIMBioS activities available publicly to the broader scientific community. All visiting researchers will be asked to follow this Data and Information Policy except when this is in conflict with the policies of their employer or is in conflict with policies of the owners of the data or software.

Scope:

This document defines the policies for sharing data and software source code that are created, generated, used, hosted, replicated, sponsored, or made available by a NIMBioS-sponsored researcher, project, or activity, or by a collaboration in which NIMBioS materially participates (e.g. involves expenditure of NIMBioS resources). In the remainder of this document, data and software source code within the scope of this policy are collectively referred to as NIMBioS-sponsored data and software source code, respectively. Data or software used in NIMBioS activities that have more restrictive terms of use and dissemination than those set forth here are exempt from this policy. However, NIMBioS strongly encourages its participants and collaborators to consider alternatives that do not restrict sharing and free dissemination.

NIMBioS-sponsored Data:

NIMBioS is committed to making all scientific and any other data within the scope of this policy readily available to the broader scientific community.To meet this goal, NIMBioS-sponsored data or datasets are to be accessible from a web-based interface, with no restrictions for use and dissemination. Alternatively, at the choice of those generating the data, data should be made available under a Creative Commons license or compatible terms of use. Such data are to be made available in a timely manner, generally no later than one year after the conclusion of the NIMBioS-sponsored activity in which it was generated, or immediately upon publication of an associated article, whichever comes earlier, and are to be kept current if they undergo continuing updates, and are to be sufficiently documented using appropriate standards and conventions agreed upon by the biology community, including registration and deposition at a public meta-data registry and data repository if such a registry or repository exist. This documentation must include appropriate acknowledgment and attribution of any data used from other researchers or sources, as required by the copyright, license, or terms of use of such data.

NIMBioS will assist as appropriate to provide mechanisms for owners of data to effectively share these data among participants in NIMBioS activities. This includes assisting in developing any appropriate Memoranda of Understanding or Confidentiality Agreements necessary for the data useful in a NIMBioS activity to be made available for participants in that activity. NIMBioS recognizes that there are many questions associated with the open licensing of scientific data collections and encourages sponsored researchers to familiarize themselves with the issues (http://sciencecommons.org/projects/publishing/open-access-data-protocol/).

NIMBioS-sponsored Software:

NIMBioS is committed to open-source software development and distribution. Software developed with NIMBioS support or participation is expected to become readily and freely available to the broader scientific community. Specifically, NIMBioS-sponsored software is to be made accessible on

a web-accessible site hosted by NIMBioS, or at Sourceforge (http://sourceforge.net) or a similar site, for download in source code, and the source code is to be licensed under an OSI-approved Open Source license (http://www.opensource.org/licenses/). The source code is to be made available in a timely manner, meaning as early as possible but no later than the termination of the activity that generated the code, the Fellowship, or publication of an article involving the software or data generated using the software, whichever comes earlier. The source code is to be sufficiently documented, stating at a minimum the purpose, copyright and license, and acknowledging and attributing any other software or software libraries that the NIMBioS-sponsored software uses or depends on, as required by the licenses of such software. Copyright and license must be stated in every source code file, and the licenses for all the files constituting the software must be compatible.

Support By NIMBioS IT:

The NIMBioS IT staff will assist those supported by NIMBioS to select the most suitable Creative Commons or Open Source license for the data or software generated through NIMBioS support, and place the license appropriately on the website for the dataset or the software, as well as assist in depositing data, meta-data, and software source code in the pertinent public repository.

Continuation of Support:

NIMBioS IT staff will schedule a meeting with all NIMBioS Fellows approximately one month before their term at NIMBioS ends. The goal of this interview is to identify any data, data sets, and source code that the Fellow created with NIMBioS support, and to develop a recommendation for what type of continued support NIMBioS should provide for the data or data collection (for instance, hosting a database) and for the software (e.g., responding to user questions, bug resolution, or continued feature development). The recommendation will be communicated to the NIMBioS Director for consideration and approval. NIMBioS is not positioned to guarantee hosting of a database or application for the long term. NIMBioS will, however, help to establish or secure such long-term hosting if recommended.

Requests for NIMBioS Support and Data/Software:

Applications for NIMBioS support should include an estimate of the data products, models and software expected to be developed and a timetable for making these publicly available. NIMBioS Fellows must agree, before initiating NIMBioS research activities, to make these products publicly available. Four months after NIMBioS Fellows arrive at NIMBioS, or after the first meeting of a Working Group, these research products must be identified and the timetable for their release refined. The results will be tracked to ensure that appropriate research products are made openly available. The NIMBioS IT staff will assist with the development of a realistic plan and timeline for the archiving of NIMBioS-sponsored data and software.

Copyright and Acknowledgment:

Data or datasets, software, published books and scholarly articles generated or created by a NIMBioS Fellow or through a NIMBioS-sponsored activity must appropriately and conspicuously acknowledge NIMBioS and the National Science Foundation. Suggested formats for such acknowledgement are available at
http://nimbios.org/research/acknowledgment .

Postdoctoral Fellow Mentoring Plan

This Postdoctoral Fellow Mentoring Plan continues efforts in place at the National Institute for Mathematical and Biological Synthesis (NIMBioS). The Plan establishes guidelines to support and facilitate the scientific and professional development of the postdocs.

1. Orientation will include an initial in-depth conversation with the Director, Associate Director for Postdoctoral Activities, and key staff. Mutual expectations will be discussed and agreed upon including specific research and professional development goals which will be set within the first six months of arrival.

2. Career Counseling will be directed at providing the postdoc with the skills, knowledge, and experience needed to excel in his/her chosen career path. In addition to guidance provided by mentors, opportunities at the University level and elsewhere will be advertised to all postdocs. Postdocs will be offered opportunities to attend appropriate professional development conferences.

3. Experience with Preparation of Grant Proposals will be gained by direct involvement with their mentors, others at the University, and potentially collaborators from outside the University. The postdocs will have an opportunity to learn best practices in proposal preparation including identification of key research questions, definition of objectives, description of approach and rationale, and construction of a work plan, timeline, and budget. If it is found beneficial for a postdoc to develop a grant proposal, they will be given the opportunity to do so, including in the role of principal investigator. University funds will be provided for postdoc release time from NIMBioS responsibilities if a postdoc is preparing a funding proposal to an external agency.

4. Publications and Presentations are expected to result from the work supported by NIMBioS. As independent researchers, the postdocs will be responsible for the preparation of manuscripts and presentations in collaboration with mentors, other colleagues, the NIMBioS leadership team and staff, as appropriate. As appropriate to their circumstances, postdocs will receive guidance and training in the preparation of manuscripts for scientific journals and presentations at conferences. As one component of cross-cultural mentoring at NIMBioS, postdocs will be expected to visit a Minority-Serving Institution Partner to share their research.

5. Teaching and Mentoring Skills will be developed through regular meetings with mentors. Ongoing seminars will provide opportunities for postdocs to interact with graduate students and other postdocs to describe their work and assist each other with solutions to challenging research problems. Classroom teaching opportunities will be offered to those specifically interested. Opportunities to mentor students in the NIMBioS Research Experience for Undergraduates summer program will also be available as well as opportunities to participate in NIMBioS K-12 outreach activities.

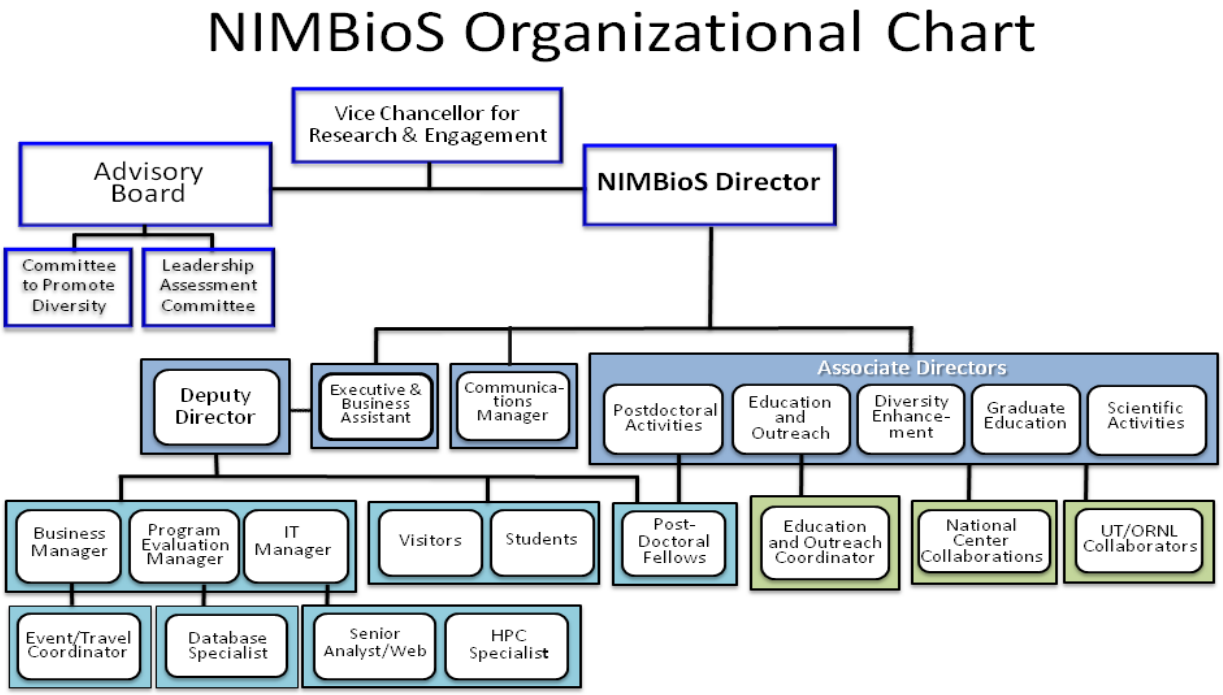
6. Instruction in Professional Practices will be provided on a regular basis and will include fundamentals of the scientific method, protocols for managing personnel, and other standards of professional practice and ethics.

7. Technology Transfer activities will include regular contact with researchers at The University of Tennessee and periodic contact with scientists at the Oak Ridge National Laboratory, as well as NIMBioS staff with specific expertise in this area.

8. Success of the Mentoring Plan will be assessed by monitoring the progress of the postdoc based on annual goals for scientific and career development, and through a procedure including an exit interview and anonymous evaluation by the NIMBioS Evaluation Manager.

NIMBioS Management Plan

The management plan for NIMBioS stated in the original proposal has been modified in a few components over the initial support period, but the major structural components and approach have remained the same. We will here outline the changes from the original plan that are already in place and point out some additional modifications planned to occur during the renewal period. Based on the evidence from the Site Reviews and from the many evaluations of activities held to date, NIMBioS has been operating quite efficiently to meet its mission and therefore we do not propose any major modifications of the current plan. The overall objective is to establish procedures to assist in developing and supporting the variety of research and educational activities at NIMBioS.



The planned organizational structure for NIMBioS during the renewal period is given in the below graphic. We here explain how this structure has changed since the initial plan for NIMBioS and what changes have been incorporated to occur for the renewal period.

Leadership Team:

NIMBioS is managed by the Leadership Team, which includes the Director, the Deputy Director and all Associate Directors, with the external Advisory Board providing recommendations for policies and activities to support. The Director reports to the UTK Vice Chancellor for Research and Engagement who has oversight of NIMBioS. The Leadership Team members all have explicit responsibilities in the various areas that impact the NIMBioS mission, and collaborate on suggesting policies and making decisions on issues which affect the entire Institute. Each Advisory Board meeting provides recommendations to the Leadership Team regarding requests for Working Groups, Investigative Workshops and Fellows. Following the Board meeting, the Leadership Team meets to discuss the recommendations and come to consensus on support, based upon the Board recommendations, available resources and the variety of activities and Fellows already supported. In general the Board makes recommendations based on the

scientific and educational criteria set for each activity, while the Leadership Team is responsible for taking account of resource constraints. The Board also provides oversight of the NIMBioS Strategic Plan and all policies that are not primarily administrative in nature.

NIMBioS is guided by the following policies and plans which have been approved by the Advisory Board: Diversity Plan, Strategic Plan, Conflict of Interest Policy, Data and Information Policy, Evaluation Policy, Intellectual Property Policy, Policy on Requests for Support for Scientific Gatherings, Privacy Policy, Reporting Policy, Security Policy, Travel Policy for Graduate Assistants. These policies are all posted on the NIMBioS website and are reviewed periodically to ensure consistency with University policies.

Advisory Board:

The Advisory Board members are chosen to provide a diverse set of perspectives on requests for NIMBioS support, taking account of the range of biological and mathematical approaches potentially supported. The Board also is expected to provide suggestions regarding NIMBioS policies and potential activities, including suggestions of potential organizers for activities. There is a Conflicts of Interest policy which determines when Board members are recused from review or discussions of a request. Board members are expected to serve a term of three years and a staggered set of terms for Board members was brought about initially by asking each member whether they wished to step down early or remain on the Board. There are currently twenty members on the Board. Recommendations from current and departing members are the basis for maintaining a pool of potential new Board members along with individuals who have been organizers for NIMBioS activities. The Board chair serves a period of two years, manages all Board meetings, and confers as needed with the Leadership Team. The Board has two standing committees, one to provide advice and assistance on promoting diversity of participants and the other to carry out an evaluation of the Leadership Team in years when no external Site Review was conducted. The Leadership Team evaluation conducted by the Board provides recommendations to the Vice Chancellor for Research regarding any aspect of the leadership of NIMBioS. The Board chair is chosen from among the current Board members via a consultation of the current Board Chair and the Leadership Team.

History of Management Plan Modifications:

The changes incorporated in the above organizational structure that have arisen since the original management plan include: (i) the addition of an Associate Director for Postdoctoral Activities, to oversee the Mentoring Plan for each postdoc; (ii) the addition of an Associate Director for Diversity Enhancement which follows upon explicit suggestions from the 2012 Site Review to ensure that an Associate Director is focused explicitly on this rather than being one of the emphases of the prior structure for which there has been a single individual as Associate Director for Education, Outreach and Diversity; (iii) adding two professional Managers for Communications and Evaluation who oversee all aspects of communication and public relations and all evaluation activities; and (iv) upon the suggestion of the Advisory Board and 2010 Site Review, adding an Executive and Business Assistant to provide support for the Director and logistics.

Changes planned for the renewal that are reflected in the Organizational Chart include addition of a Database Specialist and removal of the current position of Associate Director for Partner Relations. The Database Specialist position is responsible for maintaining all data in the NIMBioS database system which is due to be completed prior to the renewal period. This database has been designed to incorporate all data for the non-financial aspects of NIMBioS including participant demographics, products produced with NIMBioS support, and evaluation data. The Database Specialist will report jointly to the Communications Manager and the Evaluation Manager. The Associate Director for Partner Relations position is being phased out prior to the renewal, with responsibilities for partnerships now being held by

the appropriate other Leadership Team members. The Director will retain responsibility for relationships with other NSF BIO Synthesis Centers as well as other major BIO projects such as NEON and the iPlant Collaborative. The Associate Director for Education and Outreach will continue to hold responsibility for NIMBioS connections to the NSF-supported Math Institutes, in conjunction with the Director. The position of Emeritus Director is included in this proposal to allow the new Director to assign tasks as deemed appropriate to the former Director. This could include a focus on further enhancing connections with other NSF-funded entities, or building new collaborations with other federal agencies.

Continuity of Operations and Leadership Transition:

The NIMBioS Leadership Team has been quite stable over the current support period. One new Associate Director for Postdoctoral Activities was added to assume responsibility for the postdoc mentoring plan and coordinating with faculty and staff mentors. The initial Associate Director for Graduate Education moved at the end of the fourth year of NIMBioS to an academic administrative position, leading to the appointment of the current individual in this role, whose area of expertise is microbiology. Included in this proposal are funds to support graduate students from other institutions to visit NIMBioS for extended periods and oversight of this new program will be the responsibility of this Associate Director. During the fifth year, the Associate Director for Partner Relations will be phased out with responsibilities for this aspect of NIMBioS assigned to other Leadership Team members. An Associate Director for Diversity Enhancement has been added to foster new initiatives with minority-serving institutions, to encourage broader participation of researchers from under-represented groups as organizers and participants in NIMBioS activities, and to enhance interdisciplinary education opportunities at NIMBioS for students from under-represented groups.

The current NIMBioS Director intends to step out of this position upon recruitment of a new Director from an international search. Concurrent with the submission of this renewal proposal for NIMBioS, the University of Tennessee has initiated a search for a new Director. A search committee has been established and the search process has begun. The search committee reports to the Provost and Vice Chancellor for Research, who will consult as appropriate with the NSF Program Officer for NIMBioS regarding the potential for a Director candidate to be approved as the Principal Investigator on the NIMBioS award. In a manner similar to that carried out by NESCent, a new Director would assume this responsibility at the time of the renewal, in September 2013. In the event that a new Director has not as yet been hired at the time of the renewal, the current Director will continue until such time as a new Director is appointed to take on responsibility as the Principal investigator for the NIMBioS award.

The NIMBioS Leadership Team has been collaboratively pursuing many of the responsibilities of managing NIMBioS, so that if for any reason any member is unable to continue their duties, other members can fill in to keep all major NIMBioS initiatives operating smoothly. The Deputy Director oversees the daily activities of NIMBioS, and the staff have all held their positions for essentially all of the time NIMBioS has been operating. Cross-training across all staff positions has allowed staff to regularly fill in for each other during vacations and other absences, so operations will not be severely affected by the temporary loss of any single staff member. In the event the Director is unable to continue, two of the Associate Directors have the requisite experience to step in as interim Director. Similarly, there are a large number of University faculty who have been involved in NIMBioS and can temporarily assume the responsibilities if any Associate Director is unable to continue serving.

Advisory Board Members:

- Chair: Susan Holmes, Professor, Dept. of Statistics, Stanford Univ.
- Sarah Brosnan, Asssistant Professor, Dept. of Psychology and Neuroscience Institute, Georgia State Univ.
- Erika Camacho, Assistant Professor, Mathematical and Natural Sciences Division, Arizona State Univ., Phoenix
- Scott Edwards, Professor and Curator, Dept. of Organismal and Evolutionary Biology, Harvard Univ.
- Sarah Elgin, Professor, Biology Dept., Washington Univ.
- Bard Ermentrout, University Professor, Computational Biology and Dept. of Mathematics, Univ. of Pittsburgh
- Eli Fenichel, Assistant Professor, School of Forestry and Environmental Studies, Yale Univ.
- Julius Jackson, Professor, Dept. of Microbiology and Molecular Genetics, Michigan State Univ.
- Colleen Jonsson, Professor, Dept. of Microbiology and Immunology, Univ. of Louisville
- Laura Kubatko, Associate Professor, Depts. of Statistics and Evolution, Ecology and Organismal Biology, Ohio State Univ.
- Ellis McKenzie, Senior Scientist, Division of International and Population Studies, Fogarty International Center, National Institutes of Health
- Kiona Ogle, Assistant Professor, Dept. of Ecology, Evolution and Environmental Science, Arizona State Univ., Tempe
- Carl Panetta, Biomedical Modeler, Pharmacokinetics Shared Resource, St. Jude Children's Research Hospital
- Raina Robeva, Professor, Dept. of Mathematical Sciences, Sweet Briar College
- Lisa Sattenspiel, Professor, Dept. of Anthropology, Univ. of Missouri, Columbia
- Ynte Hein Schukken, Professor, Dept. of Population Medicine and Diagnostic Sciences, College of Veterinary Medicine, Cornell Univ.
- Marcy Uyenoyama, Professor, Biology Dept., Duke Univ.
- Colleen Webb, Associate Professor, Dept. of Biology, Colorado State Univ. (Chair, beginning October 11, 2012)
- Jianhong Wu, Professor and Canada Research Chair in Industrial and Applied Mathematics, Dept. of Mathematics and Statistics,York Univ.
- Aziz Yakubu, Professor and Chair, Dept. of Mathematics, Howard Univ.

NIMBioS Leadership Team:

- Ernest Brothers, Associate Director for Diversity Enhancement, Assistant Dean of the Graduate School
- Alison Buchan, Associate Director for Graduate Education, Associate Professor, Dept. of Microbiology
- Sergey Gavrilets, Associate Director for Scientific Activities, Distinguished Professor, Depts. of Ecology and Evolutionary Biology and Mathematics
- Louis J. Gross, Director (a new Director is to be named), Distinguished Professor, Depts. of Ecology and Evolutionary Biology and Mathematics
- Suzanne Lenhart, Associate Director for Education and Outreach, Chancellor’s Professor, Dept. of Mathematics
- John New, Associate Director for Postdoctoral Activities, Professor, Dept. of Comparative Medicine, College of Veterinary Medicine
- Chris Welsh, Deputy Director

NIMBioS Senior Personnel:

- Paul R. Armsworth, Assistant Professor, Dept. of Ecology and Evolutionary Biology
- Michael Berry, Professor, Dept. of Electrical Engineering and Computer Science
- Barry Bruce, Professor, Dept. of Biochemistry, Cell and Molecular Biology
- Virginia Dale, Landscape Ecology and Regional Analysis Group, Group Leader, Oak Ridge National Laboratory
- Judy Day, Assistant Professor, Depts. of Mathematics and Electrical Engineering and Computer Science
- Shigetoshi Eda, Associate Professor, Infectious Diseases and Immunology, Center for Wildlife Health, Dept. of Forestry, Wildlife and Fisheries, Institute of Agriculture
- Vitaly Ganusov, Assistant Professor, Depts. of Microbiology and Mathematics
- Michael Gilchrist, Associate Professor, Dept. of Ecology and Evolutionary Biology
- Yetta Jager, Environmental Sciences Division, Research Scientist, Oak Ridge National Laboratory
- Jaewook Joo, Assistant Professor, Dept. of Physics and Astronomy
- Cristina Lanzas, Assistant Professor of Epidemiology, Dept. of Comparative Medicine, College of Veterinary Medicine
- Agricola Odoi, Associate Professor of Epidemiology, Dept. of Comparative Medicine, College of Veterinary Medicine
- Brian O'Meara, Assistant Professor, Dept. of Ecology and Evolutionary Biology
- Dan Simberloff, Gore-Hunger Professor of Environmental Science, Dept. of Ecology and Evolutionary Biology
- Jeremy Smith, Governor's Chair, Dept. of Biochemistry, Cell and Molecular Biology and Director, ORNL/UT Center for Molecular Biophysics
- Francisco Úbeda de Torres, Assistant Professor, Dept. of Ecology and Evolutionary Biology
- Xiaopeng Zhao, Assistant Professor, Dept. of Mechanical, Aerospace, and Biomedical Engineering