Agroecology Program
at Florida International University

Research, Education, Outreach

UNDERSTANDING SYNTHETIC BIOLOGY IN AGROECOSYSTEMS: BENEFITS AND RISK ASSESSMENT

Krish Jayachandran and Stephany Alvarez-Ventura

Department of Earth and Environment | Florida International University

Synthetic Biology Workshop | June 24-27th, 2014

FIU
Florida International University
Miami's public research university

Outline

- Identify links within current collaborative project: FCCAgE
- Colloquium
- Projects for iGEM
- Develop a working guildline

Identify Links

- Fall 2014
- Current Major Project: FCCAgE
  - MDC-Microbiology and medicine
  - STU- Plant Tissue Culture
  - IAU- Soils and Bioinformatics
- FIU
  - Faculty within various disciplines
- USDA-ARS
  - MM-Mars
  - Developing fungal disease resistance for Cacao
- UF-TREC
  - GMO Papaya-viral disease resistance

Development of Colloquium

- Spring 2015
- Colloquium
  - Discussions of Synthetic Biology with students and faculty of various disciplines
  - Ecological and Environmental Implications
  - Working Projects cross disciplines
  - Explore and evaluate iGEM projects
  - Lab activities- using Kits
- Presentations and Discussion session at FIU Agroecology Symposium

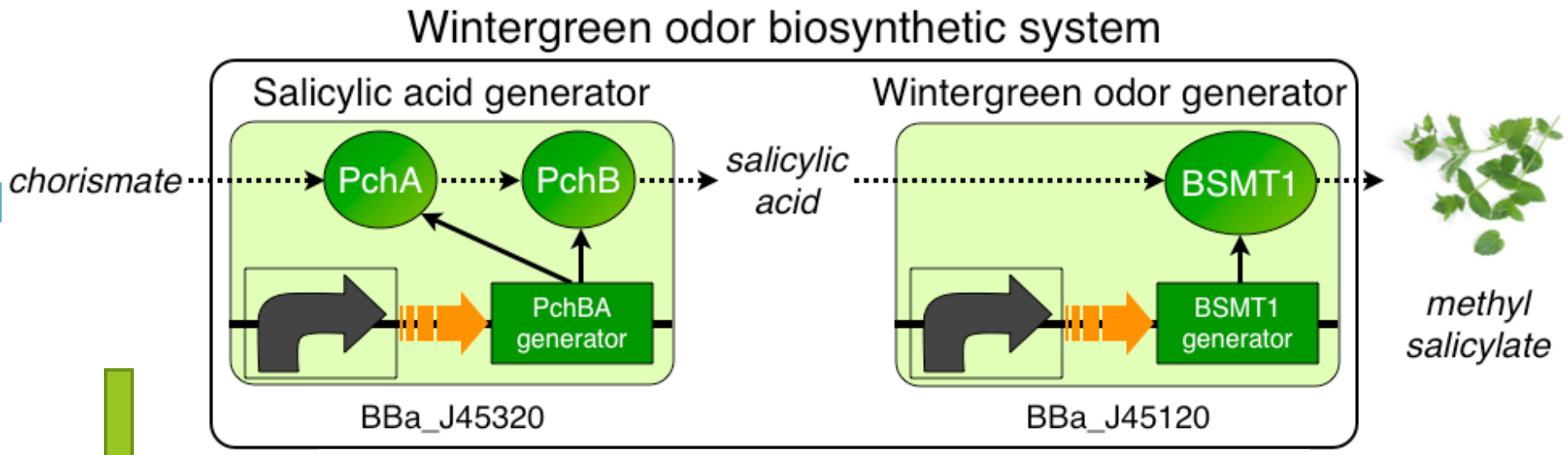
Sample Projects

- **Applications of Wintergreen Scent for Repellent of Varroa mite in Honey bee Colonies**

Table I. Toxicity of essential oils for *V. jacobsoni* and *A. mellifera* in percent [42].

Essential oil	MM. evap (%)			MM top. (%)		BM evap. (%)		
	24 h	48 h	72 h	24 h	48 h	24 h	48 h	72 h
Wintergreen	50	100		5	10	0	5	7

Imdorf, et.al. 1999



http://parts.igem.org/File:BBa_J45700.png

www.swissinfo.ch

$

?

FIU
Florida International University
Miami's public research university

Sample Project

- Understanding Soil Microbiology
  - Nitrogen-fixing and phosphorus solubilizing genes in plant growth promoting rhizobacteria
  - Benefits and Risk Assessment

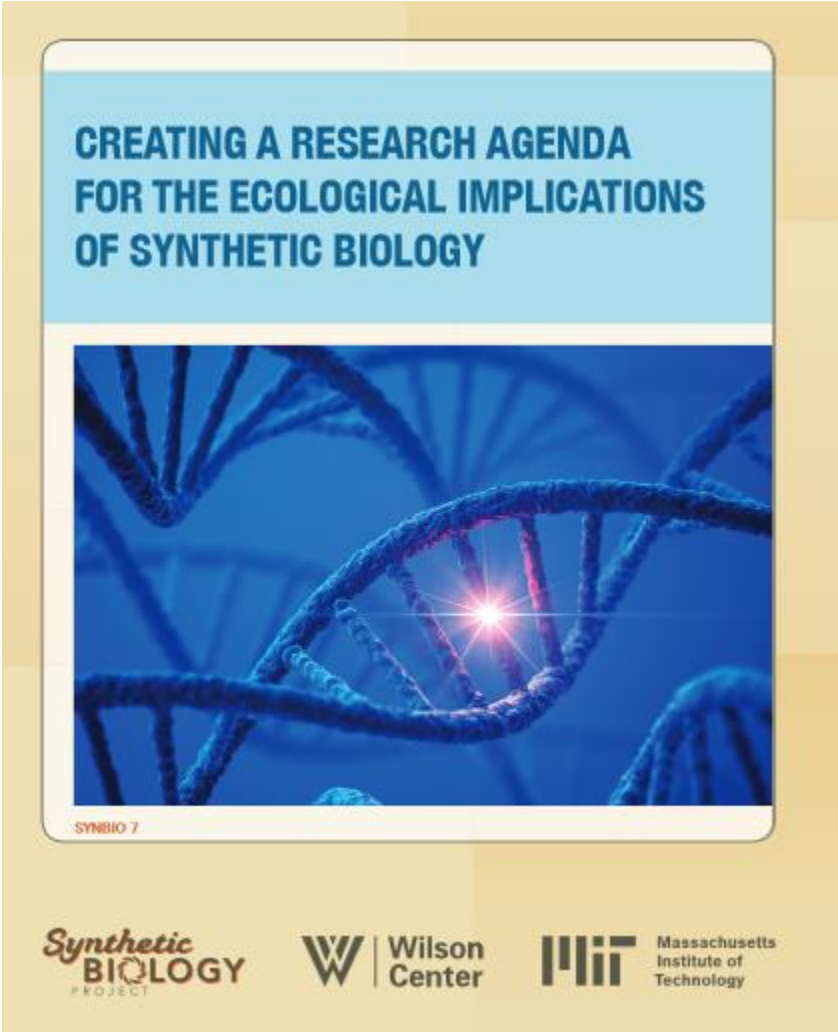
Sample Project

- Biofuels
  - Increasing Lipid Biosynthesis for Biodiesel production
  - Benefits and Risk Assessment

Benefits and Risk Assessment

- Teams should include Environmental Scientists/Ecologist
- Develop a guideline for appropriate ecological questions
  - Level of appropriate benefit
  - Analyze current ecological models for synthetic biology implications
    - offer recommendations for applications in agroecosystems

Resources



FIU
Florida International University
Miami's public research university

1)Comparators

Synthetic biology's pursuit of producing novel organisms challenges the established practice by risk analysts of comparing a modified organism to its wild-type "parent."

- ☐ How does the lack of a wild type comparator affect risk assessments?
- ☐ What alternative testing schemes are needed for "no analog" organisms, possibly even in "no analog" ecosystems?

2) Phenotypic characterization

- How can one identify and prioritize synthetic traits and/or synthetic organisms of concern?
- **Which phenotypes are most relevant for assessing ecological interactions and consequences of such organisms in the short and long term?**

3) Fitness, genetic stability, and lateral gene transfer

These properties contribute to and are affected by the interaction of organisms with their environments.

- How does one measure these properties and interactions in organisms produced using synthetic biology with consistency, reliability, and confidence?

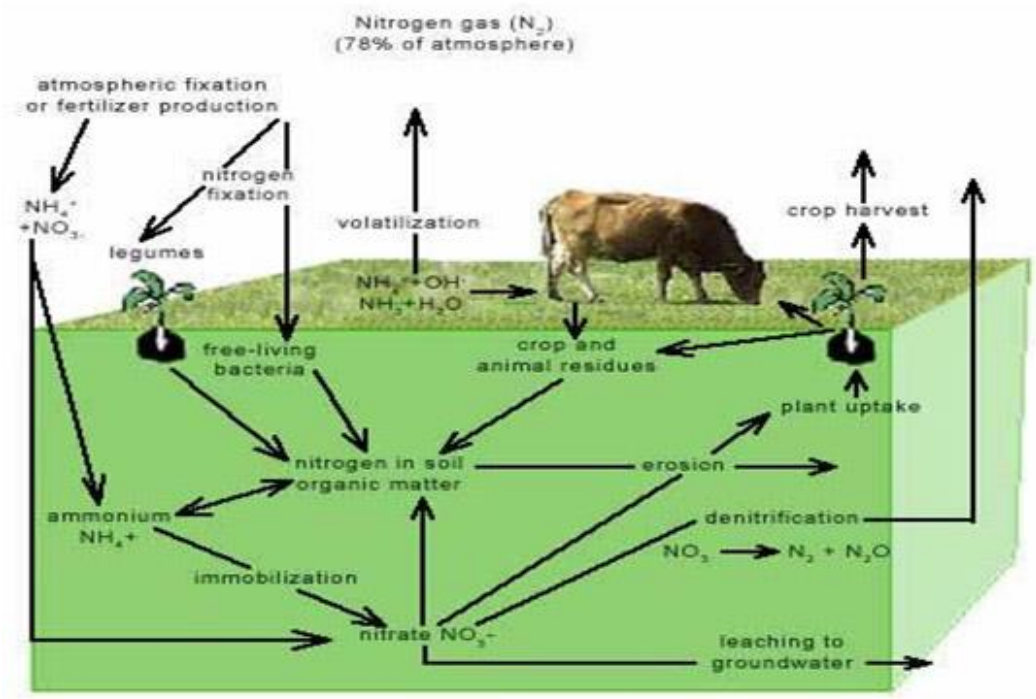
- What metrics are needed for measuring these properties?

4) Control of organismal traits

- What degrees of biological and physical control should be required in advance of deployment of a modified organism?
- **How do environmental conditions affect the need for intrinsic and external controls for organisms produced using synthetic biology?**
- Which types of environmental releases are likely to be irreversible?

5)Monitoring and surveillance

- ☐ Is it feasible to monitor these organisms and their ecological/evolutionary effects?
- ☐ Should monitoring be broad-based, targeted or both?
- ☐ How can existing systems of monitoring and surveillance be used in this effort?
- ☐ What new systems of monitoring and surveillance are needed?
- ☐ What role should baseline data play in these efforts?
- ☐ Who manages and curates the data? Who manages access?

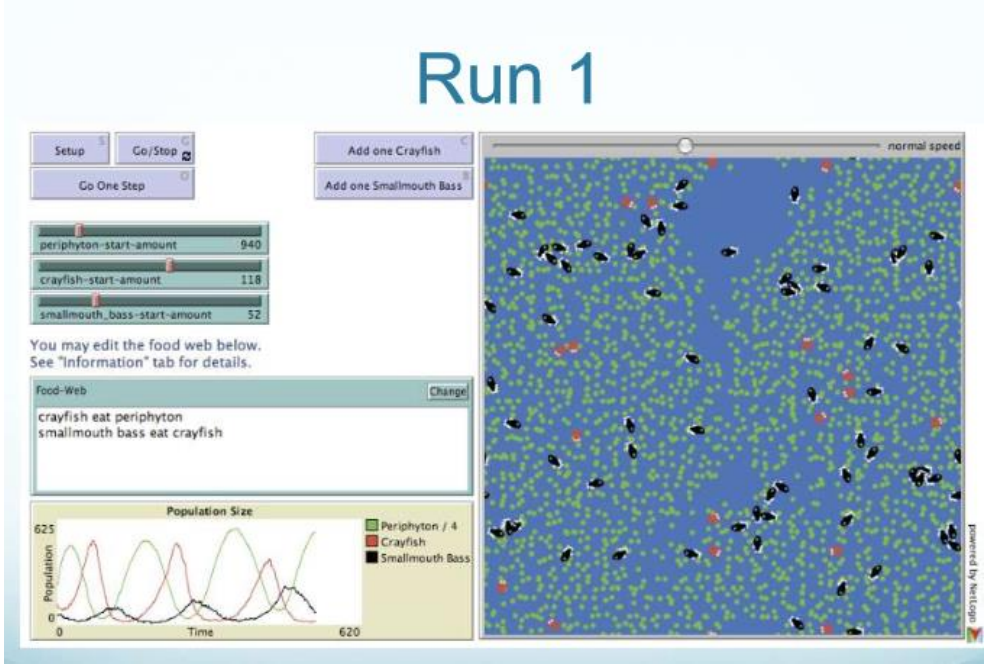


FIU
Florida International University
Miami's public research university

6) Modeling

- What modeling tools exist for synthetic organisms and are they sufficient for situations where organisms produced using synthetic biology are released into the environment?

- **Can existing models be combined across disciplines, or are new approaches needed to integrate natural, physical, and social sciences with engineering?**



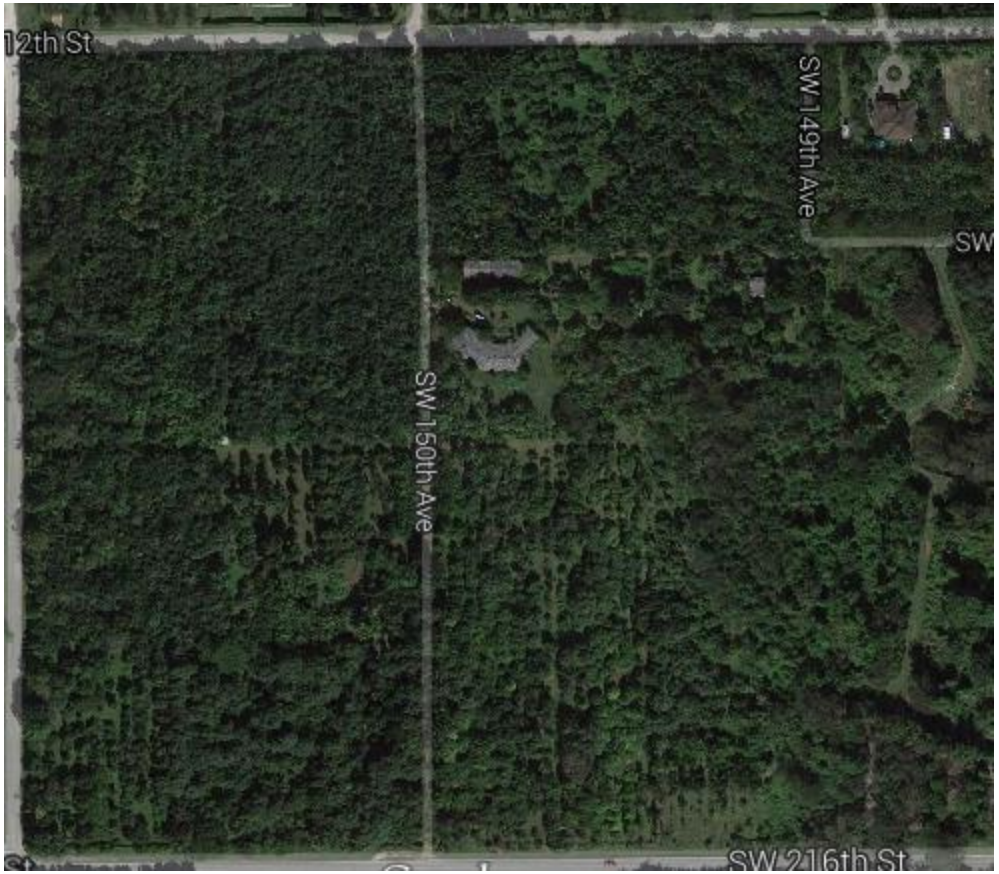
http://www.esa.org/

7)Standardization of methods and data

- What research is needed in order to standardize testing methods, data reporting, and organism characterization for ecological evaluations?

- How should data collection and integration be handled? Who is responsible for developing, promoting, and enforcing standards?

CASA



FIU
Florida International University
Miami's public research university

Acknowledgement

- Synthetic Biology Workshop Team
- Drs.: Malcolm Campbell, Laurie J. Heyer, Todd T. Eckdahl, Jeffrey L. Poet, and Katie Kendig.

References:

- Imdorf, Anton; Bogdanov, Stephen; Ochoa Ibanes, Ruben; and Calderone, Nicolas W. Use of essential oils for the control of Varroa jacobsoni Oud. in honey bee colonies. Apidologie 30(1999): 209-228. Print