



# **NIMBioS EVALUATION REPORT**

**REPORTING PERIOD SIX**

**SEPTEMBER 1, 2013-August 31, 2014**

**NATIONAL INSTITUTE FOR MATHEMATICAL AND BIOLOGICAL SYNTHESIS**

**October, 2014**

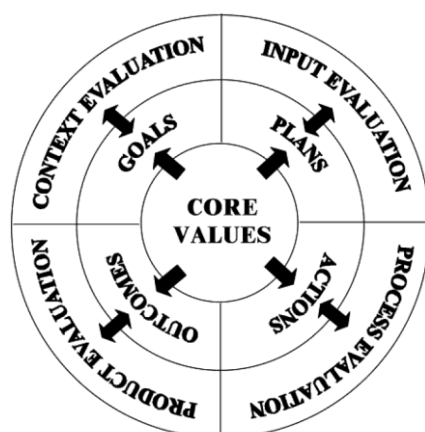
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## INTRODUCTION

This is an evaluation summary of NIMBioS activities during the sixth annual reporting period (RP 6) to the National Science Foundation. This report covers the period of September 1, 2013-August 31, 2014. The NIMBioS evaluation program follows the CIPP systems approach, which takes into account not only the outcomes of the center, but how the outcomes are achieved. The evaluation addresses four main interconnected evaluation phases as seen in Figure 1<sup>1</sup>:

**Figure 1. The CIPP Model for Evaluation used to guide the NIMBioS evaluation process**



For all parts of the system, the NIMBioS evaluation process is grounded in its core values of (1) taking a collaborative approach to science and science education, and (2) increasing the diversity of researchers and educators at the interface of mathematics and biology.

### CONTEXT (GOALS)

Context is not a specific phase of the evaluation process, but rather a constant form of evaluation that takes place during the input, process, and product evaluations as NIMBioS seeks to ensure that it is meeting its goals for each part of the system and that those goals are relevant and in line with its core values.

### INPUTS

The input evaluation seeks to assess the responsiveness of NIMBioS' inputs to its goals. Specifically, NIMBioS is interested in ensuring that we are continuously maintaining a diverse atmosphere in a number of ways. Data sources for input evaluations include the participant demographic survey and accepted requests for support. At this phase, several goals comprise the context for the input evaluation:

1. NIMBioS participants will represent diverse gender, racial, ethnic, institutional, career, disciplinary, and geographic backgrounds.
2. NIMBioS will meet or exceed its participant diversity benchmarks.

<sup>1</sup> Stufflebeam, D.L. (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.

3. NIMBioS will support activities across the spectrum of categories of requests for support.
4. NIMBioS will support Working Group and Investigative Workshop requests from a range of discipline areas.

## PROCESS

The process evaluation seeks to evaluate congruence between goals and activities. This type of evaluation is situated in monitoring and judging activities at NIMBioS, mainly through periodic evaluative feedback surveys from participants and organizers. Other process evaluation data sources include evaluation case studies which look more closely at what factors of NIMBioS participation contribute to positive changes in participants' research and/or academic careers. Although the context at this phase will differ for different types of NIMBioS events, several overarching goals comprise the context for the process evaluation:

1. Participants will be satisfied with the event/program overall.
2. The event/program will meet participant expectations.
3. Participants will feel the event/program made adequate progress toward its stated goals.
4. Participants will feel they gained knowledge during the event/program.
5. Participants feel that participating in the event/program will have an impact on their future research/academic career.
6. Participants will be satisfied with the accommodations offered by NIMBioS.

## PRODUCTS

The products evaluation seeks to monitor, document, and assess the quality and significance of the outcomes of NIMBioS activities. It provides guidance for continuing, modifying, or terminating specific efforts. Data sources for product evaluations include participant self-report of NIMBioS products resulting from affiliation (e.g. journal articles, student education, software), Web of Science data, data collected from participant evaluation forms and follow-up surveys. At this phase, several goals comprise the context for the evaluation:

1. NIMBioS publications will be highly interdisciplinary.
2. NIMBioS publications will be highly cited.
3. NIMBioS publications will highly collaborative.
4. NIMBioS participants will produce other scholarly products, including book chapters, presentations, proposals for follow-on research, meetings/Workshops, student education, data/software, and/or publicity in other media.

## INPUT EVALUATION

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The input evaluation seeks to assess the responsiveness of NIMBioS' inputs to its goals. Specifically, NIMBioS is interested in ensuring that it is continuously maintaining a diverse atmosphere in a number of ways. Data sources for input evaluations include the participant demographic survey and accepted requests for support.

### CONTEXT

1. NIMBioS participants will represent diverse gender, racial, ethnic, institutional, career, disciplinary, and geographic backgrounds.
2. NIMBioS will meet or exceed its participant diversity benchmarks.
3. NIMBioS will support activities across the spectrum of categories of requests for support.
4. NIMBioS will support Working Group and Investigative Workshop requests from a range of discipline areas.

### SUMMARY OF ACTIVITIES

Research program activities during RP 6 included:

- 19 Working Group meetings
- 8 Investigative Workshops
- 75 Short-term visitors
- 18 Postdoctoral Fellows
- 6 Sabbatical Fellows
- 5 Visiting Graduate Student Fellows
- 1 Visiting Scholar
- 6 Graduate Student Fellows
- 6 Graduate Research Assistantships

Education and Outreach program activities during RP 6 included (see Annual Report for more details on these events):

- A NIMBioS Seminar Series
- Biology in a Box Program
- Research Experiences for Undergraduates Program
- Undergraduate Research Conference at the Interface of Biology and Mathematics
- Adventures in STEM Camp
- Joint MBI-CAMBAM-NIMBioS Summer Graduate Program
- UT STEM Summer Symposium
- BioQUEST Workshop--Biology by the numbers: Brining Math to the High School Biology Classroom
- Teacher Collaboration Program
- Evolutionary Approaches to Peace Workshop

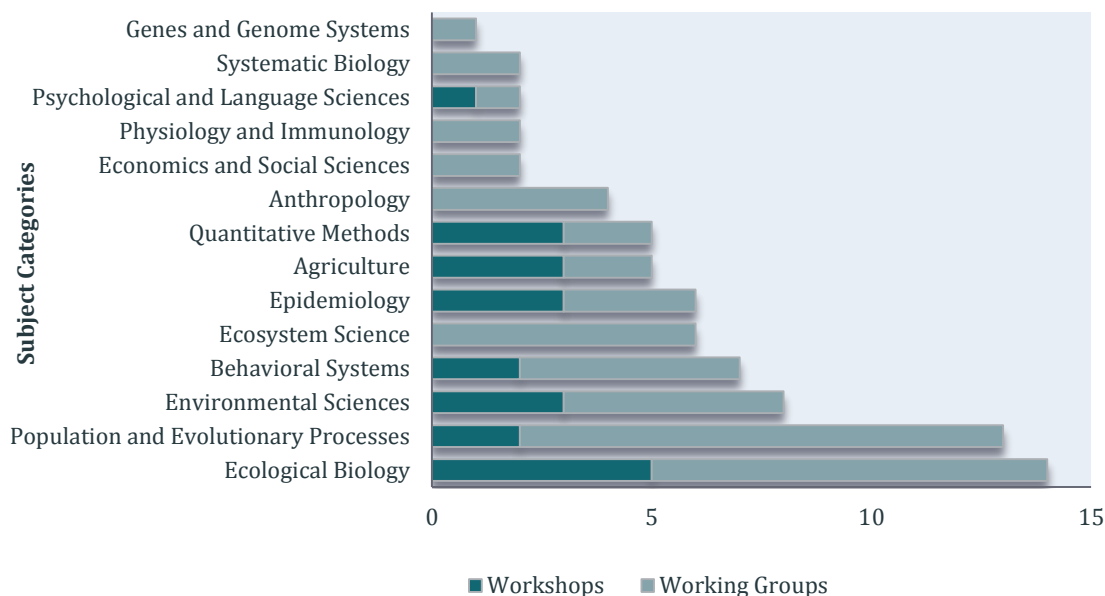
Other events included:

- 1 Advisory Board Meeting

## DIVERSITY OF RESEARCH ACTIVITIES

NIMBioS is interested in supporting research activities from diverse subject areas. Working Group and Investigative Workshop Organizers are asked to categorize their proposed events into preselected research categories to help NIMBioS leadership ensure that a broad range of research areas are covered. Figure 2 shows the diversity of subject areas associated with NIMBioS Working Groups and Investigative Workshops during RP 6 (each supported event may have up to three subject areas).

**Figure 2. Diversity of Subject Areas of Working Groups and Investigative Workshops, RP 6**



## DIVERSITY OF PARTICIPANTS

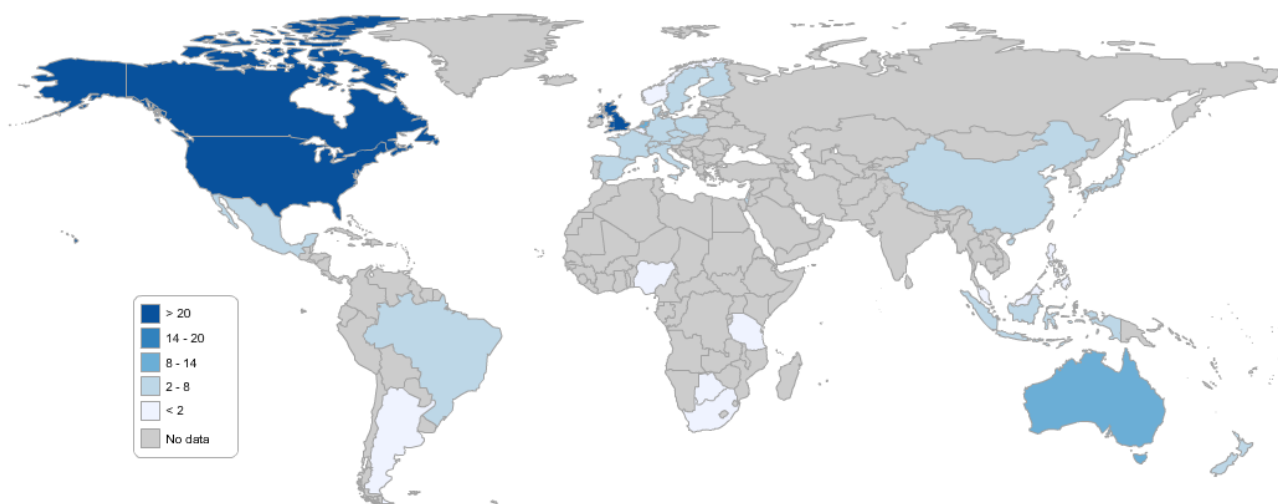
One of the core values of NIMBioS is to increase the diversity of researchers and educators at the interface of mathematics and biology. NIMBioS collects voluntary demographic data from event applicants to gauge whether our program is fairly reaching and benefitting everyone regardless of demographic category and to ensure that those in under-represented groups have the same knowledge of and access to programs and other research and educational opportunities, and to assess involvement of international participants in the program. An electronic demographic survey aligned to the reporting requirements of the National Science Foundation was sent to all participants before their arrival at NIMBioS. Four weeks before the date of each event, a link to the survey was sent to each participant who had not visited NIMBioS within the last year. Reminder emails were sent to non-responding participants at one and two weeks after the initial contact date. The overall response rate for the demographic survey during RP 6 was 98%. Demographic questions regarding gender, race, ethnicity, and disability status were optional. When feasible, the evaluation staff supplied missing demographic data from other sources (e.g. institution, primary field of study). The evaluation staff did not assume race, ethnicity, or disability status for any participant who did not report this information. All demographic information is confidential, and results are reported only in the aggregate.

## PARTICIPANT DEMOGRAPHICS

### GEOGRAPHIC DIVERSITY

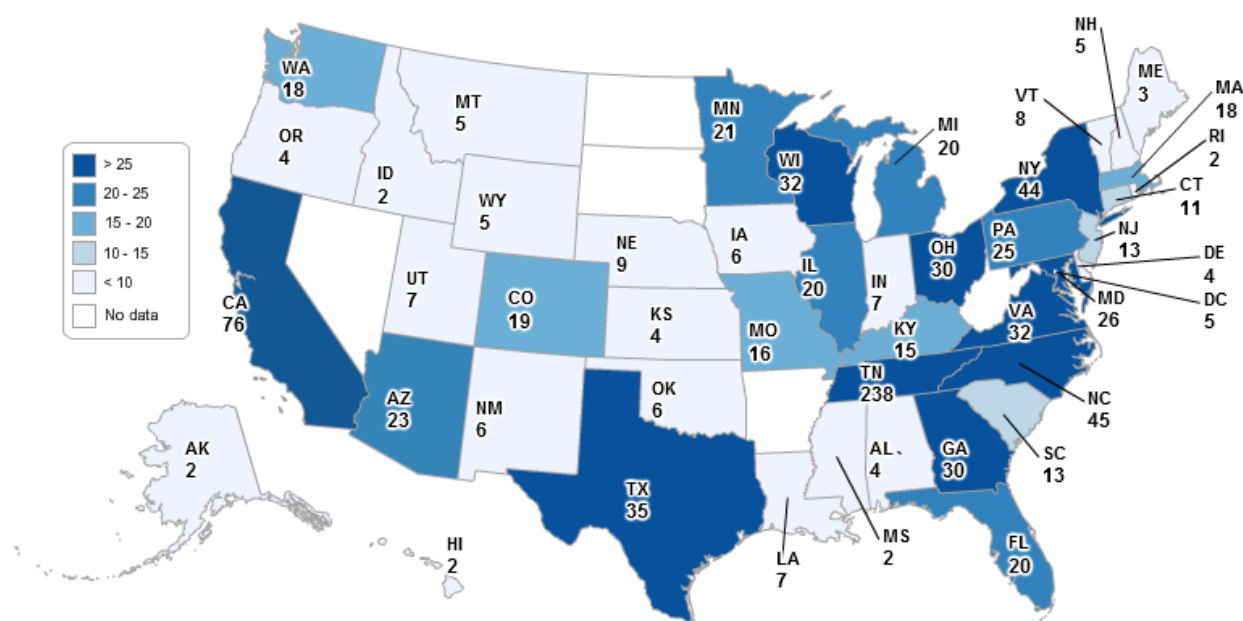
During RP 6, a total of 1123 participants (922 different individuals) from 33 countries participated in NIMBioS events. Most participants came from the United States (84%), followed by Canada (4%) and the United Kingdom (3%) (Figure 3).

**Figure 3. NIMBioS RP 6 Participants by Country**



Within the U.S., 46 different states were represented. The largest percentage of participants came from within Tennessee (25%), followed by California (8%), North Carolina (5%), New York (5%), Wisconsin (5%), and Texas (4%) (Figure 4).

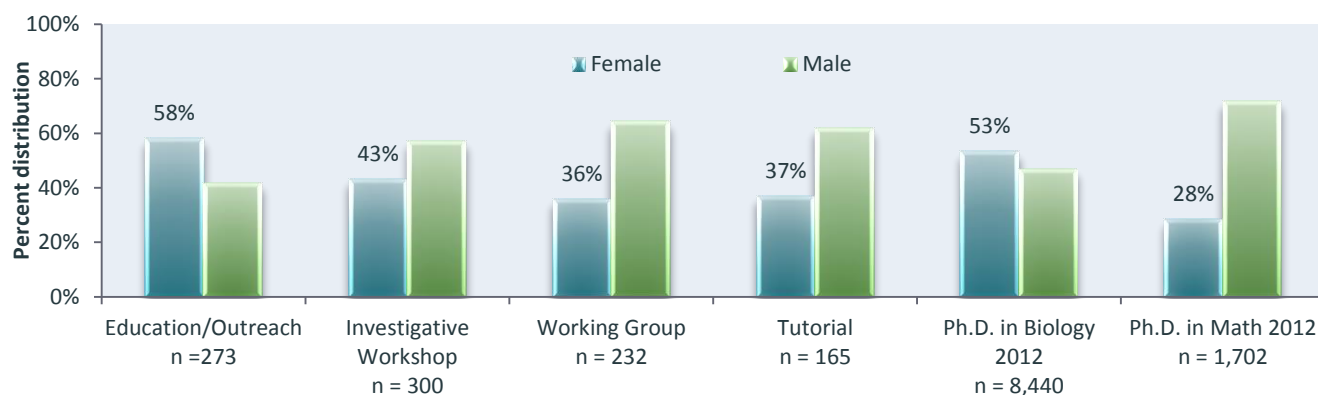
**Figure 4. NIMBioS RP 6 Participants by U.S. State**



## GENDER, RACIAL, AND ETHNIC DIVERSITY

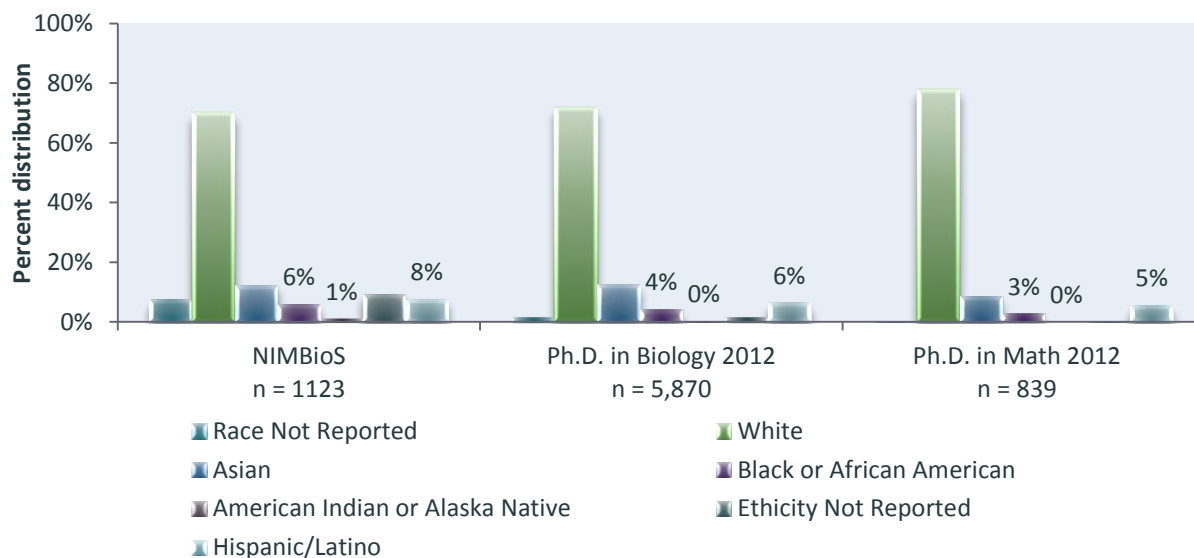
Across all events during RP 6, the gender ratio was 56% male to 44% female. Within specific activity types, the gender ratio varied slightly, with the greatest gender equity seen in Education and Outreach activities and the least in Working Groups (Figure 5). Two comparison groups shown are all individuals receiving doctorates in biology and mathematics in the U.S. in 2012<sup>2</sup>. The distribution of females in NIMBioS activities falls within the range of practicing Ph.D.'s in biology and mathematics in the U.S.

**Figure 5. Gender composition of participants by event type**



Overall minority representation<sup>3</sup> during RP 6 was around 13%. Representation of various minority categories was on par with current trends in minority representation for doctoral recipients in the biological sciences, and greater than that in the mathematical sciences (Figure 6). Two comparison groups shown are all individuals receiving doctorates in biology and mathematics in the U.S. in 2012<sup>4</sup>.

**Figure 6. Minority representation of NIMBioS participants (n = 1123)**



<sup>2</sup> Data from the 2012 NSF Survey of Earned Doctorates, [http://www.nsf.gov/statistics/sed/2012/data\\_table.cfm](http://www.nsf.gov/statistics/sed/2012/data_table.cfm)

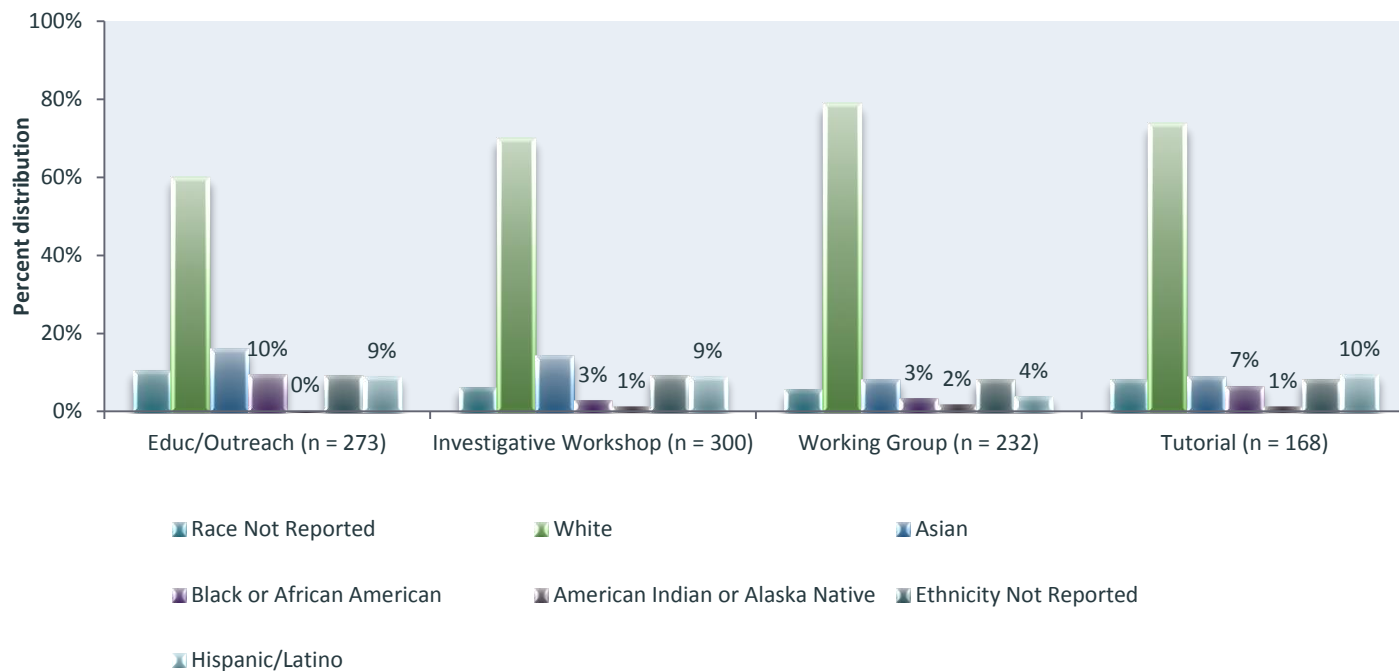
<sup>3</sup> For the purposes of this report, "underrepresented minority" refers to those who self-identify as American Indian or Alaska Native, black or African American, and/or Hispanic or Latino (NSF Survey of Earned Doctorates, 2012)

<sup>4</sup> Data from the 2012 NSF Survey of Earned Doctorates, [http://www.nsf.gov/statistics/sed/2012/data\\_table.cfm](http://www.nsf.gov/statistics/sed/2012/data_table.cfm)



Minority representation varied considerably among programs. Tutorial activities showed greatest percentage of Hispanic/Latino participants (10%). Among the different event types, participants self-identifying racially as white were always in the majority. Black or African American participants were represented most strongly in Education/Outreach Events (10%) (Figure 7).

**Figure 7. Minority representation of participants, by event type**



## DIVERSITY BENCHMARKS

Per the suggestion of the Site Review carried out at NIMBioS in June 2010, the NIMBioS Leadership Team has consulted with the NIMBioS Advisory Board in response to the recommendation by the Site Review that we establish a variety of benchmarks for our programs.

The Site Review particularly recommended that benchmarks be developed on participation in Working Groups and Investigative Workshops relative to gender and under-represented groups, and on geographical diversity of participants.

Benchmarks for diversity in participants at NIMBioS activities:

1. Gender: Across all Working Groups and Investigative Workshops, the proportion of female participants will be at least 30%.
2. Geographic - International participation: Across all Working Groups and Investigative Workshops, at least 10% of participants will be from outside the USA.
3. Under-represented groups (overall): Across all NIMBioS activities, we will increase the percent of participants from under-represented groups by approximately 10% per year. [ $F(t+1) = 1.1 F(t)$  where  $F(t)$  is the proportion of total participants from underrepresented groups in Year  $t$ , and  $F(t+1)$  is the proportion of total participants from underrepresented groups in Year  $(t+1)$ ].
4. Underrepresented groups (Working Groups and Investigative Workshops): Comparable to the overall goal for all activities, we aim to increase the proportion of participants from under-represented groups in Working Groups and Investigative Workshops by 10% per year.
5. Local participants: To avoid overrepresentation of the University of Tennessee community in activities, we will limit participation by UT/ORNL faculty/staff to approximately 15% of the total participants in Working Groups and Investigative Workshops.

Benchmarks for diversity in activity organizers:

1. Gender: Across all Working Groups and Investigative Workshops, approximately 30% of the organizers will be female.
2. Local: No more than 25% of Working Group/Investigative Workshop organizers will be UT faculty/staff.
3. Underrepresented groups: We will encourage researchers from underrepresented groups to be organizers/co-organizers of requests for support, but no specific goal is set because of the small number of organizers

Table 1 shows values by year for the above benchmarks.

**Table 1. Diversity measures for NIMBioS Working Groups, Investigative Workshops, and all events (including Tutorials and Education and Outreach activities in addition to Working Groups and Workshops) by year**

		Yr 1*	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6**	Overall
<b>Participant diversity</b>								
Gender	(Benchmark: approximately 30% female)							
	Working Groups	19%	22%	27%	34%	34%	36%	29%
	Investigative Workshops	40%	40%	38%	39%	39%	43%	40%
	All events	37%	42%	38%	39%	39%	44%	40%
International	(Benchmark: approximately 10% outside USA)							
	Working Groups	20%	19%	19%	18%	24%	26%	21%
	Investigative Workshops	10%	22%	21%	19%	5%	23%	17%
	All events	7%	12%	14%	16%	14%	11%	12%
URG	(Benchmark: increase proportion approximately 10% per year)							
	Working Groups	9%	10%	7%	8%	9%	9%	9%
	Investigative Workshops	7%	10%	14%	14%	11%	12%	11%
	All events	9%	11%	11%	13%	11%	13%	11%
Local	(Benchmark: No more than 15% from UT/ORNL)							
	Working Groups	14%	15%	16%	18%	14%	9%	14%
	Investigative Workshops	22%	23%	10%	7%	11%	4%	13%
	All events	35%	20%	16%	13%	16%	5%	18%
<b>Organizer diversity</b>								
Gender	(Benchmark: approximately 30% female)							
	Working Groups	11%	13%	16%	28%	27%	23%	20%
	Investigative Workshops	25%	29%	38%	39%	0%	52%	31%
	All events	23%	28%	27%	34%	30%	36%	30%
Local	(Benchmark: No more than 25% UT Faculty/Staff)							
	Working Groups	28%	22%	20%	28%	21%	16%	23%
	Investigative Workshops	75%	36%	12%	17%	0%	12%	25%
	All events	57%	42%	33%	27%	21%	21%	34%

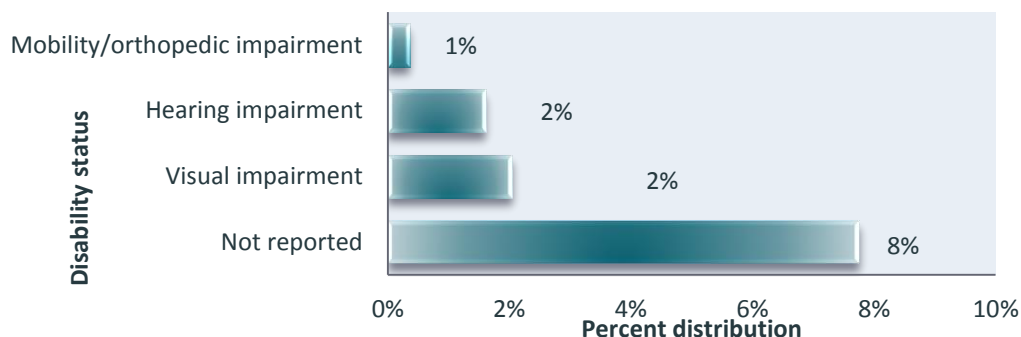
\*Year 1 includes activities from March-August 2009

\*\* Year 6 includes activities from September 2013-March 2014

## ABILITY DIVERSITY

Disclosure of disability status by participants to NIMBioS is optional. Around 2% overall indicated having some sort of disability during RP 6. Nearly 2% indicated having some sort of visual impairment, while 1% indicated having a hearing or mobility impairment (Figure 8).

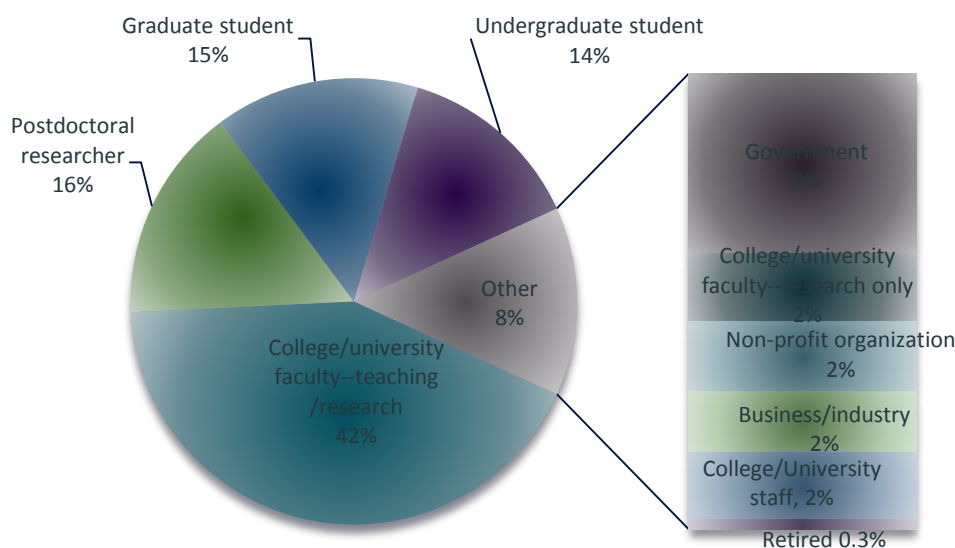
**Figure 8. Disability status of participants (n = 1123)**



## INSTITUTIONAL AND DISCIPLINARY DIVERSITY

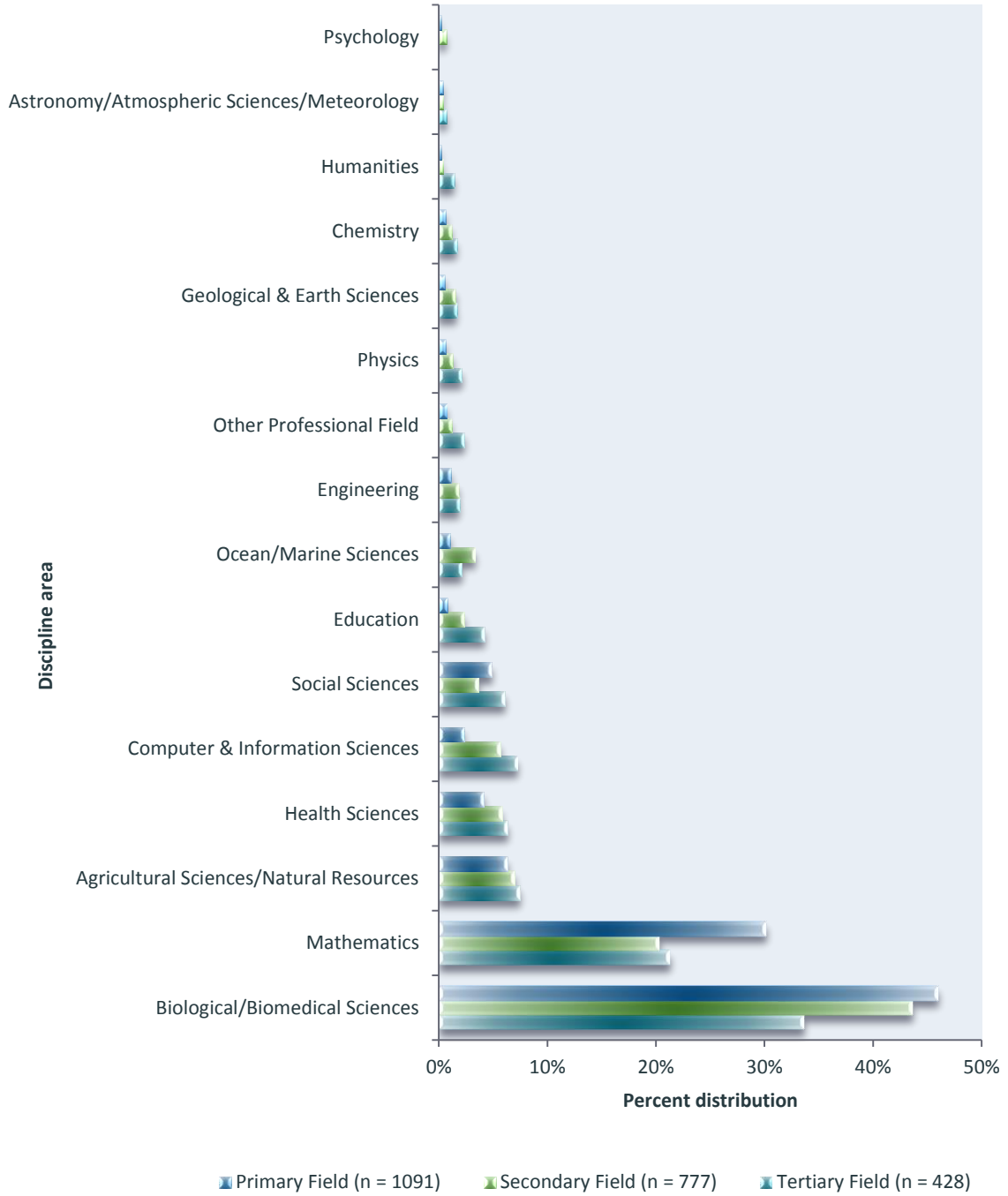
The majority of NIMBioS participants were college/university faculty or staff, postdoctoral researchers, or graduate/undergraduate students; however, participants came from government, non-profit, or other positions as well (Figure 9).

**Figure 9. Employment status of participants (n = 1123)**



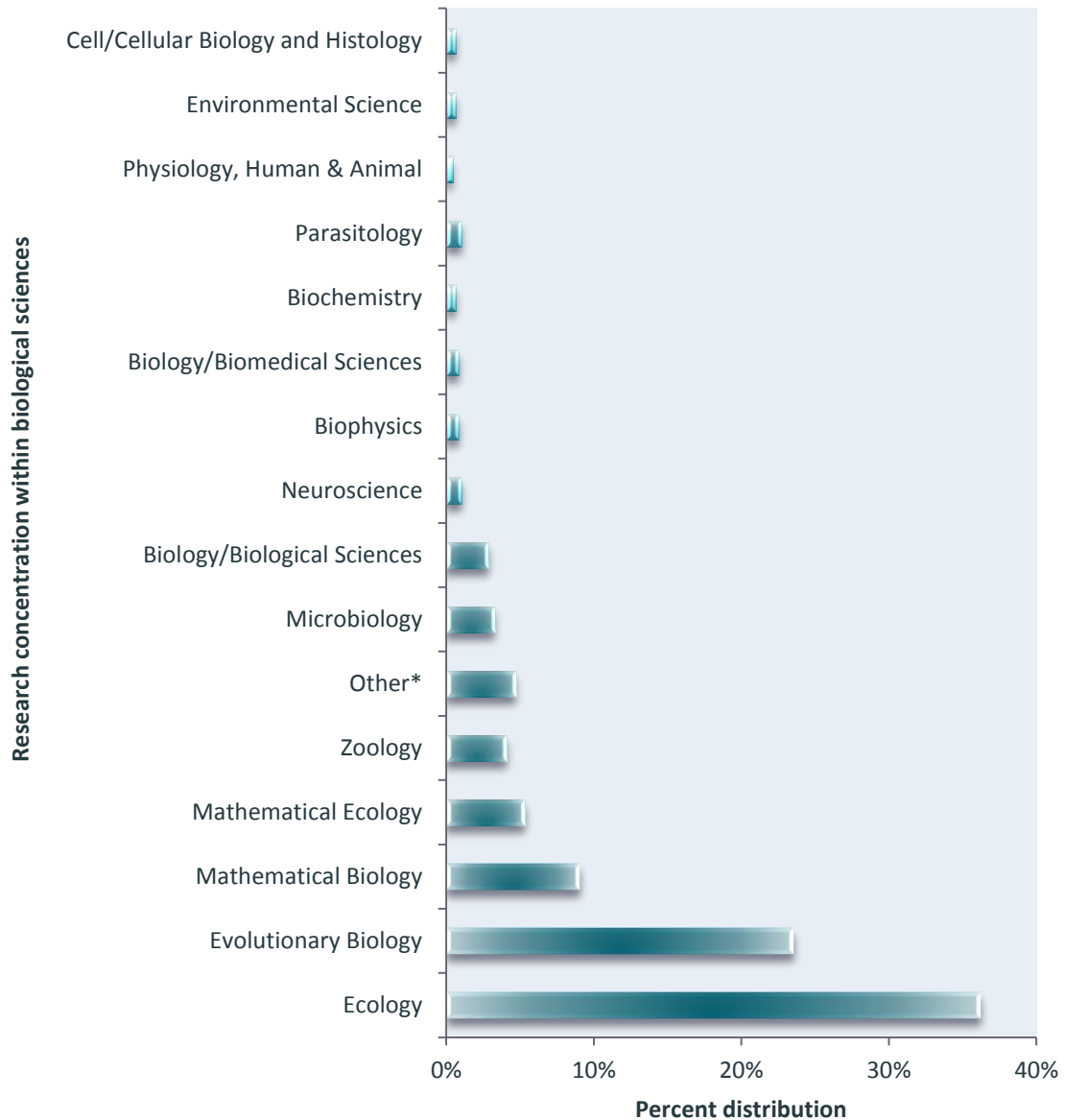
Most participants at NIMBioS indicated their primary fields of study, as well as areas of concentration within those fields. Many indicated their secondary and tertiary fields of study as well. The most commonly reported fields of study included biological/biomedical sciences, mathematics, and agricultural sciences/natural resources, although many other disciplines were represented (Figure 10).

Figure 10. Primary, secondary, and tertiary discipline areas of participants



The 489 participants naming Biological/Biomedical Sciences as their primary field of study indicated 28 different areas of concentration within which they would classify their primary areas of research/expertise. The most commonly indicated area of concentration was ecology (36%), followed by evolutionary biology (23%) and mathematical biology (9%) (Figure 11).

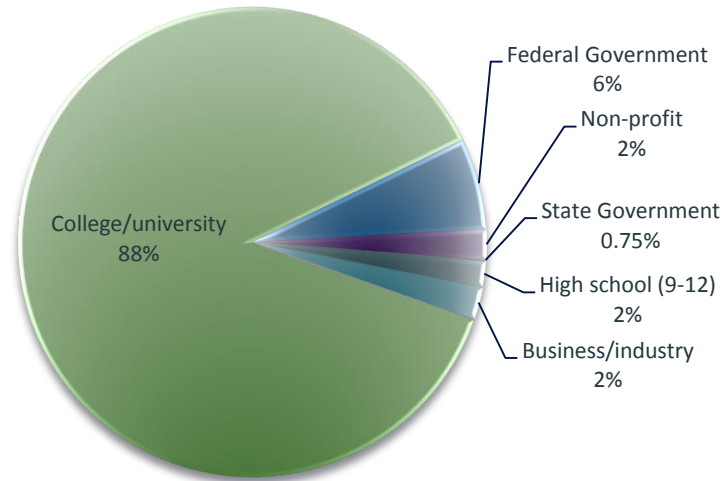
**Figure 11. Participant research/expertise area concentrations within biological/biomedical sciences field of study (n = 489)**



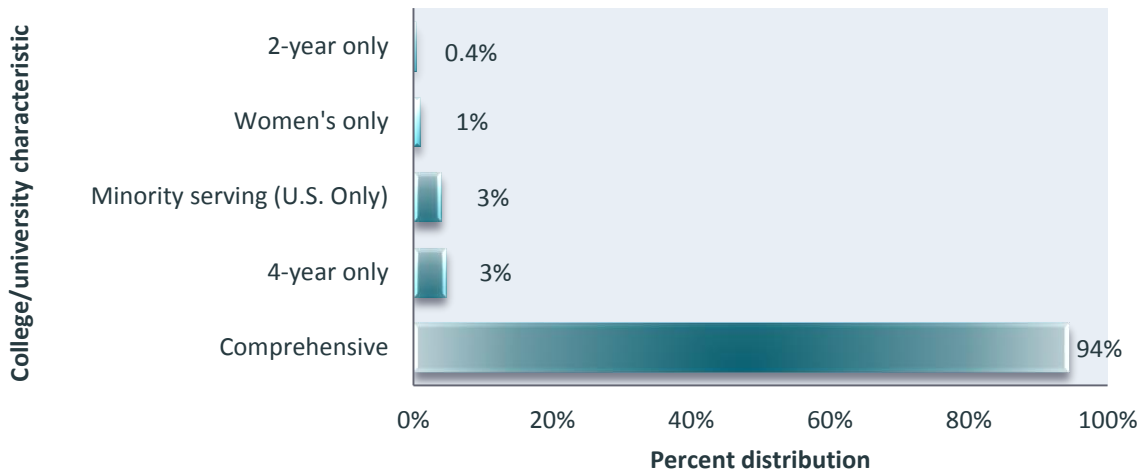
\* Other concentrations having fewer than 0.75% of participants each: Wildlife/Range management, Chemistry, Immunology, Theoretical Biology, Plant Physiology, Developmental Biology/Embryology, Wildlife Health, Cell/Cellular Biology and Histology, Molecular Biology, Behavioral Ecology, Genetics, Human & Animal

Participants during RP 6 represented 595 different institutions, including colleges and universities, government institutions, private businesses, non-profits, and high schools (Figure 12). Of the colleges/universities represented, most were classified as comprehensive (having undergraduate and graduate programs) (Figure 13).

**Figure 12. Types of institutions represented (n = 595)**



**Figure 13. Characteristics of participants' colleges/universities**



## PROCESS EVALUATION

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The process evaluation seeks to evaluate congruence between activities and goals. This type of evaluation is situated in monitoring and judging activities at NIMBioS, mainly through periodic evaluative feedback surveys from participants and event organizers. Other process evaluation data sources include evaluation case studies which look more closely at what factors of NIMBioS participation contribute to positive changes in participants' research and/or educational careers.

NIMBioS conducted formal process evaluations of its first and last Working Group meetings, Investigative Workshops, Undergraduate Research Conference at the Interface of Biology and Mathematics, Postdoctoral Fellowship program, and Research Experiences for Undergraduates/Veterinary Students programs. An evaluation of the Teacher Collaboration program is ongoing as well. Evaluations were carried out via electronic surveys sent to all participants either after participation in a NIMBioS event, or both before and after participation if a pre/post comparison of responses was warranted. Evaluation findings, along with suggestions for improvement, were shared with event organizers, as well as NIMBioS staff as needed. Improvements to program content and format, as well as NIMBioS' overall operations, are made accordingly. Following is a brief summary of the process evaluations of NIMBioS' major activities during RP 6.

### PROCESS EVALUATION OF RESEARCH PROGRAM ACTIVITIES

Working Group and Tutorial evaluation highlights are aggregated across all events in their respective categories.

#### CONTEXT

1. Participants will be satisfied with the event overall.
2. The event will meet participant expectations.
3. Participants will feel the group made adequate progress toward its stated goals.
4. Participants will feel they gained knowledge about the main issues related to the research problem.
5. Participants will feel they gained a better understanding of the research across disciplines related to the group's research problem.
6. Participants feel that participating in the event will have on their future research.
7. Participants will be satisfied with the accommodations offered by NIMBioS.

#### WORKING GROUPS

NIMBioS Working Groups are chosen to focus on major scientific questions at the interface between biology and mathematics that require insights from diverse researchers. The questions to be addressed may be either fundamental, applied or both, and may be focused around a particular biological topic, or one from mathematics that is driven by biological insight. NIMBioS is particularly interested in questions that integrate diverse fields, require synthesis at multiple scales, and/or make use of or require development of new mathematical/computational approaches.

Working Groups are relatively small (10-12 participants, with a maximum of 15), focus on a well-defined topic and have well-defined goals and metrics of success (e.g., publications, databases, software). Selection of Working Groups is based upon the potential scientific impact and inclusion of participants with a diversity of backgrounds

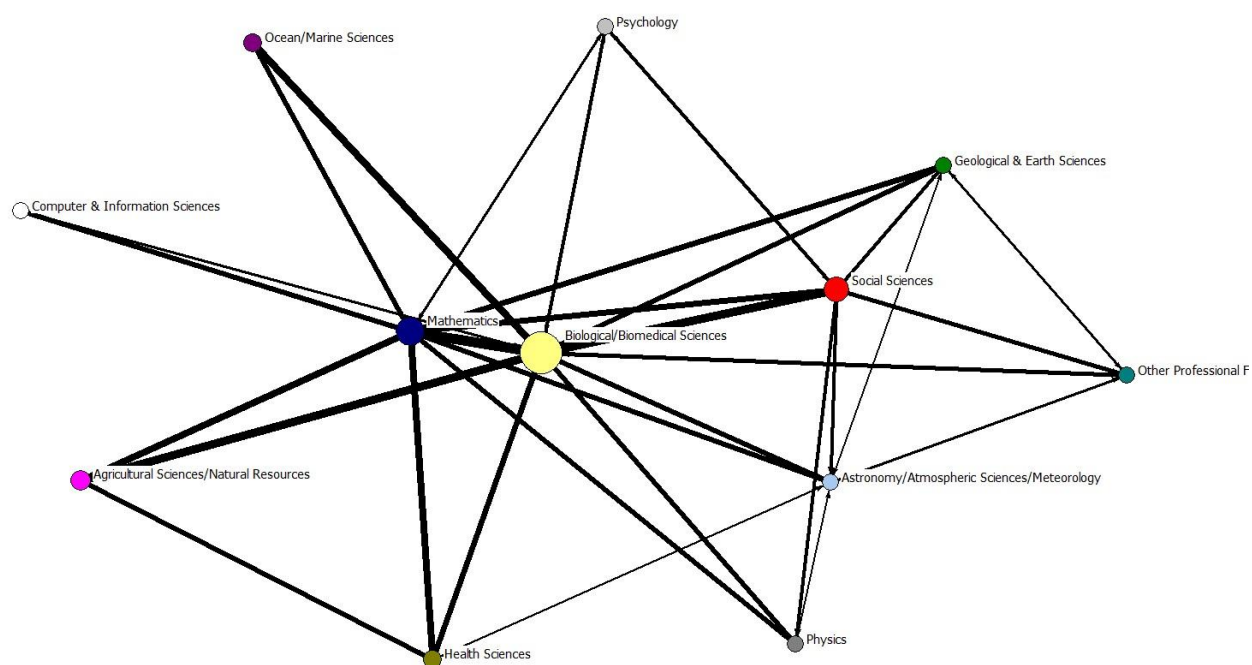


and expertise that match the scientific needs of the effort. Organizers are responsible for identifying and confirming participants with demonstrated accomplishments and skills to contribute to the Working Group. Given this emphasis, Working Group activities rarely involve recently-trained researchers such as postdocs and graduate students. Participation by international researchers is encouraged; though generally there will not be more than 2-3 individuals from outside North America in a Working Group. Working Groups typically meet 2-4 times over a two year period, with each meeting lasting 3-5 days; however the number of participants, number of meetings, and duration of each meeting is flexible, depending on the needs and goals of the Group. Plans can include visits to NIMBioS for subsets of Working Group members to collaborate with NIMBioS IT staff and researchers on Working Group needs.

### WORKING GROUP SUMMARY, RP 6

During RP 6, NIMBioS hosted a total of 19 Working Group meetings, including the start of six new groups and the return of 13 established groups. A total of 232 participants from 214 institutions took part in the Working Groups. During RP 6, participants came together from 12 different major fields of study to focus on the respective scientific questions of their groups. Figure 14 shows the cross-disciplinary connections fostered among Working Group members through the meetings hosted at NIMBioS during RP 6. Node radius is representative of the log scaled number of participants in each field of study. Line size is representative of the number of times researchers from each field were brought together to collaborate and problem-solve at NIMBioS.

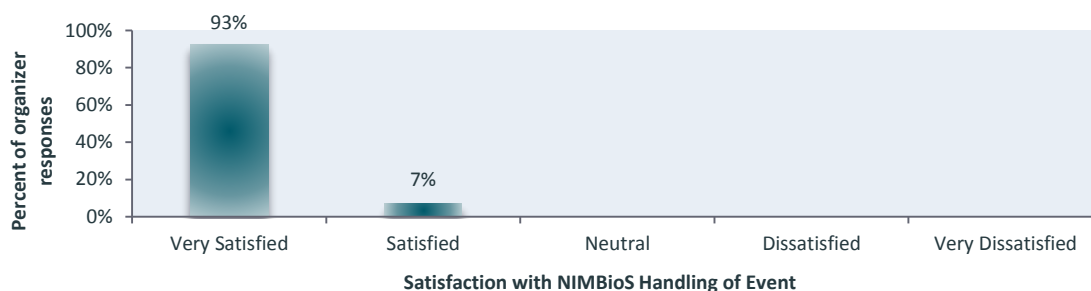
**Figure 14. Working Group cross-disciplinary collaboration**



### ORGANIZER FEEDBACK

Beginning in November 2011, NIMBioS began collecting satisfaction feedback from Working Group organizers to the following question: As an event organizer, how satisfied were you overall with the way your event was managed by NIMBioS (from the application process through the wrap-up of the event)? Figure 15 summarizes the responses to this question for RP 6 organizers of beginning Working Groups.

**Figure 15. Working group organizer satisfaction with NIMBioS handling of event (n = 54)**



## FIRST MEETINGS

During RP 6, NIMBioS hosted the first meetings of six Working Groups, with a total of 78 participants (

Table 2) (See <http://www.nimbios.org/workinggroups/> for more details about specific Working Groups).

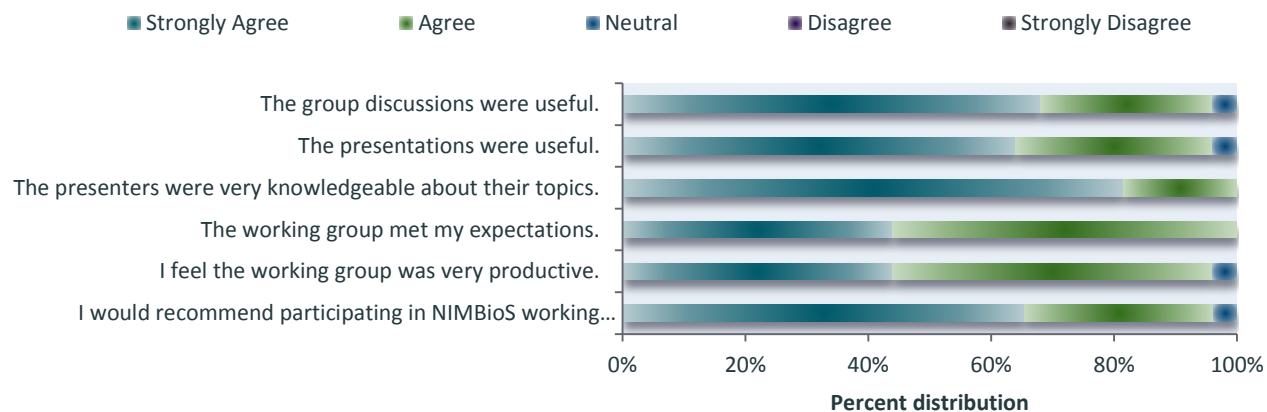
Evaluation surveys were sent to all participants. A total of 70 participants took part in the evaluation of the first meetings of their Working Groups. Seventeen of these participants were organizers and only answered questions about how they well they felt NIMBioS managed their events.

**Table 2. Working Group First Meetings Hosted by NIMBioS**

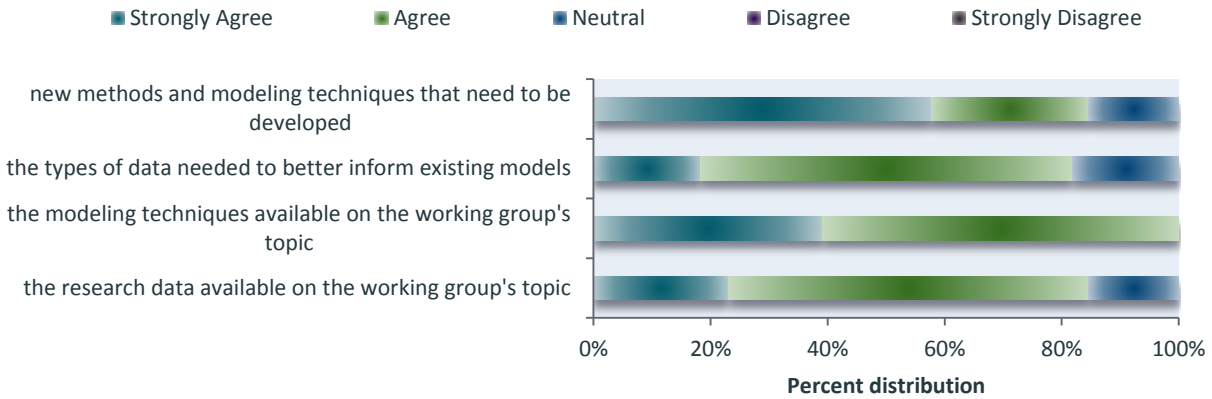
Title of Working Group	Dates	# Participants
Climate Change and Vector-borne Diseases	December 3-5, 2013	14
Evolution of Institutions	March 13-14, 2014	13
Evolution of Sustainability	March 26-28, 2014	10
Plant-Soil Feedback Theory	October 31-September 2, 2013	12
Migratory Habitat	May 5-8, 2014	15
Computational Landscape Genomics	May 13-16, 2014	14

## HIGHLIGHTS OF WORKING GROUP FIRST MEETING EVALUATION RESPONSES

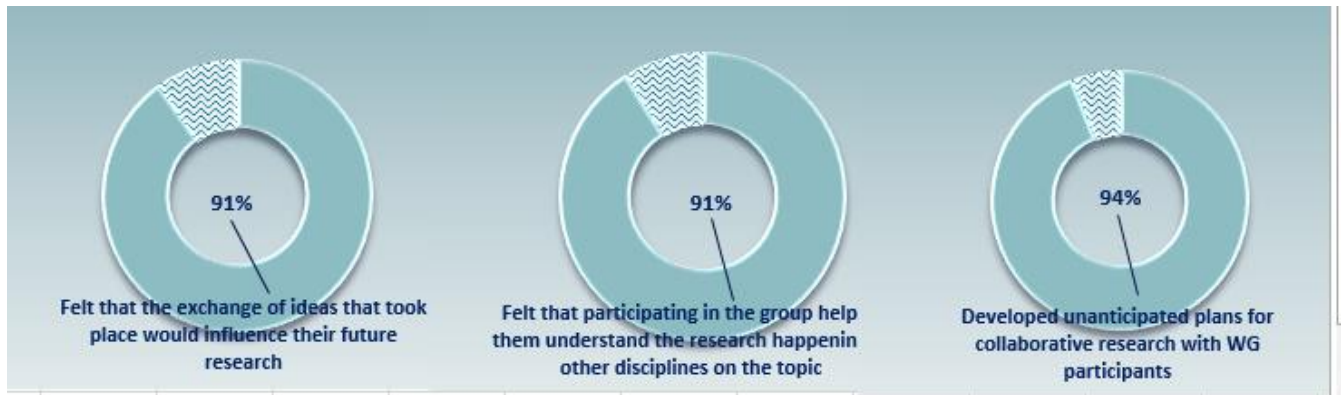
**Figure 16. Overall satisfaction with the content and format of the Working Groups**



**Figure 17. Participant responses to the following question--As a result of participating in this Working Group, I have a better understanding of:**



**Figure 18. Percent of participants in first meetings of Working Groups who:**



## WORKING GROUP SECOND, THIRD, AND FOURTH MEETINGS

During the reporting period, NIMBioS hosted the second meetings of six Working Groups, with a total of 75 participants, and the third meeting of four Working Groups, with a total of 44 participants. Three groups held their fourth meetings with a total of 35 participants (Table3).

**Table 3. Working Group Second and Third Meetings Hosted by NIMBioS**

Title of Working Group	Dates	# Participants
<b>Second Meetings</b>		
Biotic Interactions	September 23-26, 2013	14
Hierarchy and Leadership	September 18-20, 2013	12
Human Risk Perception and Climate Change	January 21-23, 2014	11
Nonautonomous Systems and Terrestrial Carbon Cycle	March 17-21, 2014	12
Plant-Soil Feedback Theory	April 28-30, 2014	13
Climate Change and Vector-borne Diseases	June 23-25, 2014	13
<b>Third Meetings</b>		
Play, Evolution, and Sociality	October 30-September 1, 2013	12
Within-host Modeling of Mycobacterium avium subsp. paratuberculosis (MAP) Infections	December 9-11, 2013	11
Hierarchy and Leadership	April 21-23, 2014	11
Biotic Interactions	May 12-16, 2014	10
<b>Fourth Meetings</b>		
Ocean Viral Dynamics	January 7-9, 2014	12
Optimal Control for Agent-based Models	January 21-24, 2014	12
Within-host Modeling of Mycobacterium avium subsp. paratuberculosis (MAP) Infections	July 20-23, 2014	11

Beginning in March 2011, NIMBioS changed its policy on evaluation of Working Group meetings to only sending full evaluation surveys to participants after the first and final meetings, rather than after every meeting, however, comments were solicited about the general feeling about the group's progress. Some participant comments:

*Very positive. Exceeded my expectations. There will be products (papers from the collective group) that result from these Working Groups.*—Ocean Viral Dynamics Participant, Meeting 3

*My experience with this Working Group is extremely positive. The group brought together experts in animal behavior, evolution and mathematical modelling that would have otherwise never met as one group. This fostered new ideas and created environment in which a systematic pursuit of these ideas can be established. The group started new working relationships and enabled establishment of several international working teams that focus on the mathematical analysis and modelling of play from different perspectives. Due to the team work of the group, these perspectives are complementary and stimulate each other.*—Play, Evolution, and Sociality Participant, Meeting Two

## CONCLUDING WORKING GROUPS

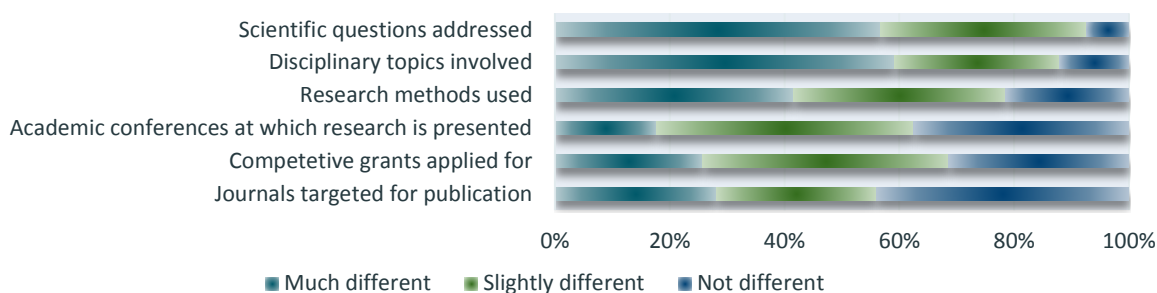
NIMBioS received notification that six Working Groups had reached their conclusions (Table 4). It is the policy of NIMBioS to send follow-up evaluation surveys to Working Group participants after the final meeting summary has been received from Working Group organizers. A total of 45 participants responded to the final evaluation for their groups.

**Table 4. Concluded Working Groups, RP 6**

Title of Working Group	Dates	# Participants
Multiscale Modeling of the Life Cycle of <i>Toxoplasma gondii</i>	May 2011- January 2014	20
Optimal Control for Agent-based Models	April 2011- July 2013	17
Ocean Viral Dynamics	April 2012-January 2014	16
Multiscale Modeling of the Life Cycle of <i>Toxoplasma gondii</i>	May 2011-July 2013	18
Within-host modeling of MAP infections	June 2012-july 2013	14

## HIGHLIGHTS OF WORKING GROUP FOLLOW-UP EVALUATION RESPONSES

**Figure 19. Ways in which Working Group research collaborations differed from participants' other research collaborations**

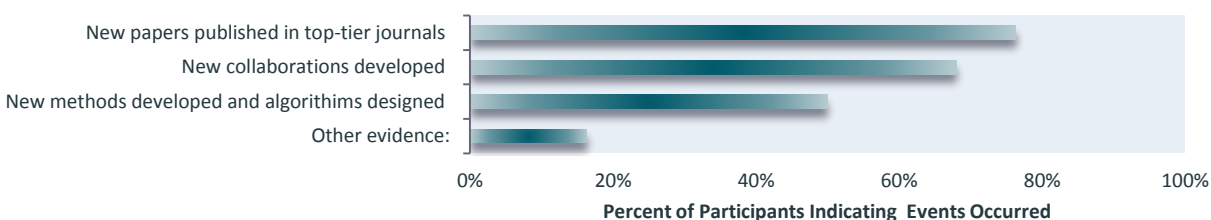


**Comments:** *"The multiscale approach was specifically original, also with the possibility to interact in small groups (contrarily to conferences)"*

*"The new and highly interesting for me was the interdisciplinarity of the collaboration."*

*"The group published or will publish more than 13 manuscripts based on NIMBioS WG program, which is way more than we envisioned at the beginning!"*

**Figure 20. Participant self-reported evidence to support new insights and collaborations within the group**



**Comments:** *“There is ongoing work from a collaboration of several members. It might not be totally correct to say that there were “New methods developed and algorithms designed,” but certainly there was a new approach to a previously poorly explored task/problem.”*

*“More papers to be submitted this year”*

## INVESTIGATIVE WORKSHOPS

NIMBioS Investigative Workshops differ from Working Groups in that they focus on a broader topic or set of related topics at the interface of biology and mathematics and have relatively large size (30-40 participants). Workshops attempt to summarize/synthesize the state of the art and identify future directions, and they have potential for leading to one or more future Working Groups. Organizers invite 15-20 key participants, and the remaining 15-20 participants are filled through open application from the scientific community.

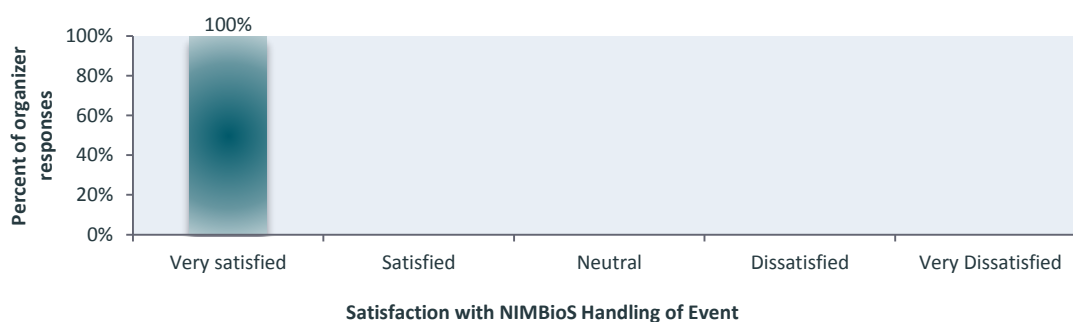
NIMBioS hosted eight Investigative Workshops during RP 6 with a total of 300 participants (Table 5). Evaluation surveys were sent to all Workshop participants. A total of 285 participants took part in the evaluation of the Workshops. Twenty-five of these participants were organizers and only answered questions about how they well they felt NIMBioS managed their events.

**Table 5. Workshops Hosted by NIMBioS**

Title of Working Group	Dates	# Participants
Analyzing Animal Vocal Sequences	October 21-23, 2013	43
Animal Social Networks	March 6-8, 2014	44
Insect Pest Resistance Evolution	November 14-15, 2013	29
Interface Disease Models	March 11-13, 2014	36
Vectored Plant Viruses	March 17-19, 2014	33
Modeling Contamination of Fresh Produce	April 24-25, 2014	41
Predictive Models for ERA	April 28-30, 2014	43
Leptospirosis Modeling	June 3-5, 2014	31

## HIGHLIGHTS OF WORKSHOP EVALUATION RESPONSES

**Figure 21. Workshop organizer satisfaction with NIMBioS handling of event (n = 25)**



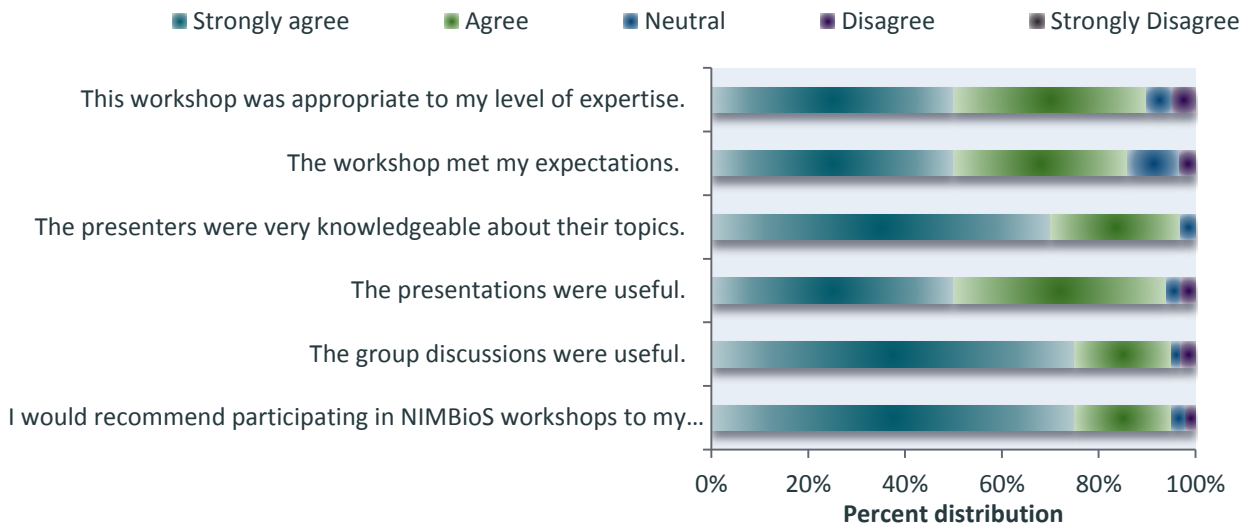
**Organizer comments:**

*“A great group of attendees and wonderful logistical support from the staff. We expect to have several to many concrete outcomes from the Workshop.”*

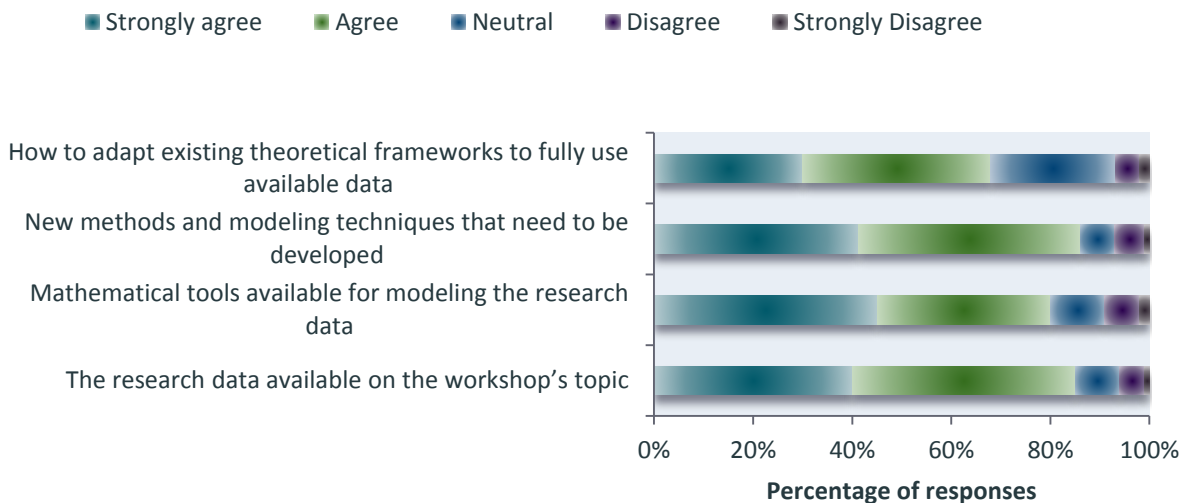
*“NIMBioS staff was wonderful!”*

*“Outstanding support staff. Thanks!!!”*

**Figure 22. Overall satisfaction with the content and format of the Workshop**



**Figure 23. Participant responses to the following question-- As a result of participating in this Workshop, I have a better understanding of:**



**INVESTIGATIVE WORKSHOP PARTICIPANT COMMENTS:**

*"I believe that it was a very good Workshop. I am starting to collaborate with some people I met in the Workshop and I am now aware of different methods that I did not know they exist."*

*"I learned a great deal about different types of population models that may be useful in interpreting our research group's data sets."*

*"I was very impressed and stimulated by the range of studies discussed during the meeting. I think I gained a new appreciation for some areas that I had never thought of as subjects where modeling could provide valuable insights."*

*"I am already in touch with some people I met at the Workshop and exist the possibility to collaborate."*

*"This was one of the most fertile Workshops for developing new collaborations I have ever attended!"*



## PROCESS EVALUATION OF EDUCATION AND OUTREACH PROGRAM ACTIVITIES

### SUMMER RESEARCH EXPERIENCES

The NIMBioS *Summer Research Experiences (SRE)* program took place on the University of Tennessee, Knoxville (UT) Knoxville campus June 9-August 1, 2014. Eighteen undergraduates and two high school teachers were chosen to participate in the program.

During the eight-week program, participants lived on campus at UT, and worked in teams with UT faculty to conduct research at the interface of mathematics and biology. The six research projects for the 2014 program included:

- Prospects for the continued global Argentine ant supercolony
- Modeling transmission and control of bovine respiratory disease
- A dynamic systems approach to tracking the facial expressions and conscious experience of emotion
- Living on the edge: How location within a geographic range affects genetics and individual fitness
- Statistical techniques for predicting cardiac rhythm disorder
- Mathematical modeling of granuloma formation in Johne's Disease

Program organizers were Suzanne Lenhart (Dept. Mathematics/NIMBioS), and Kelly Sturner (NIMBioS). Mentors in the program included Matt Zefferman (Evolutionary social science), Keenan Mack (Evolution of cooperation), Cristina Lanzas (Veterinary Medicine), Suzanne Lenhart (Mathematics), Shi Chen (Veterinary Science), Jeff Larsen (Social psychology), Charles Collins (Mathematics), Julia Earl (Ecosystem ecology, life history theory, conservation biology), Sean Hoban (Small population dynamics), Xiaopeng Zhao (Computational biology, disease modeling), Heather Finotti (Mathematics), Shigetoshi Eda (Wildlife health), and Vitaly Ganusov (Theoretical immunology).

### CONTEXT

1. Participants will be satisfied with the program overall.
2. The research experience will meet participant expectations.
3. The research experience will impact participant plans to go to graduate school.
4. Participants will increase their research skills during the program.
5. Participant will feel they gained knowledge about the research process.
6. Participants will be satisfied with their mentors.
7. Participants will be satisfied with the accommodations offered by NIMBioS.

### HIGHLIGHTS OF REU EVALUATION RESPONSE

Figure 24. Overall satisfaction with the research experience

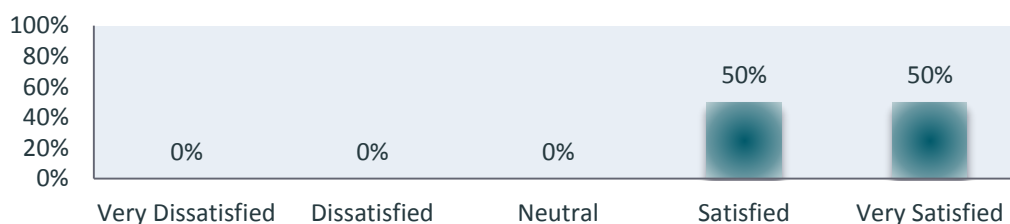


Figure 25. Participant pre-and post-program skills, response scale of -2 = extremely poor at the skill to 2 = excellent at the skill

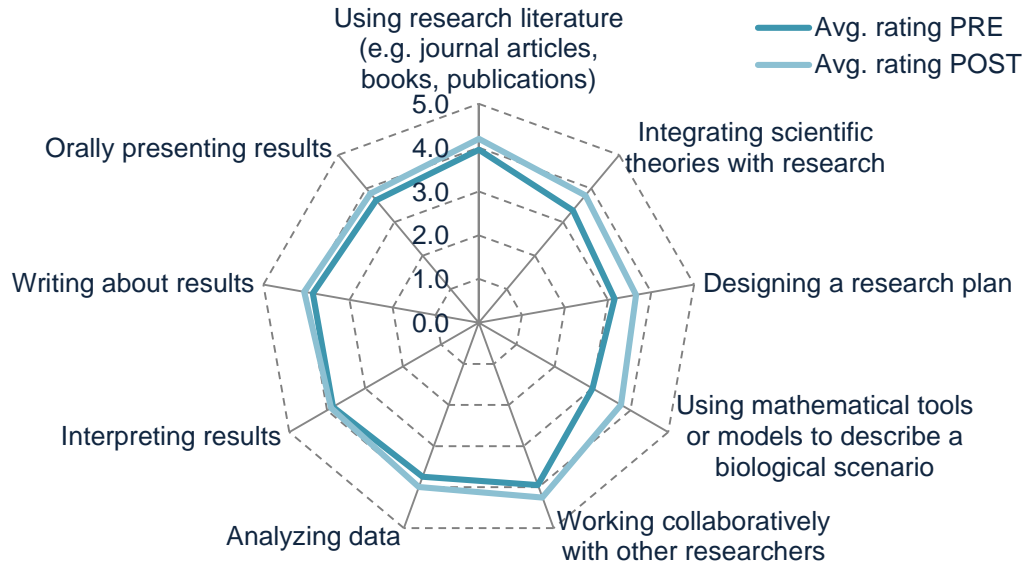
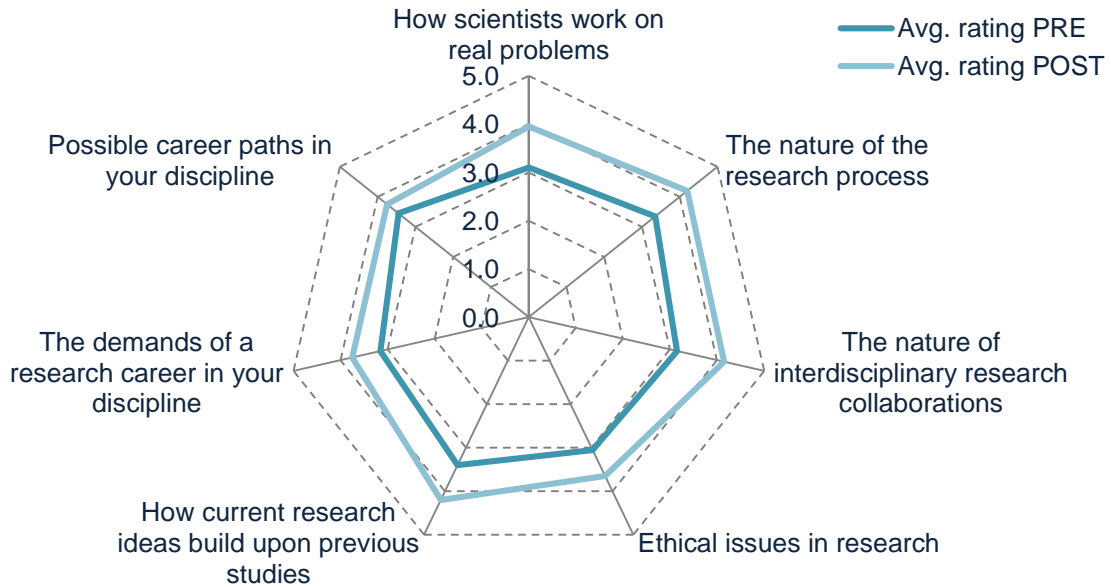


Figure 26. Participant pre- and post-program knowledge, response scale of -2 = extremely poor understanding to 2 = excellent understanding



## UNDERGRADUATE RESEARCH CONFERENCE AT THE INTERFACE OF BIOLOGY AND MATHEMATICS (URC)

The NIMBioS fifth annual Undergraduate Research Conference at the Interface of Biology and Mathematics took place at the University of Tennessee's Conference Center in downtown Knoxville November 16-17, 2013. The event was organized by the NIMBioS Education and Outreach Associate Director for Education, Outreach, and Diversity, Suzanne Lenhart, and the Education and Outreach Coordinator Kelly Sturner.

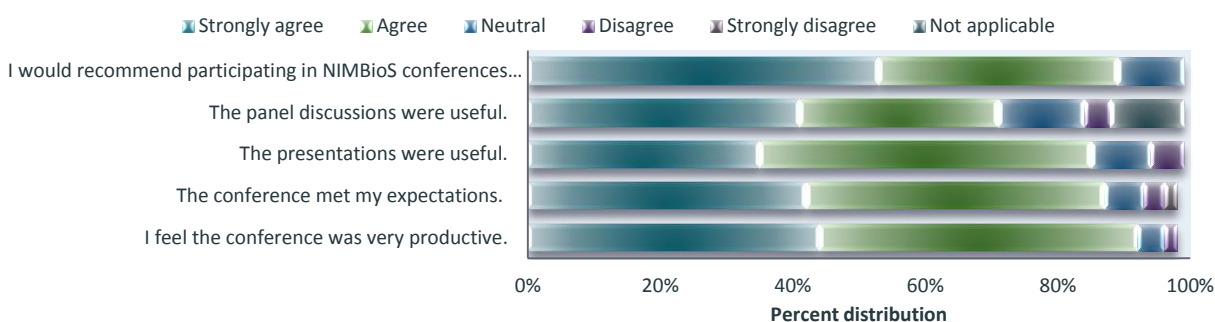
Nearly 158 participants from 66 institutions throughout the United States participated in the event. The fifth annual undergraduate research conference provided opportunities for undergraduates to present their research at the interface of biology and mathematics. Student talks and posters were featured as well as a panel discussion on career opportunities. Evaluation surveys were sent to all participants in the conference, with the exception of NIMBioS affiliates and event organizers. A total of 65 participants took part in the evaluation.

### CONTEXT

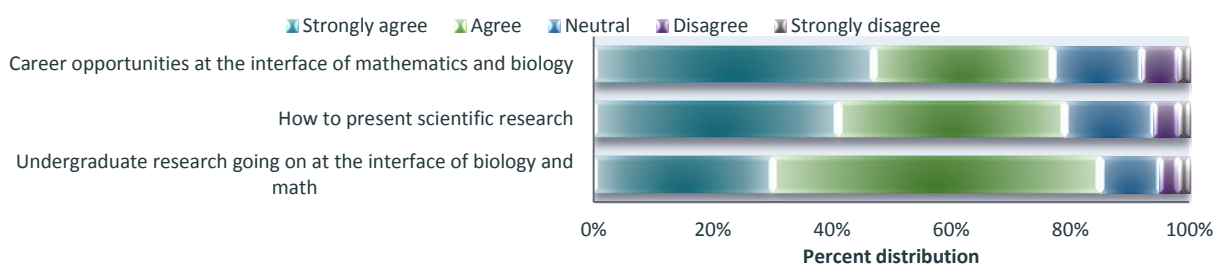
1. Participants will be satisfied with the conference overall.
2. The conference will meet participant expectations.
3. Participants will feel the conference allowed them to make new connections with others in math and biology.
4. Participants will feel they gained a better understanding of undergraduate research happening at the interface of mathematics and biology.
5. Undergraduate participants feel the conference will have an impact on their future career plans.
6. Participants will be satisfied with the accommodations offered by NIMBioS.

### HIGHLIGHTS OF URC EVALUATION RESPONSES

**Figure 27. Respondent agreement levels with statements about various aspects of the conference**



**Figure 28. As a result of attending this conference, I have a better understanding of**



## NIMBIOS POSTDOCTORAL FELLOW EXIT SURVEY HIGHLIGHTS

NIMBioS provides an opportunity for postdoctoral scholarship at the interface between mathematics and biological science that builds upon the experiences gained through the many successful postdoctoral fellows who have been in residence at the University of Tennessee, Knoxville over the past decades. Postdoctoral scholars propose synthetic projects that require an amalgam of mathematical and biological approaches, and are expected to include explicit opportunities to expand the scholar’s previous education. Projects should not require the collection of additional empirical data, but may involve many aspects (collating, formulating data bases, developing models) of synthesizing existing data. Applications are welcome from those with a range of both biological and mathematical prior experience, with highest priority given to those with explicit plans to develop their ability to effectively carry on research across these fields.

Postdoctoral Fellowships are for two years (assuming satisfactory progress toward research goals in year one). Under appropriate circumstances applicants may request periods shorter than two years, and in special circumstances a Fellow may request an extension beyond two years. NIMBIOS Postdoctoral Fellows are encouraged to participate in grant proposal development Workshops offered through UT and Fellows are permitted to serve as a Principal Investigator on grant proposals submitted through NIMBioS.

Upon leaving the Postdoctoral Fellowship program at NIMBioS, program participants are asked to fill out a short exit evaluation form that examines several aspects of satisfaction with the program’s operations. To date, 21 alumni from the program have filled out the form.

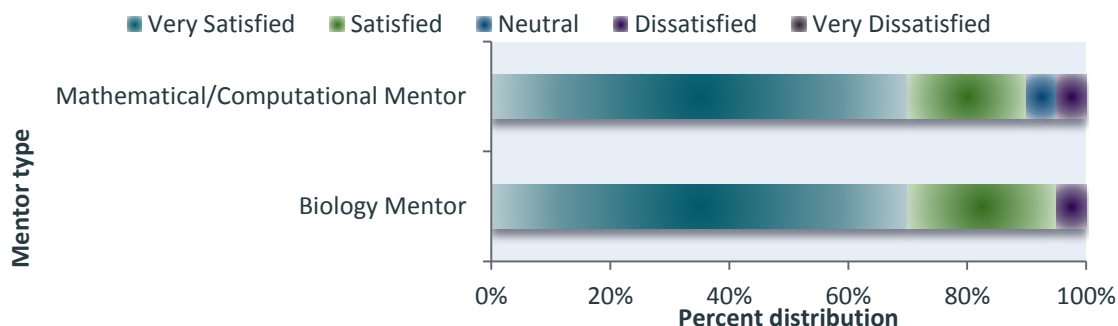
### CONTEXT

1. Participants will be satisfied with the structure of the program.
2. Participants will feel the program has been valuable to their academic careers.
3. Participants will be satisfied with the accommodations offered by NIMBioS to conduct research.
4. Participants will be with their mentors overall.
5. Participants will be satisfied with the types of advice/assistance received from their mentors.
6. Participants will be satisfied with the opportunity to participate in education and outreach activities.

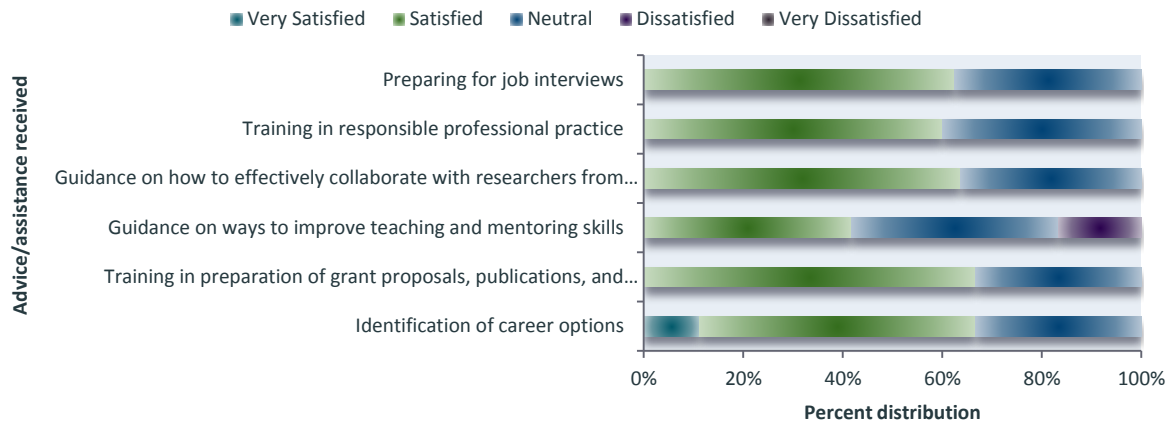
### HIGHLIGHTS OF POSTDOCTORAL FELLOWSHIP PROGRAM RESPONSES

*“If I had to do it all over again, I would be a NIMBioS postdoc again without hesitation.”*—Exiting NIMBioS Postdoctoral Fellow

**Figure 29. Postdoctoral fellow satisfaction with program mentors**



**Figure 30. Postdoctoral fellow satisfaction with advice/assistance received from program mentors**



**Figure 31. Postdoctoral fellow satisfaction with overall program experience**





NIMBioS products are published in many high-ranking journals in their respective fields. **Table 6** highlights the number of products in a selection of high-impact journals according to the Web of Science impact factor.

**Table 6. Number of NIMBioS articles published in a selection of high-impact journals, sorted by journal 5-Year Impact Factor**

Journal Title	5-Year Impact Factor	# of NIMBioS Publications in Year 6	# of NIMBioS Publications as of Oct 2014
Nature	38.16	1	3
Cell	34.37	-	1
Science	33.59	-	4
Ecology Letters	18.50	1	8
Trends in Ecology and Evolution	17.11	-	4
PLoS Biology	13.45	1	2
Systematic Biology	13.32	1	3
Proceedings of the National Academy of Sciences	10.58	1	12
Current Biology	10.45	-	1
Nature Communications	10.02	1	2
PLoS Genetics	9.44	-	2
Nucleic Acids Research	8.06	-	2
Phil Trans of the Royal Soc B-Biological Sciences	7.30	-	2
Molecular Ecology	6.79	3	7
Ecology	6.37	-	5
PLoS Computational Biology	5.94	2	5
Proc of the Royal Soc B-Biological Sciences	5.83	0	7
Evolution	5.40	4	12
The American Naturalist	5.33	-	8
Journal of Animal Ecology	5.17	-	3
Journal of the Royal Society Interface	5.17	-	3
PLoS One	4.24	1	20
BMC Bioinformatics	3.51	-	1
Animal Behaviour	3.41	-	5

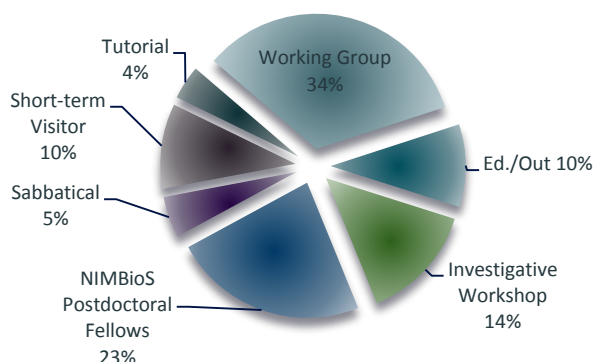
\* The journal impact factor is a measure of the frequency with which the “average article” in a journal has been cited in a particular year. The impact factor is an indicator of a journal’s relative importance, especially as compared to other journals in the same field. Impact factor calculation:  $\text{cites in year } n \text{ to articles published in year } (n-1 + n-2) / \text{number of articles published in year } (n-1 + n-2)$ .

NIMBioS publications come from a variety of activities, although Working Group participants tend to publish the largest portion of journal articles (34%), followed by NIMBioS Postdoctoral Fellows (23%) (Figure 34).

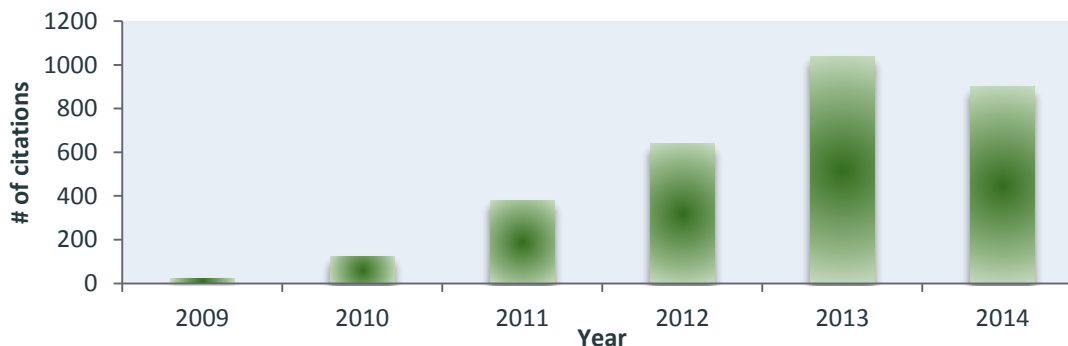
## BIBLIOMETRIC INDICATORS

Of the 385 journal articles reported by NIMBioS participants, 340 are indexed in the Institute for Scientific Information's (ISI) Web of Science (WOS). Data in the following sections are based on these articles, which involved 913 researchers from 389 unique institutions spanning 43 countries. These articles have appeared in 165 different publications, many of which are considered to have high-impact in the academic community. These articles have been collectively cited 3088 times, with an average of 9.11 cites per article, and an h-index of 25 (Figure 35). The cites per article falls within the range of the two major research fields of the publications during the last 10 years; mathematics (3.65 citers/paper) and biology (15.65 citers/paper).

**Figure 34. Distribution of journal publications submitted to NIMBioS by participants**



**Figure 35. Citations per year for NIMBioS articles**



## DISCIPLINARY SPAN OF PUBLICATIONS

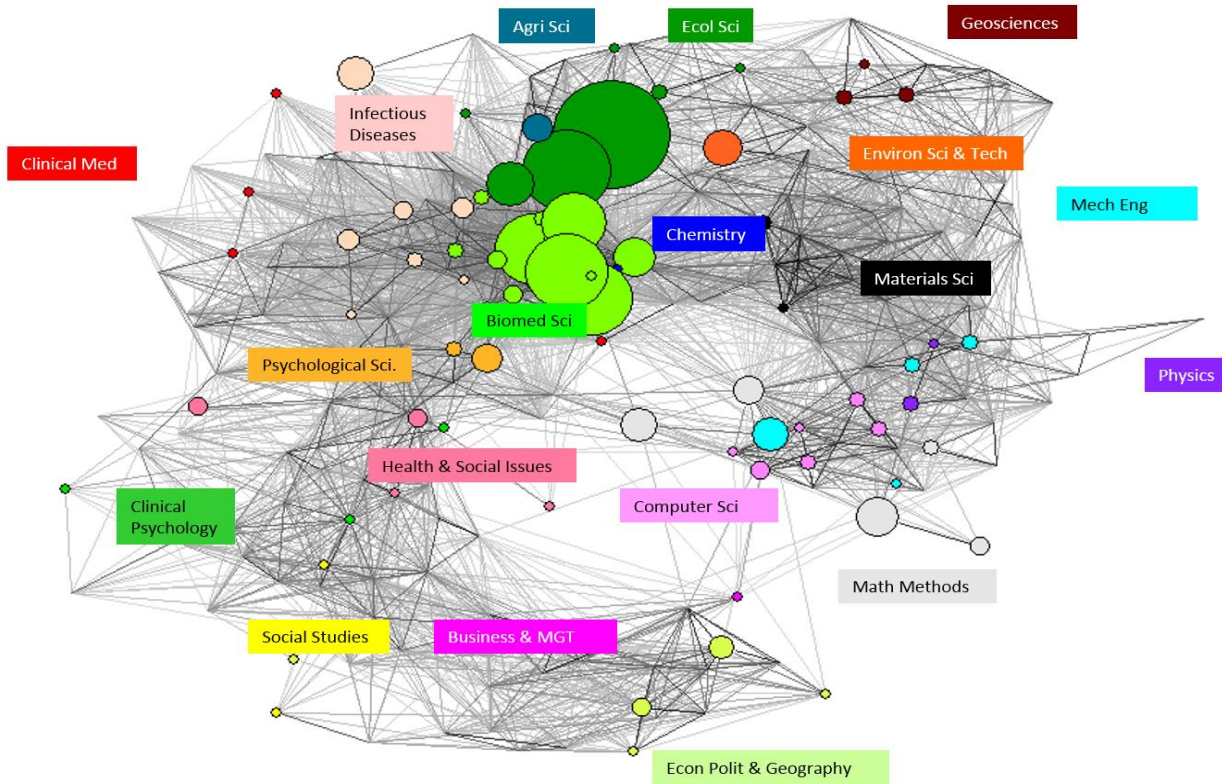
The 340 published WOS articles span 79 discipline areas, as designated by the ISI WOS Categories. Categories are assigned at the journal level based upon a combination of citation patterns and editorial judgment at the ISI. Subject categories are used in bibliometric research as a representation of the research areas in which scientists work.

Figure 36 locates the subject categories of the 340 NIMBioS articles on a network map of the WOS Categories. The gray background intersections are the 224 WOS Categories, located based on cross-citation relationships among all WOS journals in 2007 (from Rafols, Porter, and Leydesdorff, 2009). The 19 labeled "macro-disciplines" are based on factor analysis of that cross-citation matrix also. Nearness on the map indicates a closer relationship among disciplines. Circular node sizes reflect the relative number of NIMBioS participant publications. The most common



subject category in which NIMBioS publications fell was Ecology (107), followed by Evolutionary Biology (62), Multidisciplinary Sciences (52), Mathematical & Computational Biology (48), Biology (44), and Genetics & Heredity (33).

**Figure 36. Web of Science Categories for 340 WOS journal articles to date**

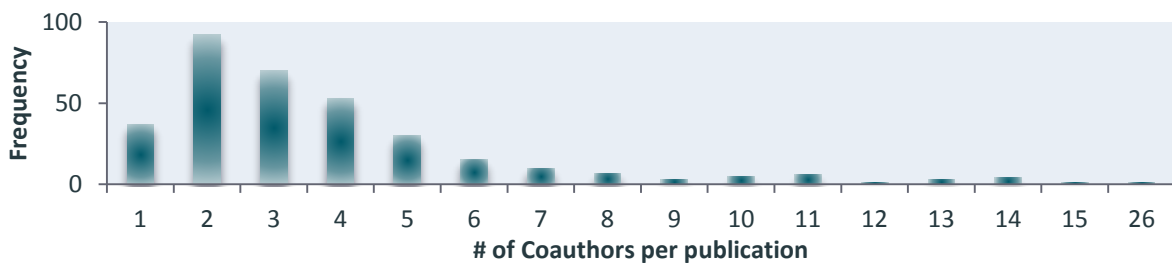


Method from Rafols, Porter and Leydesdorff (2009)

**COLLABORATION**

One of the core values of NIMBioS is to take a collaborative approach to science and science education. We are interested, therefore, in examining the number of co-authors on NIMBioS-related publications as one indicator of scientific collaboration. For the 341 WOS publications reported thus far, the average number of co-authors per paper is 3.9 (Figure 37).

**Figure 37. Coauthorship of NIMBioS publications**



Network analysis reveals key producers within the body of NIMBioS work as well. In Figure 38, grey circles represent authors and squares represent papers, colored by major event type. NIMBioS Postdoctoral Fellows (light blue squares) have produced 97 papers, while Working Groups (dark blue squares) overall have produced 127. NIMBioS Postdoctoral Fellows also frequently publish with Working Group members and Short-Term Visitors (dark green squares). Twenty-four participants have authored more than 5 papers each as a result of NIMBioS affiliated collaborations.

**Figure 38. Participant paper collaboration for all NIMBioS events**

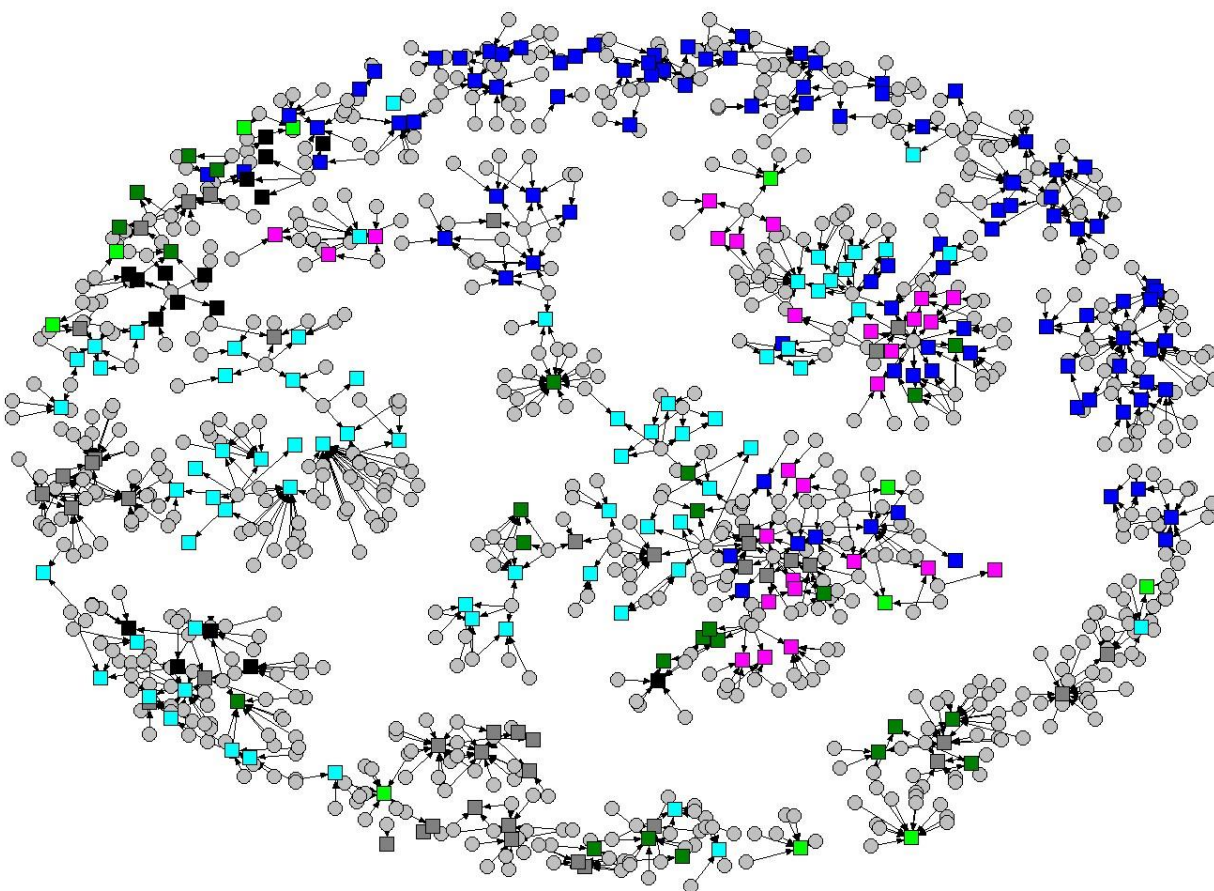
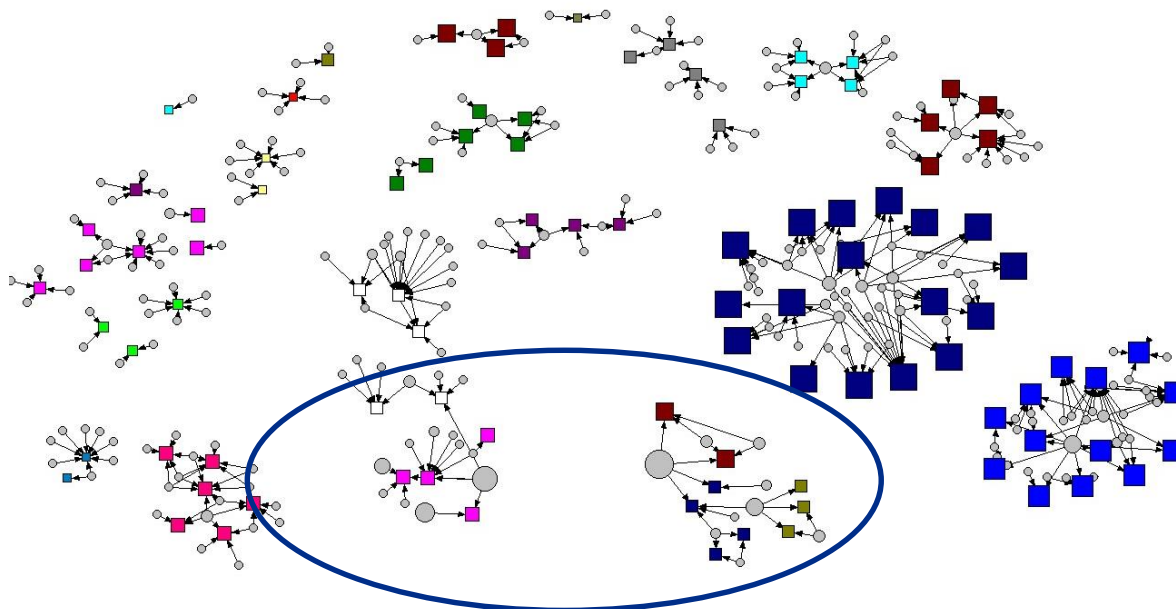


Figure 39 shows the paper-author network for Working Groups only. Grey circles represent authors and colored squares represent papers. Nodes are sized by numbers of publications for each group (squares) or a person's total number of NIMBioS affiliated publications (circles). The Synthesizing and Predicting Infectious Disease (SPIDER) Working Group (large navy blue cluster, started in 2009), has been the most prolific group with 17 publications, followed by Population and Community Ecology Consequences of Intraspecific Niche Variation (royal blue cluster, started 2009). Overall, Working Groups do not cross-fertilize with regard to co-authorship, however, some members who participate in multiple groups do author papers with members of two or more groups, as is the case with the two circled clusters at the bottom middle of the figure.

**Figure 39. Participant paper collaboration network for all Working Groups**

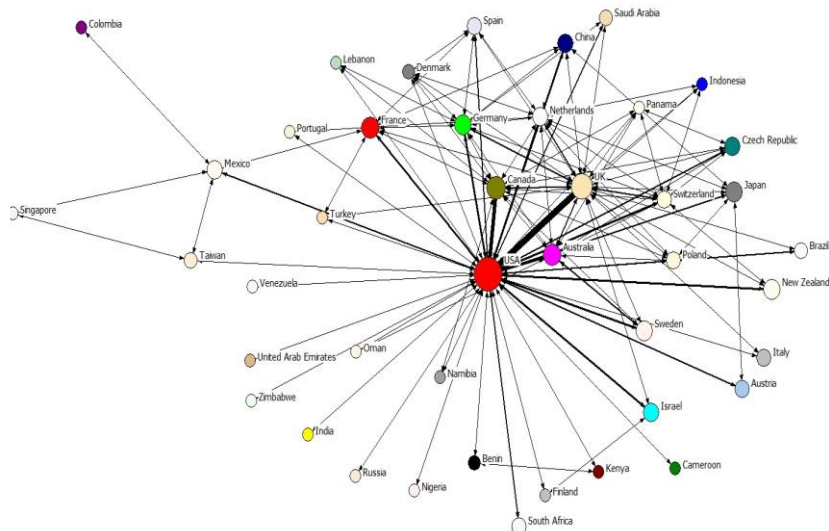


NIMBioS also fosters international collaboration among researchers. While 43 different countries have been represented by NIMBioS coauthorship through the current reporting period, the average number of countries of coauthors per paper is 1.6, with a range of 1-6 countries represented per paper (Figure 40).

Node radius represents the log scaled number of NIMBioS-affiliated papers from each country, and line size represents the number of collaborations among countries on these papers.

Coauthors of NIMBioS publications through the current reporting period came from 389 unique institutions (Figure 41). The average number of institutions represented per paper was 2.74, with a range of 1-21 institutions per paper.

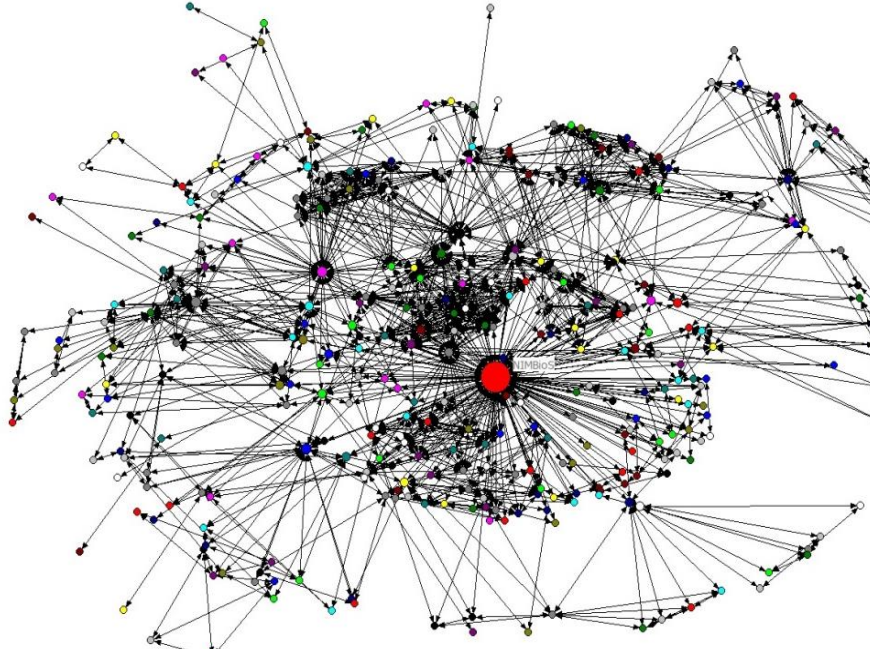
**Figure 40. International collaboration of NIMBioS publications**





Node radius represents the log scaled number of NIMBioS-affiliated papers from each institution, and line size represents the number of collaborations among institutions on these papers. NIMBioS is at the center of the graph.

**Figure 41. Cross-institutional collaboration of NIMBioS publications**



## OTHER SCHOLARLY PRODUCTS

In addition to journal publications, participants report other types of products that have resulted from their activities at NIMBioS. Figure 42 summarizes these types of products for the six-year period.

**Figure 42. Non-journal publication products arising from NIMBioS events**

