

DOE Bioenergy Technologies Office (BETO) 2015 Project Peer Review

Nationwide Bio-Fuel Resource Mapping PRISM - EM

- March 2015
- Technology Area Review

- Chris Daly and Michael Halbleib
- Oregon State University

Estimating the Potential Distribution and Yield of Biomass Crops

Resource Assessment Objective: Gain an understanding of the spatial distribution of current and potential biofuel/bio-energy feedstock resources across the country

Envisioned outcome: A series of national geo-referenced grids (maps) that describe potential productivity patterns of various feedstocks

Quad Chart Overview

Timeline

- Project start date: 01/15/2007
- Project end date: 12/31/2015
- Percent complete: 90%

Barriers

- Ft-A: Resource availability and cost
- Ft-B: Sustainable production
- Ft-C: Crop genetics

Budget

	Total Costs FY 07 –FY 12	FY 13 Costs	FY 14 Costs	Total Planned Funding (FY 15- Project End Date
DOE Funded	\$2,075,671	\$372,914	\$47,042	\$179,464
Project Cost Share (Comp.)*	\$530,274	\$83,745	\$34,525	

Partners

- Collaborations: ORNL, DOE, RMA, Sun Grant Initiative, Land Grant Resource Assessment Centers (U of Tennessee, South Dakota State Univ., Cornell, Oklahoma State Univ., USDA-ARS), U of Illinois, Iowa State U., Miss. State U., U of Georgia, SUNY
- Project management: GIS leads, Sun Grant, South Dakota State University (reporting)

Map National Feedstock Potential

- Need for mapped estimates of production potential for selected biomass feedstocks
- Local and regional field trial data were sparse
- Without extensive yield history and trial work available the ability to estimate more broadly was difficult
- Need to scale local results regionally and nationally
- Use long-term climate averages with soils data and expected crop response coupled with field plot data to provide nationally mapped estimates

Map National Feedstock Potential for Selected Crops - Overview

- Acted as Western Region GIS Center
- Identified need for national feedstock mapping
- Yield data were collected from SGI trials and literature
- Initial PRISM-EM modeling of feedstock yields was conducted
- Met with SGI species leads and colleagues to discuss yield data and model results
- Produced draft maps for review
- Delivered feedstock yield maps to ORNL

Map National Feedstock Potential for Selected Crops - Approach

- Draft meaningful maps that can be used in GIS applications
- In collaboration with species leads, achieve a good statistical fit between model and field trials
- Improve model inputs, growth response curves, additional field trial locations, additional years of data, incorporate other soils parameters
- Improve the model

PRISM-EM

Simple, statistical–process hybrid model that evaluates crop response to environmental constraints

“Limiting Factor” Approach

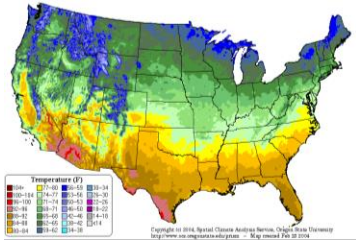
Relative Yield (0 - 100%) =

Lowest production resulting from the following functions:

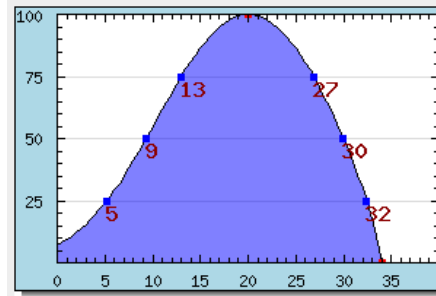
- Water Balance Model
- Winter Low Temperature Constraint
- Summer High Temperature Constraint
- Soil Properties
 - pH
 - Salinity
 - Drainage



SSURGO Soil Maps

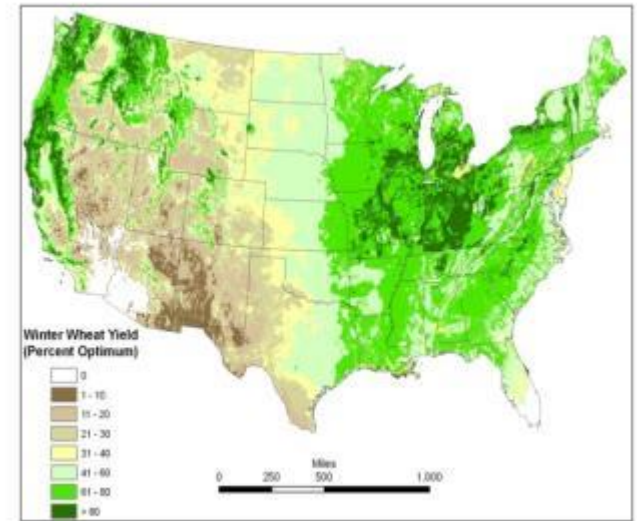


PRISM Climate Maps

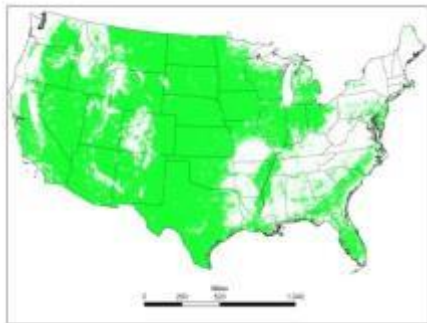


Environmental Model
PRISM-EM

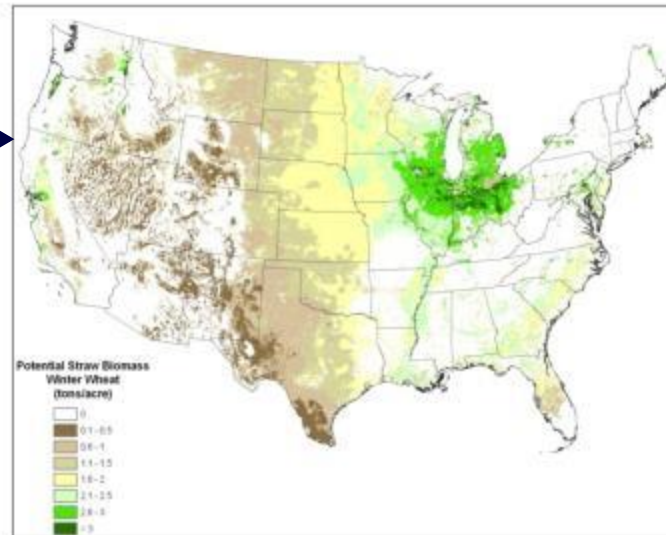
Percent of Maximum Yield



Biomass Yield



Terrain/Land Cover
Constraints
(Optional)

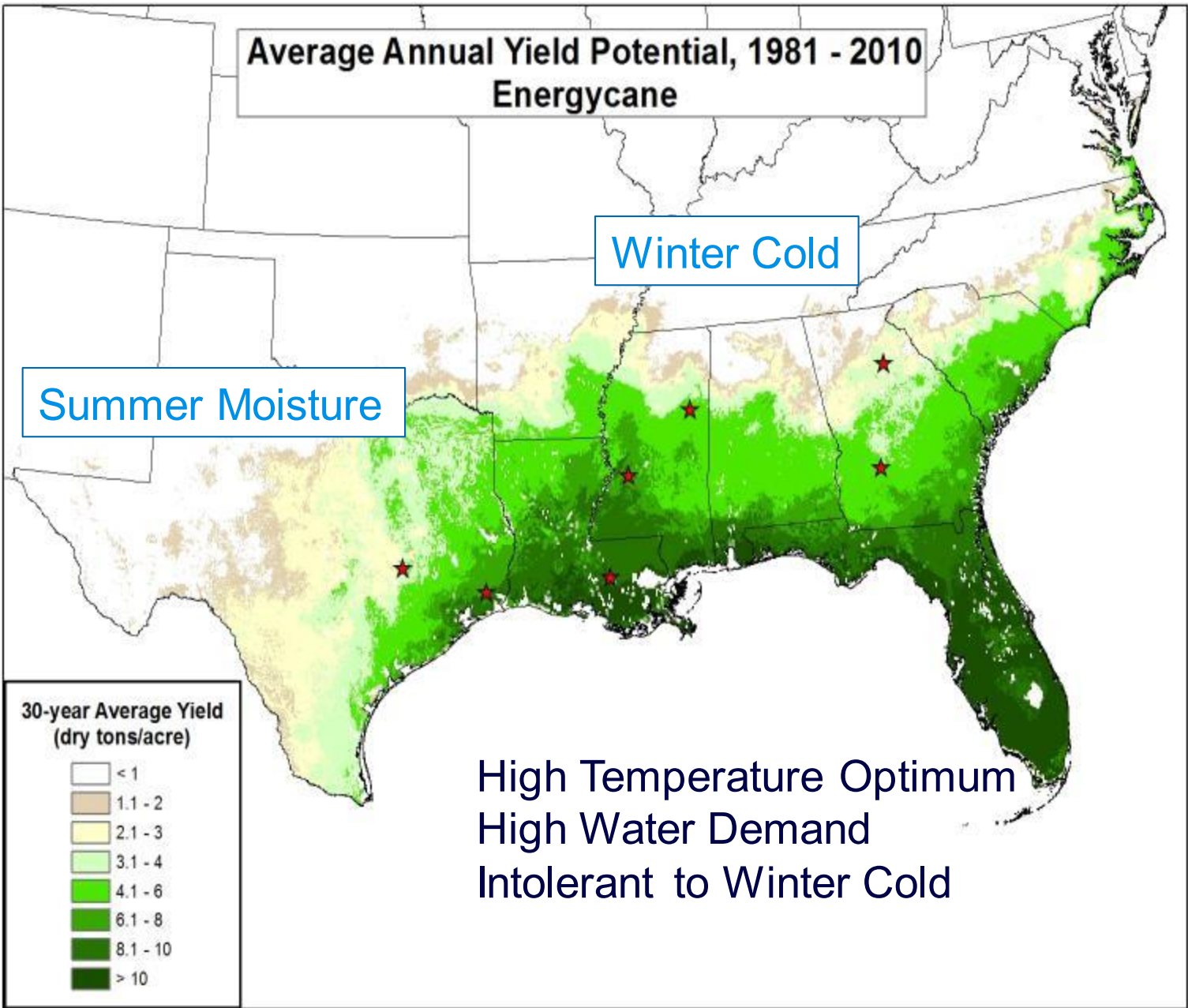


Observed Yield

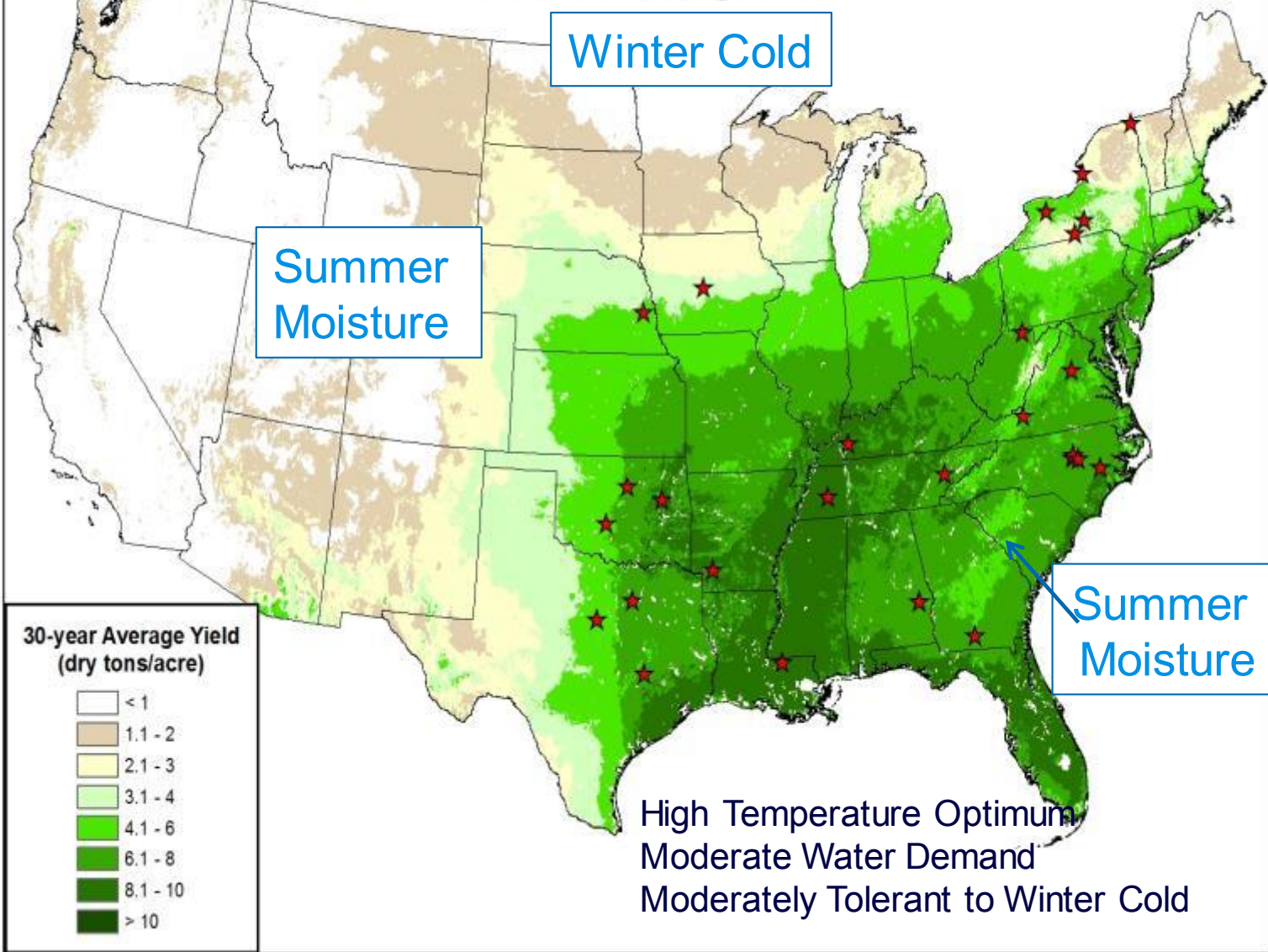
Technical Accomplishments/ Progress/Results

- To date 10 feedstocks have been modeled
 - upland switchgrass
 - lowland switchgrass
 - typical CRP mix
 - miscanthus
 - sorghum
 - poplar
 - pine
 - willow
 - camelina
- Field trial yield data has been used to create statistical relationships between modeled output and actual yield
- Relative yield maps have been converted to estimated long-term averages using the regression function derived from the relationship between the field trial data and modeled values.

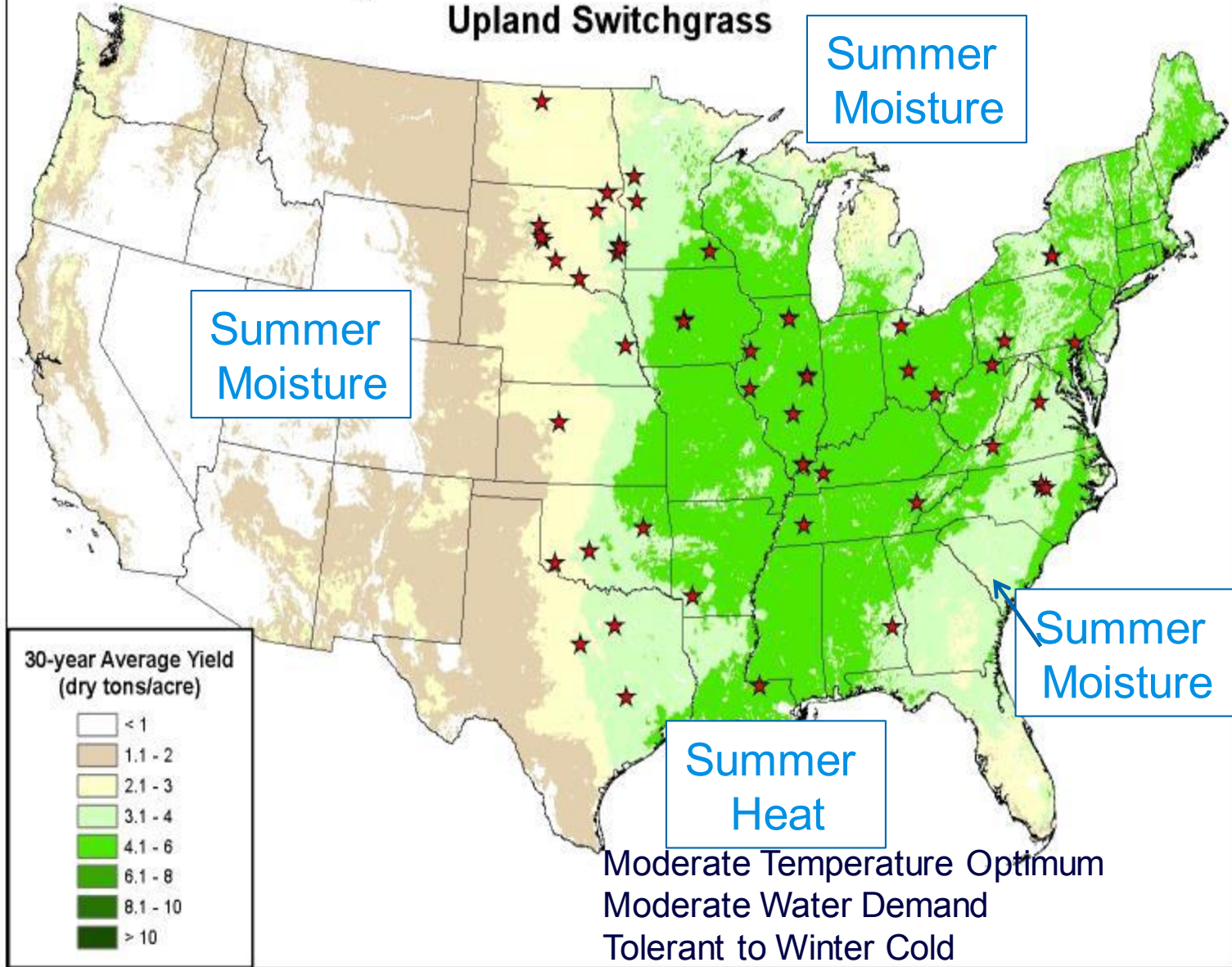
Average Annual Yield Potential, 1981 - 2010 Energy cane



Average Annual Yield Potential, 1981 - 2010 Lowland Switchgrass



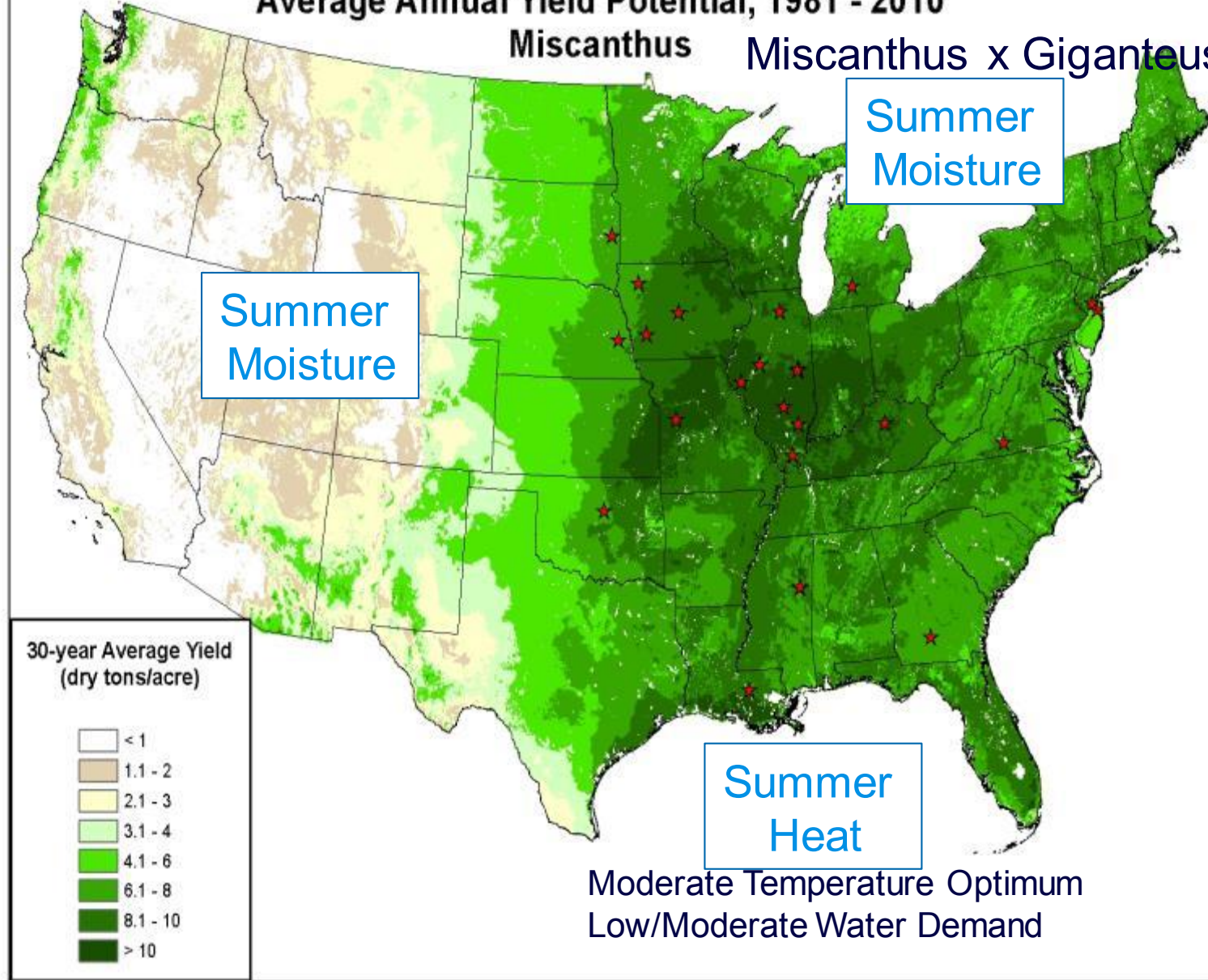
Average Annual Yield Potential, 1981 - 2010 Upland Switchgrass



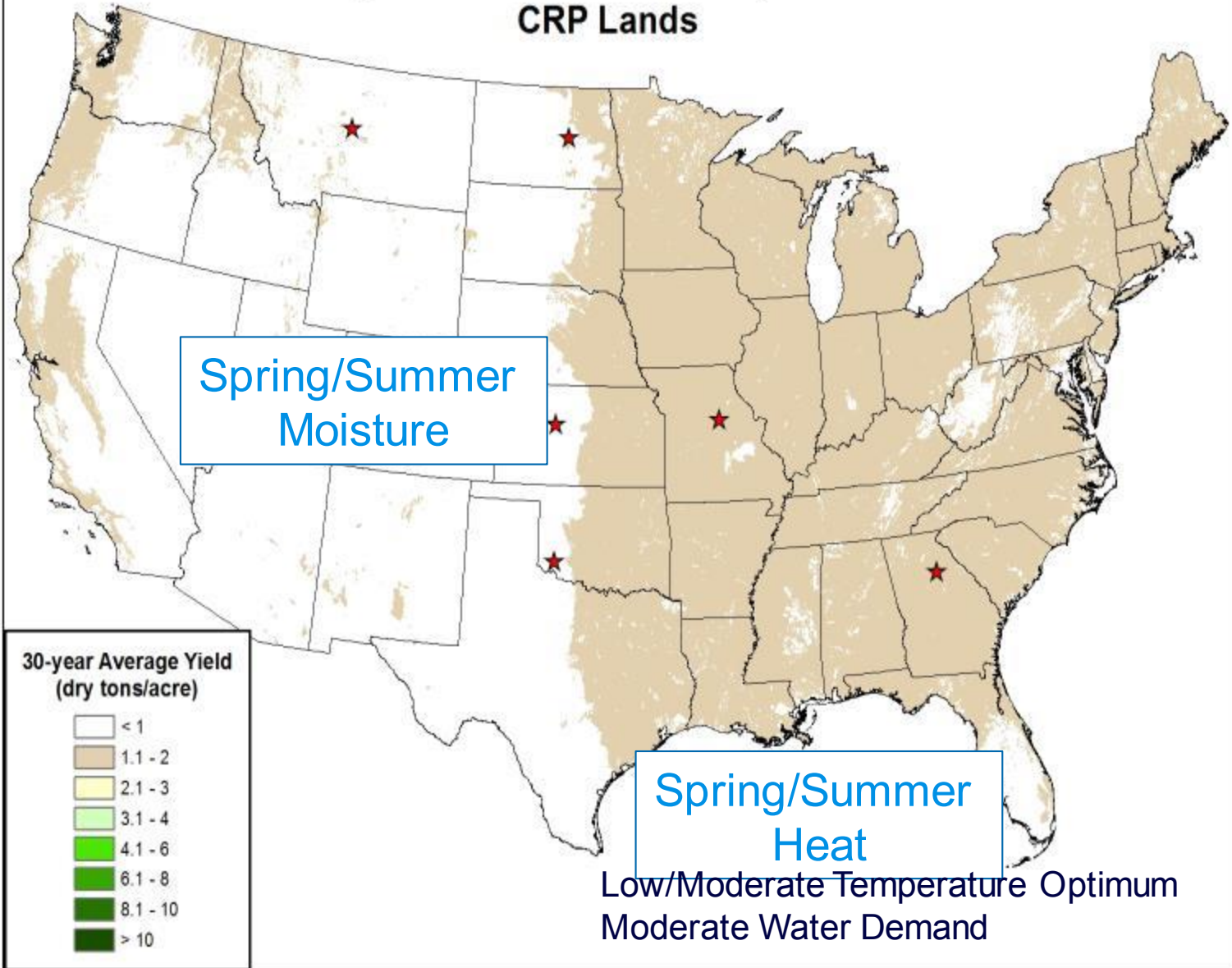
Average Annual Yield Potential, 1981 - 2010

Miscanthus

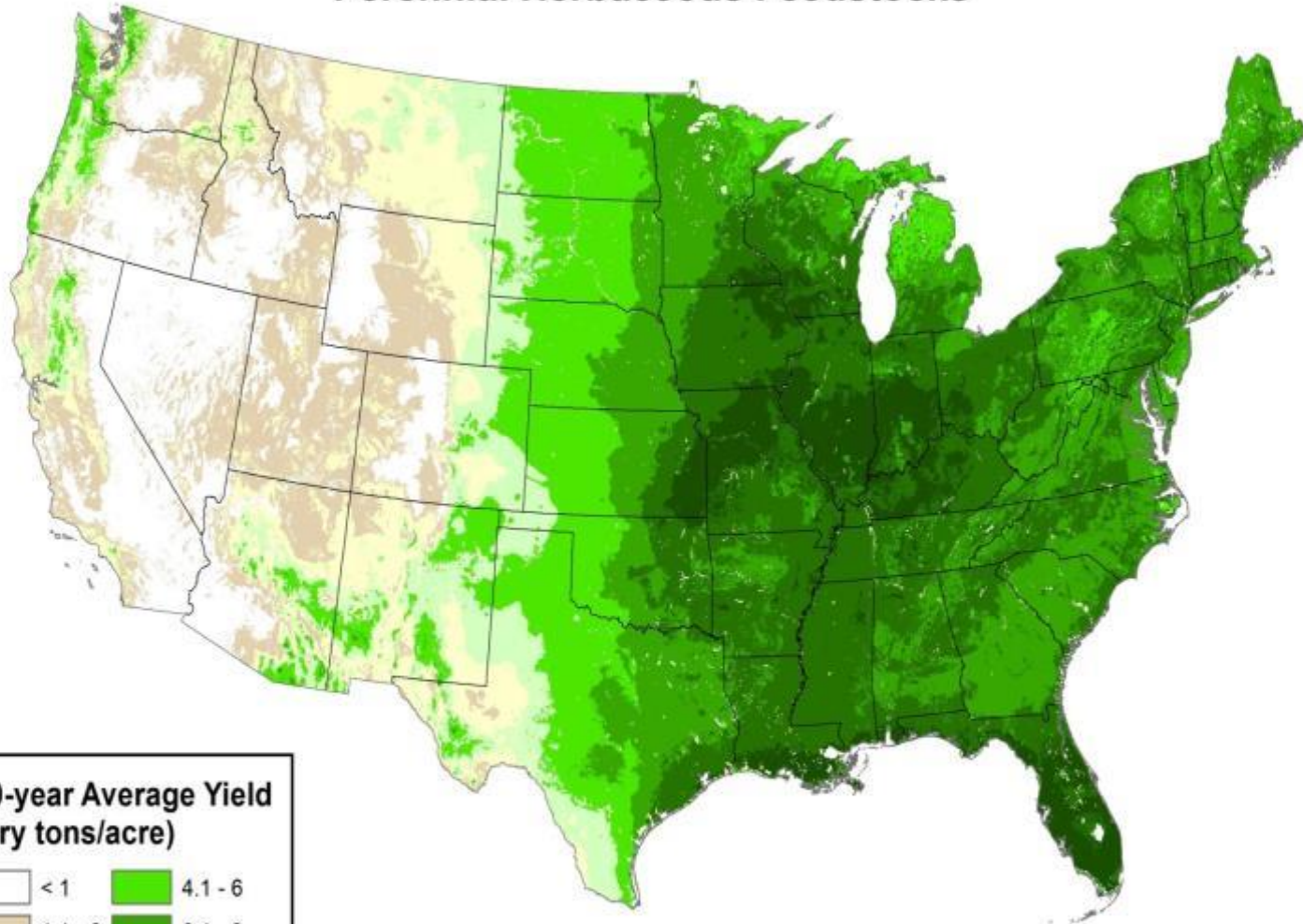
Miscanthus x Giganteus



Average Annual Yield Potential, 1981 - 2010 CRP Lands



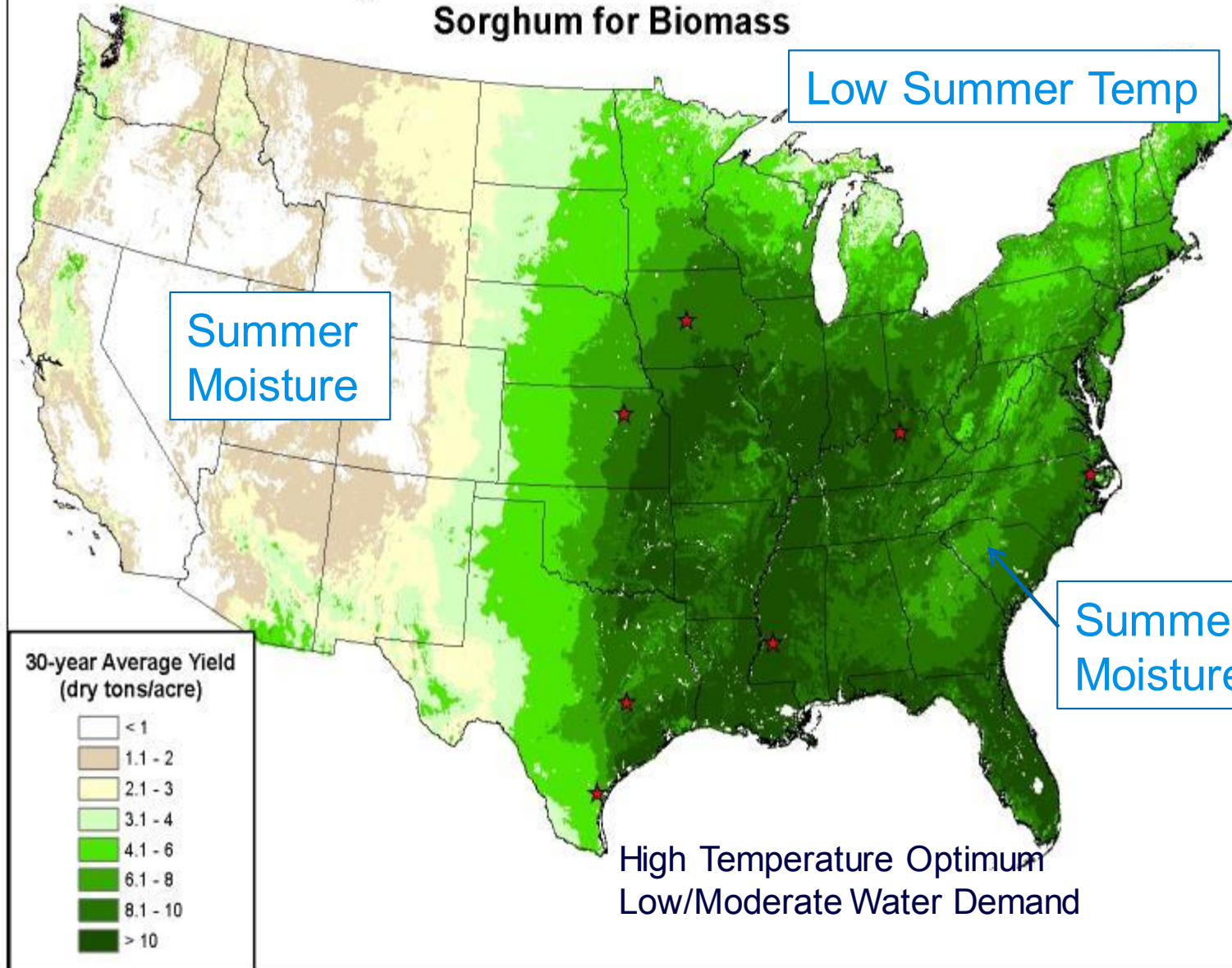
Maximum Average Annual Yield Potential, 1981-2010 Perennial Herbaceous Feedstocks



**30-year Average Yield
(dry tons/acre)**



Average Annual Yield Potential, 1981 - 2010 Sorghum for Biomass



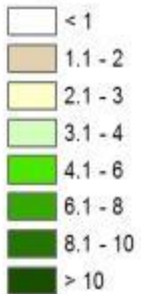
Average Annual Yield Potential, 1981 - 2010 Poplar

Populus Deltoides

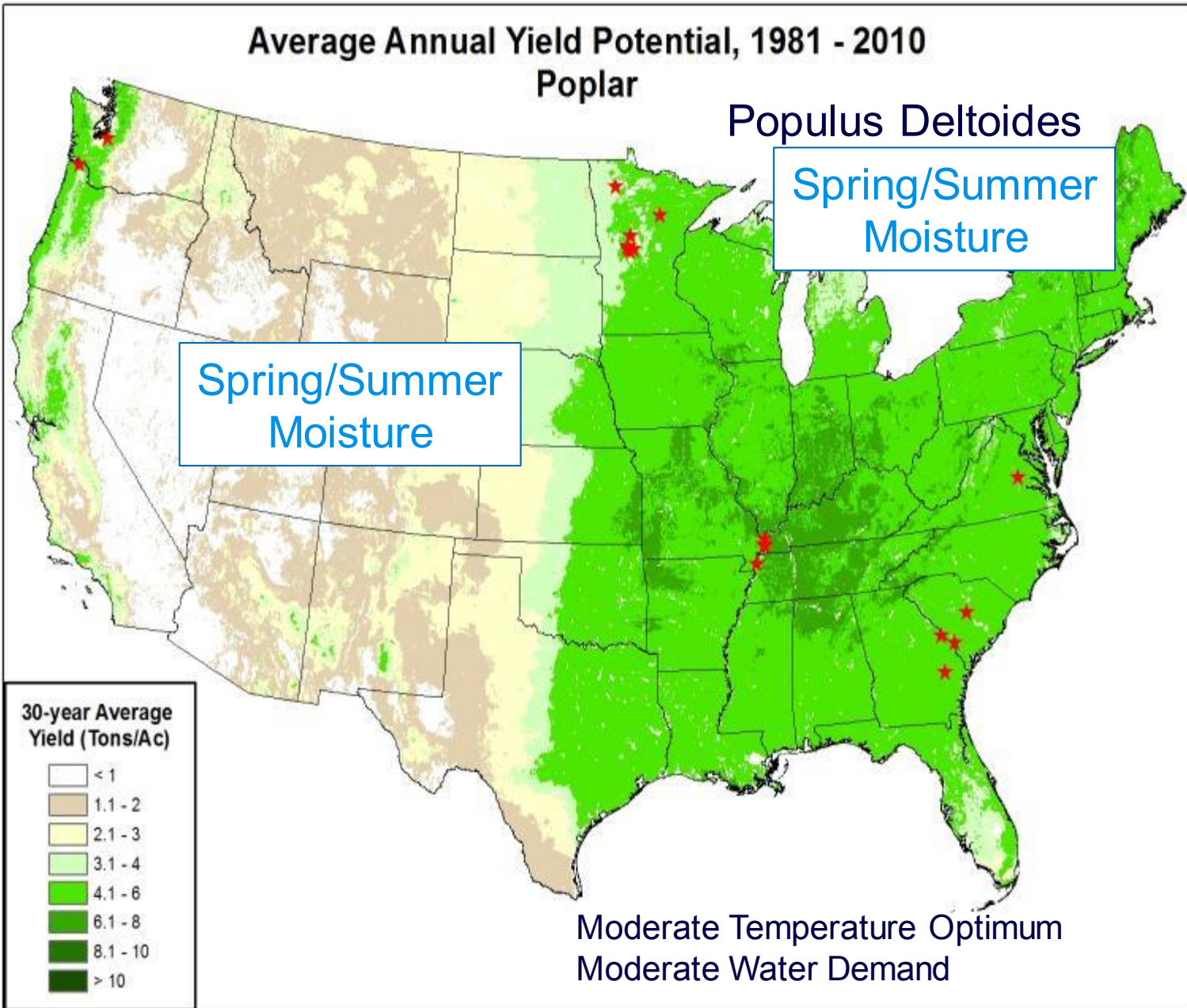
Spring/Summer
Moisture

Spring/Summer
Moisture

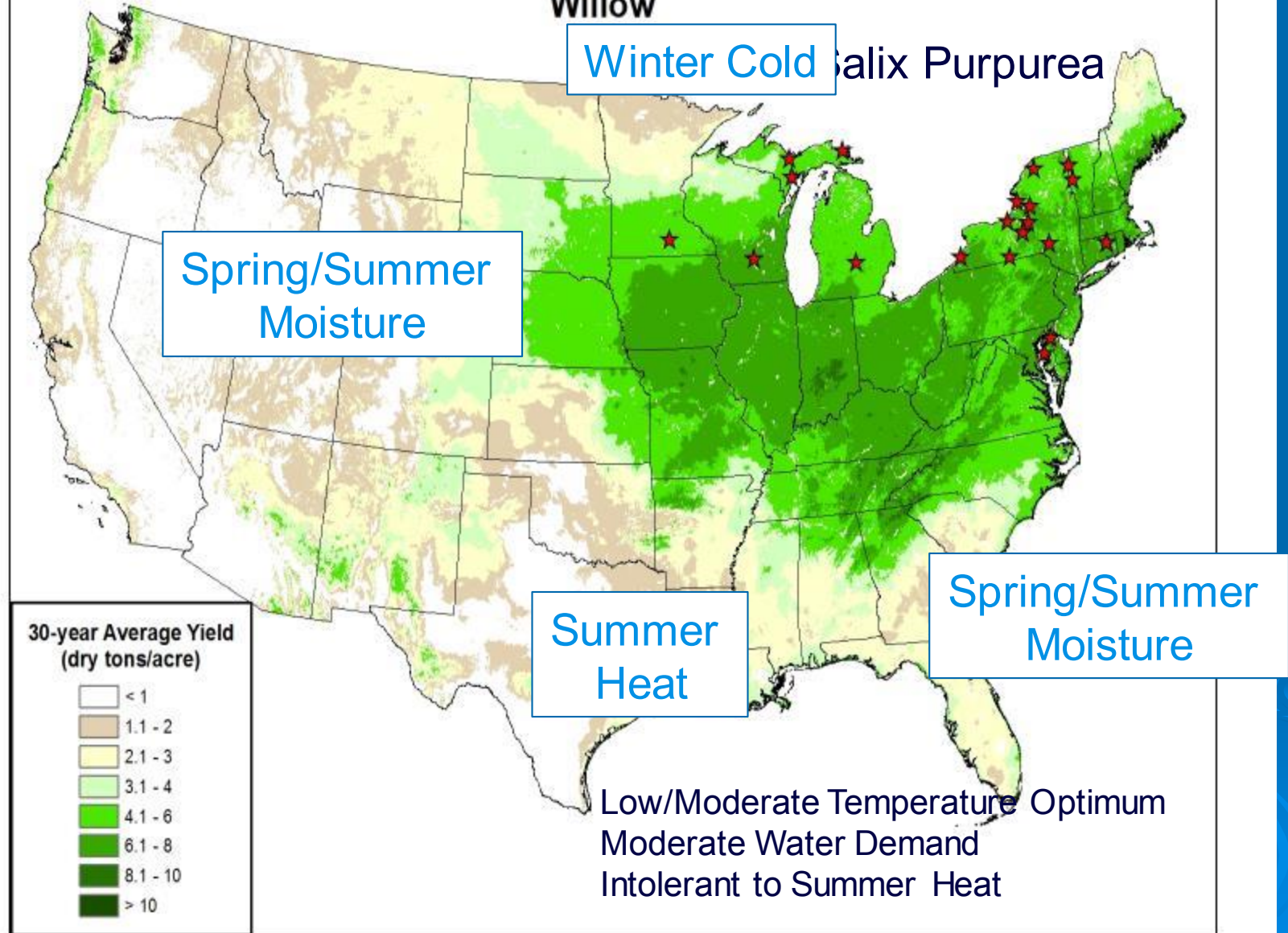
30-year Average
Yield (Tons/Ac)



Moderate Temperature Optimum
Moderate Water Demand



Average Annual Yield Potential, 1981 - 2010 Willow



Average Annual Yield Potential, 1981 - 2010 Pine

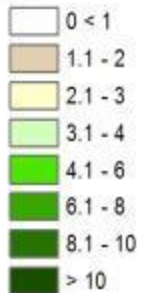
Pinus Taeda

Winter Cold

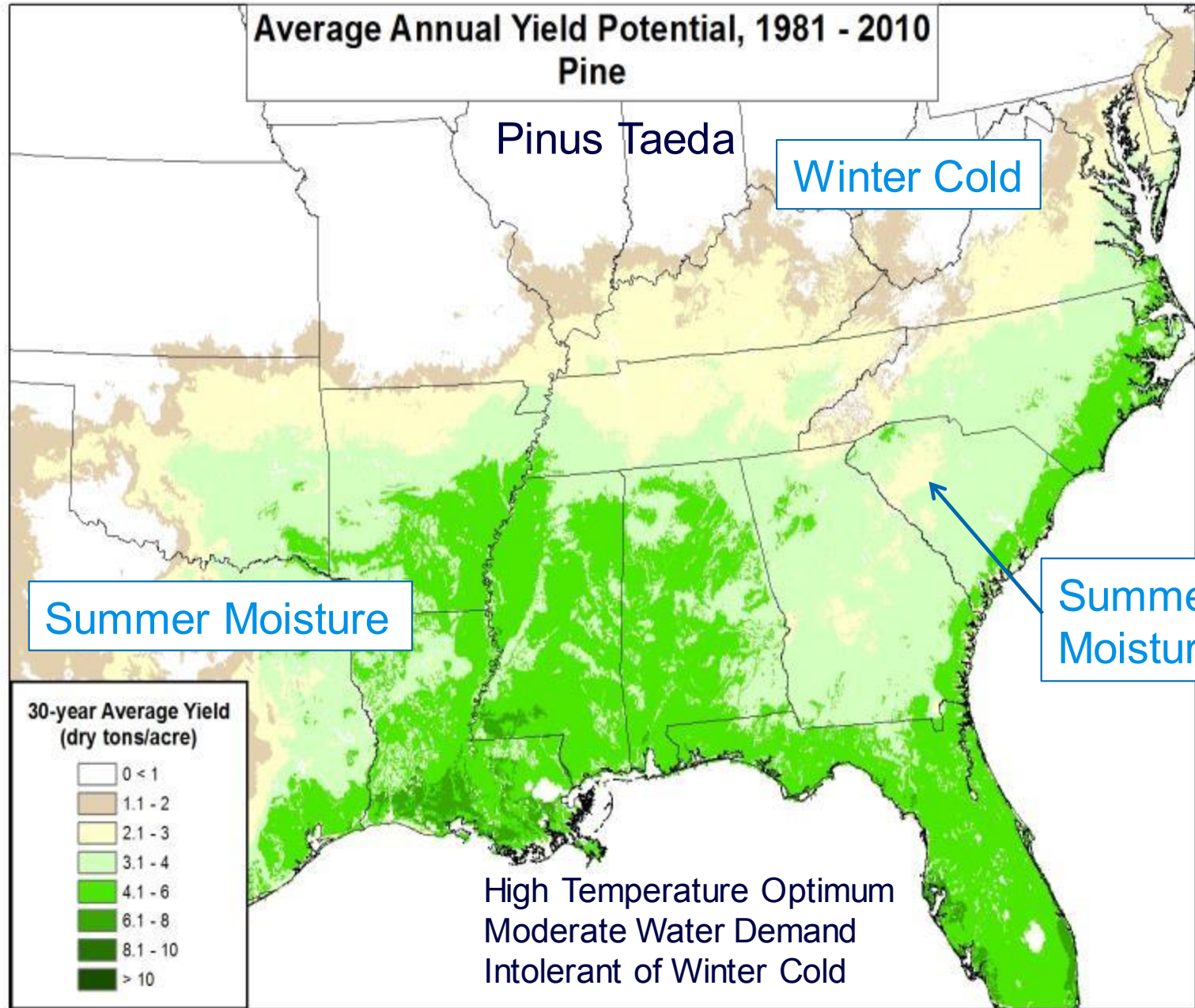
Summer Moisture

Summer Moisture

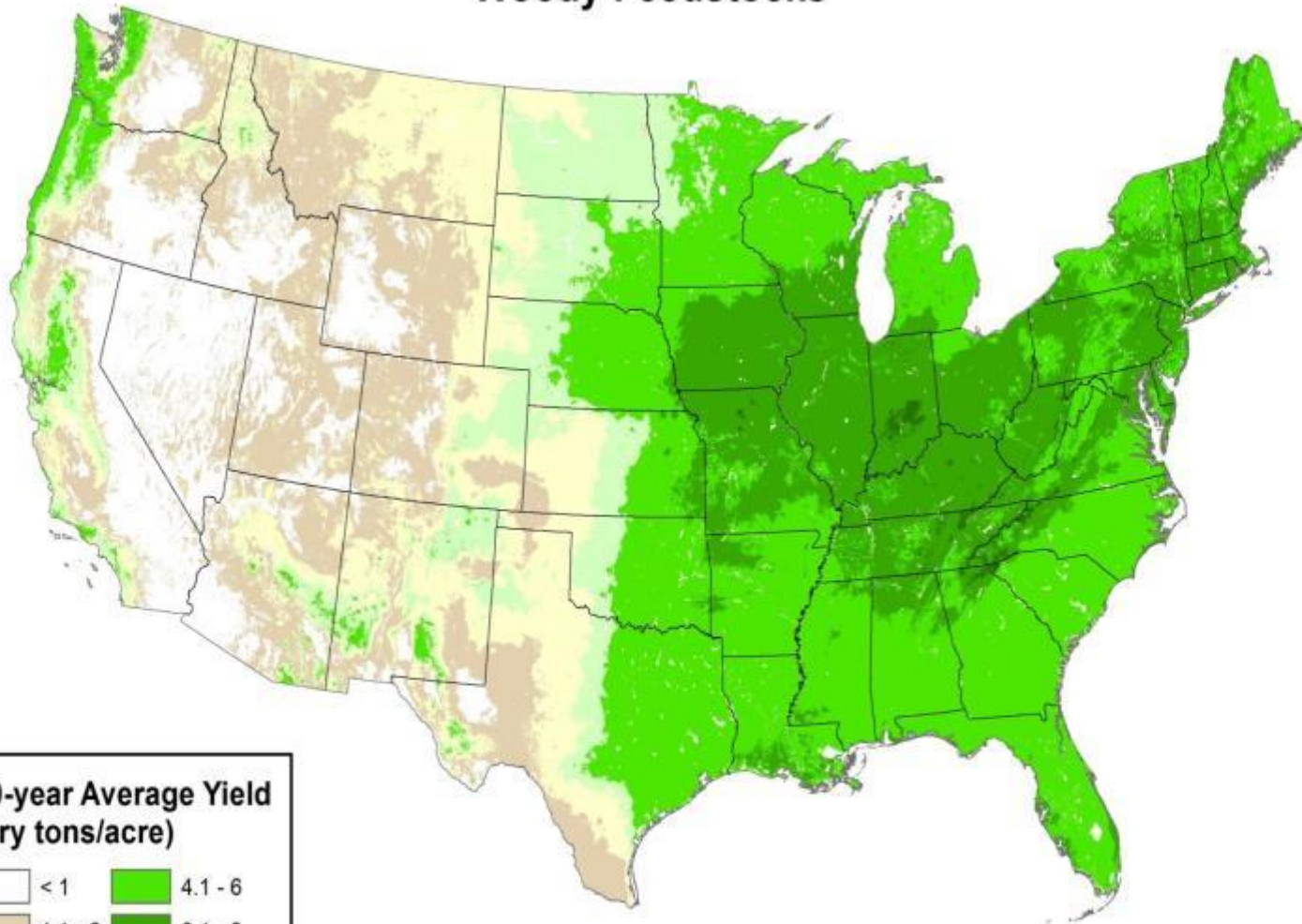
30-year Average Yield
(dry tons/acre)











High Temperature Optimum
Moderate Water Demand
Intolerant of Winter Cold



Maximum Average Annual Yield Potential, 1981-2010 Woody Feedstocks



30-year Average Yield (dry tons/acre)

	< 1		4.1 - 6
	1.1 - 2		6.1 - 8
	2.1 - 3		8.1 - 10
	3.1 - 4		> 10

Map National Feedstock Potential for Selected Crops - Challenges

- Relatively few well controlled, broadly distributed, long term, field trial locations and yield data
- Plot density and distribution not sufficient to cover environmental gradients; what happens around the “edges of the distribution”, i.e. extrapolation
- Underlying soils data may be unrepresentative due to soil amendments, modifications, and small scale variability
- Year to year variation in field trials (climate, treatments, pest pressure, trial size, etc.)
- Limited information on feedstock response to climate and soils variables

4 – Relevance

- Simple simulation modeling in parallel with field measurements provide a spatial framework for the data
- PRISM-EM was developed for this purpose and has been used on traditional crops with extensive production histories as proof of concept; intended to be used on crops with less production history, e.g. energycane, switchgrass, miscanthus

Relevance

- National maps provide baseline estimates of biomass potential and provide good first estimates of overall production potential
- Mapped yield estimates provide the ability to compare various biomass feedstock options for a given region
- Data are being used as inputs to economic analyses, siting studies, and transportation modeling
- Accessible from the KDF for interested parties
- Serve as siting guides for additional yield trials

Future Work

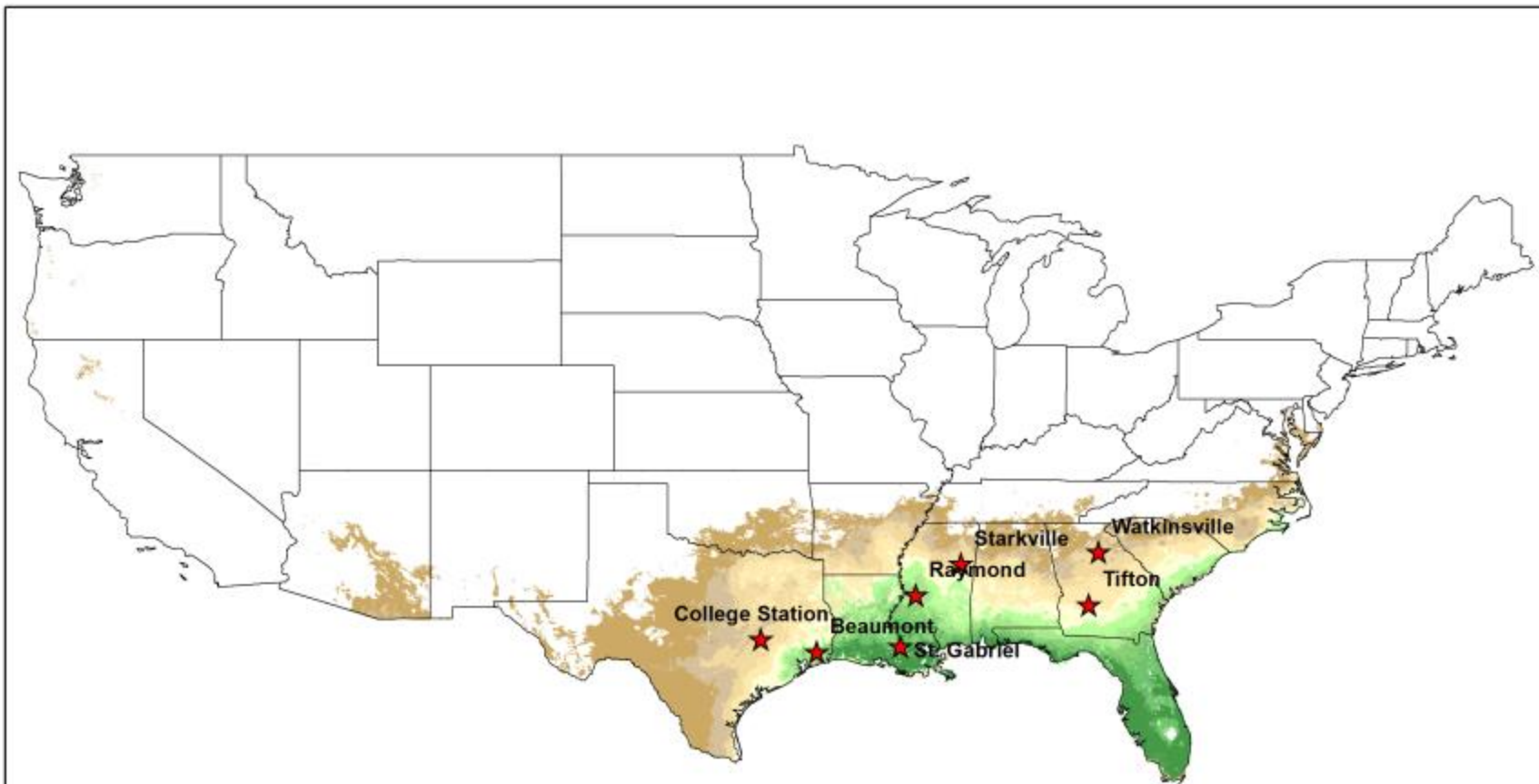
- Refine and improve the model
- Incorporate additional field trial locations
- Add additional years of trial results
- Update the mapping estimates when applicable
- Incorporate hi-resolution soils data
- Consider utilizing farm scale yield maps and data
- Consider creating risk map estimates based on historical temporal variability

Summary

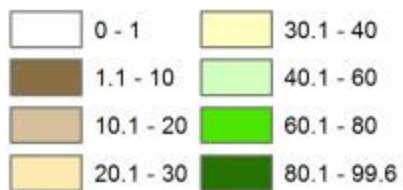
- Estimates of potential by feedstock have been produced with a reasonable level of correlation between the modeled output and the field trial locations.
- 10 maps of potential average annual yield by feedstock
- Delivery of the 30-year average yield maps to the KDF
- Delivery of individual year estimates for the same 30-year period
- Application of the data to future climate analysis (on-going)

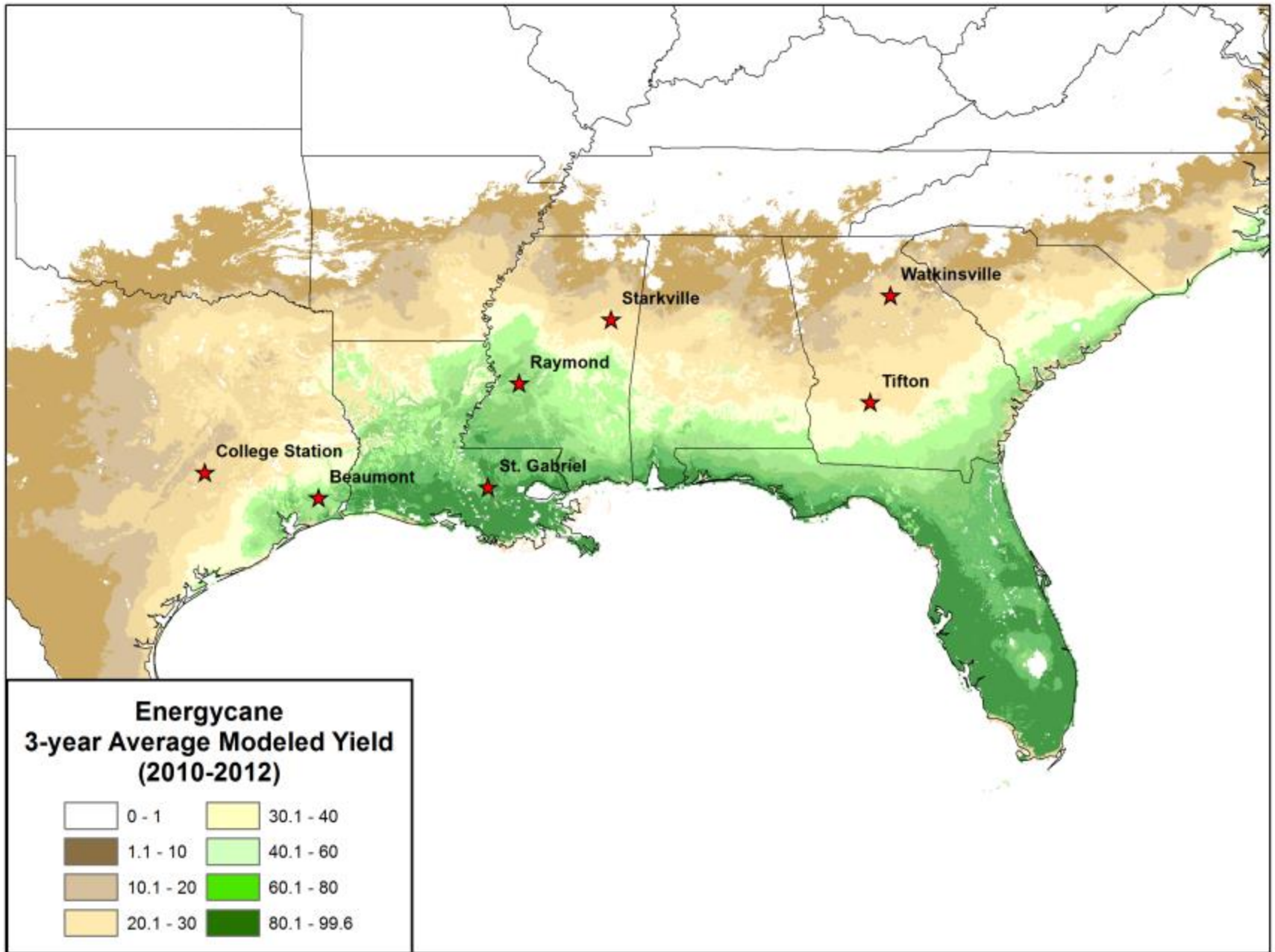
Additional Slides

PRISM-EM Mapping Example

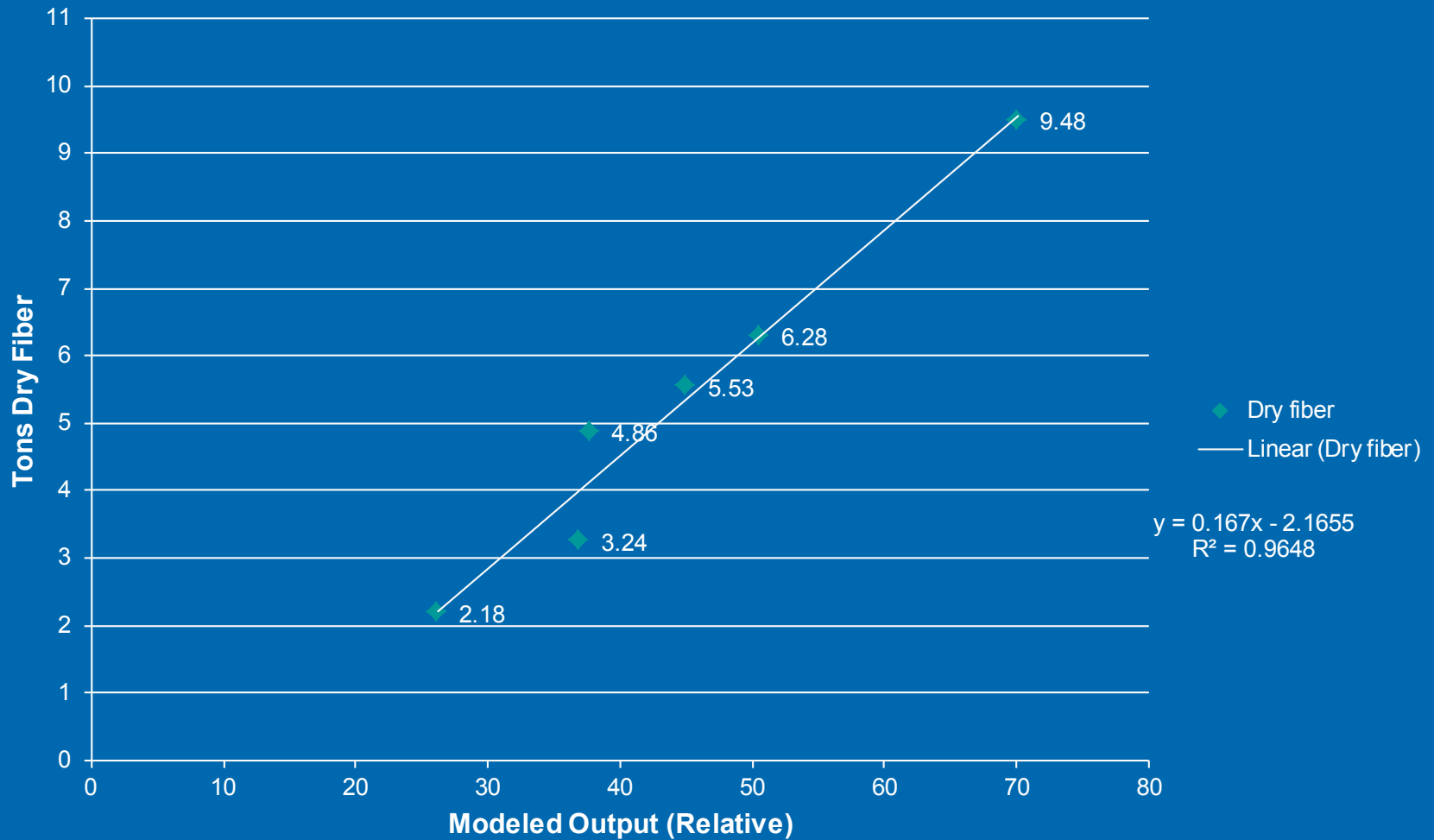


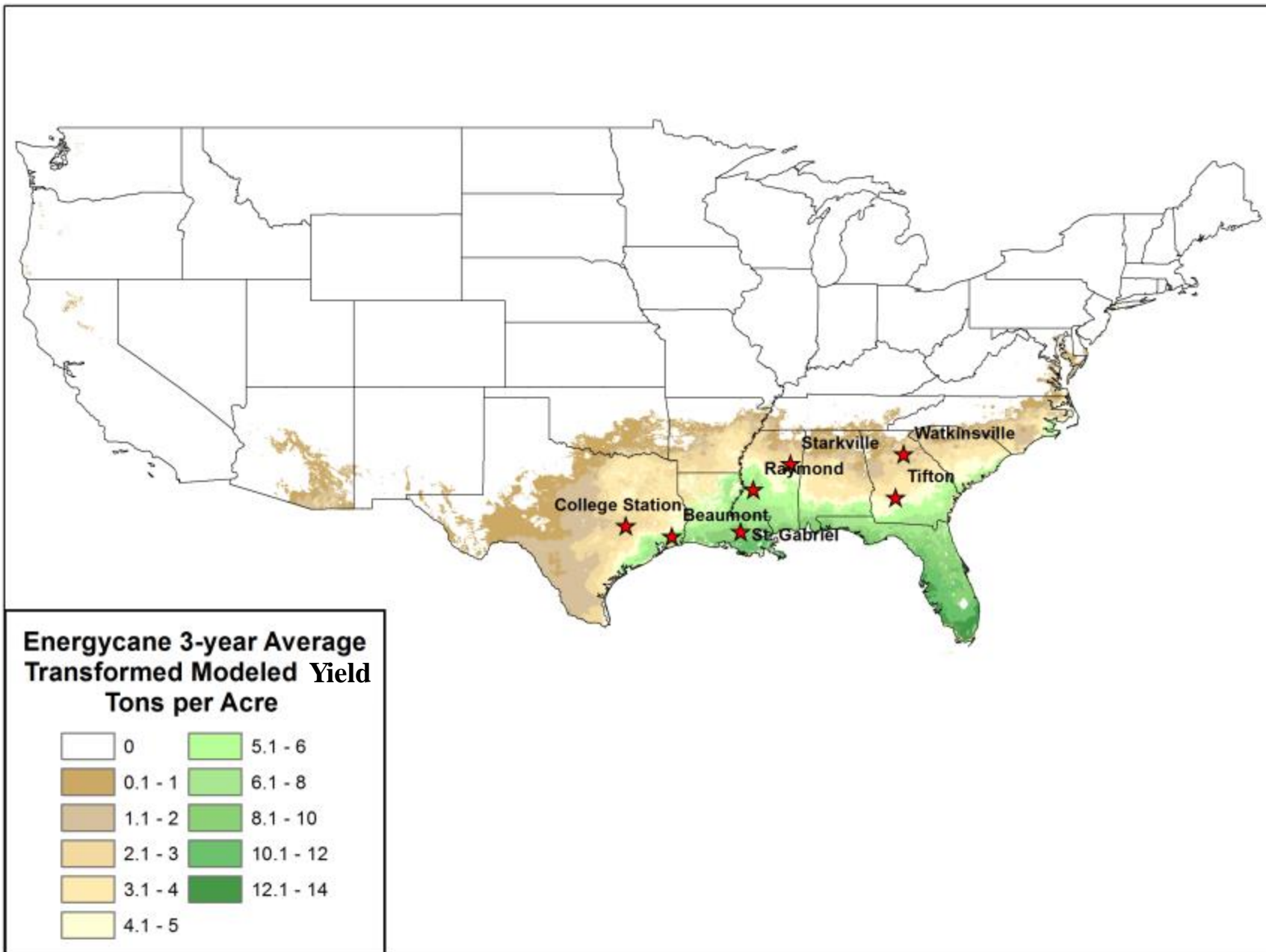
**Energycane
3-year Average Modeled Yield
(2010-2012)**

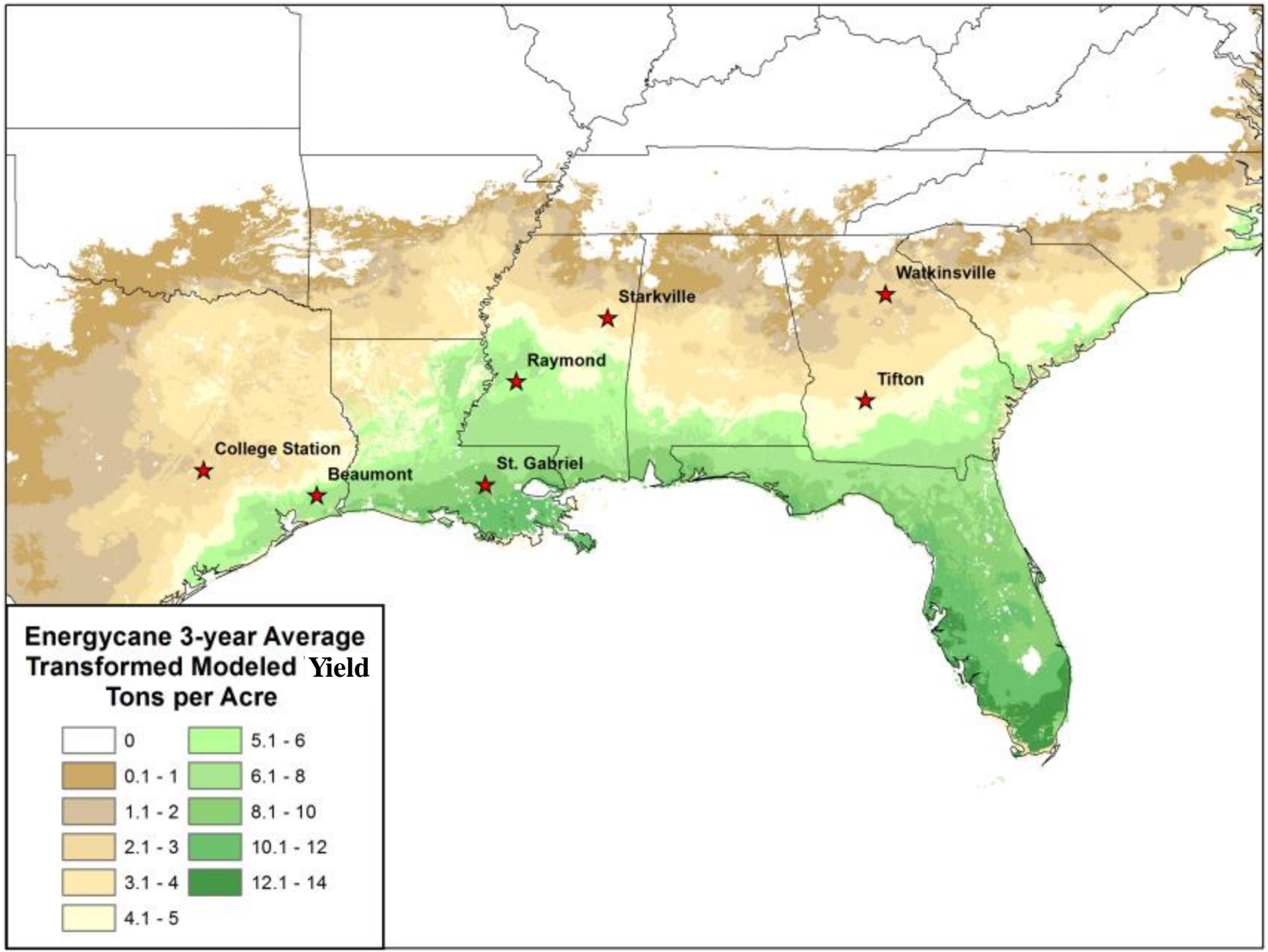


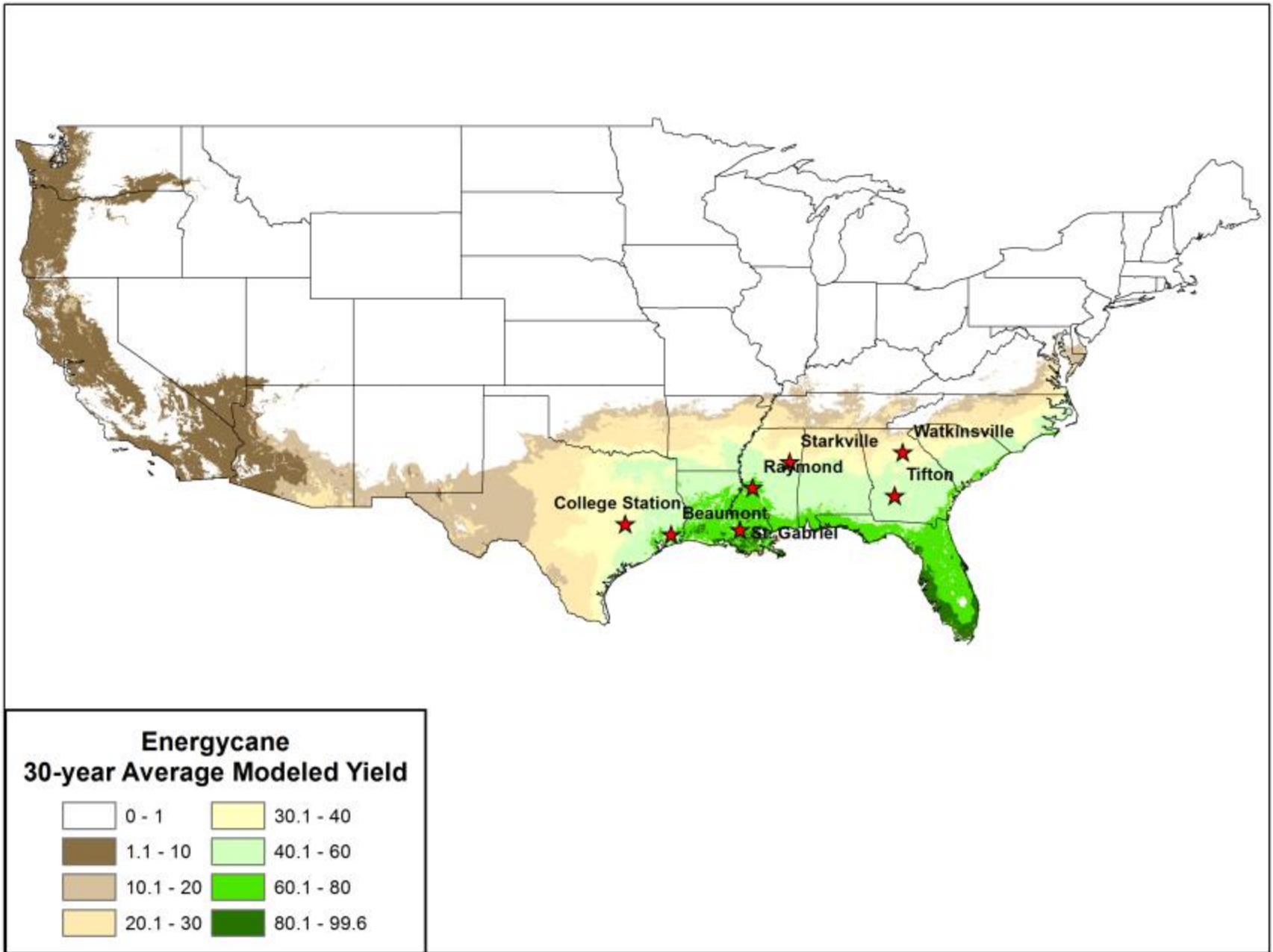


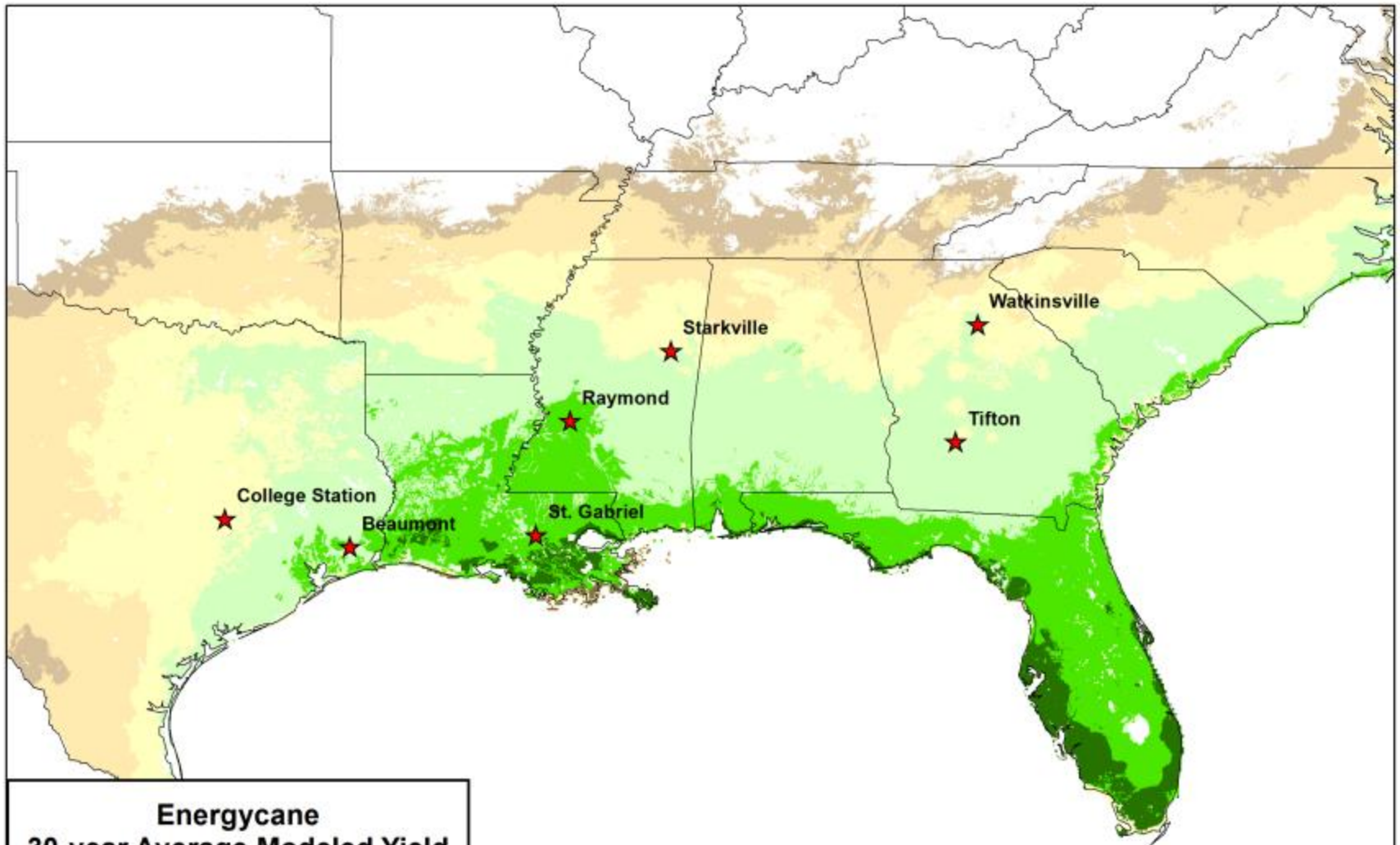
3-year Average Dry Fiber Plotted Against 3-year Average Model Output





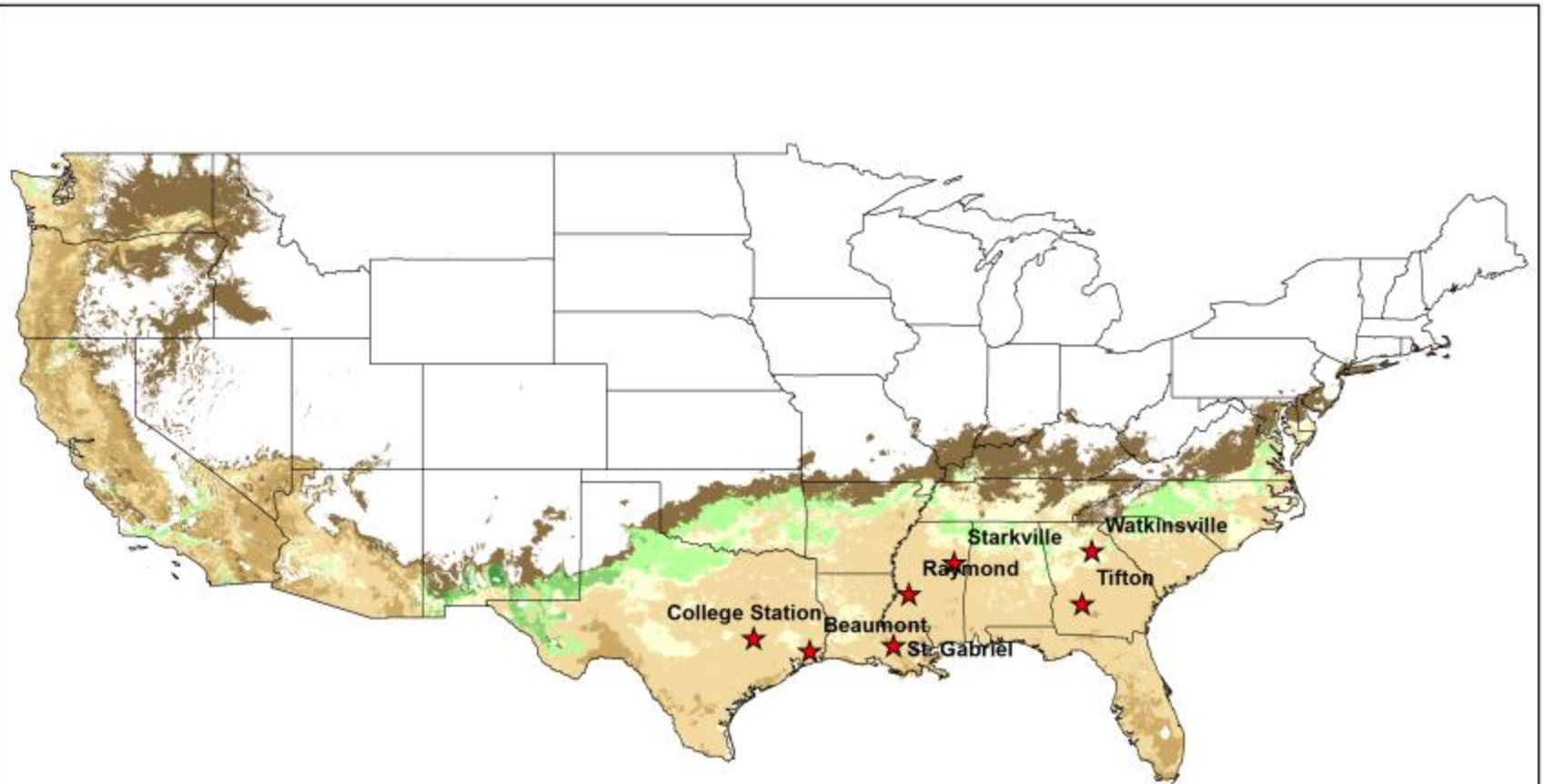




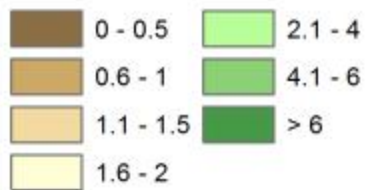


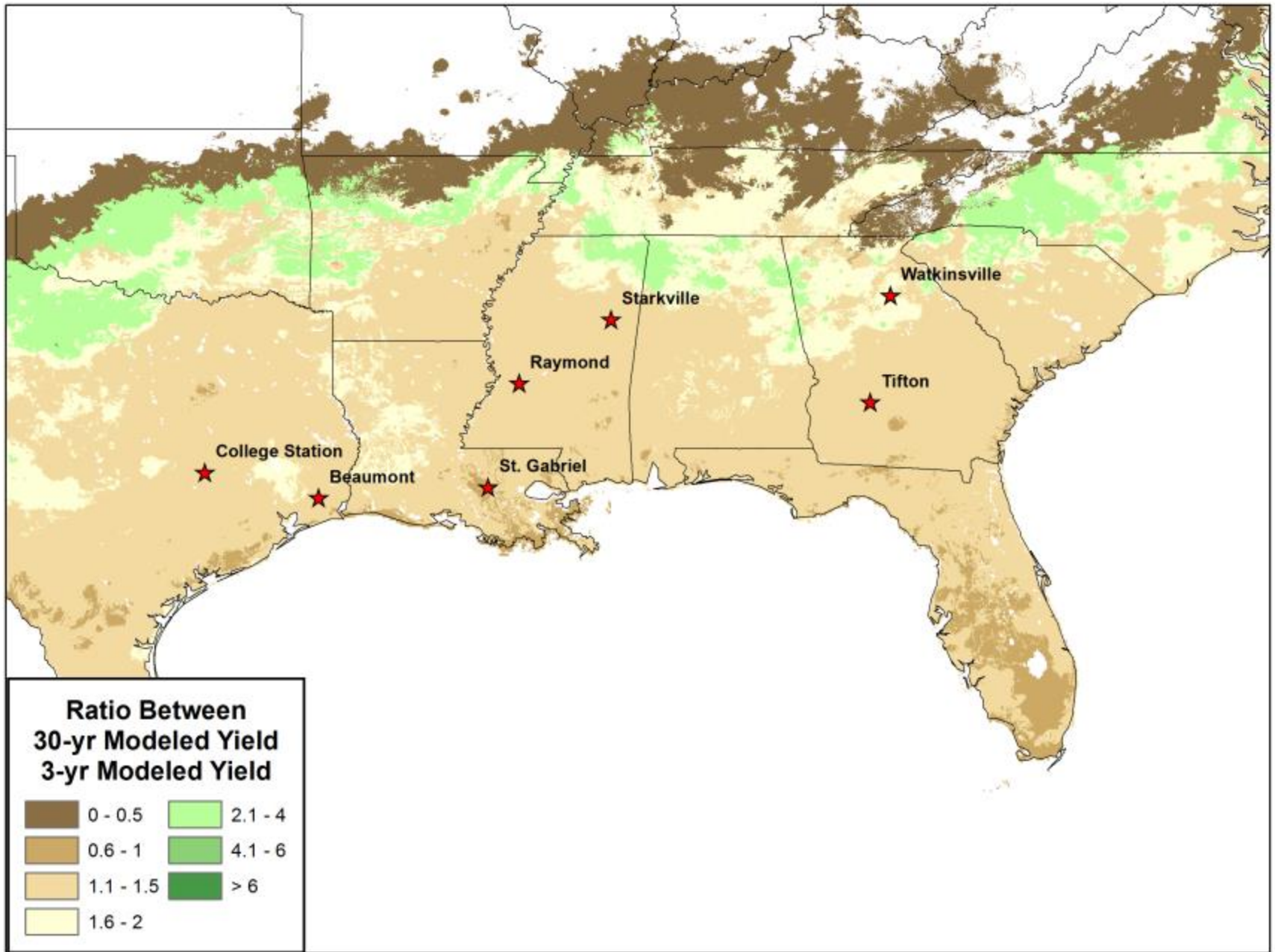
**Energycane
30-year Average Modeled Yield**

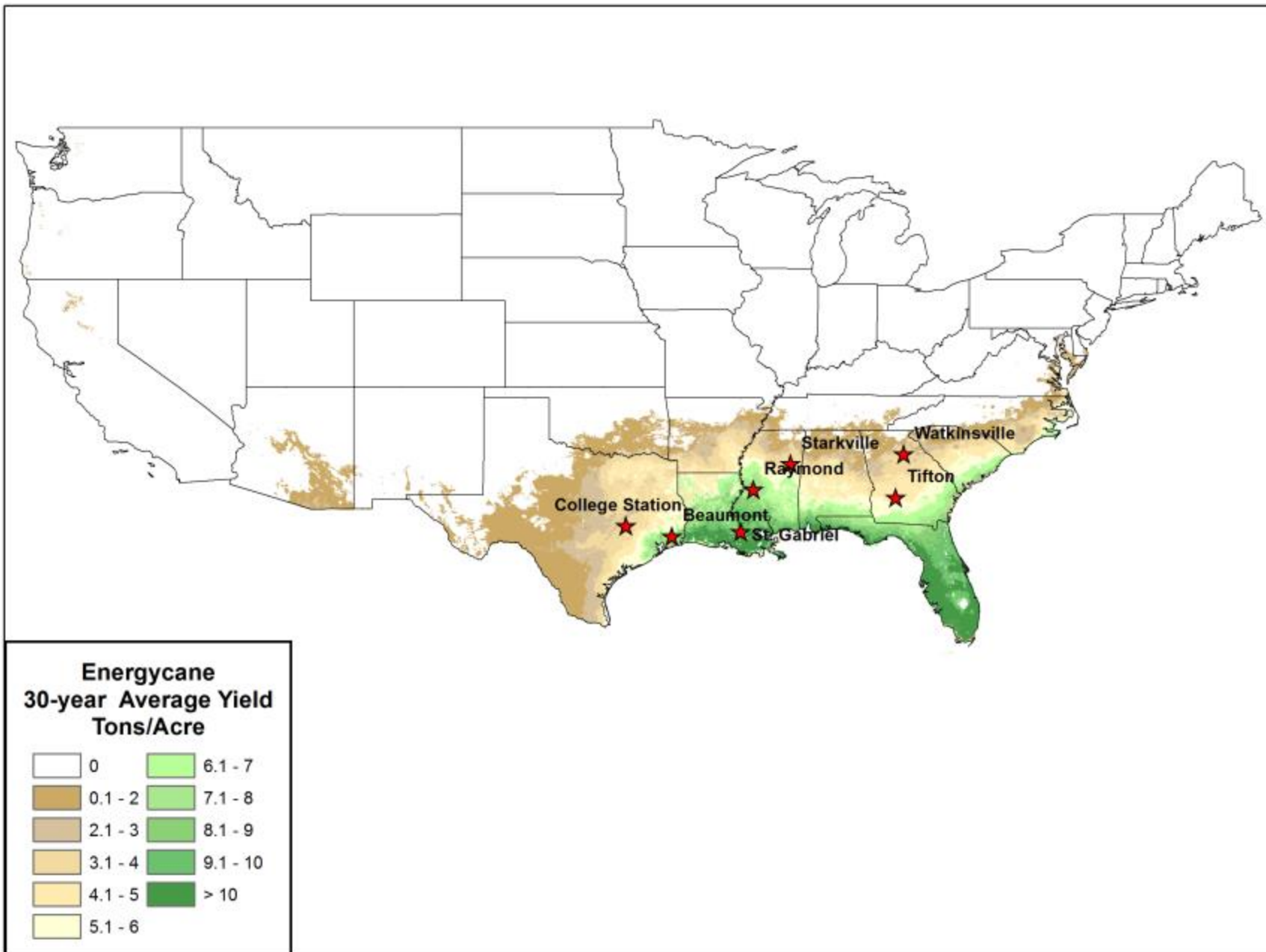
0 - 1	30.1 - 40
1.1 - 10	40.1 - 60
10.1 - 20	60.1 - 80
20.1 - 30	80.1 - 99.6

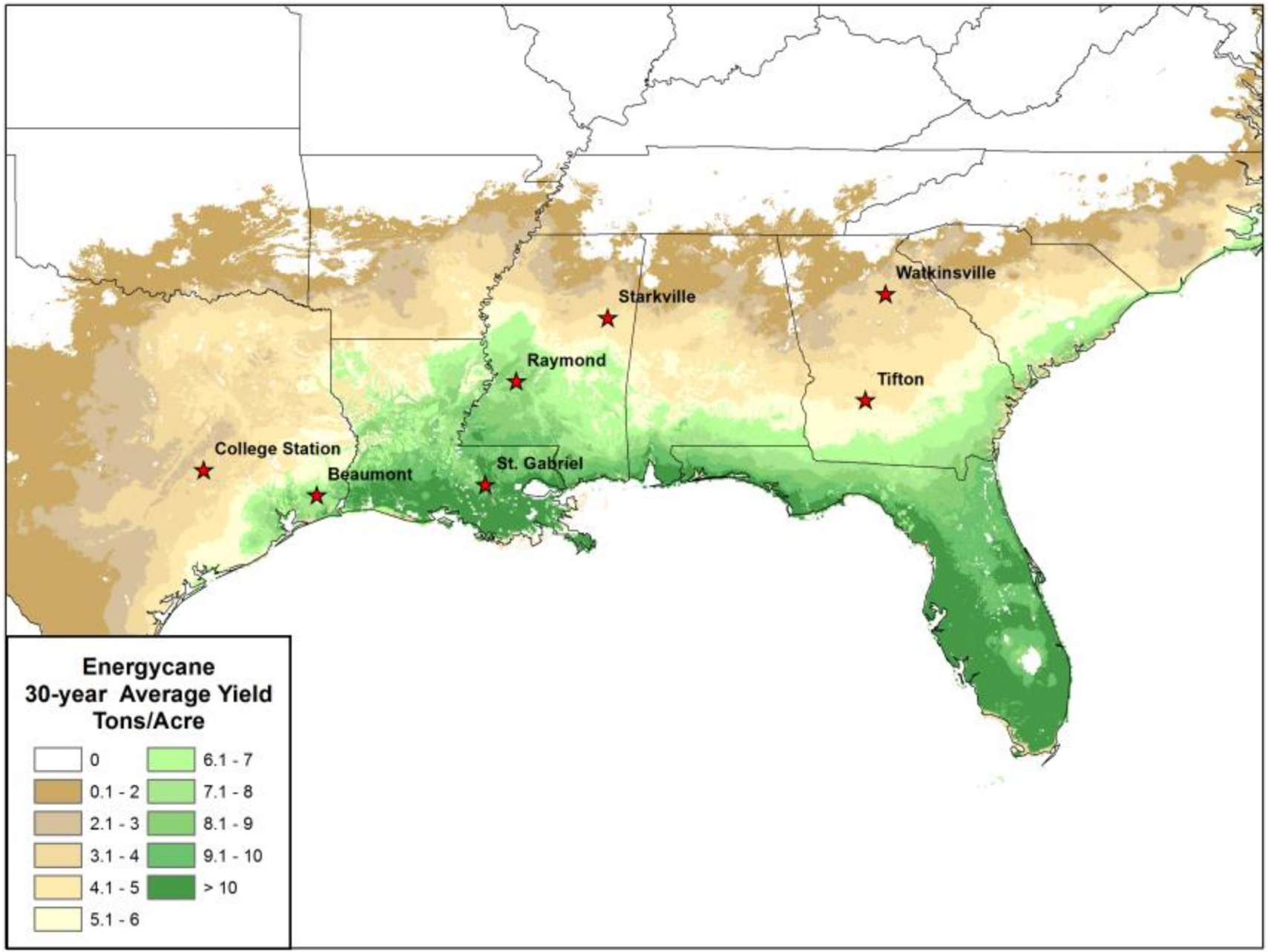


**Ratio Between
30-yr Modeled Yield
3-yr Modeled Yield**









Production Potential Maps

- Species PIs provide
 - Expert review – does the spatial pattern and distribution look reasonable
 - Typical range and average farm-level yields expected (usually lower than plot level)
 - Help in comparing weather in observed years to long term average
 - Precipitation, Maximum Temp, Minimum Temp (can be provided by PRISM)
 - Best reasonable management practices
 - Cultivar selection (assumed best local variety)
- Points to consider in developing these maps
 - Potential yield vs. likelihood of adoption
 - Maps should present current expectations
 - Future potential yield increases due to improved cultivars will likely increase spatial distribution and expected yields
 - Plot work differs from farm level production
 - How close are the maps from the different regions currently
 - These estimates are dynamic
- Addressing concerns
 - How maps will be used and who will use them—be careful
 - Perhaps more than one product (map)
 - Map version could be based on the user
 - List the assumptions that were made in the making of the map
 - Possible to present maps that are classified (binned, aggregated, grouped by potential) rather than the continuous data that research may use
 - Working groups—bullet points/white paper regarding intended use of maps
 - Possibly show field locations to help underscore uncertainty between points

Responses to Previous Reviewers' Comments

- If your project is an on-going project that was reviewed previously, address 1-3 significant questions/criticisms from the previous reviewers' comments (refer to the 2013 Peer Review Report, see notes section below)
- Also provide highlights from any Go/No-Go Reviews

Note: This slide is for the use of the Peer Reviewers only – it is not to be presented as part of your oral presentation. These Additional Slides will be included in the copy of your presentation that will be made available to the Reviewers.

Publications, Patents, Presentations, Awards, and Commercialization

PUBLICATIONS/PRESENTATIONS:	GROUP	TYPE
We submitted an abstract for the US-IALE 2010 entitled: "Climatic influences on biomass yields of switchgrass, a model bioenergy species"	GIS	Abstract
Cellulosic Bioenergy: Sustainability and Environmental Issues. Woodbury PB. Invited Briefing on Regional Cellulosic Bioenergy by the Sun Grant Initiative, 13 March, 2009, U.S. House of Representatives Cannon Office Building, Washington D.C.	GIS	Briefing
Acheampong, Kwame, The Impact of Switchgrass production on Oklahoma Hay Markets, Masters Thesis, Oklahoma State University, Dec 2009	GIS	Masters Thesis
Folakemi Sobowale. "Impact of United States Corn Based Ethanol Production on Land use in Brazil", MS Thesis, Oklahoma State University. July, 2011.	GIS	Masters Thesis
Ouedraogo, F. 2012. The Economic Impacts of Land Use Changes Associated with Switchgrass-based Ethanol Production in Oklahoma. MS Thesis. Department of Agricultural Economics. Oklahoma State University.	GIS	Masters Thesis
Weaver, L. 2012. Should We Pay Farmers Not to Farm? A Case of the Conservation Reserve Program. MS Thesis. Department of Agricultural Economics. Oklahoma State University. Paper accepted for presentation at the 2012 annual meeting AAEA, Seattle, Washington.	GIS	Masters Thesis
Woldesenbet, T. 2012. Economic and Environmental Tradeoffs from Switchgrass and Ethanol Production (A Case in Oklahoma). MS Thesis. Department of Agricultural Economics. Oklahoma State University.	GIS	Masters Thesis
Sustainable Bioenergy Feedstock Production on Marginal Lands. Woodbury PB. Invited platform panel discussion, Sustainable Bioenergy Production on Marginal Lands Seminar Series, 1 May, 2013, Cornell University, Ithaca, NY.	GIS	Panel Discussion
Chang, J., Hansen, M.C., Pittman, K., Dimiceli, C., and Carroll, M., 2007, Corn and soybean mapping in the United States using MODIS time-series data sets, Agronomy Journal, 1654-1664.	GIS	Peer reviewed publication

Publications, Patents, Presentations, Awards, and Commercialization

Chintala, R., M. C. Wimberly, G. Dijra, and M. Tulbure. In Review. Interannual variability of crop residue potential in the North Central Region of the United States. Submitted to Biomass and Bioenergy.	GIS	Peer reviewed publication
Chintala, R., M. C. Wimberly, G. Dijra. In Review. Modeling Crop Residue Potential for North Central Region of the United States Using Climate Variables. Biomass and Bioenergy.	GIS	Peer reviewed publication
Chintala, R., M. C. Wimberly, G. Dijra. In Review. Modeling Crop Residue Potential for North Central Region of the United States Using Climate Variables. Submitted to Journal of Climate.	GIS	Peer reviewed publication
Dicks, Michael R., Jody Campiche, Daniel De La Torre Ugarte, Chad Hellwinckel, Land Use Implications of Expanding Biofuel Demand, Journal of Agricultural and Applied Economics Vol. 41, No.2, August 2009, pp 1-19.	GIS	Peer reviewed publication
Rop, M., Y. Liu, and M. C. Wimberly. In Review. FWA – A framework for developing web-atlas application. Submitted to the 2011 International Conference on Software Engineering Research and Practice.	GIS	Peer reviewed publication
Tulbure, M. G., M. C. Wimberly, A. Boe and V. Owens. In Review. Climatic and genetic controls of yields of switchgrass, a model bioenergy species. Agriculture, Ecosystems, and Environ. 146:121-129	GIS	Peer reviewed publication
Tulbure, M. G., M. C. Wimberly, and V. N Owens. 2012. Response of switchgrass yield to future climate change. Environmental Research Letters 7 045903.	GIS	Peer reviewed publication
Tulbure, M., M. C. Wimberly, D. P. Roy, and G. M. Henebry. 2011. Spatial and temporal heterogeneity of agricultural fires in the central United States in relation to land cover and land use. Landscape Ecology 26: 211-224.	GIS	Peer reviewed publication
Tulbure, M.G., M.C. Wimberly, D.P. Roy, and G.M. Henebry. Spatial and temporal distribution of fires in the central United States from three years of MODIS active fire detection data. Submitted to Global Ecology and Biogeography.	GIS	Peer reviewed publication
Wright CK, Wimberly M (2013) Reply to Kline et al.: Cropland data layer provides a valid assessment of recent grassland conversion in the Western Corn Belt. Proc. Nat. Acad. Sci. USA. DOI 10.1073/pnas.1307594110.	GIS	Peer reviewed publication

Publications, Patents, Presentations, Awards, and Commercialization

Wright, C. K., and M. C. Wimberly. In Preparation. Rapid Land Use Change in the Western Corn Belt as a Result of Agricultural Intensification, To be submitted to Landscape Ecology.	GIS	Peer reviewed publication
Bioenergy and Greenhouse Gas Mitigation: The Role of Crop, Soil, and Environmental Information Sciences. Woodbury PB, van Es H, Cox W, Cherney J, DiTommaso A, Duxbury J, Buckley D, Hahn R, Lehmann CJ, Gaunt J, Hobbs P, Lauren J, Melkonian J, Thies J, Grantham D, Setter T, Russell-Anelli J, Smith S. Poster presentation at the annual GIS Day, 18 November, 2008, Cornell University, Ithaca, NY.	GIS	Poster Presentation
Bioenergy and Greenhouse Gas Mitigation: The Role of Crop, Soil, and Environmental Information Sciences. Woodbury PB, van Es H, Cox W, Cherney J, DiTommaso A, Duxbury J, Buckley D, Hahn R, Lehmann CJ, Gaunt J, Hobbs P, Lauren J, Melkonian J, Thies J, Grantham D, Setter T, Russell-Anelli J, Smith S. Poster presentation at the Second Bio-Energy Awareness Days, sponsored by the USDA, 21-23 June, 2008, Washington, DC.	GIS	Poster Presentation
Geospatial analysis of sustainable biomass feedstock production potential in the Northeast USA Sun Grant region. Ahmed Z (presenter), Peters C, Wightman J, Woodbury PB. Poster Presentation to the 2009 International Annual Meetings of the American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, 1-5 November, 2009, Pittsburgh, PA.	GIS	Poster Presentation
Quantifying the Sustainability of Bioenergy Pathways for New York and the Northeastern USA. Woodbury P, Cherney J, Wightman J, Duxbury J, Cox W, Mohler C, DeGloria S. Poster presentation at the annual GIS Day, 18 November, 2008, Cornell University, Ithaca, NY	GIS	Poster Presentation
Quantifying the Sustainability of Bioenergy Pathways for New York and the Northeastern USA. Woodbury P, Cherney J, Wightman J, Duxbury J, Cox W, Mohler C, DeGloria S. Poster presentation at the Second Bio-Energy Awareness Days, sponsored by the USDA, 21-23 June, 2008, Washington, DC.	GIS	Poster Presentation
Hansen, M., Pittman, K. Chang, J., and Becker-Reshef, I., Multi-Date Compositing Techniques, presented at the ResourceSat Real Product Innovations seminar sponsored by ASRC Management Services and the USDA Foreign Agricultural Service, November 27, 2007.	GIS	Presentation
Hansen, M.C., Chang, J. and Pittman, K., Monitoring global and regional croplands using MODIS data, Association of American Geographers Annual Meeting, April 17-21, 2007, San Francisco, CA.	GIS	Presentation
Hansen, M.C., Mueller, R., Pittman, K., and Chang, J., Mapping feedstocks using remotely sensed datasets, South Dakota and Biofuels 2008 meeting sponsored by South Dakota Agriculture and Energy, North Central Sun Grant Initiative, and the Western Governor's Association, May 20, 2008, Brookings, SD.	GIS	Presentation
Hansen, M.C., Pittman, K., Chang, J., Carroll, M., and DiMiceli, C., MODIS Vegetation Continuous Fields of Crop Type in Support of NASS Annual Crop Indicator Mapping, Association of American Geographers Annual Meeting, April 15-19, 2008, Boston, MA.	GIS	Presentation

Publications, Patents, Presentations, Awards, and Commercialization

Hansen, M.C., Pittman, K., Chang, J., Carroll, M., and DiMiceli, C., MODIS Vegetation Continuous Fields of Crop Type in Support of NASS Annual Crop Indicator Mapping, Association of American Geographers Annual Meeting, Boston, April 16, 2008.	GIS	Presentation
Approaches for Quantifying Bioenergy Feedstock Production Potential and Environmental Impacts in the Northeast Sun Grant Region. Woodbury PB. Invited platform presentation in the Seminar Series: The Science and Engineering Challenges to the Development of Sustainable Biobased Industries. 25 September, 2008, Department of Biological and Environmental Engineering, Cornell University, Ithaca, NY.	GIS	Presentation
A Researcher's View of Biofuel and Bioenergy Sustainability Analysis. Woodbury PB. Invited presentation and discussion, U.S. Department of State, 13 March, 2009, Washington D.C.	GIS	Presentation
A Spatial Analysis of Expiring Contracts under the Conservation Reserve Program (CRP), Mahesh Rao and Subodh Ganta; Association of American Geographers, 2009 National Meeting, Las Vegas, NV, March, 2009.	GIS	Presentation
Acheampong, Kwame, Michael Dicks and Brian Adam, "The Impact of Biofuel Mandates and Switchgrass Production on Hay Markets." NCCC-134: Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management: St. Louis, Mo. April 19-20, 2010	GIS	Presentation
Acheampong, K. and M.R. Dicks. "Fertilizer Demand for Biofuel and Cereal crop Production in the United States". Paper Presented at the Southern Agricultural Economics Association (SAEA) Annual Meeting, Birmingham, Alabama, February 4-7, 2012.	GIS	Presentation
Approaches for Quantifying Bioenergy Feedstock Production Potential and Environmental Impacts in the Northeast Sun Grant Region. Invited Plenary Presentation, Woodbury PB, Ahmed Z, Peters C, Wightman J. Sustainable Bioenergy and Bioproducts Research for a Better Environment and a Growing Economy, Sun Grant Initiative, 11 March, 2009, L'Enfant Hotel, Washington D.C.	GIS	Presentation
Approaches for Quantifying Bioenergy Feedstock Production Potential and Environmental Impacts in the Northeast Sun Grant Region. Woodbury PB. Invited platform presentation in the Seminar Series: The Science and Engineering Challenges to the Development of Sustainable Biobased Industries. 25 September, 2008, Department of Biological and Environmental Engineering, Cornell University, Ithaca, NY.	GIS	Presentation
Approaches for Quantifying the Sustainability of Bioenergy Feedstock Production Pathways in the Northeastern USA. Woodbury P. Invited platform presentation: Northeast Renewable Energy Conference. 26 August, 2008, Pennsylvania State University, State College, PA.	GIS	Presentation
Approaches for Quantifying the Sustainability of Bioenergy Feedstock Production Pathways. Woodbury PB. Invited platform presentation in the 78th Meeting of the Petroleum Environmental Research Forum, 18 November, 2008, Philadelphia, PA.	GIS	Presentation

Publications, Patents, Presentations, Awards, and Commercialization

Arjun Basnet, Theo Depona, Wesley Hedges, and Michael R. Dicks, "Potential Biomass Yields in the South Central US", Southern Agricultural Economics Association Annual meetings, February 5-8, 2011, Corpus Christi, TX	GIS	Presentation
Bioenergy and Greenhouse Gas Mitigation: The Role of Crop, Soil, and Environmental Information Sciences. Woodbury PB, van Es H, Cox W, Cherney J, DiTommaso A, Duxbury J, Buckley D, Hahn R, Lehmann CJ, Gaunt J, Hobbs P, Lauren J, Melkonian J, Thies J, Grantham D, Setter T, Russell-Anelli J, Smith S. Poster presentation at the Second Bio-Energy Awareness Days, sponsored by the USDA, 21-23 June, 2008, Washington, DC.	GIS	Presentation
Biomass as a Renewable Energy Resource in New York State and the Northeast USA. Woodbury PB. Invited presentation to teacher training workshop, Department of Biological and Environmental Engineering, Cornell University, 21 June 2011, Ithaca, NY.	GIS	Presentation
Current and Potential Carbon Sequestration and Biomass Energy in New York State. Woodbury, PB. Invited platform presentation in the Carbon Sequestration Seminar, Department of Natural Resources. 30 January, 2008, Cornell University, Ithaca, NY.	GIS	Presentation
Dicks, Michael R., Daniel De La Torre Ugarte, Chad Hellwinckel and Jody Campiche,, "Land Use Implications of Expanding Biofuel Demand", Southern Agricultural Economics Association 41st Annual Meetings, January 31 – February 3, 2009, Atlanta, Georgia.	GIS	Presentation
Dickson, Amanda and Michael R. Dicks "The potential economic impacts of the managed haying and grazing of CRP", Southern Agricultural Economics Association 41st Annual Meetings, January 31 – February 3, 2009, Atlanta, Georgia.	GIS	Presentation
Environmental Impacts of Ethanol and Biodiesel. Mas CJ, Wojnar Z, Woodbury PB (joint presentation by all authors). Invited platform presentation to the New York State Department of Environmental Conservation, 6 May, 2008, Albany, NY.	GIS	Presentation
Environmental Impacts of Ethanol and Biodiesel. Mas CJ, Wojnar Z, Woodbury PB. Invited briefing to the staff of the Governor of New York State, 9 June, 2008, Albany, NY.	GIS	Presentation
Folakemi Sobowale, Mike Dicks, and Jody Campiche, "Impact of US Corn-based Ethanol Production on Land Use", Southern Agricultural Economics Association Annual meetings, February 5-8, 2011, Corpus Christi, TX	GIS	Presentation
Geospatial Analysis of Opportunities and Challenges for Sustainable Biomass Feedstock Production. Woodbury, PB. Invited platform presentation in the seminar series Biofuels: The Economic and Environmental Interactions, Departments of Applied Economics and Management and Biological and Environmental Engineering. 11 February, 2008, Cornell University, Ithaca, NY.	GIS	Presentation

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Jackson, Samuel W. Southeastern Region GIS Efforts. Presentation to the Annual Meeting of the Sun Grant Initiative Regional Feedstock Partnership, Feb. 24, 2010. San Antonio, TX	GIS	Presentation
Kwame Acheanpong, Michael R. Dicks, and Brian D. Adam, "The Impact of Biofuel Mandates and Switchgrass Production on Hay Markets", February 5-8, 2011, Corpus Christi, TX	GIS	Presentation
Kwame Acheanpong, Michael R. Dicks, and Brian D. Adam, "The Impact of Biofuel Mandates and Switchgrass Production on Hay Markets", Southern Agricultural Economics Association Annual meetings, February 5-8, 2011, Corpus Christi, TX	GIS	Presentation
Multi-scale integrated modeling of sustainable herbaceous biomass feedstock production potential in the Northeastern USA. Woodbury PB, Peters C, Ahmed Z, Wightman J, Waltman S, Richard T. Invited Platform Presentation to the 2009 International Annual Meetings of the American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, 1-5 November, 2009, Pittsburgh, PA.	GIS	Presentation
New York and Northeast US Land Resources for Sustainable Bioenergy Feedstock Production. Woodbury, PB. Platform presentation in the mini-symposium: Bioenergy and Greenhouse Gases: Research Highlights and Needs in Crop, Soil, and Environmental Sciences. 14 February, 2008, Department of Crop and Soil Sciences, Cornell University, Ithaca, NY.	GIS	Presentation
New York and Northeast US Land Resources for Sustainable Bioenergy Feedstock Production. Woodbury, PB. Platform presentation in the mini-symposium: Bioenergy and Greenhouse Gases: Research Highlights and Needs in Crop, Soil, and Environmental Sciences. 14 February, 2008, Department of Crop and Soil Sciences, Cornell University, Ithaca, NY.	GIS	Presentation
Organizer and moderator of a special session on bioenergy in New York State and the Northeastern USA in the Energy Panel, Cornell Cooperative Extension Agriculture and Food Systems In-Service Meeting, 11 November, 2009, Ithaca, NY.	GIS	Presentation
Pujula, Aude L., David Maradiaga,, and Michael Dicks, "Contemporary Issues in Estimating Yield Distributions", Southern Agricultural Economics Association 42st Annual Meetings, February 7 – February 9, 2010, Orlando, Florida.	GIS	Presentation
Pujula, Aude Liliana, David Isaias Maradiaga, Hector O. Zapata and Michael R. Dicks, "A Century of Crop Yield Density Estimation with Perspectives", Presented at the American Agricultural Economics Association meetings in Denver, Co, July 2010.	GIS	Presentation
Regional Feedstock Partnership Resource Assessment. Woodbury PB. Invited platform presentation, Department of Energy Office of Biomass Programs Peer Review Meeting, 8 April 2011, Annapolis, MD.	GIS	Presentation

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Southeastern Regional Resource Assessment Report. Sun Grant Regional Feedstock Partnership Annual Meeting, Feb. 15-17, 2011.	GIS	Presentation
Sustainable Biomass Feedstock Assessment in the Northeast Sun Grant Region. Woodbury PB, Ahmed Z, Peters C, Wightman J. Invited platform presentation, Sun Grant & Department of Energy Regional Feedstock Partnership Meeting, 24 February 2010, San Antonio, TX	GIS	Presentation
Sustainable Biomass Feedstock Assessment in the Northeast Sun Grant Region. Woodbury PB, Ahmed Z, Wightman J. Invited platform presentation, Sun Grant & Department of Energy Regional Feedstock Partnership Meeting, 16 February 2011, Knoxville, TN.	GIS	Presentation
Sustainable Biomass Feedstock Production Potential and Greenhouse Gas Balance in the Northeast Sun Grant Region. Woodbury PB, Ahmed Z, Peters C, Wightman J. Invited platform presentation, Northeast Sun Grant Regional Conference, 26 May 2010, Syracuse, NY.	GIS	Presentation
Tulbure, M., and M. C. Wimberly. 2010. Climatic influences on biomass yields of switchgrass: A model bioenergy species. US-IALE Annual Symposium. April 5-9, Athens, GA.	GIS	Presentation
Tulbure, M., and M. C. Wimberly. 2010. Climatic influences on corn and soybean yields. 3rd USGS Modeling Conference: Understanding and Predicting for a Changing World. June 7-11, Denver, CO.	GIS	Presentation
Tulbure, M., M. C. Wimberly, and G. M. Henebry. 2009. Spatial and temporal distributions of fires in the central United States from 5 years of MODIS active fire detection data. International Association for Landscape Ecology, United States Regional Association Meeting. Salt Lake City, UT.	GIS	Presentation
What is the Potential for Sustainable Bioenergy Feedstock Production in New York and the Northeast? Woodbury PB. Invited presentation to the 72nd Annual Cornell Seed Conference, 2 December, 2010, Geneva, NY.	GIS	Presentation
Wimberly, M. C., M. C. Hansen, K. Pittman, J. Chang, and M. Tulbure. 2009. Applications of GIS and remote sensing to support sustainable biomass feedstock production. North Central Sun Grant Region Annual Meeting. Jan 15-16, St. Paul, MN. (Presentation)	GIS	Presentation
Wimberly, M. C., Y. Liu, M. Tulbure, and R. Bell. 2011. North Central Feedstock Assessment Team: GIS Applications to Support Sustainable Biofuels Feedstock Production. Feedstock Partnership Annual Meeting, Knoxville, TN.	GIS	Presentation

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Woldesenbet, T. and D. Shideler. "Environmental and Economic Tradeoffs from Cellulosic Ethanol: A Case Study in Oklahoma". Paper accepted for presentation in the 2012 Annual Meeting of the Southern Regional Science Association, March 24 2012, Charlotte, North Carolina.	GIS	Presentation
Wright CK (2013) Plenary presentation: Rapid land use change in the Western Corn Belt. America's Grasslands Conference: The Future of Grasslands in a Changing Landscape, Manhattan, KS, August 15-17, 2013.	GIS	Presentation
Wright CK, Wimberly M (2013) Land-use change in the Corn Belt: Influence on grasslands and wetlands. Plenary presentation, NSF Macrosystems Biology PI Meeting, Arlington, VA, June 7.	GIS	Presentation
Wright CK, Wimberly M (2013) recent grassland conversion in the Western Corn Belt. Earth Day public lecture, Dakota State University, Madison, SD, May 25.	GIS	Presentation
Wright CK, Wimberly M (2013) Recent land use change in the Western Corn Belt threatens grasslands and wetlands, Ecological Society of America Annual Meeting, Minneapolis, MN, August 4-9, 2013.	GIS	Presentation
Wright, C. K., and M. C. Wimberly. 2012. Recent Agricultural Intensification in the U.S. Corn Belt. International Association for Landscape Ecology, United States Regional Association Meeting. Newport, RI (Oral presentation).	GIS	Presentation
Wright, C. K., and M. C. Wimberly. 2013. North Central resource assessment team report. Sun Grant/DOE Regional Biomass Feedstock Partnership Annual Meeting, Tunica, MS.	GIS	Presentation
Wright, C. K., and M. C. Wimberly. 2013. Recent land use change in the Western Corn Belt threatens grasslands and wetlands. Annual Meeting of the South Dakota Chapter of the Wildlife Society, Oacoma, SD.	GIS	Presentation
Acheampong, K., Michael R. Dicks, and Brian D. Adam. 2010. "The Impact of Biofuel Mandates and Switchgrass Production on Hay Markets." Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, MO. [http://www.farmdoc.illinois.edu/nccc134].	GIS	Proceeding
Rop, M., Y. Liu, and M. C. Wimberly. 2011. FWA - A Framework for Developing Web-Atlas Applications. Proceedings of the 2011 International Conference on Software Engineering Research and Practice (SERP'11). Las Vegas, NV, July 18-21.	GIS	Proceeding

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Wright, C. K., and M. C. Wimberly. 2013. Recent land use change in the Western Corn Belt threatens grasslands and wetlands. Proceedings of the National Academy of Sciences.	GIS	Proceeding
Wright, C. K., and M. C. Wimberly. In Press. Recent land use change in the Western Corn Belt threatens grasslands and wetlands. Proceedings of the National Academy of Sciences.	GIS	Proceeding
Kwame Acheanpong and Michael R. Dicks. "Fertilizer Demand for Biofuel and Cereal crop Production in the United States".	GIS	Publication
Bioenergy Feedstock Production in the NE: Land Use, Yields, and Sustainability. Woodbury PB. Invited webinar presentation, Northeast Woody/Warm-season Biomass Consortium, 9 April 2013 (webinar presentation: http://www.newbio.psu.edu/Extension/Webinars.asp).	GIS	Webinar
Invited participant in workshop: Regional Biomass Energy Feedstock Partnership. Sponsored by the Sun Grant Initiative and the U.S. Department of Energy's Office of Biomass Programs. 27-28 February, 2008, Hall of States, Washington D.C.	GIS	Workshop
New York State Renewable Fuels Visioning Meeting. Participate in an invitation-only workshop to develop a vision for biofuels for New York State. Sponsored by the New York State Energy Research and Development Authority, the New York Department of Agriculture and Markets, and the New York Department of Environmental Conservation. January 29, 2009, Albany, NY.	GIS	Workshop
Sustainable Biomass Resources in the Northeast. Woodbury PB, Ahmed Z, Peters C, Wightman J. Invited presentation to the 2009 Workshop: Re-imagining Sustainable Landscapes, 3 December, 2009, Pennsylvania State University, State College, PA.	GIS	Workshop

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Daly, C. "An update on the PRISM-RMA crop suitability mapping, and weather and climate web portal." Presented to the USDA RMA Davis regional and compliance offices, Davis, CA, 17 December 2014.	Presentation
Daly, C., and M. Halbleib. Potential Yield Mapping of Dedicated Energy Crops. Panel Session entitled "Integration of Supply Chains I: Breaking Down Barriers – Addressing Cost, Quality, and Quantity of Feedstocks for Optimizing Bioenergy Production." Biomass 2014: Growing the Future Bioeconomy Agenda, Washington, DC, 29-30 July 2014.	Panel Discussion
Daly, C., M. Halbleib. Potential yield mapping of bioenergy crops. Breakout session and panel discussion: Potential Yield, Composition, and Supply of Dedicated Energy Crops: Results and Outcomes of the Sun Grant Regional Feedstock Partnership. BIO International Bioenergy Congress, Philadelphia, PA, 12-14 May 2014.	Panel Discussion
Daly, C., M Halbleib, and L. Eaton. 2014. Nationwide Bio-Fuel Resource Mapping: Miscanthus feedstocks. Organized and conducted workshop for the DOE/USDA/DOT Sun Grant Initiative, Chicago, IL, 18-19 February 2014.	Workshop Conducted
Daly, C. "An update on the PRISM-RMA crop suitability mapping, and weather and climate web portal." Presented to the USDA RMA Davis regional and compliance offices, Davis, CA, 11 December 2013.	Presentation
Daly, C., M Halbleib, and L. Eaton. 2013. Nationwide Bio-Fuel Resource Mapping: Woody biomass feedstocks. Organized, conducted, and hosted workshop for the DOE/USDA/DOT Sun Grant Initiative, Corvallis, OR, 18-19 September 2013.	Workshop Conducted
Daly, C., M Halbleib, and L. Eaton. 2013. Nationwide Bio-Fuel Resource Mapping: CRP grass biomass feedstocks. Organized and conducted workshop for the DOE/USDA/DOT Sun Grant Initiative, Kansas City, MO, 25-26 July 2013.	Workshop Conducted
Daly, C., M Halbleib, and L. Eaton. 2013. Nationwide Bio-Fuel Resource Mapping: Sorghum biomass feedstocks. Organized and conducted workshop for the DOE/USDA/DOT Sun Grant Initiative, Oak Ridge National Laboratory, TN, 27-28 June 2013.	Workshop Conducted
Daly, C., and M. Halbleib. "Spatial Weather and Climate Data and Web-Based Access Tools for Improved Agricultural Risk Management." Presented to the Administrator and senior personnel, USDA Risk Management Agency, Washington, DC, 12 June 2013.	Presentation
Daly, C., M Halbleib, and L. Eaton. 2013. Nationwide Bio-Fuel Resource Mapping: Switchgrass biomass feedstocks. Organized, conducted, and hosted workshop for the DOE/USDA/DOT Sun Grant Initiative, Corvallis, OR, 29-30 May 2013.	Workshop Conducted
Daly, C., M Halbleib, and L. Eaton. 2013. Nationwide Bio-Fuel Resource Mapping: Energy cane biomass feedstocks. Organized and conducted workshop for the DOE/USDA/DOT Sun Grant Initiative, Jackson, MS, 7-8 May 2013.	Workshop Conducted

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Halbleib, M.D., C. Daly, and D.B, Hannaway. 2012. Nationwide crop suitability modeling of biomass feedstocks. Sun Grant Initiative 2012 National Conference: Science for Biomass Feedstock Production and Utilization, New Orleans, LA, 2-5 October 2012.		Proceedings Paper
Halbleib, M., C. Daly, M. Doggett, D. Hannaway. Modeling of Bio-energy Feedstock Biomass in the US. Sun Grant Feedstock Partnership annual meeting, Indianapolis, IN, 14-15 Mar 2012.		Presentation
Daly, C. "Nationwide Bio-Fuel Resource Mapping: Estimating the Potential Distribution and Yield of Biomass Crops." Presented at Texas A&M University Biomass Group, 10 Jun 2011.		Presentation
Daly, C. "Biomass mapping of bio-energy feedstocks." Presented at the US Navy Green Fleet workshop, Honolulu, HI, 7 March 2011.		Presentation
Daly, C., M. Halbleib, M. Doggett, D. Hannaway. Nationwide Biomass Modeling of Bio-energy Feedstocks. Sun Grant Feedstock Partnership annual meeting, Knoxville, TN, 15-16 Feb 2011.		Presentation
Daly, C. and M. Halbleib. Nationwide Suitability Modeling of Bio-energy Crops: A Useful Idea? Sun Grant Feedstock Partnership annual meeting, San Antonio, TX, 24 February 2010.		Presentation
Daly, C. and M. Halbleib. Using Map Server technology and environmental datasets for feedstock development and assessment. Sun Grant Regional Initiative Energy Conference, Washington, DC, 12 March 2009.		Presentation
Daly, C. and M. Halbleib. "Western Region Sun Grant GIS team status report." Presented at the Sun Grant Regional Biomass Feedstock Partnership Workshop, Washington, DC, 9 March 2009.		Presentation