Seedy Business: Bioenergy as a New Source of Weeds





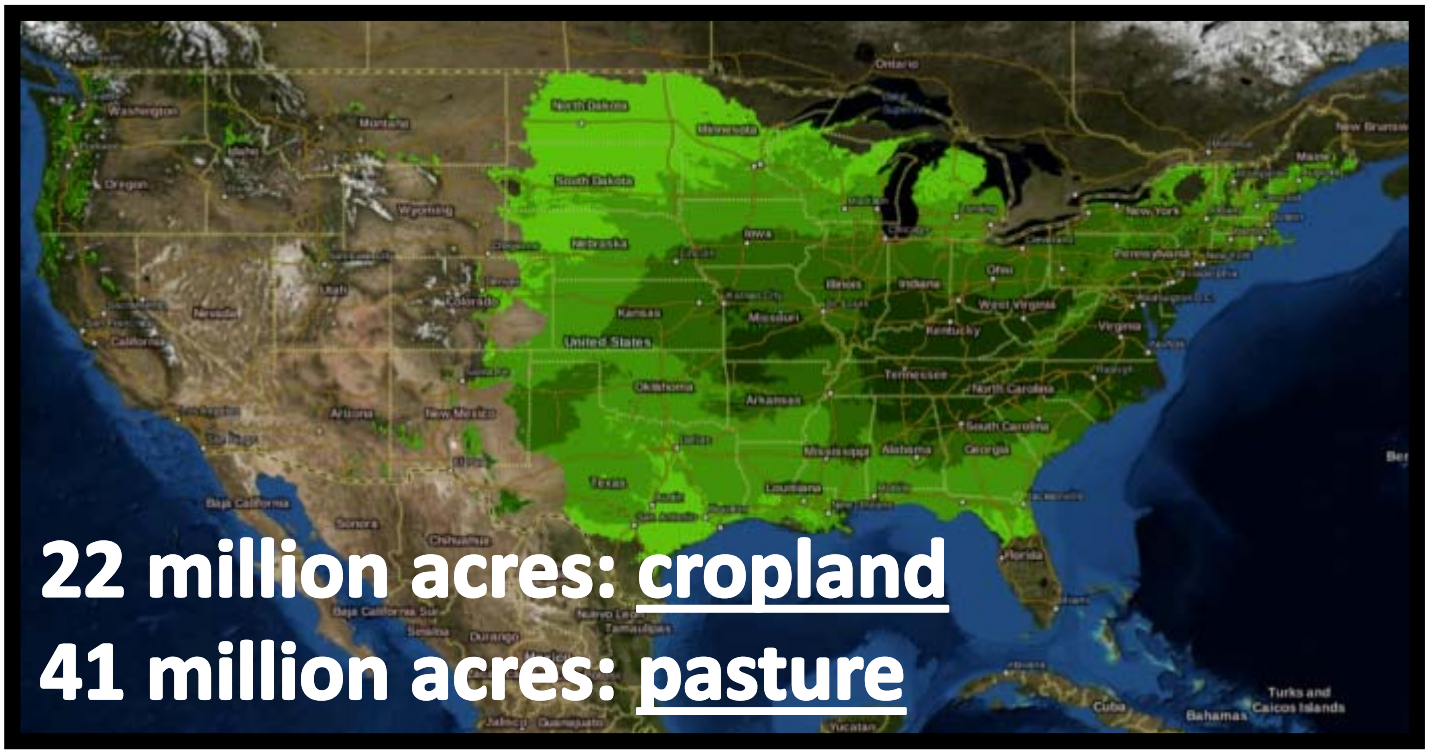
Jacob Barney
Assistant Professor
Invasive Plant Ecology

VirginiaTech

jnbarney@vt.edu

Renewable energy: Biofuels

Reduce CO_2
Increase domestic energy production
Long-term energy solution



U.S. BILLION TON UPDATE

Biomass Supply for a Bioenergy and Bioproducts Industry

The Invasive ideotype

Life history

- Perennial
- High aboveground biomass production
- Flowers late / little allocation to seed production

Physiology

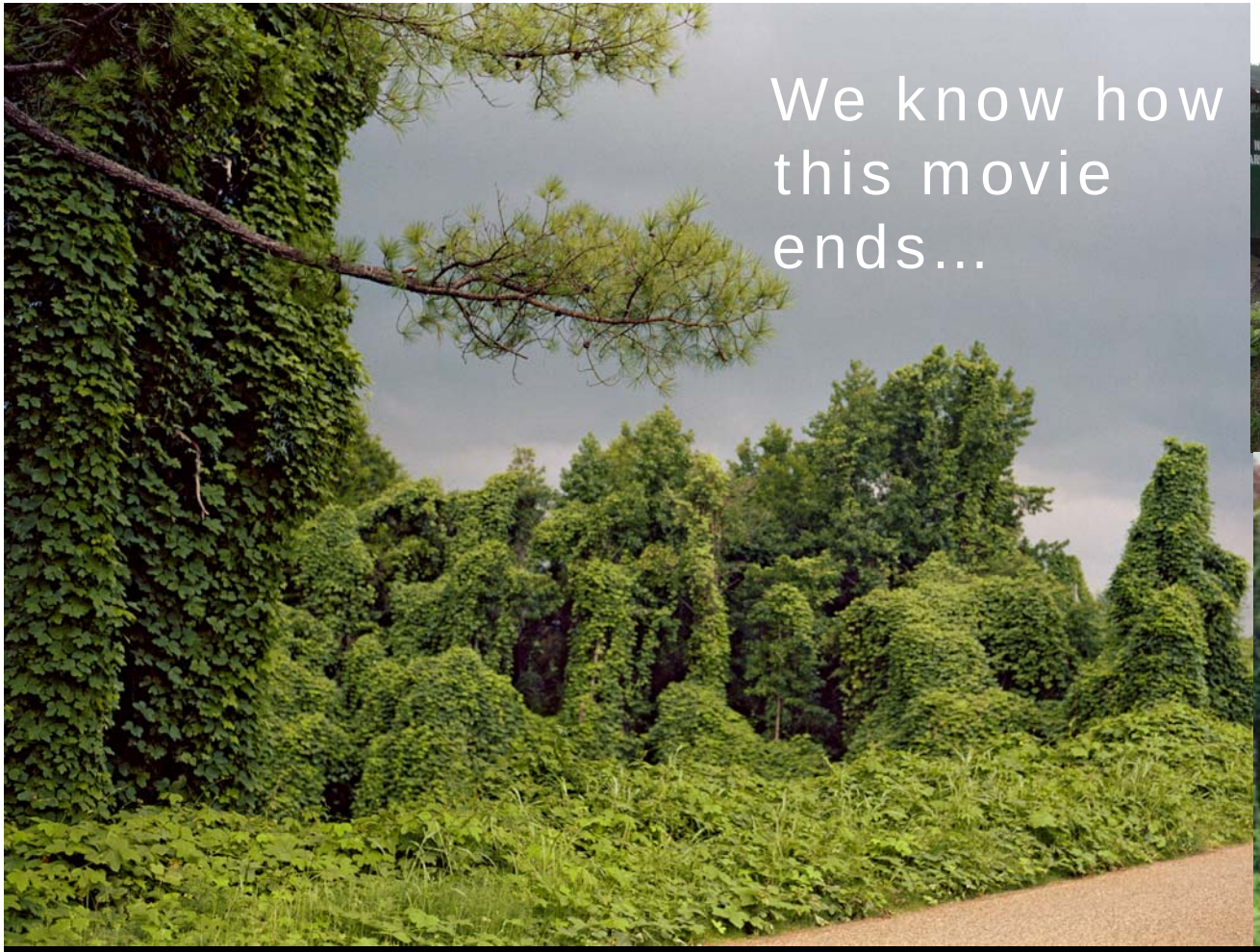
- Tolerates
  - Drought
  - Low fertility
  - Saline soils
- C_4 photosynthetic pathway
- High water/nutrient use efficiency

Other

- Highly competitive (reduces herbicide use)
- Few resident pests (reduces pesticide use)
- Allelopathic
- Re-allocates nutrients to roots in fall

“the thin green line”

	Agronomic crops	
	Corn	Soybean
Perennial	-	-
C_4 photosynthesis	X	-
Rapid establishment	X	X
Long canopy duration	X	X
Grows at high densities	X	X
Tolerates water stress	-	-
Tolerates marginal soils	-	-
Tolerates saline soils	-	-
Reallocation of nutrients to roots	-	-



- fast growing
- deep rooted
- no pests
- tolerates disturbance

85 MILLION SEEDLINGS PLANTED

Origin and Cost of Invasive Plants

The majority of our most damaging invasive plants were intentionally introduced:

- Horticulture
- Forages
- Forestry

Invasive species are costly:

$120 billion (U.S.)

$1.4 trillion (global)










Invasive Plant Impacts

- Reduce native species diversity
- Increase fire frequency
- Increase flooding
- Alter successional patterns
- Alter nutrient cycles
- Increase soil salinity
- Disrupt trophic interactions
- Reduce pollinators
- Disrupt mutualisms
- Increase management costs
- Reduce recreation
- *ad infinitum*…



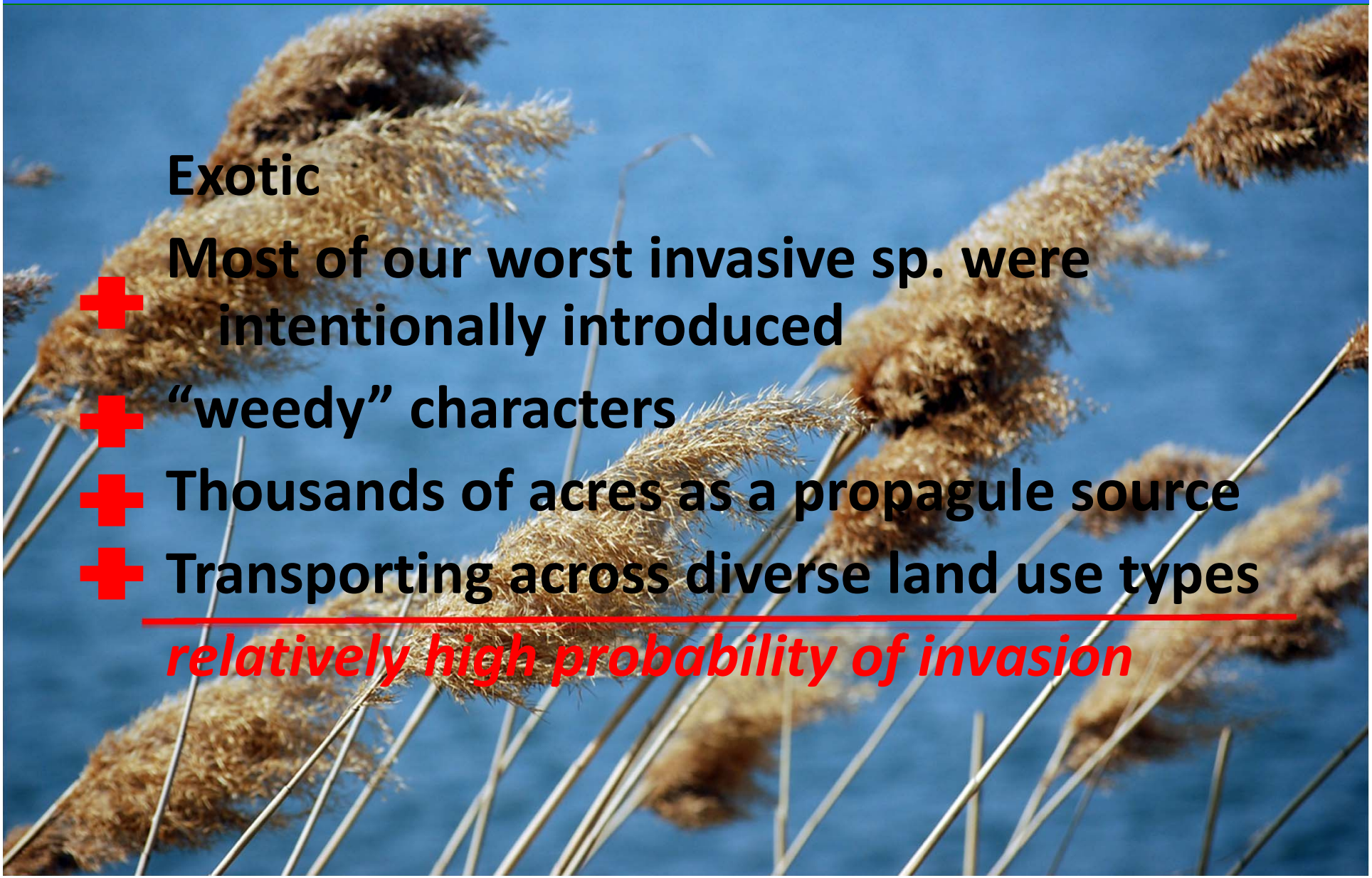



$25,000 per acre to control

Pull. Kill. Plant.


“for the most part, successful invasion is forever”
- Dan Simberloff

Invasion arithmetic



Exotic

\+ Most of our worst invasive sp. were intentionally introduced

\+ "weedy" characters

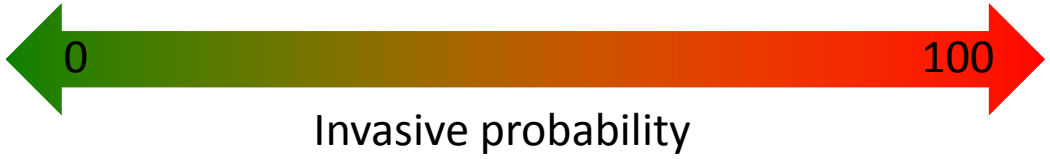
\+ Thousands of acres as a propagule source

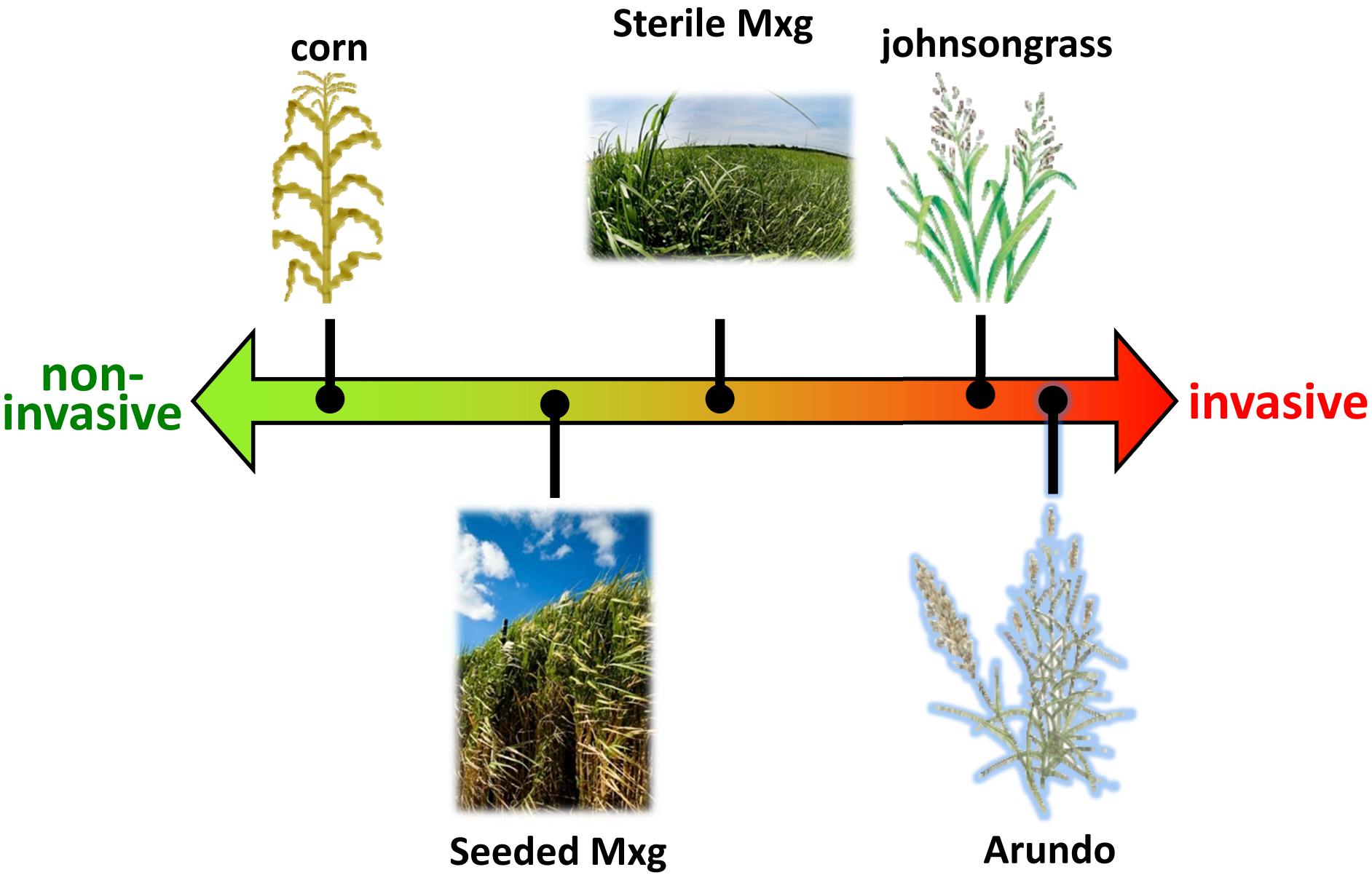
\+ Transporting across diverse land use types

relatively high probability of invasion

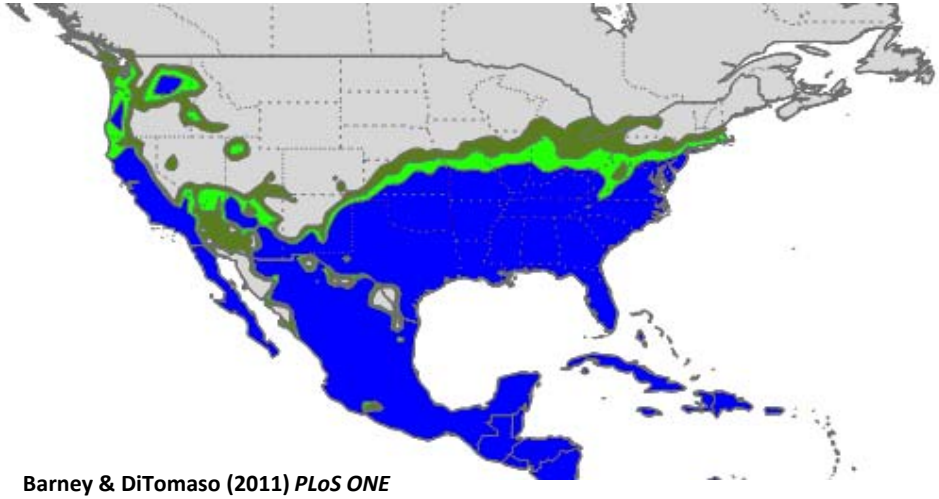
Putting invasions in context

1. **Most introduced species do not become invasive**
2. **Invasiveness is not universal**
3. **Populations are invasive, not species**
4. **All species have a non-zero invasive probability**



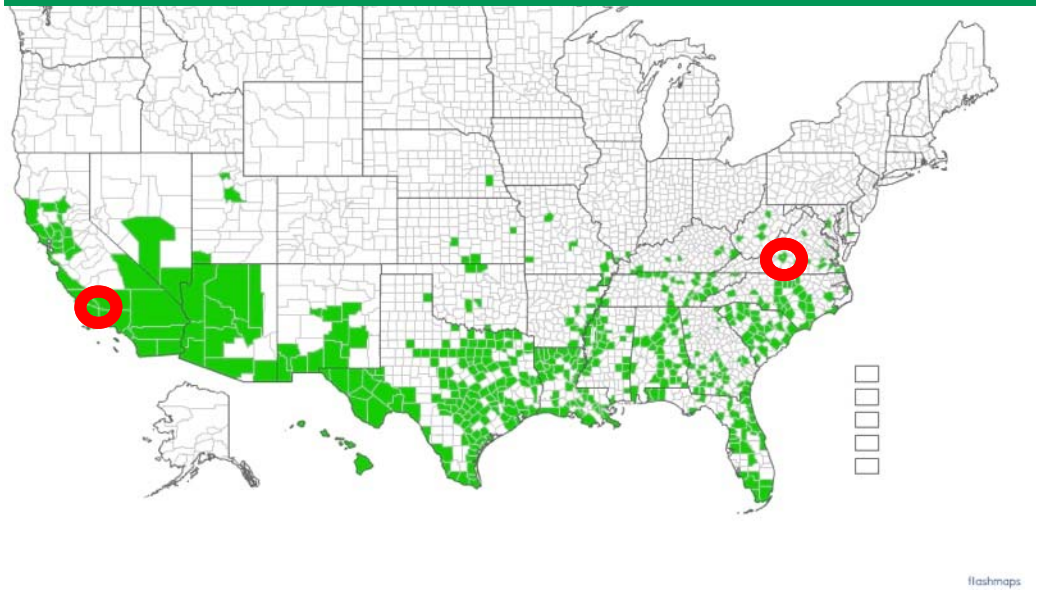

corn
Sterile Mxg
johnsongrass
non-
invasive
invasive
Seeded Mxg
Arundo

Giant reed (*Arundo donax*)



Barney & DiTomaso (2011) ***PLoS ONE***

Species are not universally invasive



biofuel supply chain

Crop selection / Breeding / GMO

FIELD

HARVEST

TRANSPORT

STORAGE

CONVERSION

Right Plant, Right Place

1. Don’t plant noxious weeds
2. Don’t plant high risk species
3. Don’t plant near wild or native populations

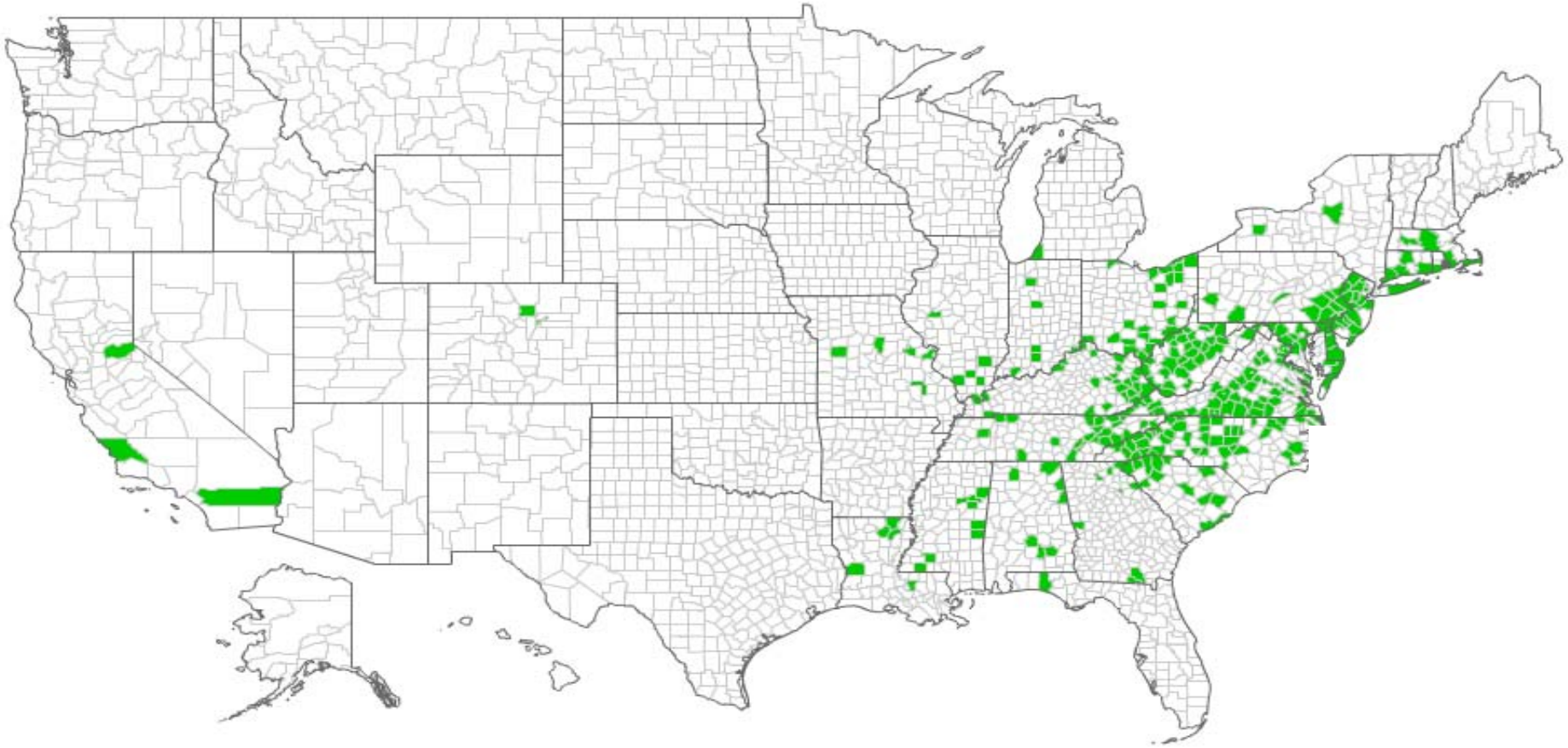
Molecular Ecology (2005) **14**, 2143–2154 doi: 10.1111/j.1365-294X.2005.02579.x

Crop-to-weed introgression has impacted allelic composition of johnsongrass populations with and without recent exposure to cultivated sorghum

P. L. MORRELL,*†§ T. D. WILLIAMS-COPLIN,* A. L. LATTU,† J. E. BOWERS,* J. M. CHANDLER† and A. H. PATERSON*†

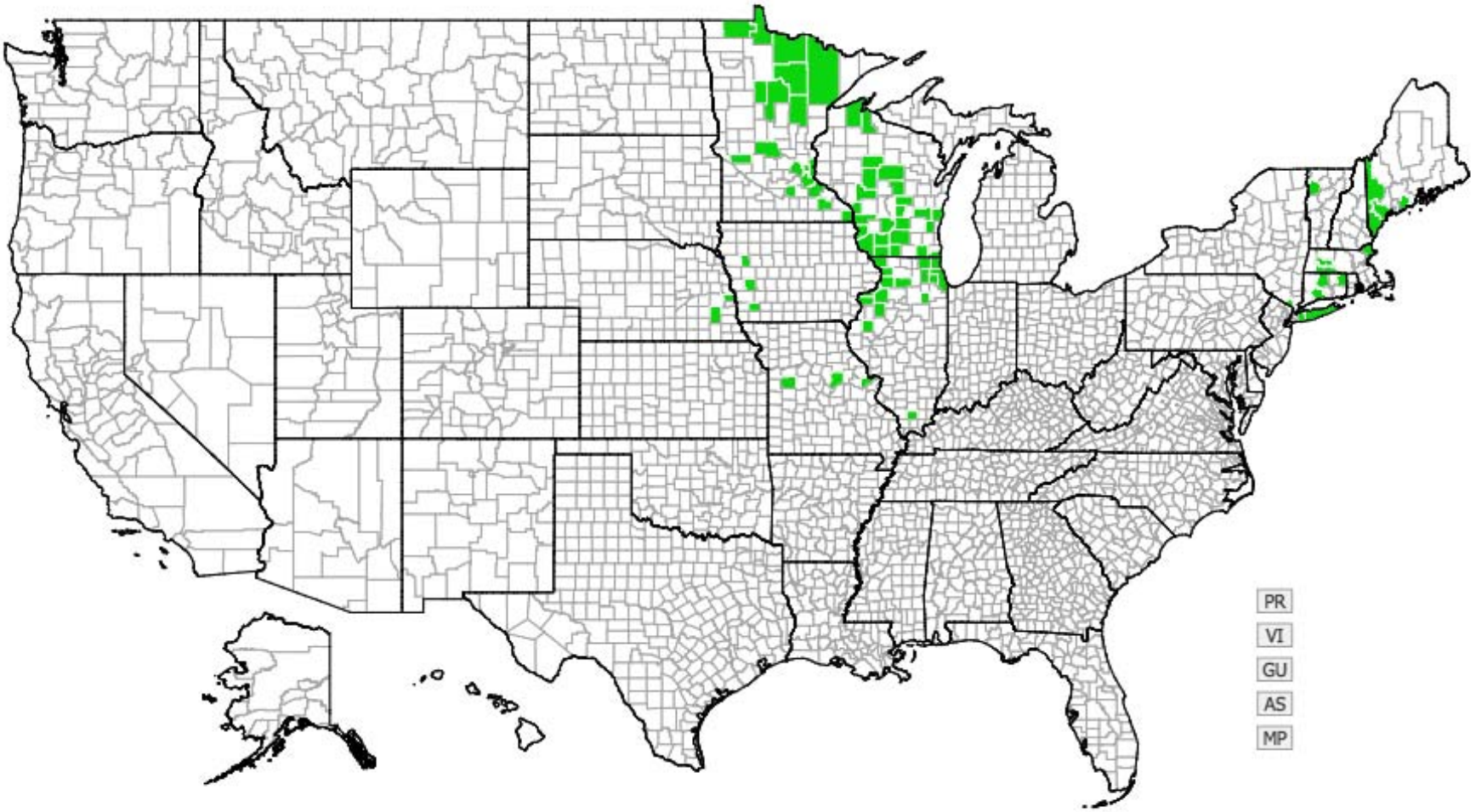
**Plant Genome Mapping Laboratory, University of Georgia, Athens, Georgia 30602, †Department of Soil and Crop Sciences, Texas A&M University, College Station, TX 77843-2474*

Naturalized
Miscanthus sinensis

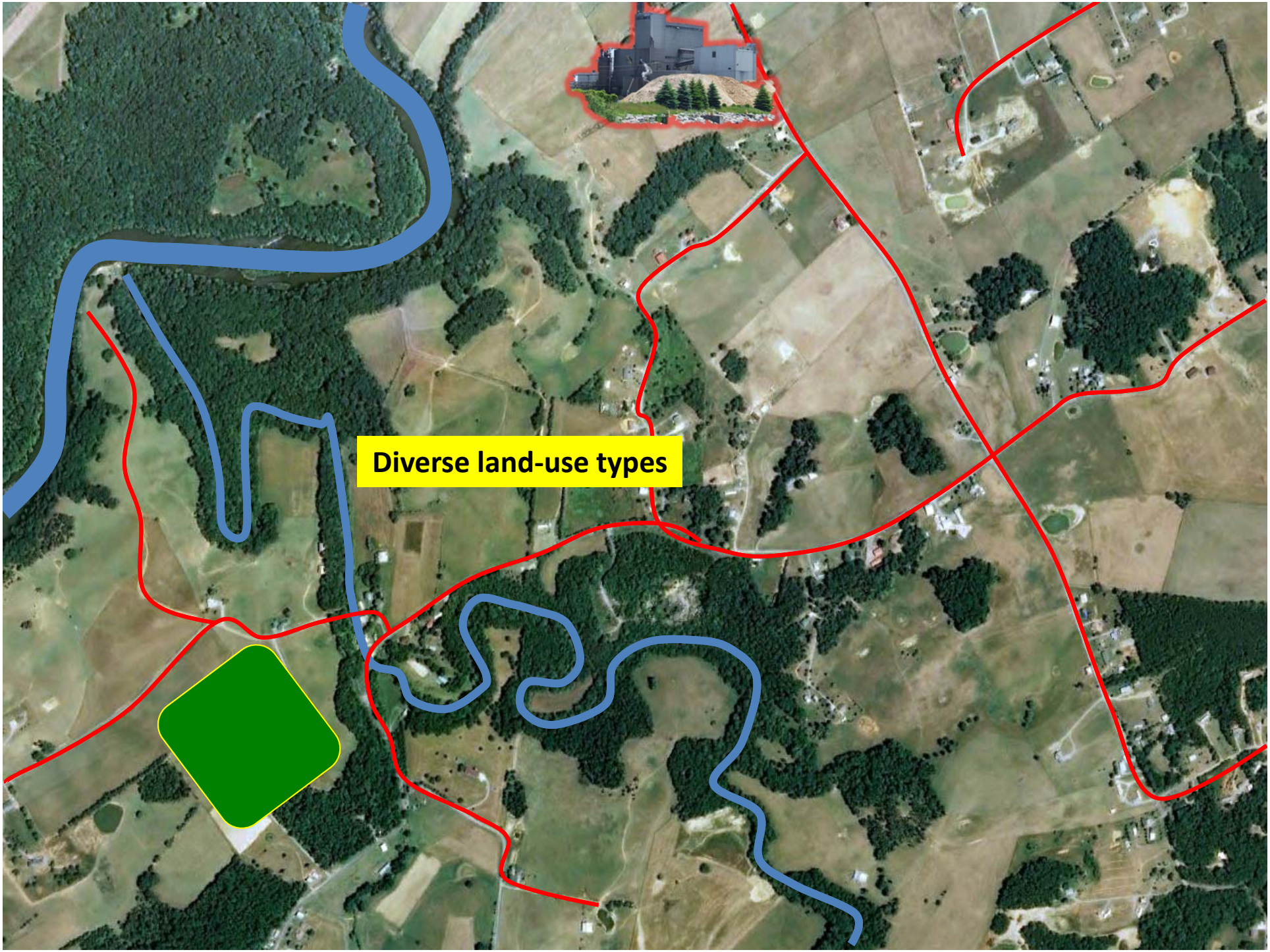


EDDMapS. 2011. Early Detection & Distribution Mapping System. The University of Georgia - Center for Invasive Species and Ecosystem Health. Available online at http://www.eddmaps.org/; last accessed October 25, 2011.

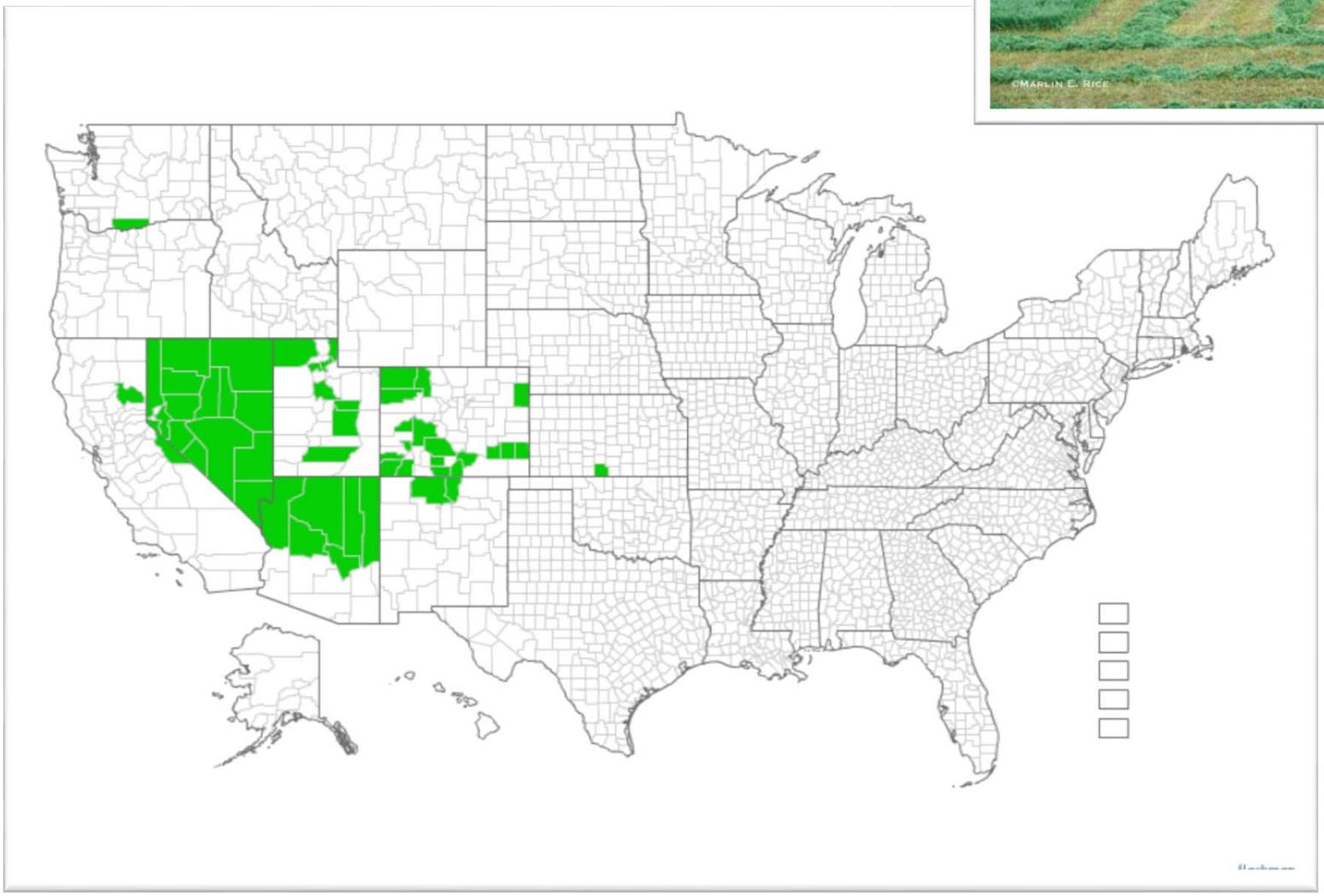
Naturalized
Miscanthus sacchariflorus



How do plants move around?


Diverse land-use types

The alfalfa “invasion”?



Storage as a propagule reservoir

- Do not store near sensitive habitats
- Visually inspect storage sites

Mitigation through Best Management Practices (BMP)

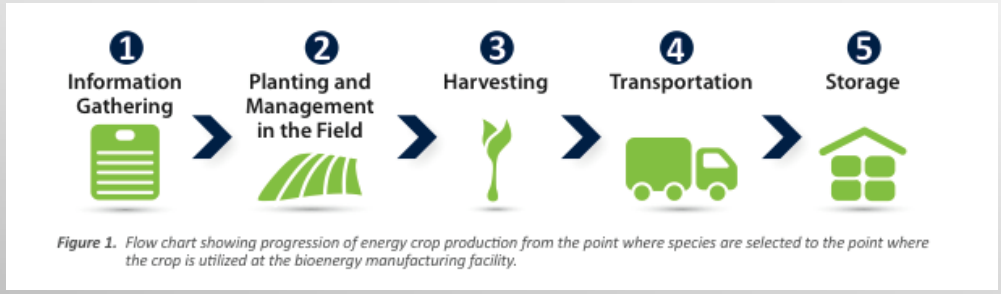
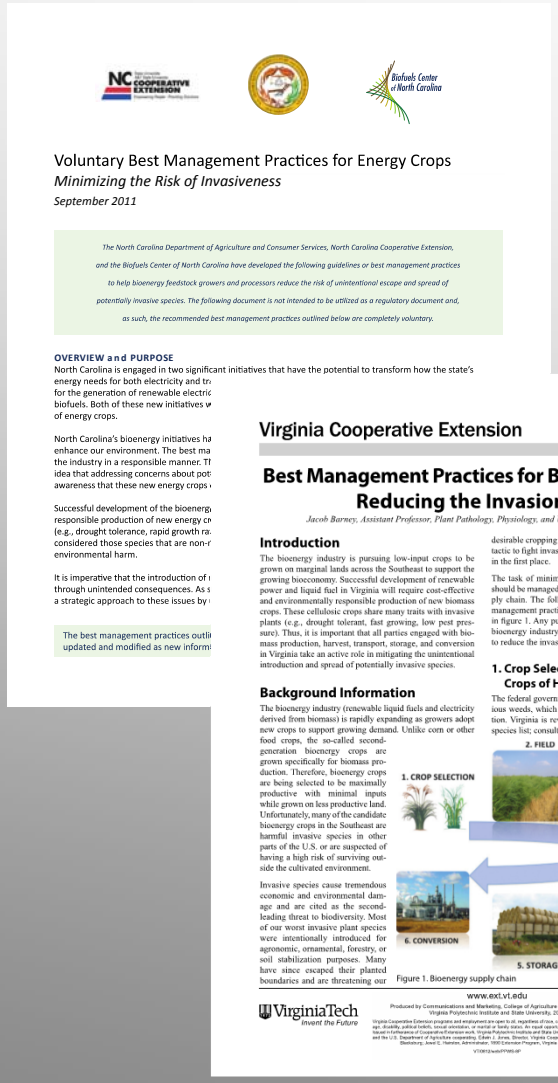


Figure 1. Flow chart showing progression of energy crop production from the point where species are selected to the point where the crop is utilized at the bioenergy manufacturing facility.

1. Right Plant, Right Place
2. Field Management
3. Responsible Harvest
4. Mindful Transportation
5. Sensible Storage



Voluntary Best Management Practices for Energy Crops
Minimizing the Risk of Invasiveness
September 2011

The North Carolina Department of Agriculture and Consumer Services, North Carolina Cooperative Extension, and the Biofuels Center of North Carolina have developed the following guidelines or best management practices to help bioenergy feedstock growers and processors reduce the risk of unintentional escape and spread of potentially invasive species. The following document is not intended to be utilized as a regulatory document and, as such, the recommended best management practices outlined below are completely voluntary.

OVERVIEW and PURPOSE

North Carolina is engaged in two significant initiatives that have the potential to transform how the state's energy needs for both electricity and tr for the generation of renewable electri biofuels. Both of these new initiatives of energy crops.

North Carolina's bioenergy initiatives ha enhance our environment. The best ma the industry in a responsible manner. Th idea that addressing concerns about pot awareness that these new energy crops

Successful development of the bioenerg responsible production of new energy cr (e.g., drought tolerance, rapid growth ra considered those species that are non-r environmental harm.

It is imperative that the introduction of through unintended consequences. As a strategic approach to these issues by

The best management practices outli updated and modified as new inform

Virginia Cooperative Extension

PUBLICATION PPWS-8P

Best Management Practices for Bioenergy Crops: Reducing the Invasion Risk

Jacob Barney, Assistant Professor, Plant Pathology, Physiology, and Weed Science, Virginia Tech

Introduction

The bioenergy industry is pursuing low-input crops to be grown on marginal lands across the Southeast to support the growing bioeconomy. Successful development of renewable power and liquid fuel in Virginia will require cost-effective and environmentally responsible production of new biomass crops. These cellulosic crops share many traits with invasive plants (e.g., drought tolerant, fast growing, low pest pressure). Thus, it is important that all parties engaged with biomass production, harvest, transport, storage, and conversion in Virginia take an active role in mitigating the unintentional introduction and spread of potentially invasive species.

Background Information

The bioenergy industry (renewable liquid fuels and electricity derived from biomass) is rapidly expanding as growers adopt new crops to support growing demand. Unlike corn or other food crops, the so-called second-generation bioenergy crops are grown specifically for biomass production. Therefore, bioenergy crops are being selected to be maximally productive with minimal inputs while grown on less productive land. Unfortunately, many of the candidate bioenergy crops in the Southeast are harmful invasive species in other parts of the U.S. or are suspected of having a high risk of surviving outside the cultivated environment.

Invasive species cause tremendous economic and environmental damage and are cited as the second-leading threat to biodiversity. Most of our worst invasive plant species were intentionally introduced for agronomic, ornamental, forestry, or soil stabilization purposes. Many have since escaped their planted boundaries and are threatening our desirable cropping systems and natural ecosystems. The best tactic to fight invasive species is to prevent their introduction in the first place.

The task of minimizing the risk of bioenergy crop escapes should be managed at several points along the bioenergy supply chain. The following guidelines are recommended best management practices at each of these steps, as diagrammed in figure 1. Any public or private enterprise engaging in the bioenergy industry should adhere to the following practices to reduce the invasion risk.

1. Crop Selection: Do Not Cultivate Crops of High Concern

The federal government and most states maintain lists of noxious weeds, which are regulated species within that jurisdiction. Virginia is reworking its noxious weed regulations and species list; consult it before choosing a bioenergy crop. Nox-

Figure 1. Bioenergy supply chain

www.ext.vt.edu

Produced by Communications and Marketing, College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University, 2012

Biofueling the next invasion…

…perhaps, but slowly. For now.

Miscanthus

Giant reed

Elephant grass

camelina

switchgrass

Reed canarygrass

jnbarney@vt.edu
https://weedeco.ppws.vt.edu/