Landscape Design for Progress toward Sustainable Bioenergy

Virginia H. Dale (vdale@utk.edu)
Adjunct Professor, University of Tennessee
Corporate Fellow Emeritus, Oak Ridge National Lab

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CBES
Center for BioEnergy Sustainability

https://cbes.ornl.gov/

THE UNIVERSITY OF TENNESSEE KNOXVILLE

U.S. DEPARTMENT OF ENERGY

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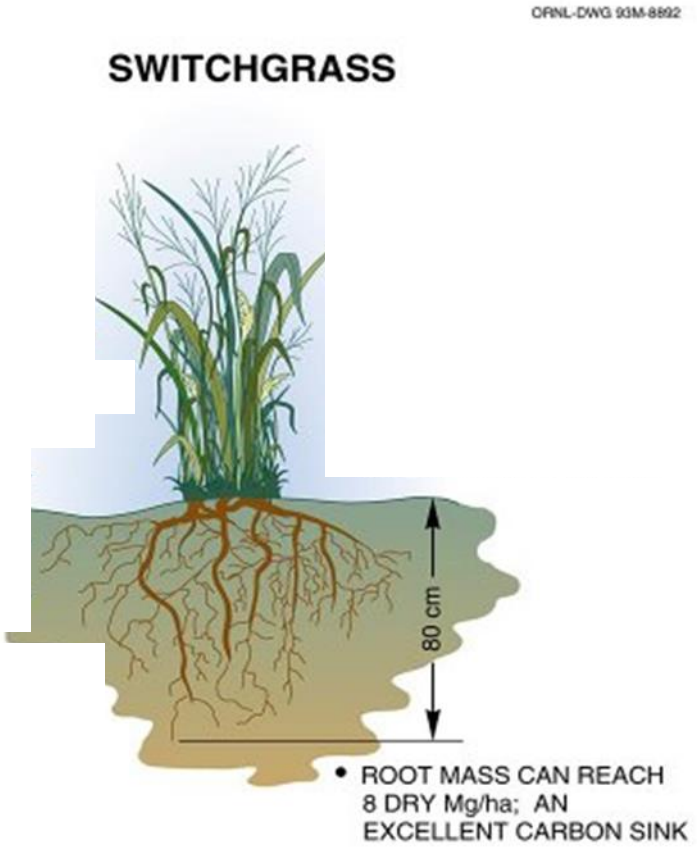
Goals for carbon economy are to

1. Enhance long-term storage of carbon



Long-term storage of carbon enhanced by using deep-rooted plants as bioenergy feedstock

Goals for carbon economy are to

1. Enhance long-term storage of carbon

2. Reduce transmission of carbon to atmosphere

Transmission of carbon to atmosphere reduced by using forest thinnings for bioenergy rather than burning them.

Goals for carbon economy are to

1. Enhance long-term storage of carbon

2. Reduce transmission of carbon to atmosphere

3. Keep fossil carbon underground

Fossil carbon kept in ground when displaced by

- **Biofuels**
- **Coproduction using bioenergy**

In addition to supporting a circular carbon economy, bioenergy can provide additional benefits

- Rural jobs
- Enhanced water quality
- Quality habitat for species of concern
- Enriched soils
- Reduced chemical use
- Diversified incomes
- Reduced pollution from burning, land-fills, & dumping
- Incentivize keeping land in forests or farms

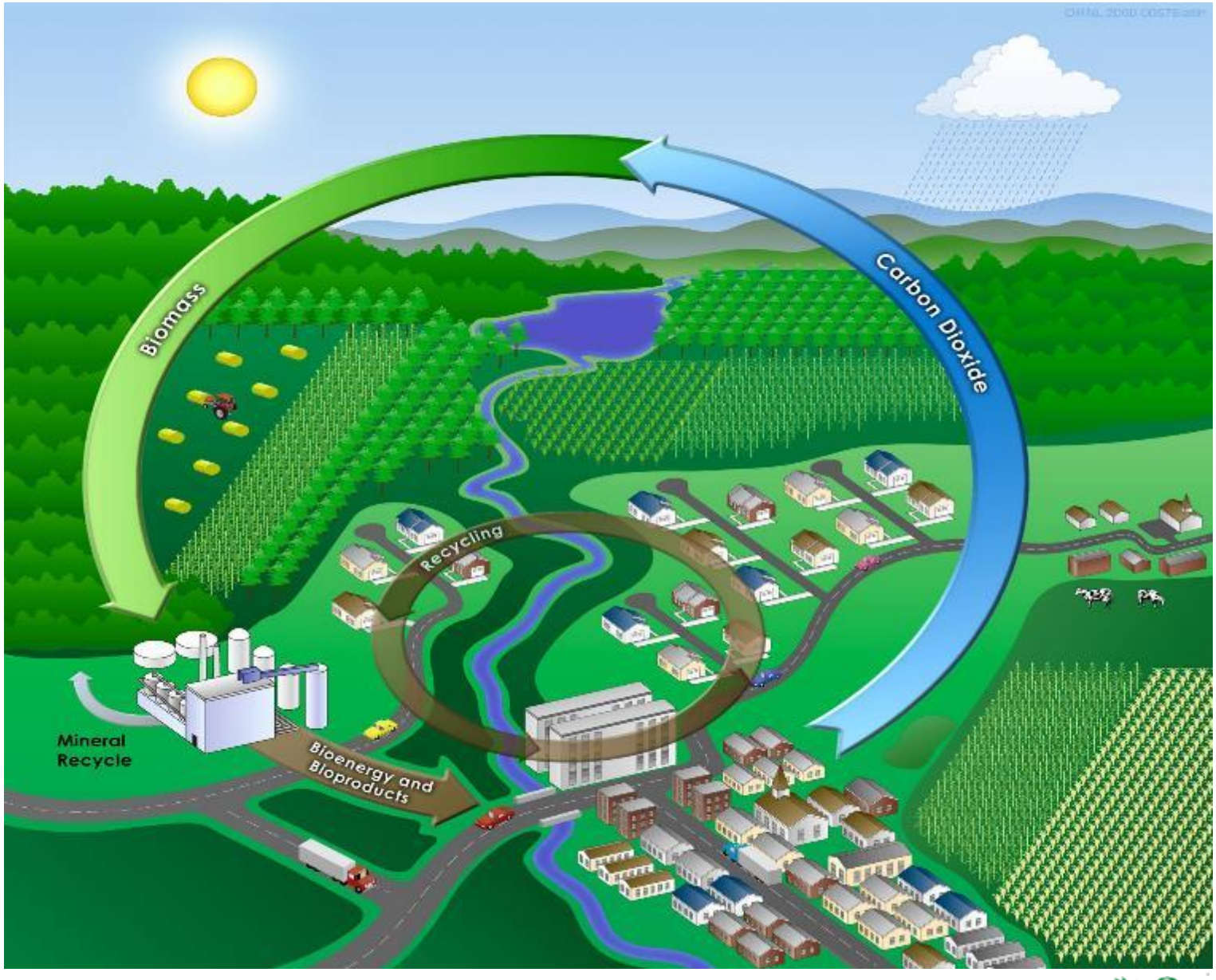
Challenges in moving toward sustainable bioenergy

- Developing & implementing land management practices that support bioenergy production
- Public perception of "available suitable" land & feedstocks that can be used for bioenergy
- Multiple benefits accrue only if the landscape is designed to support them

Well managed pine stand uses thinnings for bioenergy

Forest that needs thinning

Opportunity: Developing landscape designs for bioenergy production



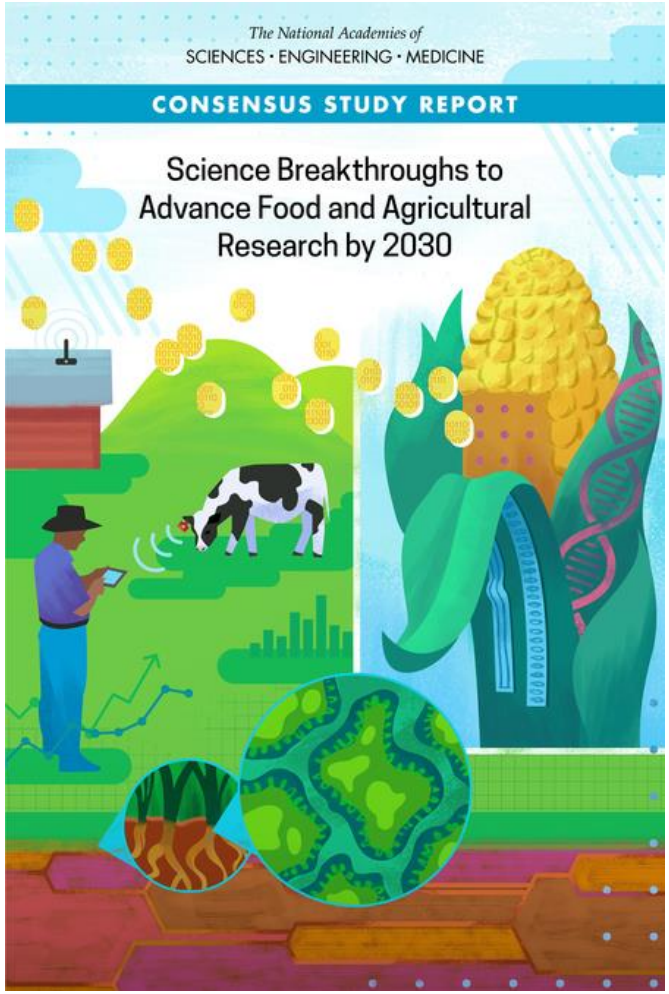
Dale et al. (2016) *Renewable & Sustainable Energy Reviews*

National Academy of Science Panel on "Scientific Breakthroughs to Advance Food and Agricultural Research by 2030"

- **NAS panel said the goal is to optimize for <u>sustainability</u> and <u>resilience</u>**
  - Meeting the **needs** of today without jeopardizing those of the future (Bruntland 1987)

What are the needs?

- **The Brundtland definition of sustainability**
  - Is difficult to apply, for it relies on poorly defined & subjective values
  - Sets forth key framing principles:
    1) Sustainability is aspirational
    2) Sustainability is about comparing relative effects of different options
    3) Other things being equal, activities that conserve non-renewable resources for future use are inherently more sustainable than activities that do not.



SUSTAINABLE DEVELOPMENT GOALS

17 GOALS TO TRANSFORM OUR WORLD

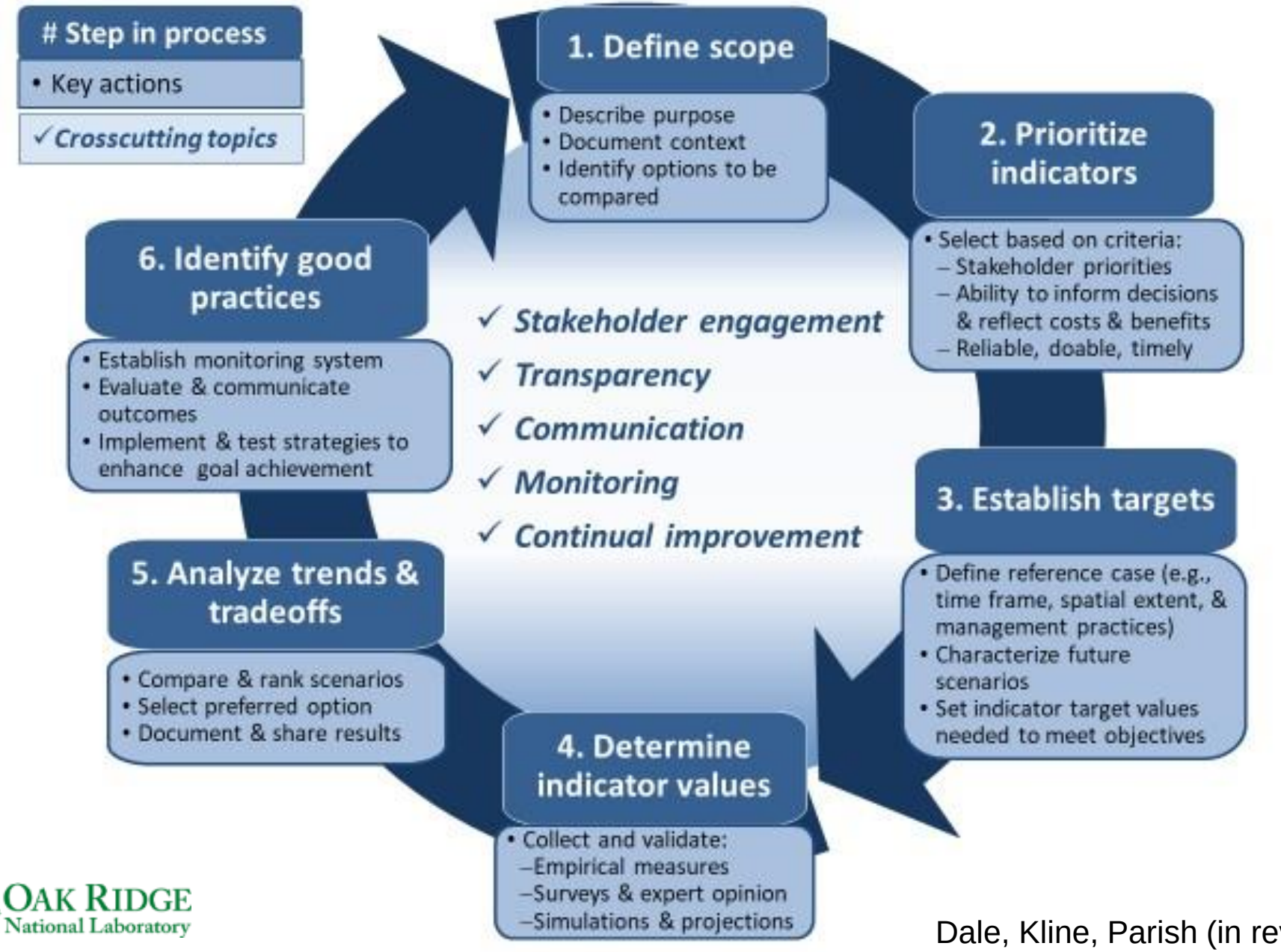
- In 2015 the United Nations established 17 Sustainable Development Goals.
- The goals are broad & somewhat interdependent
- Each goal has a unique list of targets.
- Social, environmental & economic concerns covered by 169 indicators

Bioenergy can contribute to 13 SDGs

Souza et al. (2015) *SCOPE 72*

http://bioenfapesp.org/scopebioenergy/index.php

Steps in assessing progress toward sustainability goals



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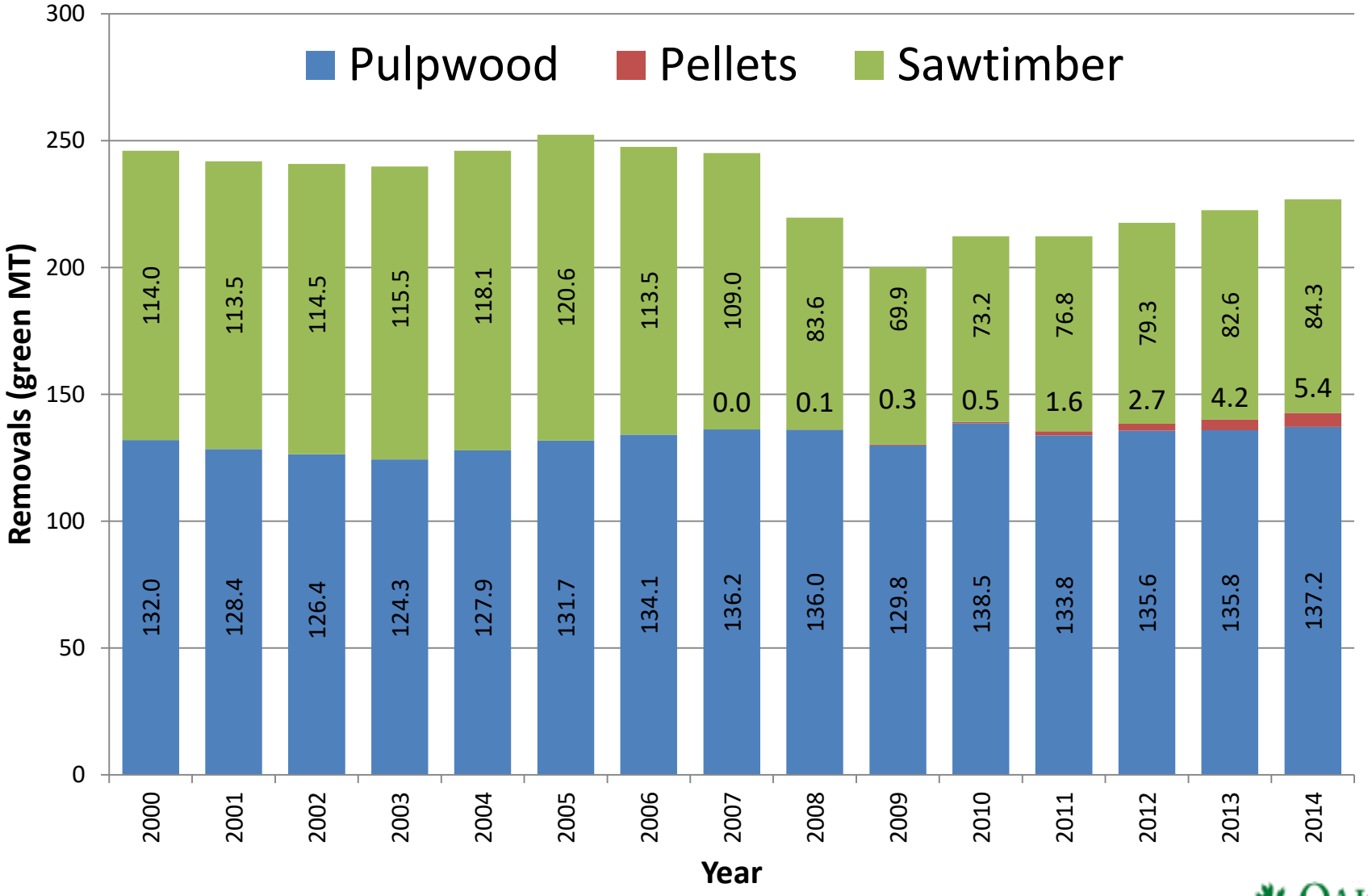
Dale, Kline, Parish (in review)

Opportunity 1. Defining scope in view of

- Context
- Stakeholders' goals for desired future conditions

Context: Wood based pellets are <3% of wood products from SE US



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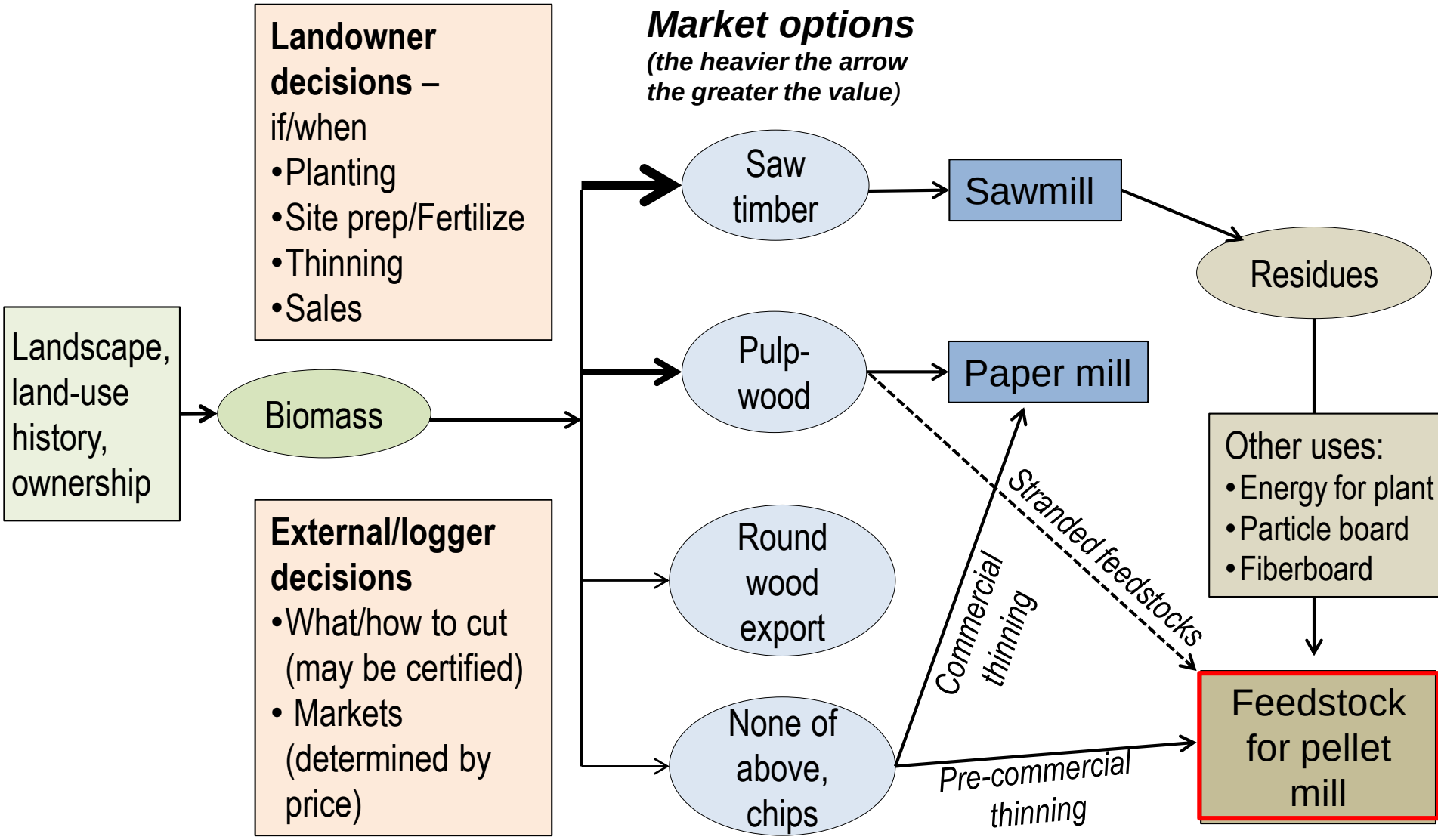
Dale et al. (2017) Forest Ecol & Mgmt

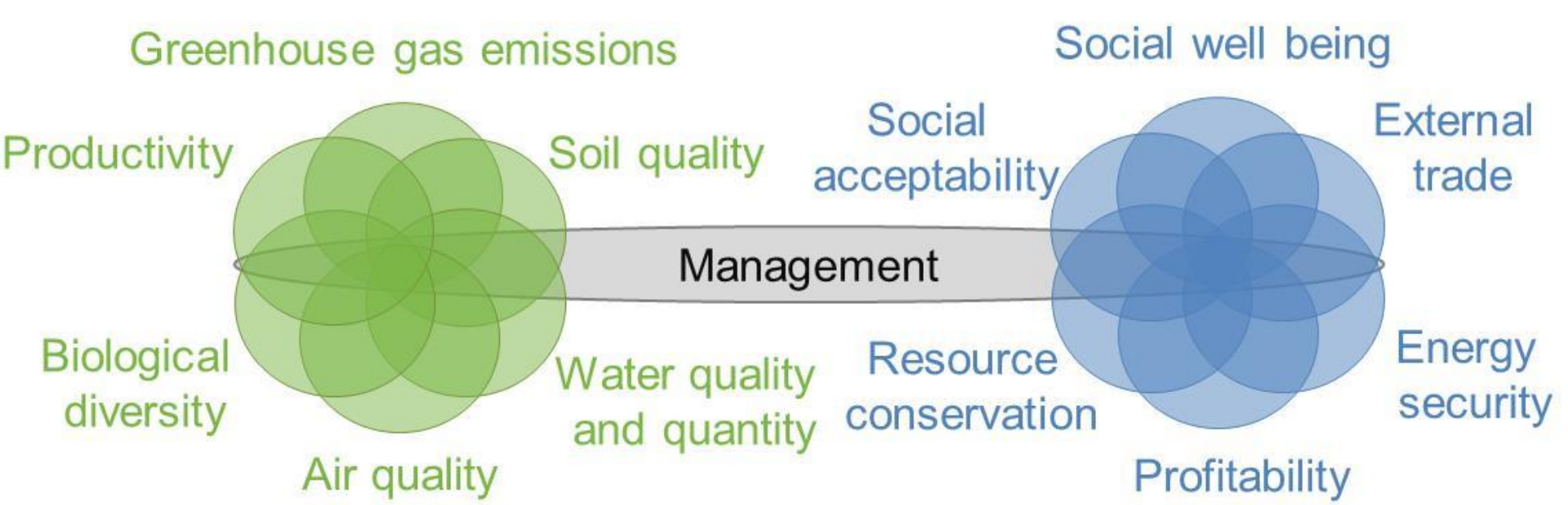
Context of SE US export wood pellet production



Fiber Sourcing Standard requires trained loggers to follow Best Management Practices

Desired conditions often relate to ecosystem services as well as social benefits

Opportunity 2. Prioritizing indicators (can build from existing checklist)



McBride et al. (2011) *Ecol Ind.*

Dale et al. (in review)

Dale et al. (2013) *Ecol. Ind.*

Recognize that measures and interpretations are context specific

Efroymson et al. (2013) *Env Manage.*

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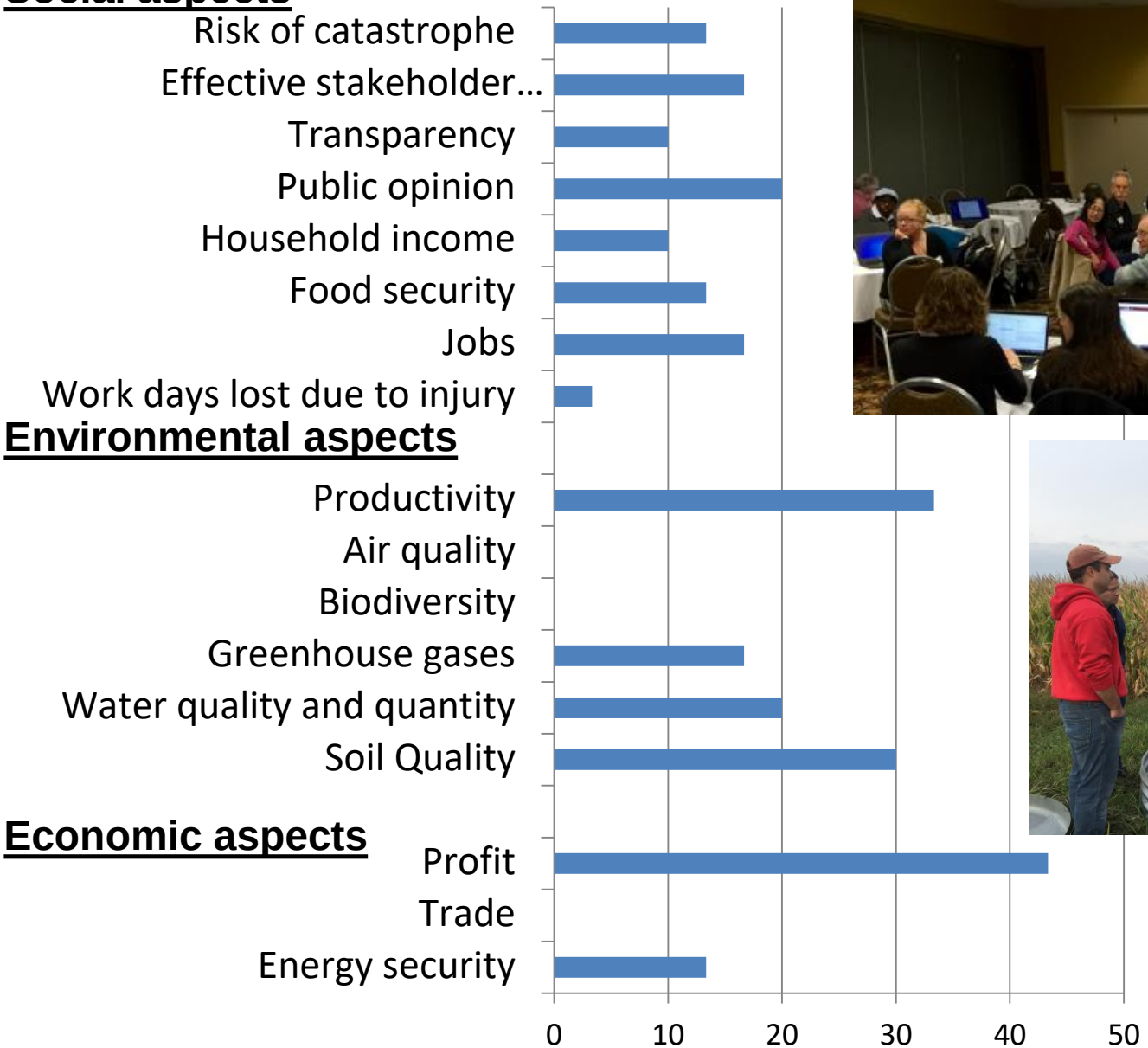
Stakeholder consensus derived via participants prioritizing indicators



Dale et al. (2018)
Biomass & Bioenergy

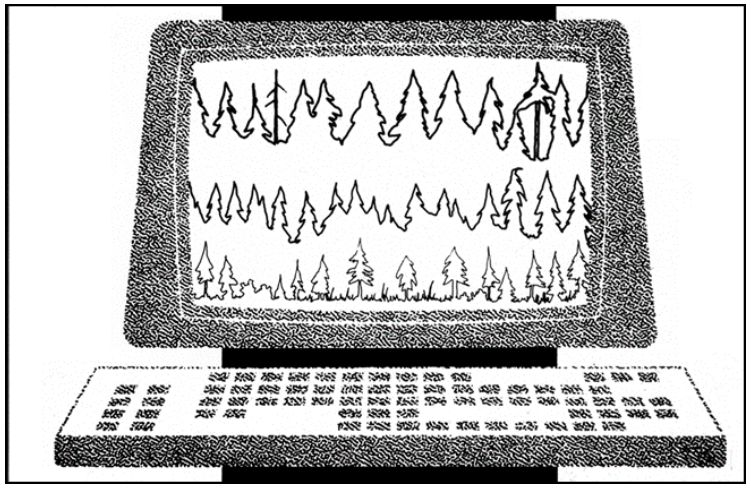
Opportunity 3: Establishing targets

- **Basis for selection**
  - Rules, regulations & policies
  - Scientific literature
  - What is reasonable & achievable in time frame
  - Model projections & iterations
  - Stakeholders' objectives

- **Factors to consider**
  - Historical conditions
  - Stresses to system
  - Interactions among indicators
  - Target bearing:
    - High (e.g., # native species)
    - Low (e.g., Amount of particulate in air)
    - Middle (e.g., pH)

Opportunity 4: Determining indicators values

- **Empirical measures**
  - Government reports
  - Industrial records
  - Citizen science
  - Expert opinion
- **Model estimates**
  - Specify the context
  - Consider potential implications of feedstock production
  - Characterize future projections



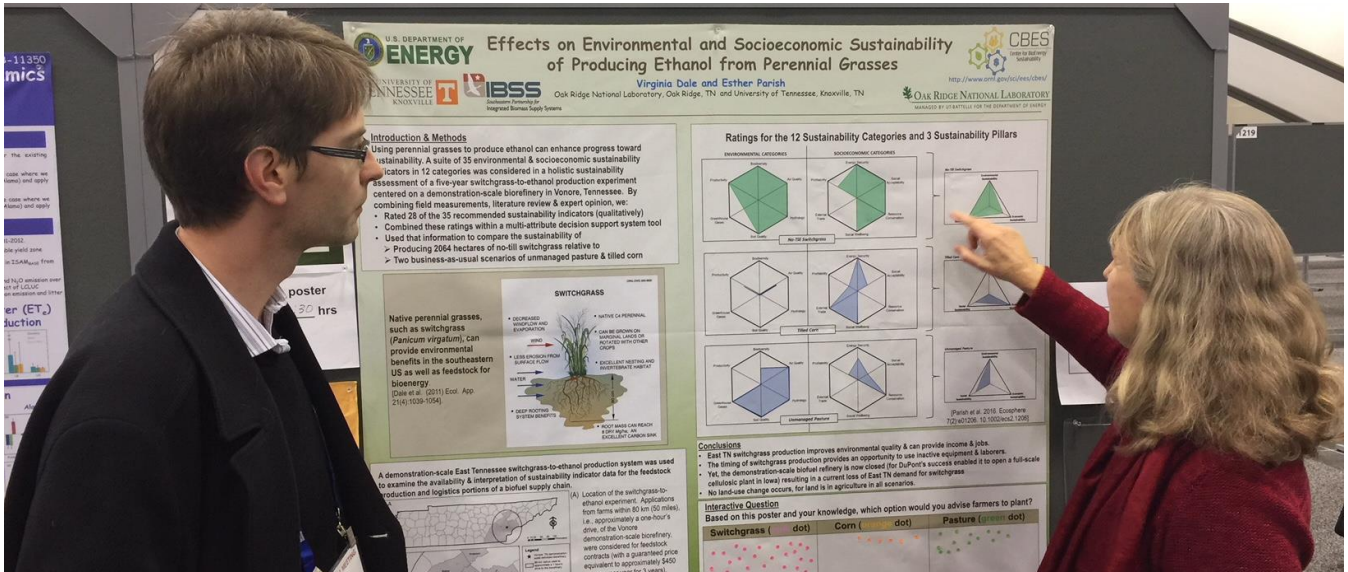
US has a robust monitoring program

For example, USDA Forest Inventory & Analysis

- Long-term survey
- All forests in the US
- Information on a variety of forest statistics
  - Forest area and location
  - Species
  - Tree size, growth, health, and mortality
  - Removals by harvest
  - Carbon accumulation

Opportunity 5: Analyzing trends & tradeoffs

- Choice of reference scenario is critical in considering trends. Hence need to know
  - Major influences on current ecosystem conditions
  - Potential futures (building from assumptions & associated uncertainties)
  - Likely alternative feedstock fates
  - Effects of no demand of bioenergy feedstocks on future conditions.
- Changes to system can affect outcomes



Parish et al. (2017)
WIREs Energy Environ

“Reality is a special case”

* Dupont closed its refinery in TN
* The largest biorefinery using cellulosic feedstock is the POET plant in Iowa
* Provides opportunity to iterate on approach

Tradeoff

1. A situation in which you must choose between two things that are opposite or cannot be had at the same time.
2. A giving up of one thing in return for another.

Scale of analysis?

Landscape perspective can mitigate need for tradeoffs

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Opportunity 6. Identifying & implementing good practices

- **Avoid negative effects**
  - Identify & conserve priority biodiversity areas
  - Apply location-specific management of biofuel feedstock production systems.
- **Attend to site selection & environmental effects in the**
  - Selection & location of the feedstock
  - Transport of feedstock to the refinery
  - Refinery processing
  - Final transport & dissemination of bioenergy.
- **Monitor, assess & report on key measures of sustainability**
- **Attend to what is "doable"**
- **Communicate opportunities & concerns to the stakeholders & get their feedback**
- **Employ adaptive management**

- Dale et al. (2017) *Forest Ecol & Manage.*
- Parish et al. 2016. *Ecosphere*

We want to part of the solution (not just playing the sand)

Key questions for fostering landscape design to support circular bioeconomy

- How does bioenergy production and use differ from business-as-usual case?
- Are there significant changes to key environmental indicators?
- How can ecosystem services be monitored & good practices implemented?
- How can stakeholders become more engaged in this approach?

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Thank you!

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