Evaluation Report

Investigative Workshop: New Soil Black Box Math Strategies

October 15-17, 2009

Pamela Bishop
Program Evaluation Coordinator
National Institute for Mathematical and Biological Synthesis
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Executive Summary

Brief Synopsis of Event

This report is an evaluation of a NIMBioS Investigative Workshop entitled "New Soil Black Box Math Strategies," which took place at NIMBioS October 15-17, 2009. NIMBioS Investigative Workshops are relatively large (30-40 participants), focus on a broader topic or a set of related topics than Working Groups, attempt to summarize/synthesize the state of the art and identify future directions, and have potential for leading to one or more future Working Groups. Participants may include post-docs and graduate students with less experience in the particular topic than those participating in Working Groups.

The New Soil Black Box Math Strategies group comprised 33 participants, including co-organizers Alison E. Bennett (University of Wisconsin) and James Umbanhower (University of North Carolina). Participants included a diverse collection of theoreticians and biologists specializing in fields such as agricultural sciences, ecology, and mathematics.

The focus of the Workshop was to work toward building a comprehensive picture of plant-soil interactions that could inform basic science as well as applied science, including restoration, conservation, and global change, with the goal of identifying theoretical frameworks for expanding our knowledge and driving the future of plant-soil interactions. Soil-plant interactions structure life as we know it. Research has demonstrated that individual plant communities, species and even individual genotypes can cultivate distinct soil communities of decomposers, mutualists, and pathogens. Various components of the plant-soil interaction have been explored, but few of these explorations have been integrated across ecological scales or included more than one component of the soil community. Similarly, individual theoretical approaches have focused on select groups (e.g. mutualists, decomposers, and pathogens) while excluding many soil organisms (e.g. soil fauna). In addition, theoretical approaches have rarely examined these groups at the same organizational scale, making it difficult to develop a comprehensive picture of plant-soil interactions.

Evaluation Design

An electronic survey aligned to the following evaluation questions was designed by NIMBioS' Evaluation Coordinator with input from the NIMBioS Director and Deputy Director:

1. Were participants satisfied with the Workshop overall?
2. Did the meeting meet participant expectations?
3. Do participants feel the Workshop made adequate progress toward its stated goals?
4. Do participants feel they gained knowledge about the main issues related to the research problem?
5. Do participants feel they gained a better understanding of the research across disciplines related to the Workshop's research problem?

6. What impact do participants feel the Workshop will have on their future research?
7. Were participants satisfied with the accommodations offered by NIMBioS?
8. What changes in accommodations, group format, and/or content would participants like to see at future similar meetings?

The final instrument was hosted online via the University of Tennessee's online survey host mrInterview. Links to the survey were sent to 32 Workshop participants on October 19, 2009 (NIMBioS Director Lou Gross, a participant in the group, was excluded from the evaluation). Reminder emails were sent to non-responding participants on October 26 and 29, 2009. By November 3, 2009, 31 participants had given their feedback, for a response rate of 97%

Highlights of Results

- Overall satisfaction with the Workshop was high among respondents, the majority of whom indicated they either agreed or strongly agreed that the Workshop was productive (90%) and met their expectations (81%).

- Almost all respondents thought the presentations were useful (81%), the presenters were very knowledgeable about their presentation topics (97%), and the group discussions were useful (85%).

- Ninety-seven percent of respondents either agreed or strongly agreed that they would recommend participating in NIMBioS Workshops to their colleagues.

- Overall, respondents reported being satisfied with the travel, housing, and other amenities provided by NIMBioS.

- Respondents reported relatively high levels of learning about new theoretical frameworks that need to be developed regarding plant-soil interactions. Learning gains, however, were lower regarding the research data available on plant-soil interactions, and how to adapt existing theoretical frameworks to fully use available data.

- Most respondents said the multidisciplinary composition of the Workshop was its most useful aspect.

- Eighty-seven percent of respondents agreed that the format of the Workshop was very effective for achieving its goals

- The majority of respondents (94%) agreed that the Workshop made adequate progress toward its goal of identifying theoretical frameworks for expanding knowledge about plant-soil interactions.

- Twenty-nine respondents said they felt that the exchange of ideas that took place during the Workshop would (or potentially would) initiate and/or influence their future research.

- Twenty-three respondents reported they developed solid plans for collaborative research with other Workshop participants, while six indicated they saw potential for collaboration in the future.

Conclusions and Recommendations

Overall, the Workshop was successful in making progress toward its goals. Survey respondents were satisfied with the meeting, indicating that it was a productive experience that met their expectations. Respondents were also satisfied with the travel, housing, and other amenities offered by NIMBioS.

The Workshop had good diversity regarding gender, occupational status, geographic dispersion, and research concentration of its participants; however, little diversity existed in the racial and ethnic composition of the group.

Respondents reported relatively high levels of learning about new theoretical frameworks that need to be developed regarding plant-soil interactions. Learning gains, however, were lower regarding the research data available on plant-soil interactions and how to adapt existing theoretical frameworks to fully use available data. A large majority of respondents said they felt that participating in the Workshop helped them understand the research going on in other disciplines regarding plant-soil interactions.

The majority of respondents agreed that the Workshop made adequate progress toward identifying theoretical frameworks for expanding knowledge about plant-soil interactions. Most respondents indicated they planned to take the knowledge they gained during the Workshop and apply it to their own research. Twenty-three respondents reported they had developed solid plans for collaborative research with other Workshop participants, while six indicated they saw potential for collaboration in the future.

Several ideas for improving future Workshops were suggested by participants, including better organization, and a more clearly defined agenda with clear objectives and goals. Other suggestions from respondents included providing participants with more background information/reading materials before the Workshop, providing more whiteboards, distributing an electronic version of the welcome packet, and a healthier selection of snacks.

Based on analysis of participant response data, the recommendations for future Workshops are as follows:

- Ensure that a clearly defined agenda with clear objectives and goals is conveyed to Workshop participants before the start of the Workshop, and discuss the day's objectives at the start of each day of the Workshop.
- A common suggestion from participants was to provide more background reading before the start of the workshop. The Wiggio group is designed to be used for this purpose; however, 11 participants did not join the Wiggio group, and two joined only after the conclusion of the workshop. Workshop organizers should work to ensure that all participants are aware of/join the Wiggio associated with the workshop. All registered participants are initially invited by NIMBioS to join the Wiggio, but it is up to organizers to encourage participants who have not accepted the invitation to join to do so. NIMBioS staff should ensure that this responsibility is conveyed more clearly to workshop organizers in the future.

- Make more background research and reading materials available to all participants before the Workshop. If feasible, consider offering a preconference webinar to Workshop participants to get everyone up to date on the latest research about the Workshop research problems.
- When possible, provide electronic copies of presentations to participants before (or even during) the workshop.
- Clearly define and communicate the goals of each of the breakout group discussion sessions each day.
- Before the conclusion of the Workshop, consider designating a specific time slot to synthesize the information provided, address the next steps that should be taken, and assign specific tasks to individuals or groups with tentative timelines for completion.

New Soil Black Box Math Strategies Workshop Evaluation Report

Background

Introduction

This report is an evaluation of a NIMBioS Investigative Workshop entitled "New Soil Black Box Math Strategies," which took place at NIMBioS October 15-17, 2009. NIMBioS Investigative Workshops are relatively large (30-40 participants), focus on a broader topic or a set of related topics than Working Groups, attempt to summarize/synthesize the state of the art and identify future directions, and have potential for leading to one or more future Working Groups. Participants may include post-docs and graduate students with less experience in the particular topic than those participating in Working Groups.

The New Soil Black Box Math Strategies group comprised 33 participants, including co-organizers Alison E. Bennett (University of Wisconsin) and James Umbanhower (University of North Carolina). Participants included a diverse collection of theoreticians and biologists specializing in fields such as agricultural sciences, ecology, and mathematics. The focus of the Workshop was to work toward building a comprehensive picture of plant-soil interactions that could inform basic science as well as applied science, including restoration, conservation, and global change, with the goal of identifying theoretical frameworks for expanding knowledge and driving the future of plant-soil interactions.

Workshop Background

Soil-plant interactions structure life as we know it. Research has demonstrated that individual plant communities, species and even individual genotypes can cultivate distinct soil communities of decomposers, mutualists, and pathogens. Various components of the plant-soil interaction have been explored, but few of these explorations have been integrated across ecological scales or included more than one component of the soil community. Similarly, individual theoretical approaches have focused on select groups (e.g. mutualists, decomposers, and pathogens) while excluding many soil organisms (e.g. soil fauna). In addition, theoretical approaches have rarely examined these groups at the same organizational scale, making it difficult to develop a comprehensive picture of plant-soil interactions.

Participant Demographics

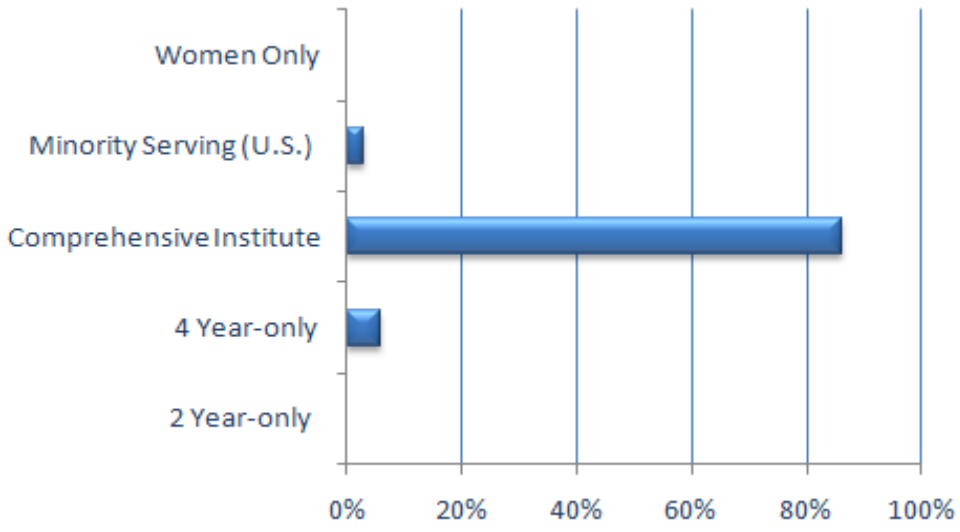
Program participants were college/university faculty (65%), graduate students (12%), postdoctoral researchers (21%), or college/university staff (1%). Primary fields of study for the 33 participants included agricultural sciences/natural resources, biological/biomedical sciences, and mathematics. (Table 1).

Table 1. *Participant fields of study and areas of concentration*

Field of Study	Concentration	# Participants
Agricultural Sciences/Natural Resources	Environmental Science	1
	Forest Sciences	1
	Natural Resources/Conservation	1
	Plant Pathology	2
	Soil Chemistry/Microbiology	2
	Soil Sciences, other	1
Biological/Biomedical Sciences	Ecology	14
	Evolutionary Biology	1
	Mathematical Biology	2
	Mathematical Ecology	2
Mathematics	Applied Mathematics	3
	Mathematical Biology	1
	Statistics	2

Participants represented 27 different institutions across three countries, including Canada, China, and the United States. Within the U.S., 17 different states were represented. Of the 26 different colleges/universities, most were classified as comprehensive (having undergraduate and graduate programs) schools (Figure 1).

Figure 1. Characteristics of participants' colleges/universities (n=26)



The 18 females and 15 males (two of whom self-identified as being of Hispanic/Latino ethnicity) mostly self-identified racially as white (Figures 2 & 3).

Figure 2. Racial composition of program participants (n=33)

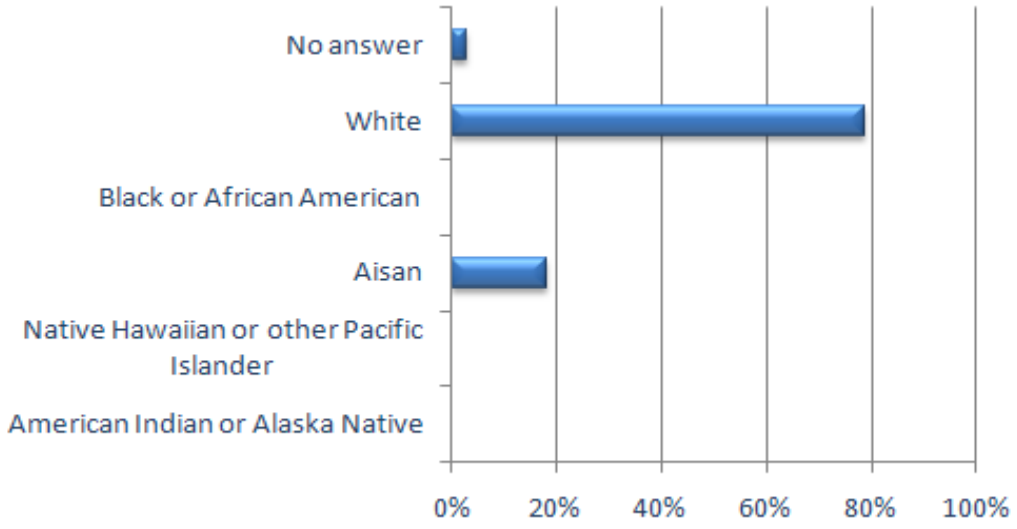
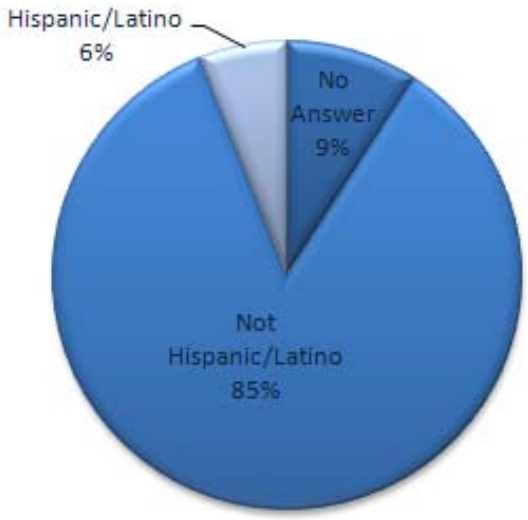


Figure 3. Ethnic composition of program participants (n=33)



Seven respondents indicated their work is currently supported by a total of nine National Science foundation grants (Table 2).

Table 2. *NSF grants supporting participant research*

Name of grant	Institution at which grant is held
Biological Dynamics at Intermediate Time Scales	University of California Davis
Biotic, Chemical, and Physical Controls Over Organic Nitrogen Cycling in Temperate Forest Soils	University of New Hampshire
Collaborative Research: Comparative Analysis of Salmon and Cod Population Responses	University of Massachusetts Amherst
Diffusion-Limitation of Predator-Prey Dynamics	University of Ohio
Collaborative Research: Epidemic waves, landscape heterogeneity, and Spatial Scale	Kansas State University
Experimental Constraints on Contributions of Mycorrhizal Symbioses to Bedrock Weathering of Calcium and Magnesium	University of New Hampshire
Fungal Life History Strategies and Evolution: Insights Into Mycorrhizal and Saprotrophic Persistence from Isotopic Measurements	University of New Hampshire
Immersed Boundary Problems in Biological Fluid Dynamics	University of North Carolina Chapel Hill
Mechanisms Maintaining Cooperation in Rhizobial Populations	University of California Berkeley
Collaborative Research: Range Limits and Their Response to Environmental Change	University of Colorado Boulder
Collaborative Research: Relationship Between Carbon Allocation to Mycorrhizal Fungi and Organic Nitrogen Use in Temperate Forests	SUNY College of Environmental Science and Forestry
Trait-Mediated Indirect Interactions: Effects on Community Assembly, Species Loss, Spatial Structure and Diversity-Stability Relationships	Antonio J Golubski (International Research Fellowship Program)

Evaluation Design

Evaluation Questions

The evaluation of the Workshop was both formative and summative in nature, in that the data collected from participants was intended to both gain feedback from participants about the quality of the current Workshop and also to inform future meetings. The evaluation framework was guided by Kirkpatrick's Four Levels of Evaluation model for training and learning programs (Kirkpatrick, 1994[1]). The evaluation questions were developed according to level one of the model, participants' reactions, in order to gather information about how participants felt about the content and format of the Workshop, as well as the accommodations provided by NIMBioS. Several questions constituted the foundation for the evaluation:

1. Were participants satisfied with the Workshop overall?
2. Did the meeting meet participant expectations?
3. Do participants feel the Workshop made adequate progress toward its stated goals?
4. Do participants feel they gained knowledge about the main issues related to the research problem?
5. Do participants feel they gained a better understanding of the research across disciplines related to the Workshop's research problem?
6. What impact do participants feel the Workshop will have on their future research?
7. Were participants satisfied with the accommodations offered by NIMBioS?
8. What changes in accommodations, group format, and/or content would participants like to see at future meetings?

Evaluation Procedures

An electronic survey aligned to the evaluation questions was designed by NIMBioS' Evaluation Coordinator with input from the NIMBioS Director and Deputy Director. The final instrument was hosted online via the University of Tennessee's online survey host mrInterview. Links to the survey were sent to 32 Workshop participants on October 19, 2009 (NIMBioS Director Lou Gross, a participant in the group, was excluded from the evaluation). Reminder emails were sent to non-responding participants on October 26 and 29, 2009. By November 3, 2009, 31 participants had given their feedback, for a response rate of 97%

Data Analysis

Data from the electronic survey included both forced-response and supply-item questions. All data were downloaded from the online survey host into the statistical software package SPSS for analysis. Quantitative data were analyzed using SPSS, while qualitative data were analyzed in SPSS Text Analysis for Surveys. Qualitative responses were categorized by question and analyzed for trends.

[1] From Kirkpatrick, D.L. (1994). *Evaluating Training Programs: The Four Levels.* San Francisco, CA: Berrett-Koehler.

Findings

Overall Satisfaction

Overall satisfaction with the Workshop was high among respondents, the majority of whom indicated they either agreed or strongly agreed that the Workshop was very productive (90%) and met their expectations (81%). Some general participant comments:

> *"The meeting was incredibly stimulating and valuable. I'm grateful that I had a chance to attend."*
>
> *"Great program! Thanks to the small staff who do everything!"*
>
> *"The large group workshop format was an effective way to explore a large field and allow mixing of different types of scientists. I didn't think it was going to work well, but it actually did. However, it led pretty directly to the need for more time for smaller collaborative groups to get together. I guess it is a sign of the success of the workshop that I was immediately wishing for more time to talk and work with the participants."*

Almost all respondents thought the presentations were useful (81%), the presenters were very knowledgeable about their presentation topics (97%), and the group discussions were useful (86%). Additionally, 97% of respondents either agreed or strongly agreed that they would recommend participating in NIMBioS Workshops to their colleagues (Table 3).

Table 3. *Participant satisfaction with various aspects of the Workshop, by level of agreement*

	n	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I feel the Workshop was very productive.	31	58%	32%	10%	0%	0%
The Workshop met my expectations.	31	55%	26%	19%	0%	0%
The presenters were very knowledgeable about their topics.	31	45%	52%	3%	0%	0%
The presentations were useful.	31	23%	58%	19%	0%	0%
The group discussions were useful.	31	65%	23%	7%	7%	0%
I would recommend participating in NIMBioS Workshops to my colleagues.	31	71%	26%	3%	0%	0%

Satisfaction with Accommodations

Overall, respondents reported being satisfied with the travel, housing, and other accommodations provided by NIMBioS during the Workshop. Twenty-nine respondents answered questions about their travel accommodations, 28 of whom said they were satisfied with their accommodations, while one indicated feeling "neutral."

The majority of participants reported being satisfied with the comfort and resources of the NIMBioS facility, as well as the quality of meals provided (Table 4). Several participants, however, indicated they would like some lighter vegetarian meals and more drink options.

Table 4. *Participant levels of satisfaction with Workshop accommodations*

Please indicate your level of satisfaction with the Workshop accommodations:	*n*	Very satisfied	Satisfied	Neutral	Dissatisfied	Strongly dissatisfied
Comfort of the facility in which the Workshop took place	31	74%	23%	3%	0%	0%
Resources of the facility in which the Workshop took place	31	71%	26%	3%	0%	0%
Quality of meals	31	71%	26%	3%	0%	0%
Quality of drinks and snacks provided	31	61%	32%	7%	0%	0%

Workshop Content and Format

Participant Learning

Ninety-four percent of respondents said they felt that participating in the Workshop helped them understand the research going on in other disciplines regarding plant-soil interactions:

> *"I was worried that the group would be too large and would fragment into sub-disciplinary interest groups, but there appeared to be some real cross fertilization and conversation across biological and theoretical approaches."*

> *"It was very interesting to see the way that ecologists model plant soil interactions and the ways that math models might be used to improve understanding. I was very impressed by the NIMBioS staff as well!"*

> *"My primary background is in applied mathematics, and I knew little about plant-soil interactions before attending this workshop. So through this workshop, I was able to learn about different perspectives on this topic."*

Respondents were also asked several questions to gauge their levels of learning about specific issues related to the research problem. Respondents reported relatively high levels of learning about new theoretical frameworks that need to be developed regarding plant-soil interactions. Learning gains, however, were lower regarding the research data available on plant-soil interactions, and how to adapt existing theoretical frameworks to fully use available data (Table 5). One of the respondent s who disagreed that they learned anything about the research data available on plant-soil interactions had this to say:

"There was not an attempt to summarize or time to discuss what research has been conducted to date. There really should have been an overview presentation of soil ecology research that has used mathematical modeling. Instead, it seems that we are now reviewing this work after the meeting to prepare for a possible manuscript. It would have been much more helpful to do this review before hand and have someone present a summary which would have catalyzed more productive discussion. This was the most disappointing aspect of the workshop."

Table 5. *Participant self-reports of learning about issues related to the Workshop's research problem*

As a result of participating in this Workshop, I have a better understanding of:	*n*	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
mathematical tools available for explaining plant-soil interactions.	31	26 %	58%	7%	10%	0%
the research data available on plant-soil interactions.	31	20%	39%	32%	10%	0%
new theoretical frameworks that need to be developed regarding plant-soil interactions.	31	42%	42%	13%	3%	0%
how to adapt existing theoretical frameworks to fully use available data.	31	26%	48%	16%	10%	0%

Progress Toward Goals

Eighty-seven percent of respondents felt the Workshop format was effective for achieving it goals. The majority of respondents (94%) agreed that the Workshop made adequate progress toward identifying theoretical frameworks for expanding knowledge about plant-soil interactions. While most participants were happy with the group's progress toward this goal, several respondents made comments about how they would improve the process:

"…I would have liked a better introduction to theoretical modeling types. Often they were just referred to as acronyms. I have had theoretical ecology classes, but that was 10 years ago and I don't use those approaches very often - so I could not quickly recall those models."

"If I had to add anyone to the discussion, I would have added someone who dealt with physics of gas/water/solids and movement of nutrients, and possibly another person interested in restoration on soil."

"I believe progress was made, but again an extra 1/2 day may have helped. The use of WIGGIO and Google documents to keep working on this goal is highly beneficial and seems to be working out well. So, even though the extra time would be great, the organizers are making up for it in part by using the web tools mentioned."

Impact on Future Research Plans

Most respondents said the multidisciplinary composition of the Workshop was its most useful aspect, as they were able to learn from those in fields other than their own:

> *"I felt we had a great mix of participants, with an extremely diverse set of viewpoints on the overarching questions. Most of the thinking I did at the workshop was a reach for me--out of my comfort zone, as we were encouraged to be--but turned out to be a lot of fun."*

> *"It is wonderful to have a group of people who are in somewhat different scientific subcultures and who are interested in figuring out how to communicate and develop projects across those subcultures."*

> *"The diverse composition of the group was super! I felt like the organizers did a really great job in covering a wide breadth of research with the people that were invited to the workshop. I enjoyed my discussions with various participants over coffee and dinner. In a way, I learned more about what people were doing and their approaches to understanding plant-soil relationships from these informal conversations than the formal break out groups."*

> *"The free flow of ideas...opened up huge amount of creativity [in] the spirit of collaboration. The renewal of purpose that comes with sharing your work with peers who think that the work is valuable ...it is the collaborations that will lead to papers, and to joined theoretical explorations of soil and joined experimental approaches that will dovetail into the theory."*

Other respondents felt the break-out group discussions were the most useful aspect of the Workshop:

> *"Breakout groups were a very effective way to discuss ideas with the depth and focus needed to actually start developing the theory we were all talking about in the big group discussions."*

> *"I felt the break out groups were really useful and productive."*

Twenty-nine respondents said they felt that the exchange of ideas that took place during the Workshop would (or potentially would) initiate and/or influence their future research. Some participant comments:

> *"I hope that I can continue to strive to take my research 'to the next level' by including a strong modeling component of my concepts/results. I will continue to do research with this in mind. I did not think this way before the workshop."*

> *"I talked with another researcher who I hadn't met before on writing an NSF grant together in the future on our common interests. The connection with her was valuable. I'm also considering writing a review and measuring data in my current experiment to support an observation that I hadn't realized wasn't well known."*

> *"I will be much more aware of thinking about how my data could be used in a mathematical model and the biggest personal benefit of the workshop was increasing my sophistication and vocabulary for thinking about this. I would be more likely now than before to approach a modeler to collaborate on a project using my data. However, I know that I could never do modeling on my own, now have the desire to try."*

"The feedback models we develop will motivate new manipulative experiments that I will design and conduct in my empirical study system of legumes and rhizobia."

"There were too many ideas around to not put some on the queue of future theoretical projects. I'm keenly interested in extending theory about mycorrhizal fungi into the functioning of soil communities and the workshop exposed me to some of the more important biological questions that need addressing."

In addition to new ideas for research, 23 respondents said that they developed plans for collaborative research with other Workshop participants, while six said the potential for collaboration was present:

"I did not expect one workshop participant to be working on a topic that highly complements my work. We ended up "merging" our conceptual models and outlining a manuscript. Other participants added a strong math component and hopefully we will be able to do some simulation modeling of our conceptual model. All of this was unexpected and exciting. I was very happy to find most participants very open to collaboration and helpful. I hope to maintain professional contact with several workshop participants."

"I'm excited to participate in the group that formed around developing a common mathematical framework for the Production Economy of Mutualisms (PEM)."

"I'm very excited by the collection of modelers and empiricists who worked on game theory to explore population and ecosystem feedback effects of the outcomes of negotiations between plant and microbial symbionts. I've thought about these ideas a lot over the past 15 years but have been unable to develop a cogent theoretical framework. This group is like a dream come true: modelers interested and able to tackle these problems that have been puzzling me for 15 years!"

"The game theory/economics group tied together my interest in mycorrhizas with rhizobium. These areas are frequently mentioned together in passing, but little synthetic work has really been done to understand these two critical plant-soil symbioses."

Suggestions for Future Workshop Meetings

Respondents were asked for suggestions for improving future Workshops. Several themes emerged from analysis of participant responses, including better organization and having more information available before the workshop. Suggestions for better organization included a more clearly defined agenda with clearly communicated objectives and goals:

"I think the first day could have been structured better to get people working together."

"I would have liked a bit more structure. I understand that it is largely up to the participants to engage and make the workshop successful, but feel that the participants often weren't quite sure of what was expected from them."

"Having a better plan for the end --- we worked on the outline for a common paper and then half of the participants had to leave to catch their flights --- most of the energy left the room with the first batch of people leaving.---- but it was all good."

"I might have had 2 additional introductory lectures -- one to summarize what is known about the plant-soil interactions and one introduction to mathematical modeling. It seemed like we addressed these issues multiple times in the small groups and I wonder if introductory lectures might have given us a more common starting point."

Some respondents suggested it would also be useful to make background information about the research problem available to participants before the Workshop so they would feel more prepared:

"Better organization and clearer goals. I think having more information ahead of time (e.g., techniques to consider, a few guiding questions, and background reading) would have helped to better structure the group time."

"I would provide more background initially about different aspects of soil ecology/modeling/theoretical frameworks. A more robust initial reading list would help, perhaps having participants nominate ahead of time one or 2 articles that they think are at the cutting edge/advance the field/challenge our assumptions/review the literature well."

"Might be useful to begin more of the discussion before arrival, perhaps on a message/discussion board?"

"Make a forum to propose some general topics and encourage more interactive communications between the participants before they come together."

Other suggestions included providing more whiteboards, distributing an electronic version of the welcome packet, and a healthier selection of snacks.

Conclusions and Recommendations

Overall, the Workshop was successful in making progress toward its goals. Survey respondents were satisfied with the meeting, indicating that it was a productive experience that met their expectations. Respondents were also satisfied with the travel, housing, and other amenities offered by NIMBioS.

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The majority of respondents agreed that the Workshop made adequate progress toward identifying theoretical frameworks for expanding knowledge about plant-soil interactions. Most respondents indicated they planned to take the knowledge they gained during the Workshop and apply it to their own research. Twenty-three respondents reported they had developed solid plans for collaborative research with other Workshop participants, while six indicated they saw potential for collaboration in the future.

Several ideas for improving future Workshops were suggested by participants, including better organization, and a more clearly defined agenda with clear objectives and goals. Other suggestions from respondents included providing participants with more background information/reading materials before the Workshop, providing more whiteboards, distributing an electronic version of the welcome packet, and a healthier selection of snacks.

Based on analysis of participant response data, the recommendations for future Workshops are as follows:

- Ensure that a clearly defined agenda with clear objectives and goals is conveyed to Workshop participants before the start of the Workshop, and discuss the day's objectives at the start of each day of the Workshop.
- A common suggestion from participants was to provide more background reading before the start of the workshop. The Wiggio group is designed to be used for this purpose; however, 11 participants did not join the Wiggio group, and two joined only after the conclusion of the workshop. Workshop organizers should work to ensure that all participants are aware of/join the Wiggio associated with the workshop. All registered participants are initially invited by NIMBioS to join the Wiggio, but it is up to organizers to encourage participants who have not accepted the invitation to join to do so. NIMBioS staff should ensure that this responsibility is conveyed more clearly to workshop organizers in the future.
- Make more background research and reading materials available to all participants before the Workshop. If feasible, consider offering a preconference webinar to Workshop participants to get everyone up to date on the latest research about the Workshop research problems.
- When possible, provide electronic copies of presentations to participants before (or even during) the workshop.
- Clearly define and communicate the goals of each of the breakout group discussion sessions each day.
- Before the conclusion of the Workshop, consider designating a specific time slot to synthesize the information provided, address the next steps that should be taken, and assign specific tasks to individuals or groups with tentative timelines for completion.

Appendix A: List of Participants

Participants

Last name	First name	Institution
Abbott	Karen	Iowa State University
Apostol	Kent	Bethel University
*Bennett	Alison	University of Wisconsin Madison
Bever	James	Indiana University Bloomington
Biederman	Lori	Iowa State University
Borrett	Stuart	University of North Carolina Wilmington
Byrne	Loren	Roger Williams University
Classen	Aimee	University of Tennessee Knoxville
Cuddington	Kim	University of Waterloo
de Graaff	Marie-Anne	Oak Ridge National Laboratory
Garrett	Karen	Kansas State University
Golubski	Antonio	University of Toronto
Gross	Louis	NIMBioS
Hastings	Alan	University of California Davis
Hobbie	Erik	University of New Hampshire
Hoeksema	Jason	University of Mississippi
Hrynkiv	Volodymyr	University of Houston Downtown
Karst	Justine	University of Alberta
Kummel	Miroslav	Colorado College
Lee	Charlotte	Florida State University
Leng	Kun (Justine)	State University of New York Buffalo
Liang	Chao	University of Wisconsin Madison
Liao	Wei (Joy Key Rose)	University of Mississippi
Miller	Laura	University of North Carolina Chapel Hill

Last name	First name	Institution
Ownley	Bonnie	University of Tennessee Knoxville
Richardson	Sarah	DePaul University
Rojas Alvarado	Claudia	Pennsylvania State University
Simms	Ellen	University of California Berkeley
*Umbanhower	James	University of North Carolina Chapel Hill
Walsh	Vonda	Virginia Military Institute
Warren	Matthew	Chinese Academy of Sciences
Mack	Keenan	Indiana University Bloomington
Zhu	Jun	Colorado State University

*** Organizer of Workshop**

Appendix B: New Soil Black Box Math Strategies Workshop Survey

New Soil Black Box Math Strategies Survey

Thank you for taking a moment to complete this survey. Your responses will be used to improve the Workshops hosted by the National Institute for Mathematical and Biological Synthesis. Information supplied on the survey will be confidential, and results will be reported only in the aggregate.

NIMBioS will send two reminder emails to Workshop participants who have not responded to this survey. If you would like to be excluded from these reminder emails, please enter your name below. Your survey results will still remain confidential and your name will not be associated with any of your responses in reporting of survey results.

Name:

Workshop Evaluation

How did you hear about this Workshop?

Please check the appropriate box to indicate your level of agreement with the following statements about this Workshop: (Very satisfied, Satisfied, Neutral, Dissatisfied, Very dissatisfied)

I feel the Workshop was very productive.
The Workshop met my expectations.
The presenters were very knowledgeable about their topics.
The presentations were useful.
The group discussions were useful
I would recommend participating in NIMBioS Workshops to my colleagues.

Please check the appropriate box to indicate your level of agreement with the following statements. As a result of participating in this Workshop, I have a better understanding of:
(Strongly agree, Agree, Neutral, Disagree, Strongly disagree)

mathematical tools available for explaining plant-soil interactions
the research data available on plant-soil interactions
new theoretical frameworks that need to be developed regarding plant-soil interactions
how to adapt existing theoretical frameworks to fully use available data

Do you feel that participating in the Workshop helped you understand the research going on in other disciplines regarding plant-soil interactions?
Yes
No
Comments:

Do you feel the Workshop made adequate progress toward its goal of identifying theoretical frameworks for expanding our knowledge about plant-soil interactions?
Yes
No
Comments:

Do you feel that the exchange of ideas that took place during the Workshop will influence your future research? Please explain:

Did you develop unanticipated plans for collaborative research with other Workshop participants? Please explain:

What do you feel was the most useful aspect of the Workshop?

What would you have changed about the Workshop?

How do you feel about the format of the Workshop?
This was a very effective format for achieving our goals
This was not a very effective format for achieving our goals ->
The Workshop format would have been more effective if:

Please indicate your level of satisfaction with the Workshop accommodations:
(Very satisfied, Satisfied, Neutral, Dissatisfied, Very dissatisfied, Not applicable)

Travel arranged by NIMBioS
Housing arranged by NIMBioS
Comfort of the facility in which the Workshop took place
Resources of the facility in which the Workshop took place
Quality of meals
Quality of drinks and snacks provided

Please indicate any changes NIMBioS can make to improve the resources and/or accommodations available to Workshop participants:

Communications Evaluation

NIMBioS is currently exploring innovative avenues for communication among its Workshop participants. Your responses to the following questions will allow us to better understand the communication needs of our scientific communities.

How satisfied were you with the opportunities provided during Workshop presentations and discussions to ask questions and/or make comments?

Very satisfied
Satisfied
Neutral
Dissatisfied
Very Dissatisfied

Please indicate any suggestions you have for facilitating communication among participants during the Workshop:

If you maintain a blog about your research and would like a link posted on the NIMBioS website, please provide the URL here, along with a brief description of the blog:

Please provide any additional comments about your overall experience with the Workshop:

Appendix C: Open-ended Survey Responses

Do you feel that participating in the Workshop helped you better understand the research going on in disciplines other than your own regarding plant-soil interactions? (n=17)

Although I feel there were many aspects of soil properties that were ignore and should be considered. Which made me feel confuse about the positive predictions that these models can provide.

I feel that the workshop was a success, and very beneficial to myself and other participants. I would highly recommend NIMBioS to my colleagues. I hope to visit Nimbios again in the future, and believe that it will continue to develop as an institute and help to advance mathematical and biological synthesis. My only recommendation is that the workshops be extended to at least 3 full days, and possibly 4 full days. Day 1 is necessary for all introductions, presentations, getting to know each other, identifying topics, etc. Day 2 is used for specific break out groups to really concentrate on a topic, and get the ideas/concepts identified and agreed upon. A full day three is needed to make concrete synthesis and progress on the idea. A half or full day 4 could be used for synopsis, summary, creating an action plan, etc.

I learned a lot about the development of plant-soil interaction models at the ecosystem level. I particularly enjoyed the lecture on network theory. I've read papers on it and spent some time looking into it, but the lecture provided a nice comprehensive overview of the tools and the questions they can and cannot answer. I enjoyed the discussions on what theory is best at doing and how it clarifies our understanding of complex interactions.

I really came away enthused and eager to follow up on many of the ideas generated.

I think the workshop could have been better organized with clearer goals - that being said, I learned something and made new contacts in an area I had not previously explored.

I was worried that the group would be too large and would fragment into sub-disciplinary interest groups, but there appeared to be some real cross fertilization and conversation across biological and theoretical approaches.

interactions within our breakout group concerning a narrower sub-topic were the most valuable part of the workshop for me

It became obvious that "new biologists" will need a toolkit of diverse mathematical and computational approaches to form hypotheses, design experiments and analyze results.

It was very interesting to see the way that ecologists model plant soil interactions and the ways that math models might be used to improve understanding. I was very impressed by the NIMBioS staff as well!

My primary background is in applied mathematics, and I knew little about plant-soil interactions before attending this workshop. So through this workshop, I was able to learn about different perspectives on this topic.

Thank you so much for hosting the workshop. I have greatly enjoyed it and started several collaborations that would have never came about without the workshop Some suggestions for improvement would include having a larger number of small spaces available for discussion in small groups, having more white boards to write things on, and setting the tables in the large lecture hall up in a horse shoe formation so that all the participants can see each others during discussions. That said, the workshop worked very well. The most valuable things that I took from the workshop were connections to other people. As I mentioned, we started new collaborations. In addition to that it was great to get comments from other people on my work, and to share ideas freely. I think that the free sharing of ideas was especially helpful. It gave us the space to collaborate and to build on each other's ideas in ways that would not have been possible otherwise. Also bringing us out of our "home turf" was important in making bridges.

Thanks for a great, informative, and productive workshop.

The most valuable parts of the meeting were the group discussions. Recombining several times to discuss different ideas was a terrific way to organize the discussions--very stimulating. I was absolutely energized by the scientific discussions and am looking forward to working with my group in the future. I also became aware of data and models that I hadn't connected with before, which was useful. I also thought that asking people what they want to get from models was useful. An idea from this was incorporated in a goal of our group project.

The workshop was very helpful as an opportunity to meet others outside of my narrow interests and to give me a sense of particularly the more theoretical side of the field. I think it could have used more background at the outset on what are the gaps in attempts to bridge plants and soil systems. The ultimate worth of the exercise will not be apparent for a while I think, as individual groups from the workshop make progress in their own particular topics.

There could have been more structure to identifying participants' research focus. For example, perhaps 5-10 mins (rather than 2-3 mins) could have been devoted to introducing ourselves and what we do. In this time we could have also stated what the major questions were in our fields. I believe by doing so, we would have been better organized and directed in the break out groups, in addition to giving participants a better understanding of the empirical and theoretical research being conducted on the topic. I would have loved to hear more detail on the kinds of models mathematicians generally use to describe the ecological questions.

There was not an attempt to summarize or time to discuss what research has been conducted to date. There really should have been an overview presentation of soil ecology research that has used mathematical modeling. Instead, it seems that we are now reviewing this work after the meeting to prepare for a possible manuscript. It would have been much more helpful to do this review before hand and have someone present a summary which would have catalyzed more productive discussion. This was the most disappointing aspect of the workshop.

Very useful and stimulating

Do you feel the Workshop made adequate progress toward its goal of identifying theoretical frameworks for expanding our knowledge about plant-soil interactions? (n=14)

Although I would have liked a better introduction to theoretical modeling types. Often they were just referred to as acronyms. I have had theoretical ecology classes, but that was 10 years ago and I don't use those approaches very often - so I could not quickly recall those models.

But, I think it could have been more structured. I think it would have been more helpful if we had read a series of theory papers prior to coming.

I believe progress was made, but again an extra 1/2 day may have helped. The use of WIGGIO and Google documents to keep working on this goal is highly beneficial and seems to be working out well. So, even though the extra time would be great, the organizers are making up for it in part by using the web tools mentioned.

I believe that theoretical frameworks were identified but I felt somewhat disconnected with this development.

I learned about a few modeling approaches (networks mainly) but there was not an attempt to provide a general framework for empiricists to think about different types of models. Although a table was included in the paper we were supposed to have discussed, this table was not discussed (nor was the paper really) and apart from the two presentations on specific modeling approaches no attempt was made to discuss theoretical frameworks.

If I had to add anyone to the discussion, I would have added someone who dealt with physics of gas/water/solids and movement of nutrients, and possibly another person interested in restoration on soil.

It was obvious that several groups made significant progress on difficult problems.

It was very fruitful.

On a small scale. The big picture synthetic component was more weakly addressed, but this seemed appropriate given the state of the science.

The groups that formed will be making some key advances. However, there appears to be so much to be done that the best we could do in many areas was to identify holes. I think the most powerful aspect of the workshop was to bring people together across the math-theory/biology divide.

The in-deep discussion in the group made contribution to design a more reasonable, and hope more realistic model.

The progress made was truly phenomenal given the limited time.

While the workshop was intense, it was demonstrated that the researcher needs additional non-calculus approaches to model plant-soil interactions.

With the caveat that those groups working on theoretical frameworks are just getting going.

Do you feel that the exchange of ideas that took place during the Workshop will influence your future research? (n=13)

I am more aware of the potential for theoretical frameworks to be constructed and tested.

I hope that I can continue to strive to take my research "to the next level" by including a strong modeling component of my concepts/results. I will continue to do research with this in mind. I did not think this way before the workshop.

I look forward to using the broad PEM framework as inspiration for future empirical work on plant-mycorrhizal interactions.

I most definitely will develop graphical and computational techniques to model plant-soil interactions.

I talked with another researcher who I hadn't met before on writing an NSF grant together in the future on our common interests. The connection with her was valuable. I'm also considering writing a review and measuring data in my current experiment to support an observation that I hadn't realized wasn't well known.

I will be much more aware of thinking about how my data could be used in a mathematical model and the biggest personal benefit of the workshop was increasing my sophistication and vocabulary for thinking about this. I would be more likely now than before to approach a modeler to collaborate on a project using my data. However, I know that I could never do modeling on my own, now have the desire to try.

It seemed like a cursory biological overview was provided, and the major focus was on solving the model analytically. I think this approach alienated the empiricists in the group. Perhaps I should have joined a break out group that had fewer theoreticians? Because I was disconnected from the theoretical approach and couldn't explicitly link our biological questions of interest to the model, I can't see that I would draw on this experience to frame my future research. I feel really disappointed by this because I was looking forward to learning more on connecting theoretical with empirical research. In addition, aside from a brief comment in the last couple of hours (a remark on using homogenization), I didn't hear about any attempts to connect small spatial scale processes with larger spatial scale processes, which from my understanding was a major goal of the workshop. I would have loved to learn more about this.

Our group already plan to the short visit next year, and all of us agree to develop the group model first

overall more valuable in terms of facilitating networking and collaborations than greatly changing my perspective on theoretical problems I want to pursue

Perspectives from other participants were very valuable. Not only did they broaden my mind, but also they helped me establish new directions in my future research.

The feedback models we develop will motivate new manipulative experiments that I will design and conduct in my empirical study system of legumes and rhizobia.

The workshop led me to look back at ideas on metapopulations.

There were too many ideas around to not put some on the queue of future theoretical projects. I'm keenly interested in extending theory about mycorrhizal fungi into the functioning of soil communities and the workshop exposed me to some of the more important biological questions that need addressing.

Did you develop unanticipated plans for collaborative research with other Workshop participants? (n=14)

Currently working on a paper that considers the effect of varying movement rates on plant distributions

hopefully a review paper and one or more theory papers based on simple models will come from our breakout group, and I was approached about possibly contributing to a pre-existing collaborative effort between two other participants (as a postdoc these opportunities are especially welcome)

I am in one group working on a model and a paper that came out of the workshop.

I did not expect one workshop participant to be working on a topic that highly complements my work. We ended up "merging" our conceptual models and outlining a manuscript. Other participants added a strong math component and hopefully we will be able to do some simulation modeling of our conceptual model. All of this was unexpected and exciting. I was very happy to find most participants very open to collaboration and helpful. I hope to maintain professional contact with several workshop participants.

I was introduced to so many new and exciting topics, and I'd like to pursue collaborative research with other Workshop participants in the near future.

I will definitely have collaborations with individuals I have not worked with before.

I would like to develop graphical techniques to model and understand plant-soil interactions.

I'm excited to participate in the group that formed around developing a common mathematical framework for the Production Economy of Mutualisms (PEM).

I'm thrilled with the plans for my group working together in the future on a review paper and models.

I'm very excited by the collection of modelers and empiricists who worked on game theory to explore population and ecosystem feedback effects of the outcomes of negotiations between plant and microbial symbionts. I've thought about these ideas a lot over the past 15 years but have been unable to develop a cogent theoretical framework. This group is like a dream come true: modelers interested and able to tackle these problems that have been puzzling me for 15 years!

Our group is exchanging literature and two of us will meet in a month to review progress on comparing theoretical vs more process-based modeling of the same question.

That was the best part of the workshop.

The game theory/economics group tied together my interest in mycorrhizas with rhizobium. These areas are frequently mentioned together in passing, but little synthetic work has really been done to

understand these two critical plant-soil symbioses.

Those that stuck with their respective working groups got a lot out of it, but I got into one that was not as productive, and then it was too late to really feel like an effective member.

What do you feel was the *most* useful aspect of the Workshop? (n=31)

break-out groups

Breakout groups were a very effective way to discuss ideas with the depth and focus needed to actually start developing the theory we were all talking about in the big group discussions.

Bringing together modelers and empiricists to engage in dialogue.

Bringing together researchers doing partly related work, to support finding common ground to develop more general theory.

Getting a large group of people with diverse interests together to consider a broad, but highly relevant scientific question/objective. Also, having wonderful facilities and accommodating staff to provide an atmosphere conducive to productivity.

group discussions

Having researchers from different but related disciplines to meet and talk to each other about research.

I felt the break out groups were really useful and productive. I wish that were participants with whom I share similar research interests (whole plant biology and stress interactions).

I felt we had a great mix of participants, with an extremely diverse set of viewpoints on the overarching questions. Most of the thinking I did at the workshop was a reach for me--out of my comfort zone, as we were encouraged to be--but turned out to be a lot of fun.

I really appreciated that many participants came who were pretty inexperienced in theory were there and that discussions identified key misunderstandings between the theoreticians/mathematicians and empirical workers. Many of these discussions won't ever produce a research product, but I think that people will change their minds about the role of theory in the field and I think that is extremely important.

Interacting with others from different, but related disciplines

Interaction with modelers.

It is wonderful to have a group of people who are in somewhat different scientific subcultures and who are interested in figuring out how to communicate and develop projects across those subcultures.

Making new contacts

Meeting people, getting a better idea how theory people approach questions and pare down the variables to get to a nugget of importance. As an empirical person, I find collecting data to be so difficult, because everything is important, but I cannot possible sample everything. The group work helped in that respect

networking and chance to develop collaborations; interactions in breakout group

personal interactions and meeting people beyond my narrow specialty.

Scientists from different field

sharing ideas in groups, recombining at breaks to focus on different ideas, meeting researchers and modelers who I hadn't met before

Small break out working groups. Informal interactions

Small group discussions/sub working groups

some new conceptual model or modified model based on old one got established

Strong interactions among all participants. It was a great opportunity to meet mathematical and biological researchers and hear their perspectives.

The breakout groups - getting to work deeply with several people with different skills, all interested in the same questions.

The breakout groups were most useful.

The diverse composition of the group was super! I felt like the organizers did a really great job in covering a wide breadth of research with the people that were invited to the workshop. I enjoyed my discussions with various participants over coffee and dinner. In a way, I learned more about what people were doing and their approaches to understanding plant-soil relationships from these informal conversations than the formal break out groups.

The free flow of ideas that opened up huge amount of creativity the spirit of collaboration The renewal of purpose that comes with sharing your work with peers who think that the work is valuable on more tangible side it is the collaborations that will lead to papers, and to joined theoretical explorations of soil and joined experimental approaches that will dovetail into the theory

The mixing of theoreticians and empiricists

The wide variety of talented professionals.

The working groups

To interact with people with different background

What would you change about the Workshop? (n=29)

A few more tutorials to bring everyone up to speed.

Add more white boards!

An introduction to plant-soil interactions in general, and read ahead package that provided a more thorough introduction to the field.

Better organization and clearer goals. I think having more information ahead of time (e.g., techniques to consider, a few guiding questions, background reading) would have helped to better structure the group time.

By no means would I want an arrangement that would cause everyone to lose focus, but at several points I felt the need for a little unscheduled quiet time to mull over what I had learned, read a news paper, or struggle with a new point of view. The three days' duration felt right, but they did zoom by with not much time to turn around, it seemed.

Can't think of anything to change -- I thought everything went very well.

Have the whole-group meetings in a more circle-seating format. The classroom format made it more difficult to have a discussion. However, that would probably require a smaller group, which would result in fewer choices during the break-out periods.

Having a better plan for the end --- we worked on the outline for a common paper and then half of the participants had to leave to catch their flights --- most of the energy left the room with the first batch of people leaving.---- but it was all good.

I ate badly--lots of cookies and chocolate croissants. I should have eaten more healthy food and didn't feel good physically by the end. That wasn't the fault of the organizers, but more healthy snacks such as apple slices, humus, sliced or roasted vegetables, low fat yogurt could have helped.

I might have had 2 additional introductory lectures -- one to summarize what is known about the plant-soil interactions and one introduction to mathematical modeling. It seemed like we addressed these issues multiple times in the small groups and I wonder if introductory lectures might have given us a more common starting point.

I think the balance was right in having more time in smaller groups than big group, and switching between groups being possible but not required also felt like a good choice. I think maybe a slightly smaller total size would've helped the pace and focus of the large group discussions.

I think the first day could have been structured better to get people working together.

I would have asked participants before the workshop to prepare questions that they thought needed answers (empiricists) and to identify classes of models that were typically used to answer other ecologically relevant questions (theoreticians). I would have devoted some more time the first day to present this material. Or perhaps some reading material could have been made available on the different classes of models? I enjoyed the brief presentations by Charlotte and Stuart, and would have liked to have seen some more of this. I also didn't like the "dead time" during which theoreticians were busy attempting to analytically solve the proposed models. I wasn't sure what to do in that time, and

wasn’t entirely convinced that was a good use of the workshop time. For example, if one of the goals was to identify future working groups, maybe we should have spent some more time on that?

I would have liked a bit more structure. I understand that it is largely up to the participants to engage and make the workshop successful, but feel that the participants often weren't quite sure of what was expected from them.

I would provide more background initially about different aspects of soil ecology/modeling/theoretical frameworks. A more robust initial reading list would help, perhaps having participants nominate ahead of time one or 2 articles that they think are at the cutting edge/advance the field/challenge our assumptions/review the literature well.

I would suggest to bring more mathematicians.

I would've loved to have a field trip with all other participants. The workshop was kind of intensive, and I was feeling a bit exhausted at the end of the day. Also, perhaps it would've been better to send out all the relevant literature a few days ahead of time. Not everybody was an expert on this topic, and I had to do extensive reading on biology at the beginning of the conference to catch up.

It would be helpful to have a little more structure for the discussions and development of the group paper.

It would have been nice to have information about research interests of participants distributed to everyone before the workshop. This would facilitate better networking and expectations about the participants. It would have been helpful to have a pre-published information or description of the workshop.

make a forum to propose some general topics and encourage more interactive communications between the participants before they come together.

Might be useful to begin more of the discussion before arrival, perhaps on a message/discussion board?

More math language speaks

more whiteboards! A few more rooms for breakout groups--the number of groups was limited by the amount of space available

Nothing.

Pre-survey of needs and wants.

see earlier comments

The paper writing was sprung on us right at the end. I think that should have been done at the beginning to pare down the really important topics that should be attacked during the workshop. I feel that that table could have been a pre-meeting exercise by individuals, that could have been discussed right away- then we could have really gotten at the unanswered questions, rather than potentially

reinventing the wheel.

The way the listing of working group topics and breakout sessions was handles was frustrating, disorganized and rather appalling. I don't think the time was structured as well as it could have been. I would change the approach to the breakout sessions and have set aside more time for discussion of major questions.

To give mine lectures at the beginning of the workshop, to let people know the basic knowledge of other disciplines.

The Workshop format would have been more effective if: (n=3)

The organizers would have taken more of a leading role.

the participants were aware of the activities and informed of everyone's research interests ahead of time.

there was more planning about how to create meaningful breakout sessions. I hated the loose structure for this. There was no debate about what the most important questions/topics in soil ecology are that should be approached with modeling. Instead the topics that became the subject of working groups were people's pet interests which may or may not be relevant to addressing big questions in plant-soil interactions.

Please indicate any changes NIMBioS can make to improve the resources and/or accommodations available to Workshop participants: (n=17)

A large number of people do not drink soft drink, sweet tea. Perhaps more juice at breaks.

Add information about local events & transportation to the welcome packet?

Caffeinated black tea would be nice.

Dinner at the hotel was fine, but it would have been ideal to have access to wine or beer for that meal (although some participants did find a loophole in that regard, which was satisfactory).

Espresso!

Everything was exceptional. Thank you very much for your hard work!

It might be good to distribute electronic versions of some of the welcome packet, particularly the list of participant names with contact info (on a related note I forgot earlier, I did not find Wiggio particularly convenient and our group has decided to just use group emails and "reply all" for our further interactions).

It was terrific!

It would be nice to have smart boards or other facilities that would facilitate saving information from discussions. Best of all would be to have computers and/or software available to efficiently produce and save conceptual diagrams. But in general the facilities are quite nice.

Minor ones -- lights on the whiteboards, better printing support, projectors in all breakout spaces/rooms.

More space for break out groups.

More whiteboards and more break-out rooms--also the arrangement of the big room was less conducive to discussion--could it be arranged in a big circle or something?

Thanks!

The hotel rooms were clean, well-lighted, and staff were very helpful. I would be happy to share a hotel room to save NIMBioS money to allow more people to enjoy this opportunity. The NIMBioS facility was clean, chairs were comfortable and wonderfully intuitively adjustable. The posts in the center of the main room were an impediment to full group interaction. There needed to be more boards. I prefer chalkboards because the solvents and pigments in the whiteboard pens trigger my asthma. Excellent availability of printing, internet, and math software. The meals were very good - especially the vegetarian offerings, which can often be confined to steamed vegetables. The snacks were a little too heavy on cheap cookies. I appreciated the hot-pot devoted to tea-water (rather than being contaminated with disgusting coffee-water). However, it was too small and ran out of water constantly. I appreciated access to the microwave to heat my own drinks.

This part was top notch.

Too many sweet foods -- a generic problem in our culture.

You might suggest that people bring a laptop if they have one. I hadn't thought of it, and I was about the only one who didn't have one. I did use the computers at the hotel and NIMBioS, so it worked out ok. We had trouble regulating the temperature in our small conference room.

Please indicate any suggestions you have for facilitating communication among participants during the Workshop: (n=11)

again, maybe slightly smaller size

As usual, some participants spoke out a lot whereas others were relatively reticent. Workshop organizers did try to moderate discussions, but it did not change the usual conversational dynamic. Quieter people did sometimes participate more fully in breakout groups. It might be helpful to have smaller workshops. There was an attempt to involve people by providing opportunities to write questions on white boards.

I felt comfortable asking questions. I do believe that some did not feel comfortable.

I underestimated how much difficult it could be to speak one another's language (empiricists and theoreticians). I think some structured preparations could have helped with this (see comments before).

If a lot of communication is going to be done on computers during the meeting (such as by Wiki), suggest that people bring a laptop.

More time!

Need ways to encourage some of the younger participants to speak up.

occasionally there was a tendency for those more articulate or aggressive to lead discussions down particular avenues that may be unproductive for the group as a whole. The organizers could more actively moderate some of the discussions to ensure everyone's voice is heard.

some sort of an egroup

Unfortunately I was unable to check email in the 2 days leading up to the workshop, therefore I did not have adequate time to read the suggested article, or make other preparations. I suggest sending out reading material, or info to prepare for the workshop much farther in advance. I really did not know what to expect when the workshop started.

You could consider getting that gear that is used in classrooms sometimes to allow everyone to indicate, for example, whether they agree or disagree with a statement - and which then provides a summary of the responses to the organizer. (Sorry I don't remember what they're called...)

Please use this space for any additional comments: (n=4)

Great program! Thanks to the small staff who do everything!

Thank you very much for organizing this wonderful and successful workshop!!

The large group workshop format was an effective way to explore a large field and allow mixing of different types of scientists. I didn't think it was going to work well, but it actually did. However, it led pretty directly to the need for more time for smaller collaborative groups to get together. I guess it is a sign of the success of the workshop that I was immediately wishing for more time to talk and work with the participants.

The meeting was incredibly stimulating and valuable. I'm grateful that I had a chance to attend.