Invasive Species Research in Non-Tidal Compensatory Mitigation

PROGRESS REPORT: October 2019

Index: 779691

Douglas A. DeBerry, Principal Investigator
Environmental Science and Policy Program
College of William and Mary
Williamsburg, VA 23287

This progress report is presented to The Resource Protection Group (RPG) in summary of work completed under the above-referenced research program at the College of William & Mary (W&M). A summary of tasks completed is provided below, followed by a precis of the remaining tasks and a proposed schedule revision thereto. The next section includes major findings to-date along with preliminary recommendations for revising invasive species performance standards required by the Interagency Review Team (IRT), the multi-agency group that oversees Virginia's mitigation banking industry. The final section includes a summary of the procedures and timing for the final phase of the project (Greenhouse Experiment).

For convenience, the original schedule of tasks for this research is presented in Table 1 below, excerpted from the proposal for which this research grant was awarded (note that the schedule below does not include task milestones for the stream component of this research grant, which was added via change order in spring 2018).

Table 1. *Time/Resource Allocation and Project Schedule*
The table below summarizes anticipated time and resource allocation as well as a preliminary project schedule for the above-referenced tasks over the projected three-year timeframe for completion:

Task	Time Allocation	Resource Allocation	Schedule by Task
Literature Review	9 months	PI	NTP through Dec 2017
Field Study – Site Selection	6 months	PI and soil Technical Advisor with input from RPG	NTP through Sept 2017
Field Study – Sampling	3 months	PI with Project Scientist and student support	mid-July through mid-Sept 2018
Field Study – Data Analysis and Interpretation	4 months	PI with input from soil Technical Lead, Project Scientist, and student support	Sept 2018 through Dec 2018
Greenhouse Experiment	12 months	PI with Project Scientist and student support	Jan 2019 through Dec 2019
Greenhouse Data Analysis and Interpretation	3 months	PI with input from soil Technical Lead, Project Scientist, and student support	Jan 2020 through March 2020
Report and White Paper	3 months	PI with input from soil Technical Lead	March 2020 through May 2020

Progress Summary by Task

- *Literature Review*: COMPLETED; final document submitted to RPG in April 2018

- *Field Study – Site Selection*: WETLANDS AND STREAMS COMPLETED
  - wetland sites completed summer 2018
  - stream sites completed summer 2018 and summer 2019

- *Field Study – Sampling*: WETLANDS AND STREAMS COMPLETED
  - wetland sites completed summer 2018 (170 plots; target species: *Arthraxon hispidus*, *Microstegium vimineum*, *Typha* spp.)
  - stream sites completed summer 2018 and summer 2019 (160 plots; target species: *Lespedeza cuneata*, *Lonicera japonica*, *Microstegium vimineum*)
    - Note – the 2018 stream field season was cut short by Hurricane Michael in early October, which brought high winds that removed much of the canopy foliage across the field sites that remained to be sampled; canopy cover is an important environmental factor in the stream analysis; therefore, completion of sampling had to be postponed until 2019

- *Field Study – Data Analysis and Interpretation*: WETLANDS COMPLETED
  - wetland data analysis completed spring 2019; submitted to RPG in Dakota Hunter's MS Thesis, May 2019

- *Field Study – Data Analysis and Interpretation*: STREAMS IN PROGRESS
  - stream data analysis underway; anticipated completion date December 2019

- *Greenhouse Experiment*: IN PROGRESS
  - invasive species seed collection completed late summer 2019
  - seed germination trials will begin November 2019
  - Greenhouse Experiment will begin in earnest in January 2020 (NOTE: this will require a revised contract completion date; see below)

- *Report and White Paper*: IN PROGRESS
  - a significant component of the final reporting on this task has been completed with the literature review and Dakota Hunter's MS thesis
  - final delivery on the report and white paper will occur at the end of the revised contract term (see below)

Proposed Schedule Revision

As noted above, the 2018 field season was cut short and, as a result, the stream sampling portion of the Field Study could not be completed until late summer 2019 (to keep time-of-year

consistent with the 2018 sampling effort). This delay in field research has necessarily shifted the start of the Greenhouse Experiment phase to January 2020. Accordingly, **by submission of this progress report, we respectfully request a revised contract completion date of December 31, 2020**. If this request meets RPG's approval, please acknowledge via email to Doug DeBerry at dadeberry@wm.edu.

Other Project Accomplishments

- MS THESIS: Under the auspices of this research grant, Dakota M. Hunter completed a Master of Science degree in Biology at W&M and successfully defended his thesis in the spring of 2019
- PRESENTATION: VAWP Symposium, Richmond, VA – May 17, 2019: presented results of invasive species research in compensatory wetland mitigation (D. A. DeBerry)
- PRESENTATION: SWS Annual Meeting, Baltimore, MD – May 31, 2019: presented results of invasive species research in compensatory wetland mitigation (D. M. Hunter)
- MANUSCRIPTS: Two draft manuscripts describing the wetland component of the study have been prepared and are currently being revised to submit for peer-reviewed publication (submission goal of mid-November 2019)

Brief Summary of Results – Wetland Study

A detailed review of the wetland component of this research is provided in Dakota Hunter's MS Thesis titled "Invasive Species Research in Compensatory Wetland Mitigation: Investigating Plant Community Composition and Environmental Correlates with Three Invasive Plants." There are two primary lines of inquiry addressed in Mr. Hunter's thesis, as summarized below.

1) **Which environmental variables are most important in explaining the relative abundance of invasive species on compensatory wetland mitigation sites?**

The wetland study focused on three invasive species in Virginia: *Arthraxon hispidus*, *Microstegium vimineum*, and *Typha* spp. Important environmental factors that emerged from the statistical models are summarized in Table 2 (these are the factors that will be tested in the Greenhouse Experiment phase of the project, as outlined below).

Table 2: Important environmental factors from the wetland component of the Field Study.

	Arthraxon	***Microstegium***	***Typha***
Hydrology	X	X	X
Phosphorus	X	X	X
Nitrogen	X	X	X
Iron	X		X
Cover		X	

2) What is the relationship between invasive plant abundance, native species composition, and native species richness on compensatory wetland mitigation sites?

This is an important question because it is the one most likely to result in meaningful revisions to invasive species performance standards in Virginia. Key findings are presented below (Figures 1-3, which are referenced in the summary points below and presented on the following pages, are PowerPoint slide excerpts from recent presentations at professional meetings).

- Figure 1 below shows that there is no statistical difference between the *composition* of species at the invaded end of the gradient and the non-invaded end of the gradient.
- A finding that is somewhat surprising (but consistent with previous research) is that **native species richness was actually *highest* when invasion was moderate** (i.e., around 5-8% relative abundance of the invader; see Figure 3), which means that the commonly used performance standard of 5% is too low because it requires mitigation site managers to indiscriminately kill an inordinate number of native species when treating the invaders at a 5% threshold.
- Figure 2 shows species accumulation curves, from which we concluded that invaders like *Typha* and *Microstegium* are NOT excluding native species, particularly at moderate levels of invasion. **Based on these results, in invasive species management scenarios it is more likely that the agency-mandated killing of invasive species at such low thresholds (5%) is removing native species via collateral damage from non-selective herbicide use.**
- Figure 3 provides a graphical depiction of invasive species relative dominance across the invasion gradient (A = most invaded, E = no invasion). Taking *Microstegium* as an example, an appropriate invasive species performance standard that promotes responsible management without undue loss of native species richness is somewhere between 29% and 8% (the midpoint of this range is 18.5%). As Figure 3 indicates, this result is generalizable to the other species in this study as well.

Performance Standard Recommendation

Based on the above results, an **appropriate threshold to trigger invasive species remediation in compensatory wetland mitigation is 15%**. This number splits the difference between invasive species dominance (i.e., >20%) and lower levels of invasion (i.e., 5-8%), the latter of which is clearly accompanied by higher values of native species richness. In so doing, a 15% threshold would also strike a balance between vigilant invasive species management and careless, indiscriminate killing at higher levels of native species richness.

It is not clear whether the stream data will produce a similar result, but that analysis is ongoing and will be available soon.

Figure 1: Community composition summary (Sørenson Similarity matrices). The letters represent relative positions of sample plots across the invasion gradient along transects [each transect had five plots along a gradient from most invaded (A) to least invaded (E)].

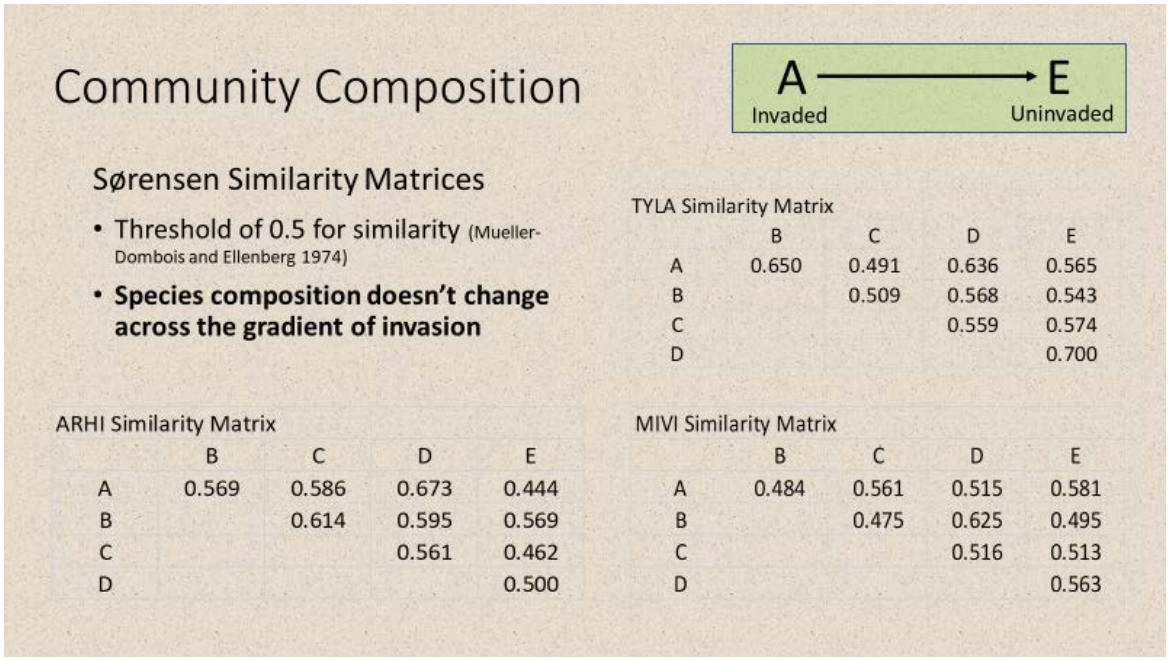


Figure 2. Species Richness across plots as expressed in species accumulation curves. Moderately invaded plots (green lines on graphs) had the highest species richness values for the *Microstegium* and *Typha* transects, and among the highest for *Arthraxon* transects.

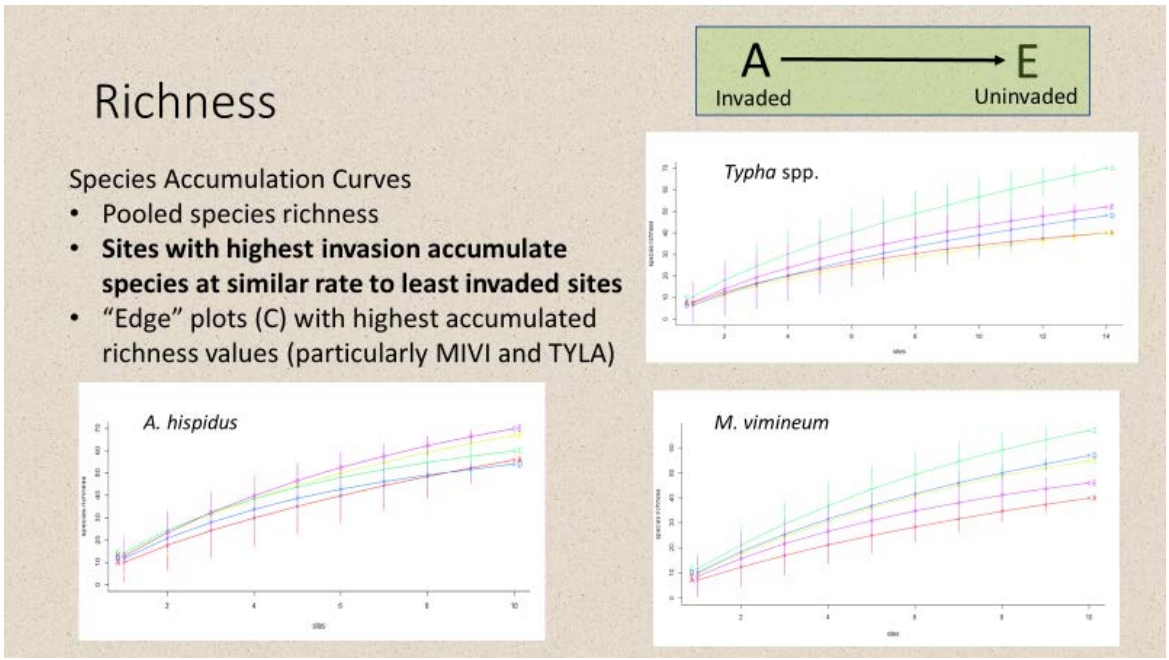
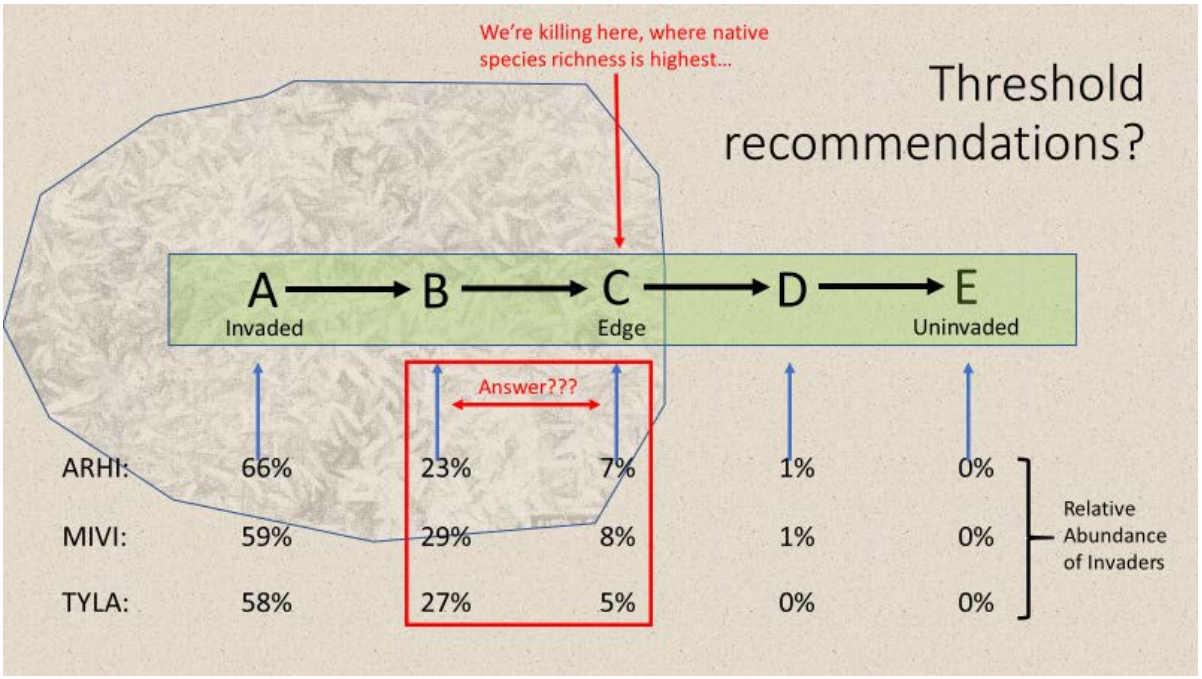


Figure 3. Graphic depiction of invasion gradient with relative dominance of invaders.



Greenhouse Experiment – Summary of Approach and Revised Schedule

The final phase of the project is the Greenhouse Experiment, which is set to begin in January 2020 (pending RPG approval of the proposed schedule revision) and run through most of the calendar year. Below is a summary of important concepts and milestones related to that effort.

- Seeds: Invasive seed has been collected from field sites. We'll be running some preliminary germination trials leading up to the January 2020 start date. Native seeds will be acquired from Ernst Conservation Seeds in Pennsylvania.
- During the experiment, seeds will be sown in experimental containers with amended soil media adjusted to relative levels of soil physiochemical variables in accordance with the Field Study results. Hydrology and cover (shade) will be controlled as well. Below is a summary of the anticipated layout.
    - Given the results presented in Table 2 above, there are 4 important factors for each species
    - We anticipate manipulating 2 conditions for each factor (normal level/high level) with a minimum of five replicates for each condition, which would equal 40 experimental containers for each species (minimum).

    - We anticipate using a 6" x 6" container size, which is a recommendation from colleagues
- A mix of native species seeds will be sown with invasive seeds in each trial – the composition and amount of seed will be consistent across trials for each target species.
- Once germinated, plants in each container will be allowed to grow unabated throughout the growing season.
- Aboveground biomass will be harvested in late summer 2020 and weighed to provide a biomass value for each species in each trial.
- Biomass values will be summarized and subjected to statistical evaluation.

Once the Greenhouse Experiment is complete, the final phase of the project (Report and White Paper) will be concluded and submitted for peer review (including RPG review), with the goal of receiving and incorporating all comments into final documents to be delivered by December 31, 2020 (pending RPG approval of the proposed schedule revision).