Understanding a Complex System: Faculty-Undergraduate Collaboration in Multi-year Ecological Research Teams

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Challenges for ecologists at primarily undergraduate institutions (PUIs)

 # 1) Time for research is more limited than in graduate school, a post-doctoral position, a research station, or a Research-1 university. Why?

Teaching load -- multiple courses and sections at once, without teaching assistants and often no lab prep assistance.

The high quality of the PUI course experience – more writing (time-consuming grading), more personal attention (student conferences), more student-centered laboratory experiences (unique lab planning).

Less generous sabbatical policies.

No graduate students.

Less likely to have technicians or post-docs.

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Challenges for ecologists at primarily undergraduate institutions (PUIs)

 # 2) Ecological studies are often complex, multi-faceted, and last multiple years.

Limited funding.

Can't rely on post-docs to bring new skills to the lab, but difficult to find time and resources for the professor to acquire new skills.

No grad students hanging around for 7 years !

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A solution – involve undergraduates in your research program

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Advantages of involving undergraduates in ecological research programs at PUIs

A large, willing pool of potential junior collaborators.

Often at little cost – students gain course credit, and/or the college may fund undergraduate research internally.

Great enthusiasm for your project; not worried about their own thesis project.

Available funding sources for undergrad research and teacher training.

They're fun !

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Challenges of involving undergraduates in ecological research programs at PUIs

Limited length of involvement – one year typical.

Frequent, repetitive training.

Inexperience and less maturity; data quality control.

Limited time per week – class conflicts.

Attracting and inspiring the best students – often oriented toward biomedical/pre-med, not ecology & evolution.

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Three models of faculty-student collaboration in ecological research at PUIs

Model A – Multiple projects / single students, mostly Seniors .

Model B – One project / one team – Juniors and Seniors.

Model C – Linked projects / one team – developmental.

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Model A
Multiple projects / single students

Jr./Sr. student approaches professor

Professor interviews student, determines interests, offers menu of projects

1-2 months reading, developing “proposal”

4-8 months conducting research, data collection

1-2 months analyzing data, preparing poster, presenting at college event and regional meeting

1 month, writing Independent research paper drafts

Student leaves

X 3 - 6 students

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Model A

Advantages

Student-centered

Explore new research directions

Disadvantages

Student-centered; not faculty-centered

Explore new research directions; thinly spread

No economy of scale in training and planning; time drain

Loads of preliminary data; few / no publications

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Model A 1999-2000

Tasmia Shariff – Cost of defense in *Brassica rapa*

Kelly Reynolds – Garlic mustard in variable light environments

Kham Vongpaseuth – Wetland vegetation response to purple loosestrife biocontrol

Tony Mazzarella – Smut fungus disease in a broomsedge population

Outcomes

2 posters @ undergrad research conference

Data in funded USDA grant proposal
1 student in Ph.D program

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Model B One project / one team – Juniors & Seniors

Jr./Sr. student approaches professor

Professor interviews student, explains project, makes offer to join team

Summer–Fall semester: set up study, collect field data, read literature

Spring semester : collect lab data, analysis, poster preparation and presentation at college and regional meetings, research paper drafts

Students leave

Student continues for 2nd year

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Model B

Advantages

Single, faculty-defined research focus

Higher efficiency in planning, training, management

Substantial data sets – more publications

Students learn teamwork

Easier quality control

Disadvantages

Less student-centered

All research eggs in one basket – student mistakes

Re-training each year

Large data sets require more time for analysis, ms prep, but Seniors graduate

Model B 2004 - 2005

Kerry Mauck, Kelly-Marie McCartney, Brian Dunn –

Enemies and competition in the forest herb layer; roles of native and non-native plants

Outcomes

2 posters @ regional meeting

Data for NSF RUI grant proposal

1 student in Ph.D program

2 publications

Journal of the Torrey Botanical Society 134(1), 2007, pp. 1–17

Ecological comparison of two co-invasive species in eastern deciduous forests: *Alliaria petiolata* and *Microstegium vimineum*[1]

Janet A. Morrison[2,3], Heather A. Lubchansky, Kerry E. Mauck, Kelly-Marie McCartney, and Brian Dunn

Department of Biology, The College of New Jersey, P.O. Box 7718, Ewing, NJ 08628

Morrison, J. A., H. McMahon, K. Mauck, K. M. McCartney, and B. Dunn. (Department of Biology, The College of New Jersey, P.O. Box 7718, Ewing, NJ, 08628). Ecological comparison of two co-invasive species in eastern deciduous forests: *Alliaria petiolata* and *Microstegium vimineum*. J. Torrey Bot. Soc. 134: 1–17. 2007.—Many communities invaded by one non-native plant species also are invaded by others due to a shared response to environmental factors that promote invasive species generally, such as fragmentation, disturbance, and proximity to seed sources. Direct comparison of these co-invasive species in their shared communities therefore is necessary for understanding the ecology of invaded communities, particularly if management resources must be prioritized. We compared ecological characteristics of two of the most important co-invasive herb layer species in forests of the eastern United States, *Alliaria petiolata* (garlic

Journal of Ecology 2007

Experimental field comparison of native and non-native maple seedlings: natural enemies, ecophysiology, growth and survival

JANET A. MORRISON* and KERRY MAUCK

Department of Biology, The College of New Jersey, PO Box 7718, Ewing, NJ 08628, USA

Summary

1. *Acer platanoides* (Norway maple) is an important non-native invasive canopy tree in North American deciduous forests, where native species diversity and abundance are greatly reduced under its canopy. We conducted a field experiment in North American forests to compare planted seedlings of *A. platanoides* and *Acer saccharum* (sugar

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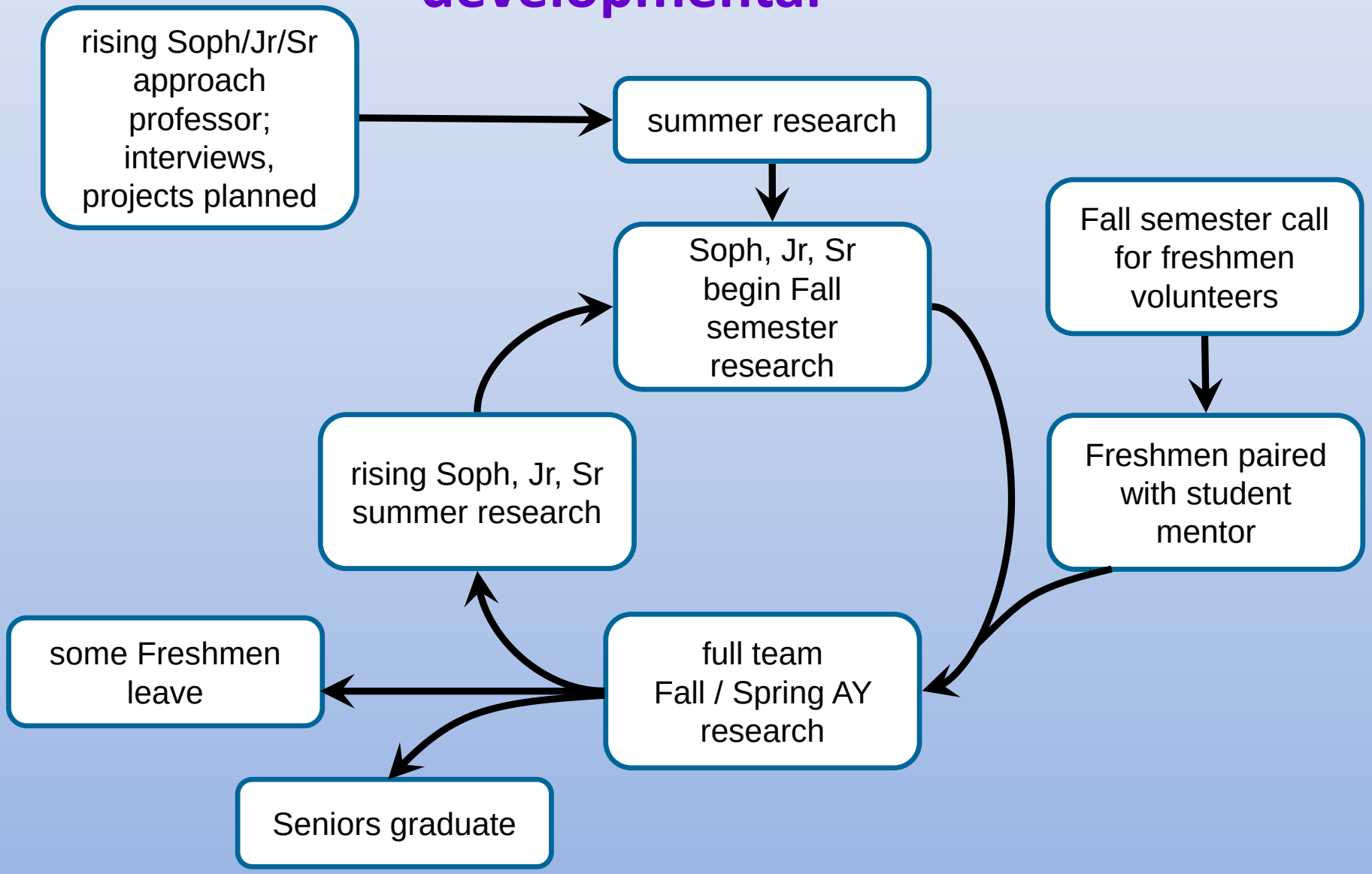
Model C Linked projects / one team – developmental



Model C

Advantages

Longer-term involvement by students = increased likelihood of bringing significant projects to fruition

Training efficiency via student mentors

Students become more valuable as junior collaborators

Stimulates intellectual exchange and creativity

Disadvantages

Increased management needs compared to Model B

Continuous structure – no breaks for just writing up

Assigning authorship

Model C 2006 – present

Linked projects on a natural plant-pathogen interaction and its role in plant invasiveness

Multi-year spatial and temporal patterns of smut fungus disease in *Andropogon virginicus* (the grass broomsedge), and effects on fitness

Development of experimental infection protocols

Population genetics of *A. virginicus* and its smut pathogen *Sporisorium ellisii* – molecular marker development

Ecological comparisons of native eastern and non-native invasive Hawaiian populations of *A. virginicus* – germination, competitive ability, photosynthesis, plant size, disease status

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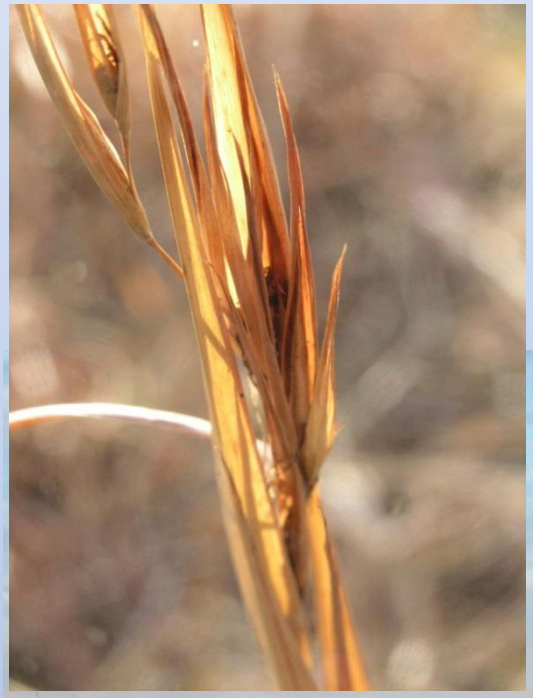
Model C 2006 – present



Multi-year spatial and temporal patterns of smut fungus disease in *Andropogon virginicus* (the grass broomsedge), and effects on fitness

Ray Shupak – summer, Junior, Senior
Artur Romanchuk – summer, Junior, summer, Senior
Jessica Decker – summer, Senior
Ermal Bojdani – summer, Junior, Senior
Emily Nowicki – Freshman, summer, Sophomore, Junior, Senior
Brittany Graf – Senior
Ann Ligocki – Senior

And 7 other Freshmen volunteers

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Model C 2006 – present

Population genetics of *A. virginicus* and its smut pathogen *Sporisorium ellisii* – molecular marker development

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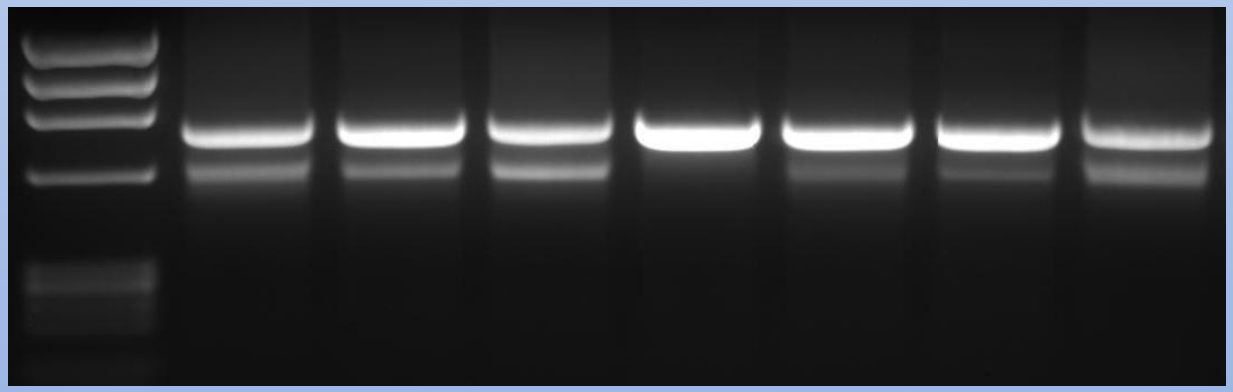

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Model C 2006 – present

Development of experimental infection protocols

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Model C 2006 – present

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From Model A to Model C in the *Andropogon* – smut fungus research

Spring - Fall 2000 – Tony Mazzarella

Fall 2000 – Spring 2001 – Brian Policastro } **overlap**

Fall 2001 – Spring 2002 – Mariam Chowdry and Erin Costanza **partners**

Fall 2002 – Spring 2003 – Theo Sabelnik **solo**

Spring 2003 – Andi Bruno and Brooke Newman **partners**

Fall 2003 – Sara Smith **solo**

Spring, Summer, Fall 2004 – Spring 2005 – Sean Halloran **solo**

Fall 2004 – Spring 2005 – Erin Scaglione and Debbie Ubele **partners**

Fall 2005 – Spring 2006 – Kara Horner and Mirjana Jojic **partners**

Model C starts summer 2006

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Outcomes so far . . .

1 presentation at an international meeting :
Conference on the Ecology and Management of Plant Invasions

5 presentations at national meetings :
ESA, BSA, ASPB

8 presentations at regional meetings :
NEEC, Mid-Atlantic ESA

6 presentations at undergraduate research conferences

USDA grant funded

3 - 4 publications in prep

4 students to E&E Ph.D programs

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Additional lessons about long-term ecological research with undergraduates from Sacred Heart University

Dr. Jennifer Mattei
Dr. Mark Beekey

Long-term research on the ecology of the Long Island Sound horseshoe crab population

www.projectlimulus.org

Keep students on the project for multiple seasons; combine experienced students with new students.

Double check protocols frequently for quality control.

Make connections between the ecological research and their career interests.

Go after smaller grants that have an education focus and incorporate community-based research in your program :

Some undergrads are preparing to be teachers.

Many colleges require community service.

Use tiered system of community teaching – professor teaches undergrads, undergrads teach school programs and help train community/school research volunteers.