June 13th, 2016

Enhancing the Global Carbon Sink

Trent R. Northen

and the Carbon Sink Team

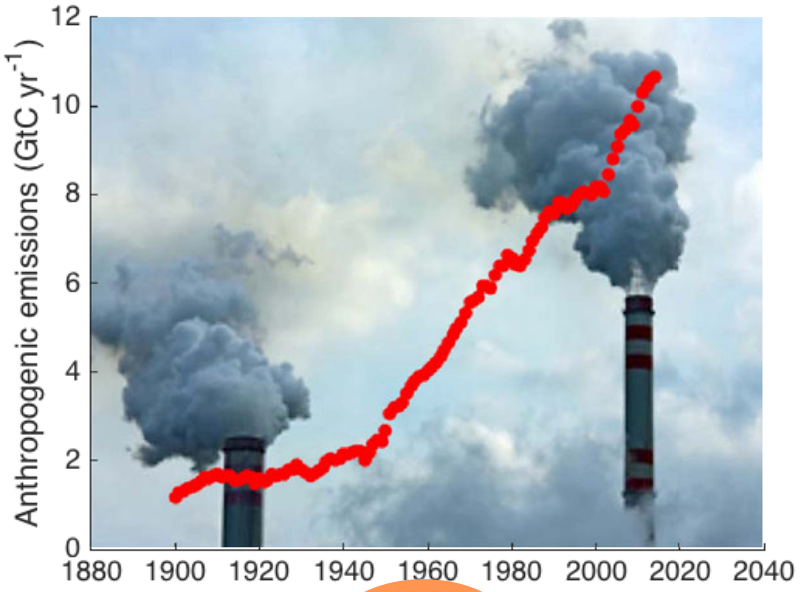
BERKELEY LAB
NREL NATIONAL RENEWABLE ENERGY LABORATORY
Los Alamos NATIONAL LABORATORY
Pacific Northwest NATIONAL LABORATORY
BROOKHAVEN NATIONAL LABORATORY
Argonne NATIONAL LABORATORY
Lawrence Livermore National Laboratory
OAK RIDGE National Laboratory
INL Idaho National Laboratory

The Sink for Global Anthropogenic CO_2 Emissions

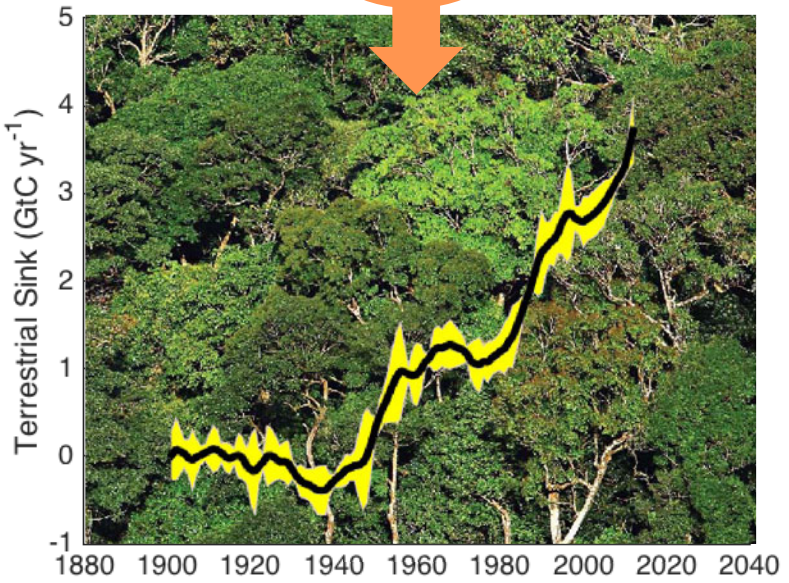
Data for 2005-2014. Global Carbon Project

Source: Enhancing the Global Carbon Sink. Presented at the Big Ideas Summit April 22 2016

The land carbon sink has doubled in the last 40 years



30%

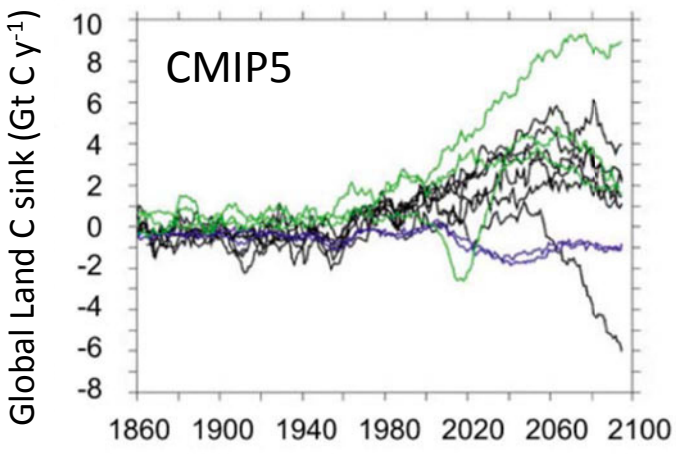


Data from the Global Carbon Project 2015

Source: Enhancing the Global Carbon Sink. Presented at the Big Ideas Summit April 22 2016

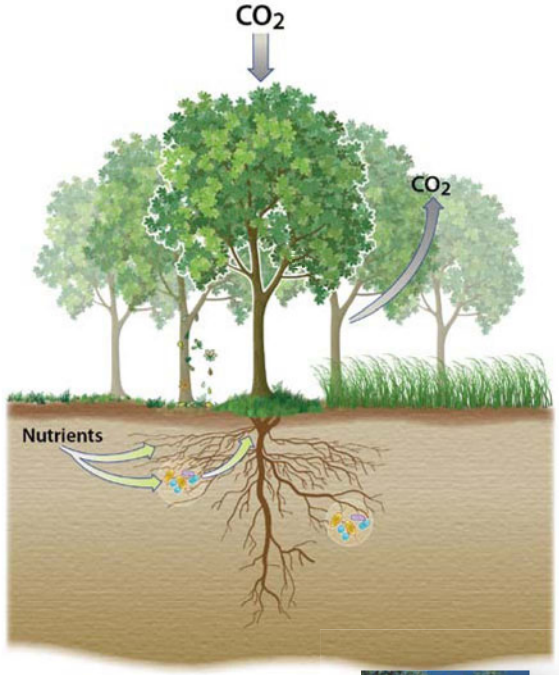
Why has the land sink increased?

- CO_2 fertilization?
- Nitrogen deposition?
- Forest regrowth?
- Warming climate?



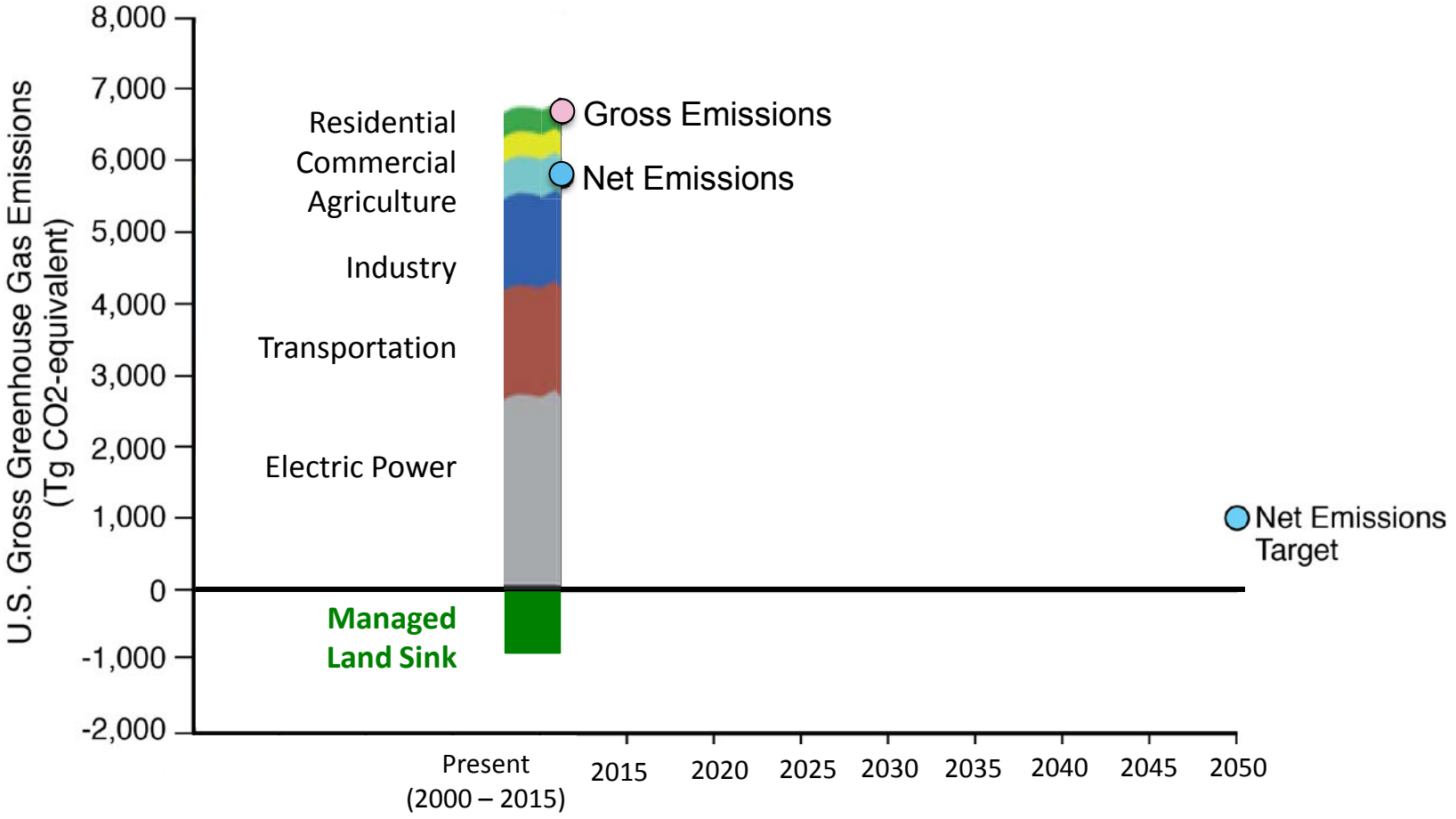
Friedlingstein et al. 2014

How much carbon can vegetation and soils hold?



Source: Enhancing the Global Carbon Sink. Presented at the Big Ideas Summit April 22 2016

The U.S. carbon sink of managed lands is critical to U.S. carbon mitigation pathways

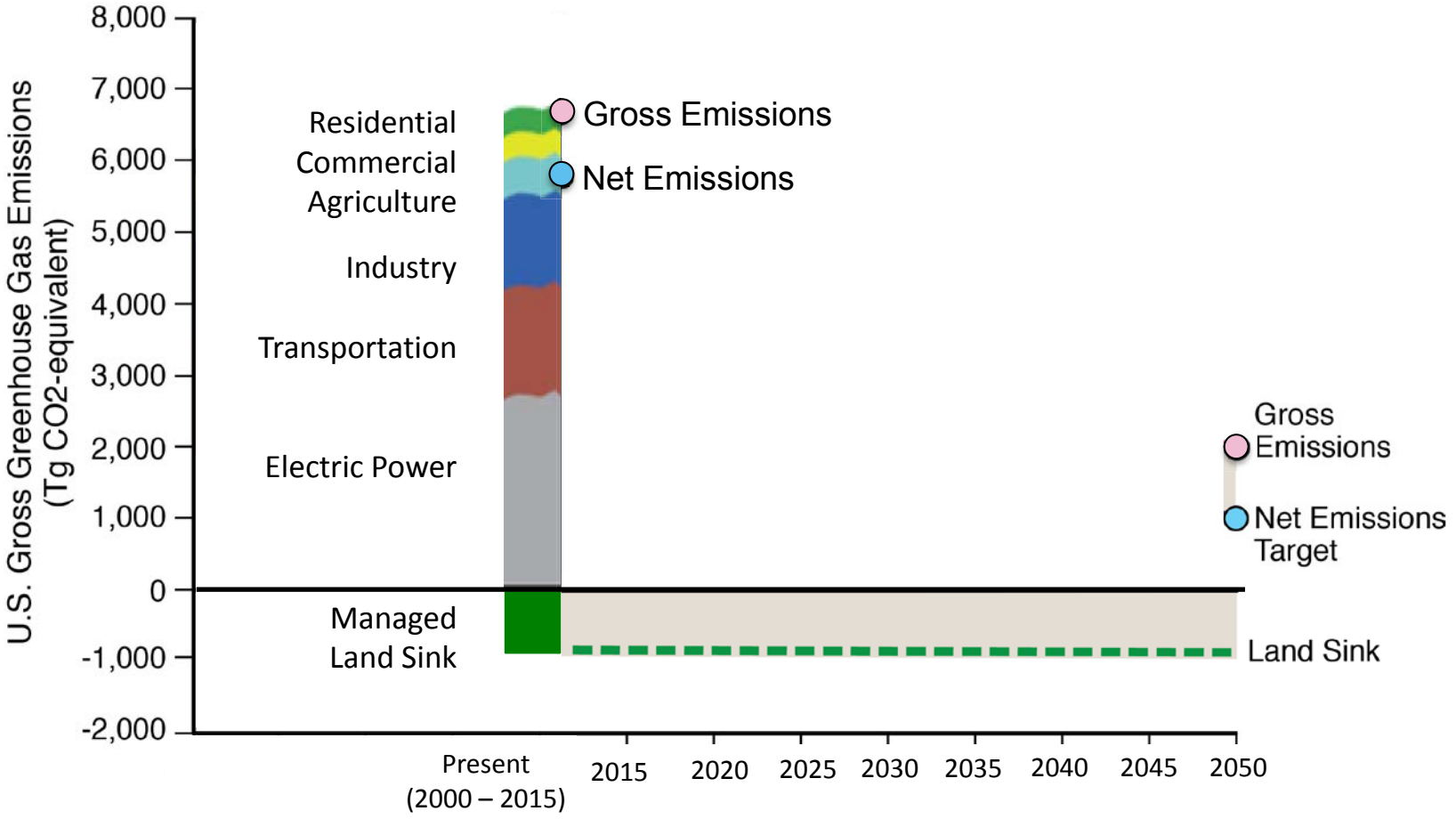


Williams et al., Pathways for Deep Decarbonization for the U.S., 2014

Historic land sink for AFOLU (Agriculture, Forestry, Other Land Use, Wetlands): US EPA Inventory of U.S. GHG Emissions and Sinks: 1990 – 2011

Slide: Enhancing the Global Carbon Sink. Presented at the Big Ideas Summit April 22 2016

The U.S. carbon sink of managed lands is critical to U.S. carbon mitigation pathways

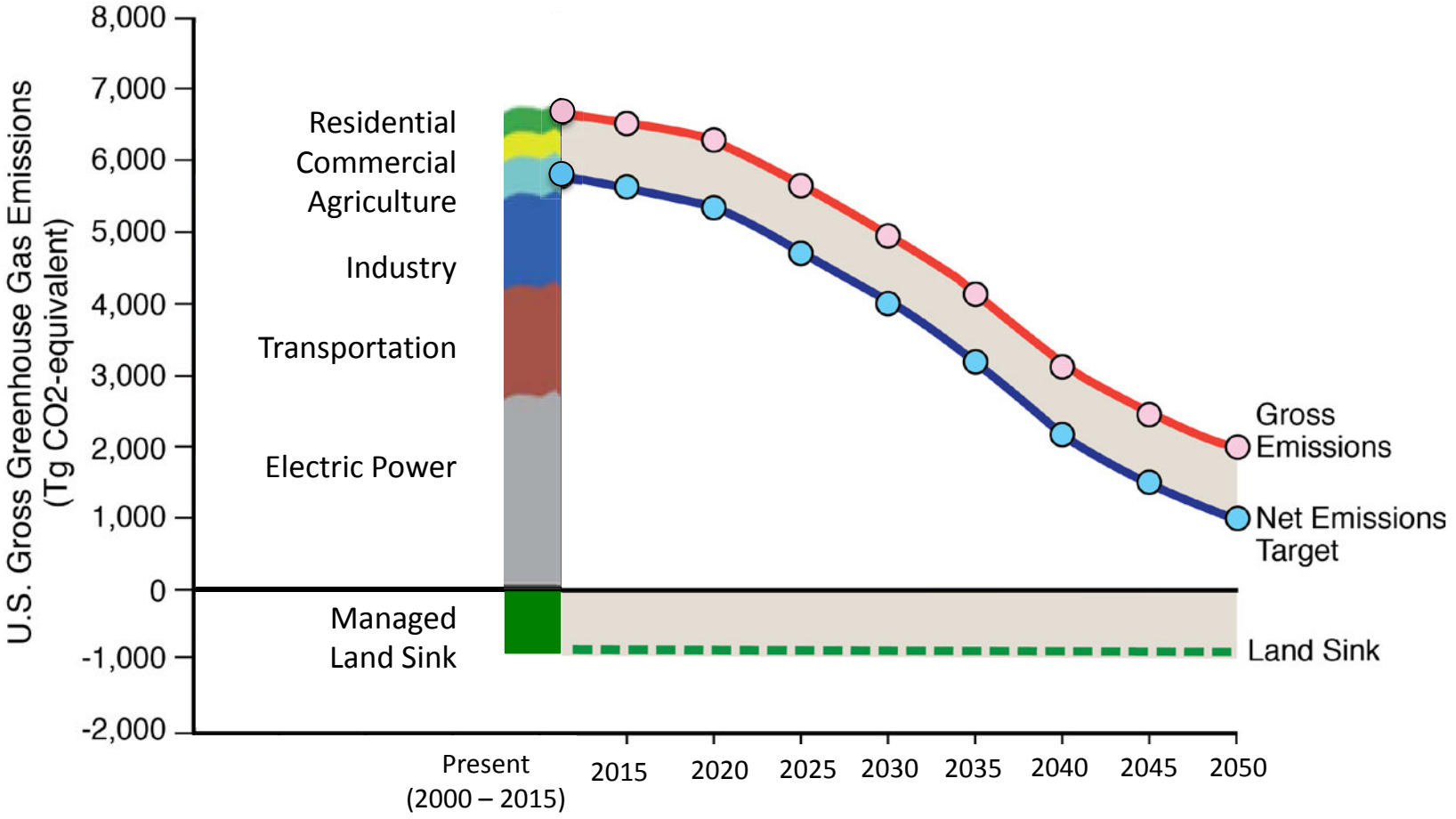


Williams et al., Pathways for Deep Decarbonization for the U.S., 2014

Historic land sink for AFOLU (Agriculture, Forestry, Other Land Use, Wetlands): US EPA Inventory of U.S. GHG Emissions and Sinks: 1990 – 2011

Slide: Enhancing the Global Carbon Sink. Presented at the Big Ideas Summit April 22 2016

The U.S. carbon sink of managed lands is critical to U.S. carbon mitigation pathways

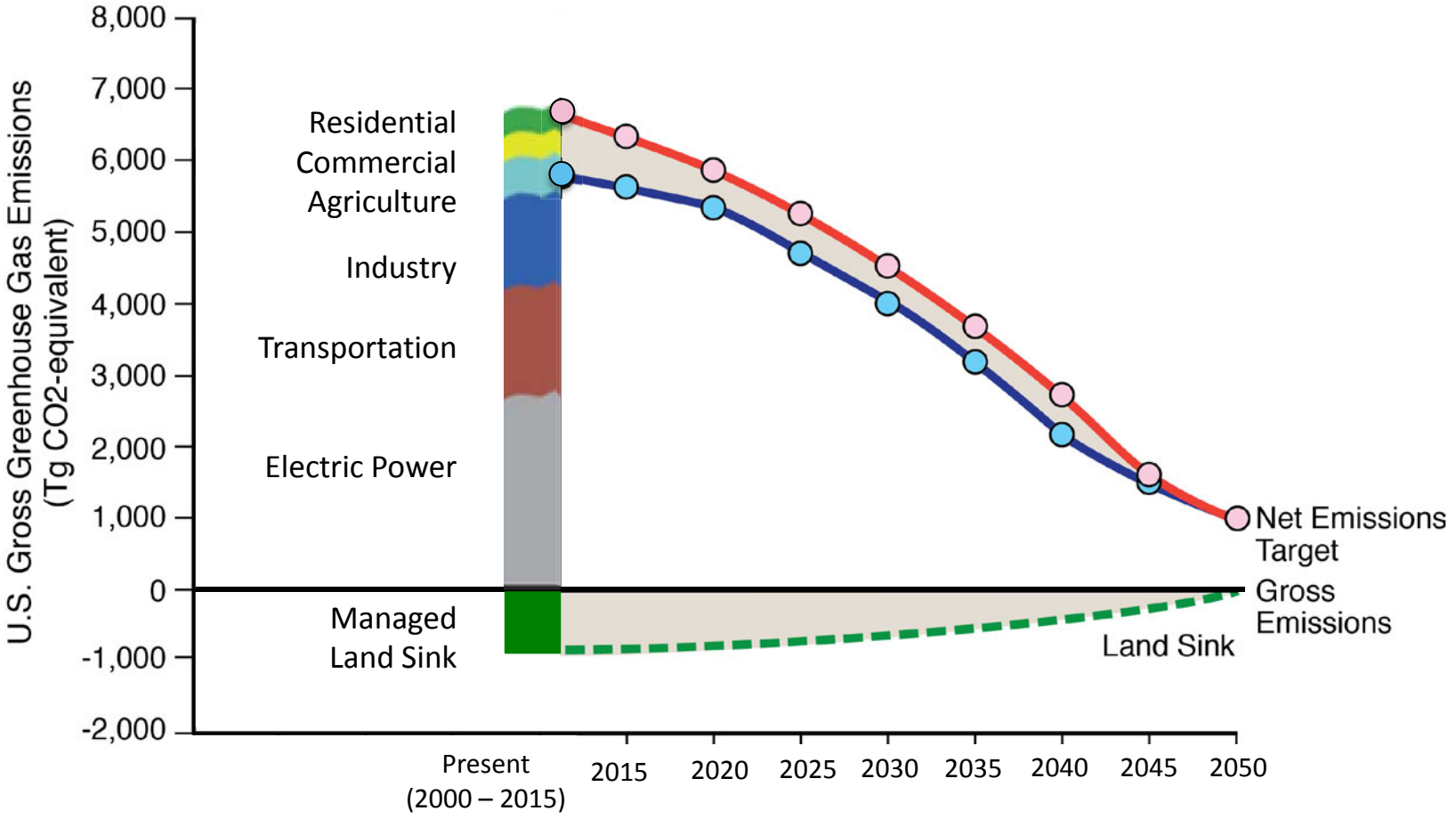


Williams et al., Pathways for Deep Decarbonization for the U.S., 2014

Historic land sink for AFOLU (Agriculture, Forestry, Other Land Use, Wetlands): US EPA Inventory of U.S. GHG Emissions and Sinks: 1990 – 2011

Slide: Enhancing the Global Carbon Sink. Presented at the Big Ideas Summit April 22 2016

The U.S. carbon sink of managed lands is critical to U.S. carbon mitigation pathways

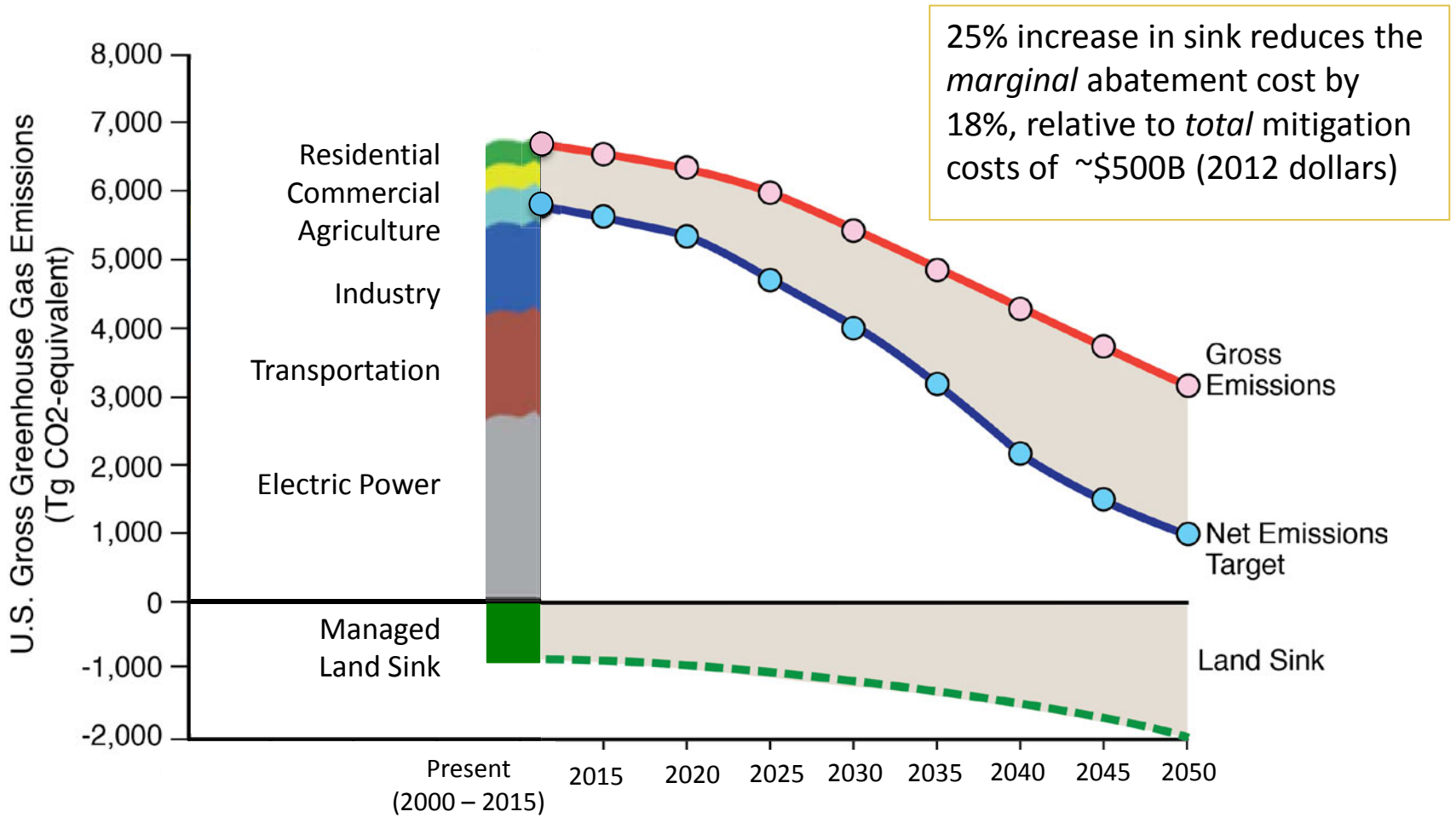


Williams et al., Pathways for Deep Decarbonization for the U.S., 2014

Historic land sink for AFOLU (Agriculture, Forestry, Other Land Use, Wetlands): US EPA Inventory of U.S. GHG Emissions and Sinks: 1990 – 2011

Slide: Enhancing the Global Carbon Sink. Presented at the Big Ideas Summit April 22 2016

The U.S. carbon sink of managed lands is critical to U.S. carbon mitigation pathways



Williams et al., Pathways for Deep Decarbonization for the U.S., 2014

Historic land sink for AFOLU (Agriculture, Forestry, Other Land Use, Wetlands): US EPA Inventory of U.S. GHG Emissions and Sinks: 1990 – 2011

Slide: Enhancing the Global Carbon Sink. Presented at the Big Ideas Summit April 22 2016

Energy Efficiency

Decarbonized Elec.

Fuel Switching

Large unmanaged risk
Large untapped potential

Slide: Enhancing the Global Carbon Sink. Presented at the Big Ideas Summit April 22 2016

Goals: Enhancing the global carbon sink

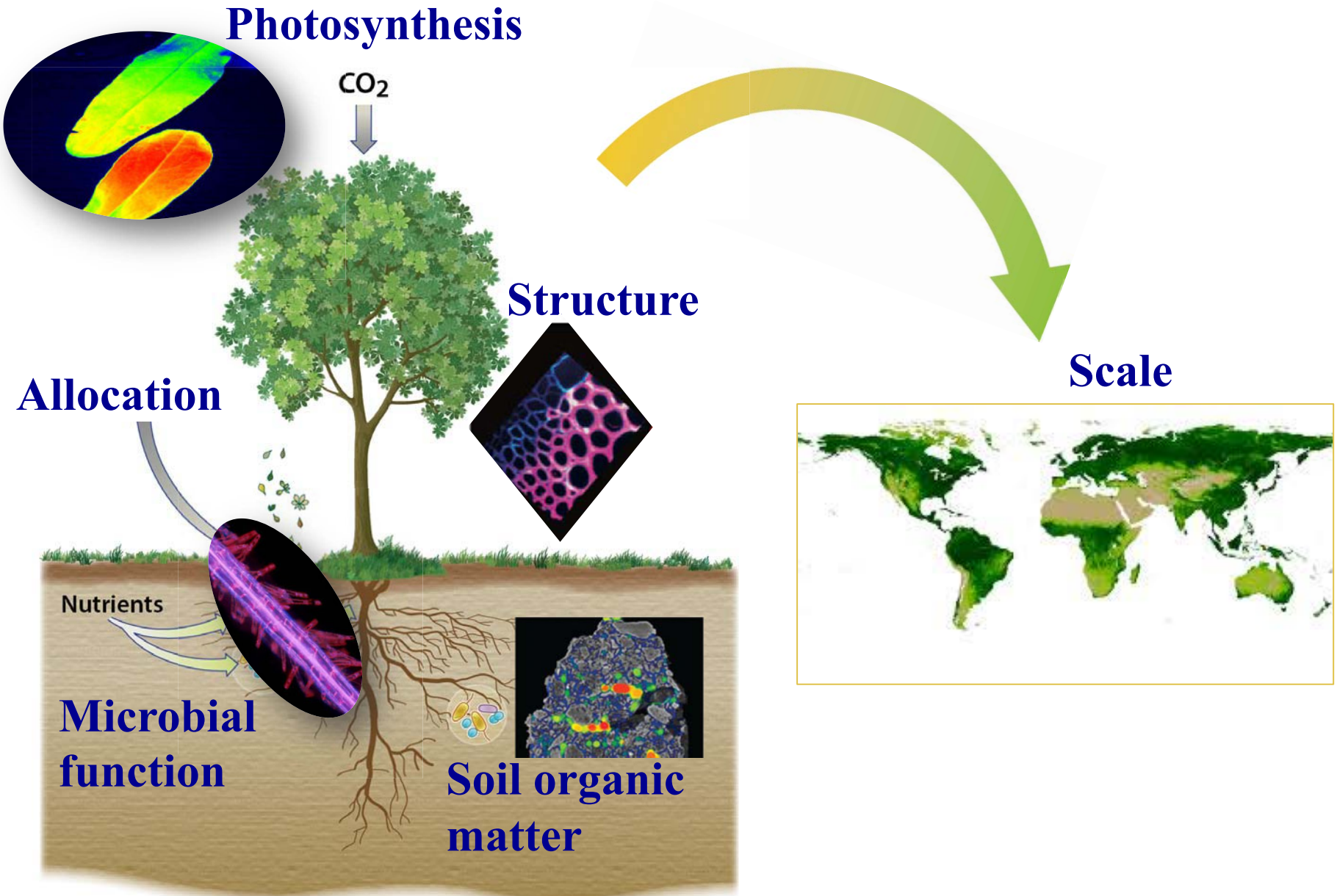
Fundamental understanding
Future trajectory
Sink potential

Vulnerability
Risk
Resilience

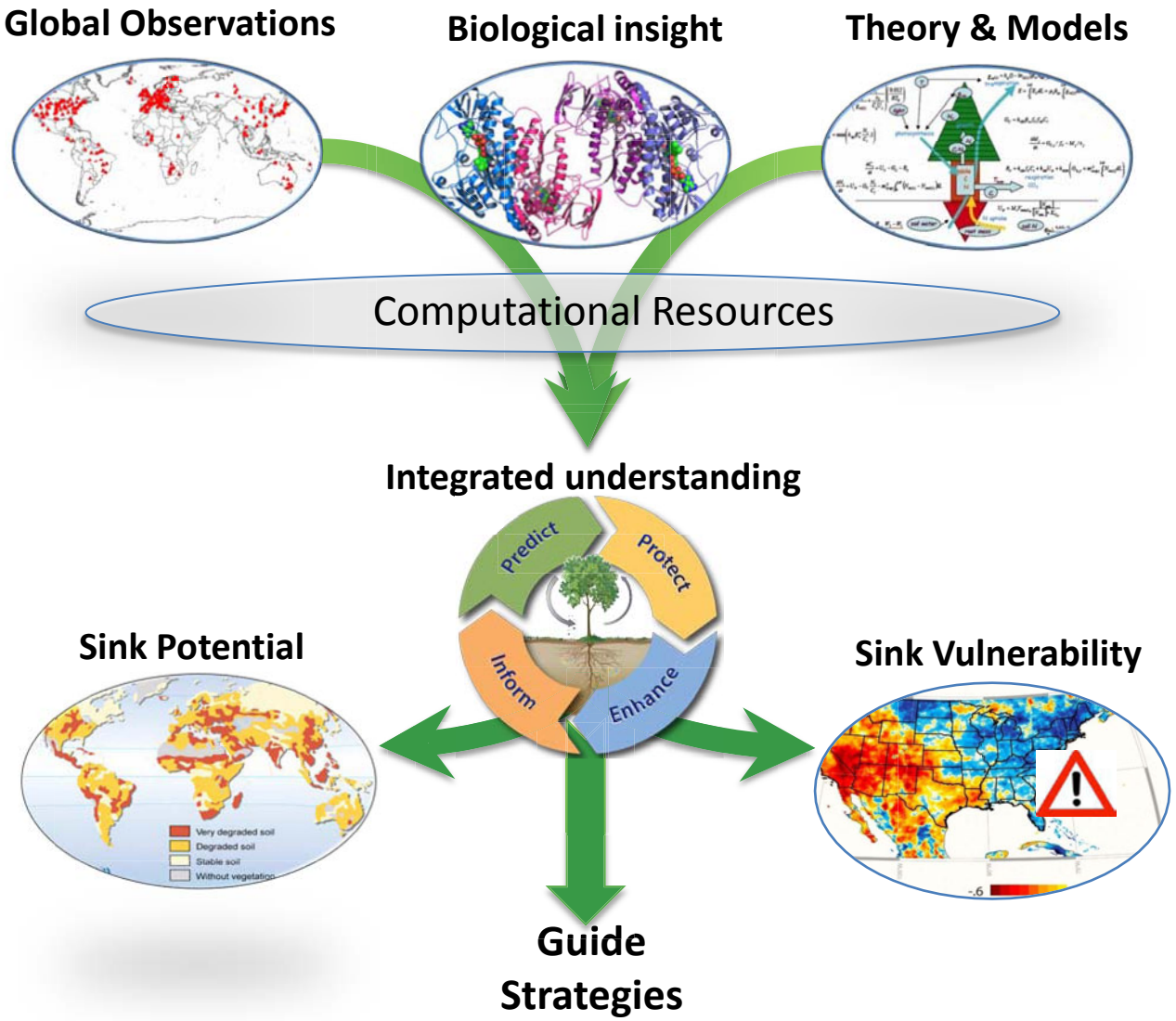
Eco-technologies
Soil health
Scaling

Slide: Enhancing the Global Carbon Sink. Presented at the Big Ideas Summit April 22 2016

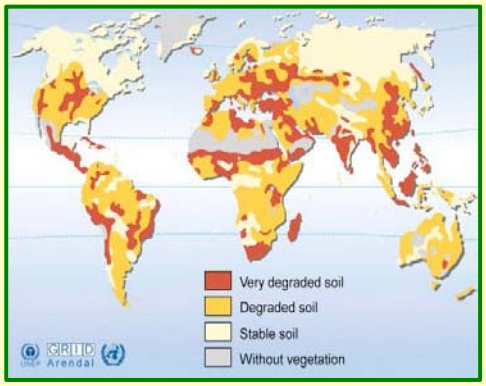
System control points



Understanding sink potential and vulnerability



Enhancing the carbon sink has significant co-benefits



Restore soil carbon to native levels
Fertility, soil water, arable land—food, erosion

Expand carbon-neutral biomass
Decarbonized energy supply

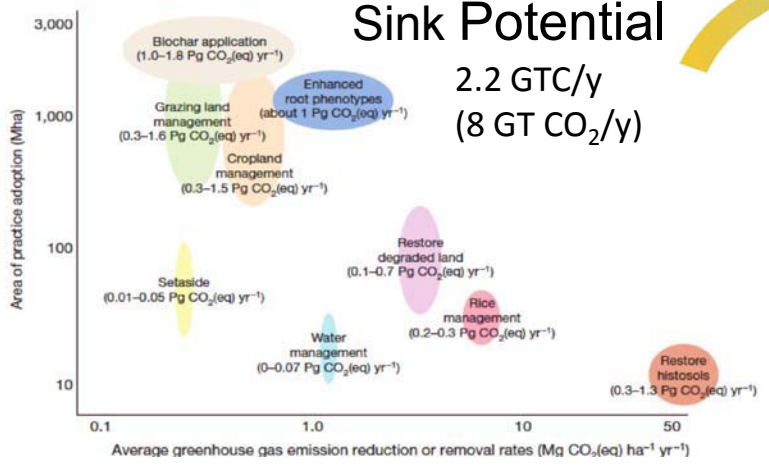
Maintain ecosystem resilience
Biodiversity, resources, fire risk

Slide: Enhancing the Global Carbon Sink. Presented at the Big Ideas Summit April 22 2016

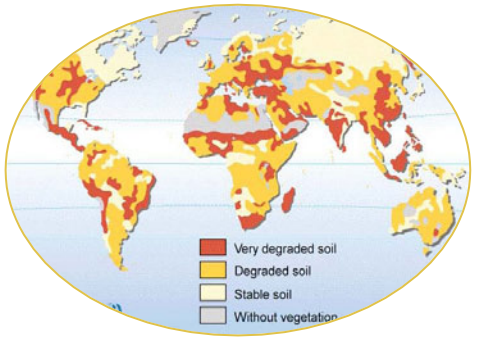
Example: Re-build soil carbon stocks

Sink Potential

2.2 GTC/y
(8 GT CO_2/y)



Target regions and strategies



Degraded lands

Managed lands

Marginal lands

Scale
Evaluate
Feedback

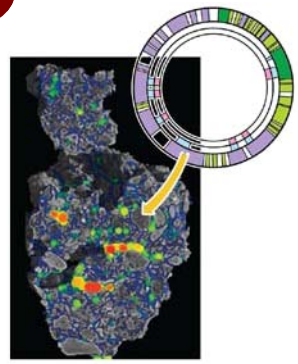
Conduct R & D

1

2

3

4



Climate benefits

Co-benefits

Enhance soil moisture
and nutrient retention

Paustian et al. 2016 Nature

Slide: Enhancing the Global Carbon Sink. Presented at the Big Ideas Summit April 22 2016

Breakthroughs and Benefits

Mission Innovation Products

- Moderate-cost mitigation approaches w/co-benefits
  - 117 COP21 countries depend on land sink
- More carbon-neutral bioenergy
- Integration of C sink into GHG scenarios and commitments

Scientific Products

- New capabilities for multi-benefit ecosystems
- Quantification of opportunities and risks associated with sink
- Improved climate prediction

"Build options space for policy and technology decision-makers based on the fidelity of our knowledge"

U.S. DEPARTMENT OF ENERGY

Why DOE? Why Now?

1

DOE Mandate

Mission Innovation
Environmental
impacts of energy

2

Grand Challenge

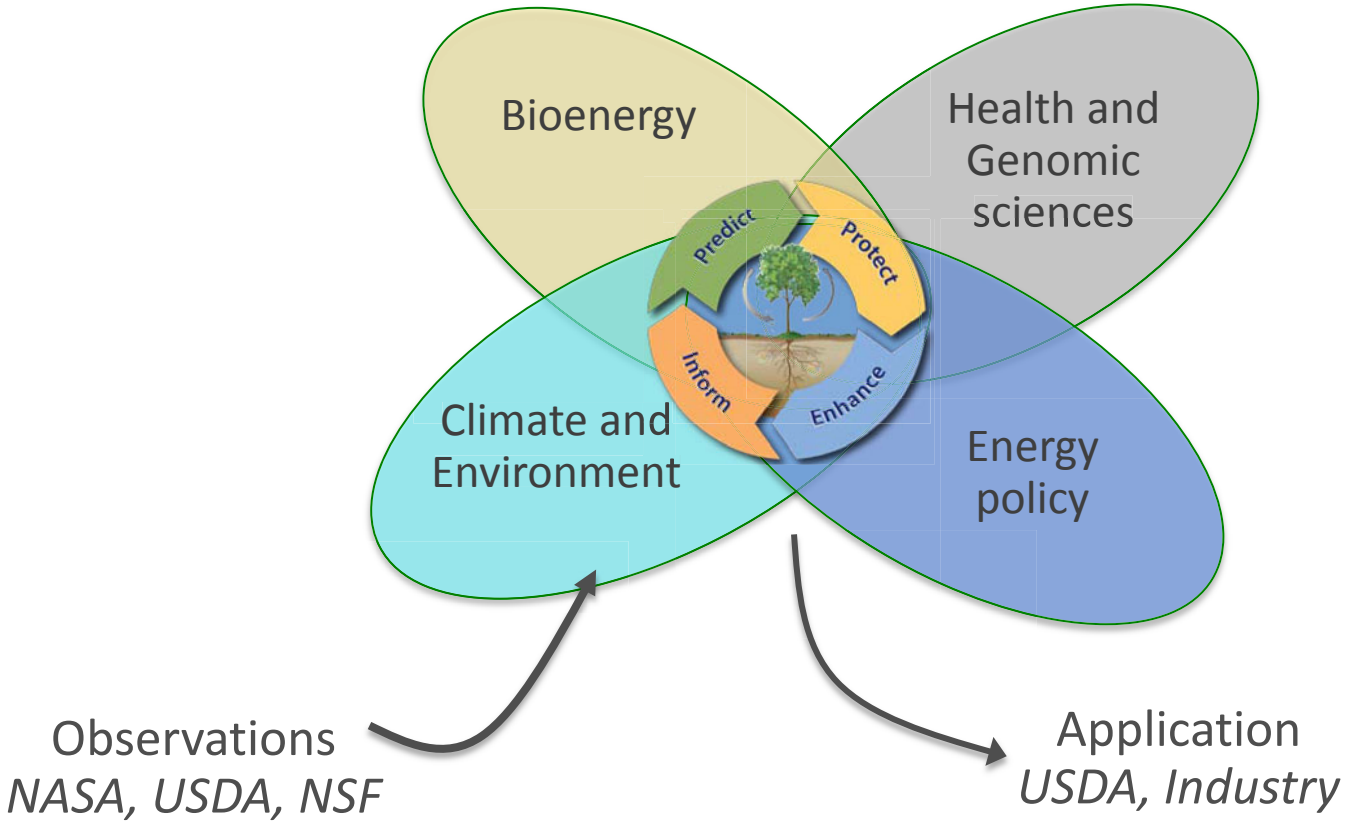
Spans Science, EERE,
FE, ARPA-E, EPSA,
Int'l Affairs

3

Only DOE

Is poised to tackle
this Challenge

The Carbon Sink in DOE Mandate and Strengths



Team Members

Multi-lab & cross-program scientific leadership

Margaret Torn
Senior Scientist and Senior Program Advisor

Trevor Keenan
Research Scientist

Andrew Jones
Program Domain Lead

Umakant Mishra
Geospatial Scientist

Nate McDowell
Staff Scientist, Director of Los Alamos Res. Park

Richard Sayre
Senior Research Scientist

Alistair Rogers
Biologist

Jenny Mortimer
Director of Plant Systems Biology

Gregg Beckham
Staff Engineer

Karis McFarlane
Research Scientist

Ruby Leung
Laboratory Fellow, Chief Scientist ACME

Ghassem Asrar
Director of JGCRI

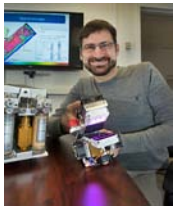
Forrest Hoffman
Senior Scientist

Stan Wullschleger
Scientist, NGEE PI

Gerald Tuskan
Distinguished Scientist

Eoin Brodie
Deputy Director, Climate and Ecosystem Sciences Division

Kirsten Hofmockel
Lead Scientist



Shawn Serbin
Assistant Ecologist

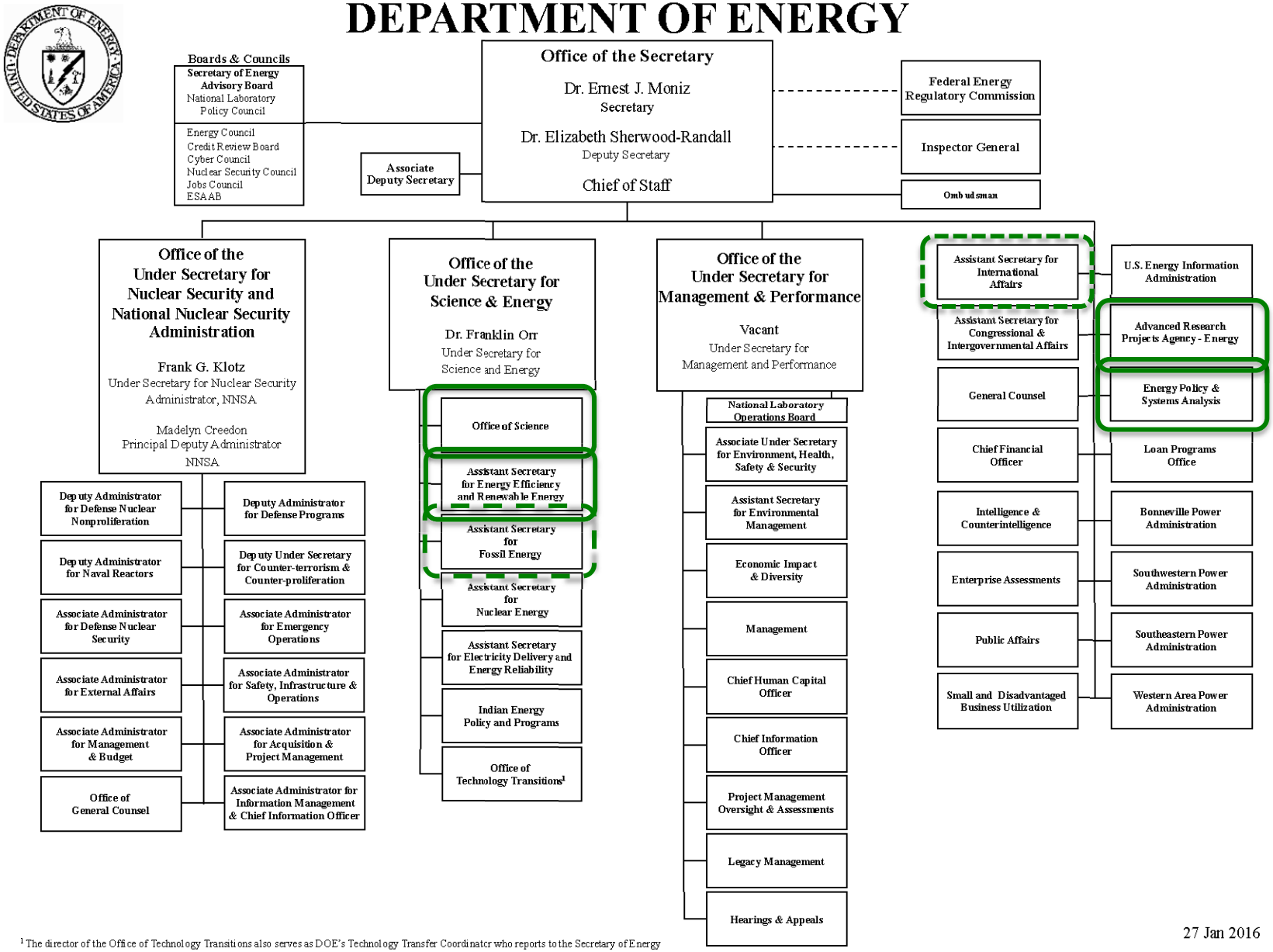
Trent Northen
Director, Environmental Genomics & Systems Biology Division

Not pictured: Erin Searcy

Team Contacts

Margaret Torn	mstorn@lbl.gov
Ghassem Asrar	ghassem.asrar@pnnl.gov
Richard Sayre	rsayre@newmexicoconsortium.org
Trevor Keenan	trevorkeenan@lbl.gov
Andrew Jones	adjones@lbl.gov
Gregg Beckham	gregg.beckham@nrel.gov
Nate McDowell	mcdowell@lanl.gov
Ruby Leung	Ruby.Leung@pnnl.gov
Trent Northen	trnorthen@lbl.gov
Forrest Hoffman	forrest@climatemodeling.org
Eoin Brody	elbrodie@lbl.gov
Umakant Mishra	umishra@anl.gov
Stan Wullschleger	wullschlegsd@ornl.gov
Jenny Mortimer	jcmortimer@lbl.gov
Gerald Tuskan	gatuskan@lbl.gov
Ali Douraghy	adouraghy@lbl.gov
Alistair Rogers	arogers@bnl.gov
Shawn Serbin	sserbin@bnl.gov
Karis McFarlane	mcfarlane3@llnl.gov
Erin Searcy	erin.searcy@inl.gov

DEPARTMENT OF ENERGY



[1] The director of the Office of Technology Transitions also serves as DOE's Technology Transfer Coordinator who reports to the Secretary of Energy

27 Jan 2016