Sustaining Southeastern Forests:

The Economic and Water Use Impacts of Privately-Owned Pine Woodlands and Restored Longleaf Pine Forests

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THE JONES CENTER AT ICHAUWAY

USDA United States Department of Agriculture

Natural Resources Conservation Service

UNIVERSITY OF GEORGIA

Warnell School of Forestry & Natural Resources

Image: Chambers English

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THE LONGLEAF ALLIANCE

FOREST SERVICE U S DEPARTMENT OF AGRICULTURE

U.S. FISH & WILDLIFE SERVICE DEPARTMENT OF THE INTERIOR

AMERICA'S LONGLEAF

Thank you!

Image: Chambers English

Management Challenges

Landowners face real and perceived economic barriers with native longleaf pine restoration.

Drought period hydrology leads to declining aquatic biodiversity in some Southeastern streams.

Forest restoration of longleaf or loblolly pine may offer landscape-scale benefits, but costs to producers and partners must be quantified.

Image: Chambers English

Key Take-Aways

1. Open pine management may improve wetland hydrologic function during drought periods.
2. Where strong pine straw markets exist, longleaf pine straw management is profitable without financial assistance.
3. Additional payments or restructuring of benefits could realize fuller benefits of loblolly and longleaf open pine systems.
4. Loblolly open pine systems may even be more cost-effective measure for water use management.

Image: Chambers English

Longleaf Pine Ecosystems

Sparse overstory & diverse understory.

Multiple age classes.

Maintained through Indigenous and lightning-ignited fires.

29 threatened and endangered species.

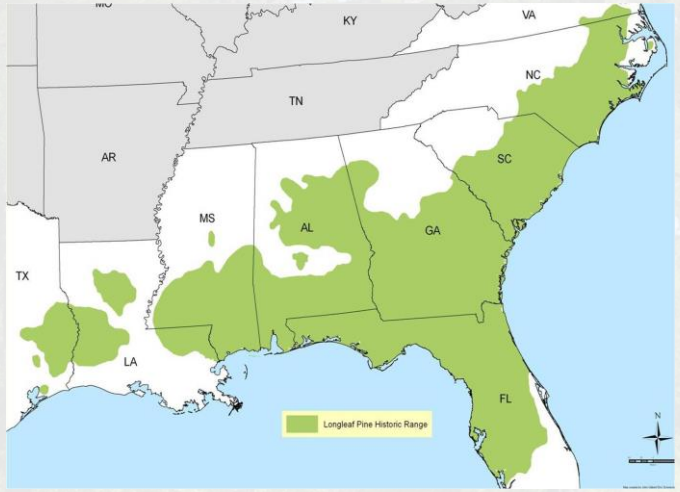
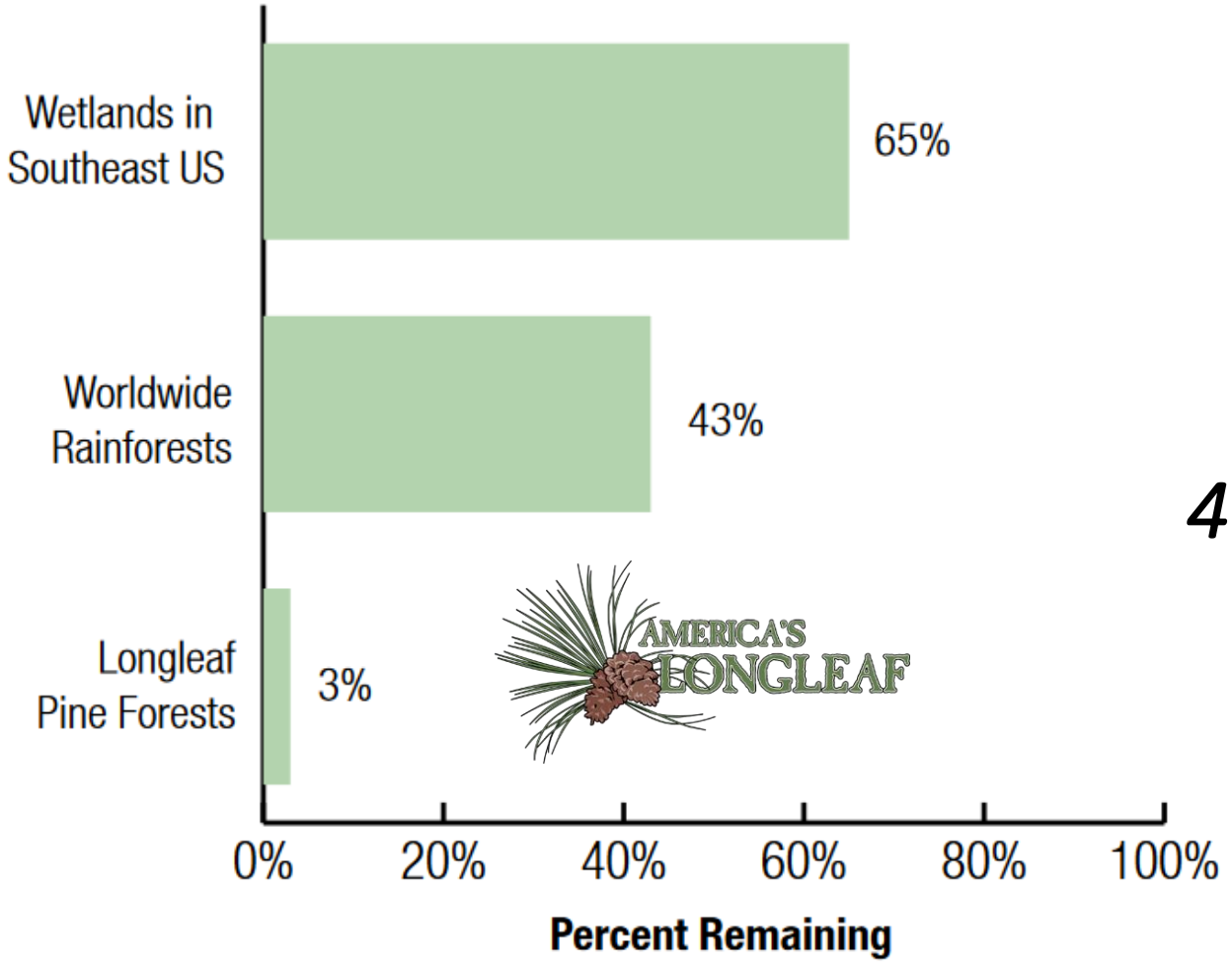


Image: Chambers English

A Landscape in Transition

Photos: Georgia Encyclopedia, Library of Congress/Lewis Hine, United States Forest Service, Bugwoodcloud.org



An Imperiled Ecosystem:
4 million acres to 8 million acres?

Image: America's Longleaf Restoration Initiative

NRCS Longleaf Pine Initiative (2010)

USDA United States Department of Agriculture

Natural Resources Conservation Service

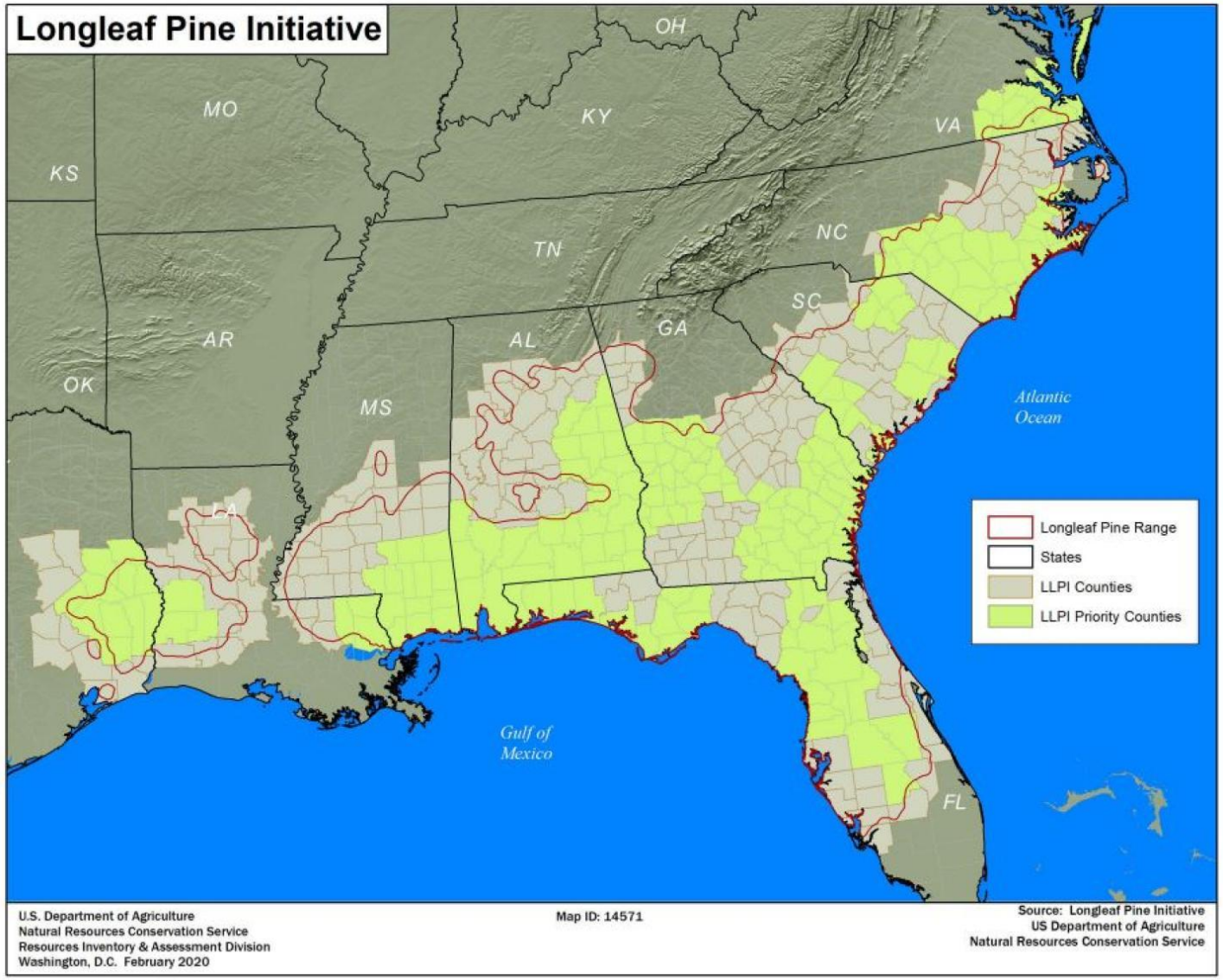


Image: Natural Resources Conservation Service

United States Department of Agriculture

Natural Resources Conservation Service

2021 Leader in Longleaf Establishment: 52,406 acres

Image: Alabama Cooperative Extension Service, United States Department of Agriculture, National Park Service

United States Department of Agriculture

Natural Resources Conservation Service

Environmental Quality Incentives Program (EQIP)

Practices including:

490 - Tree/Shrub Site Preparation
612 - Tree/Shrub Establishment
338 - Prescribed Burning
394 - Firebreak
666 - Forest Stand Improvement

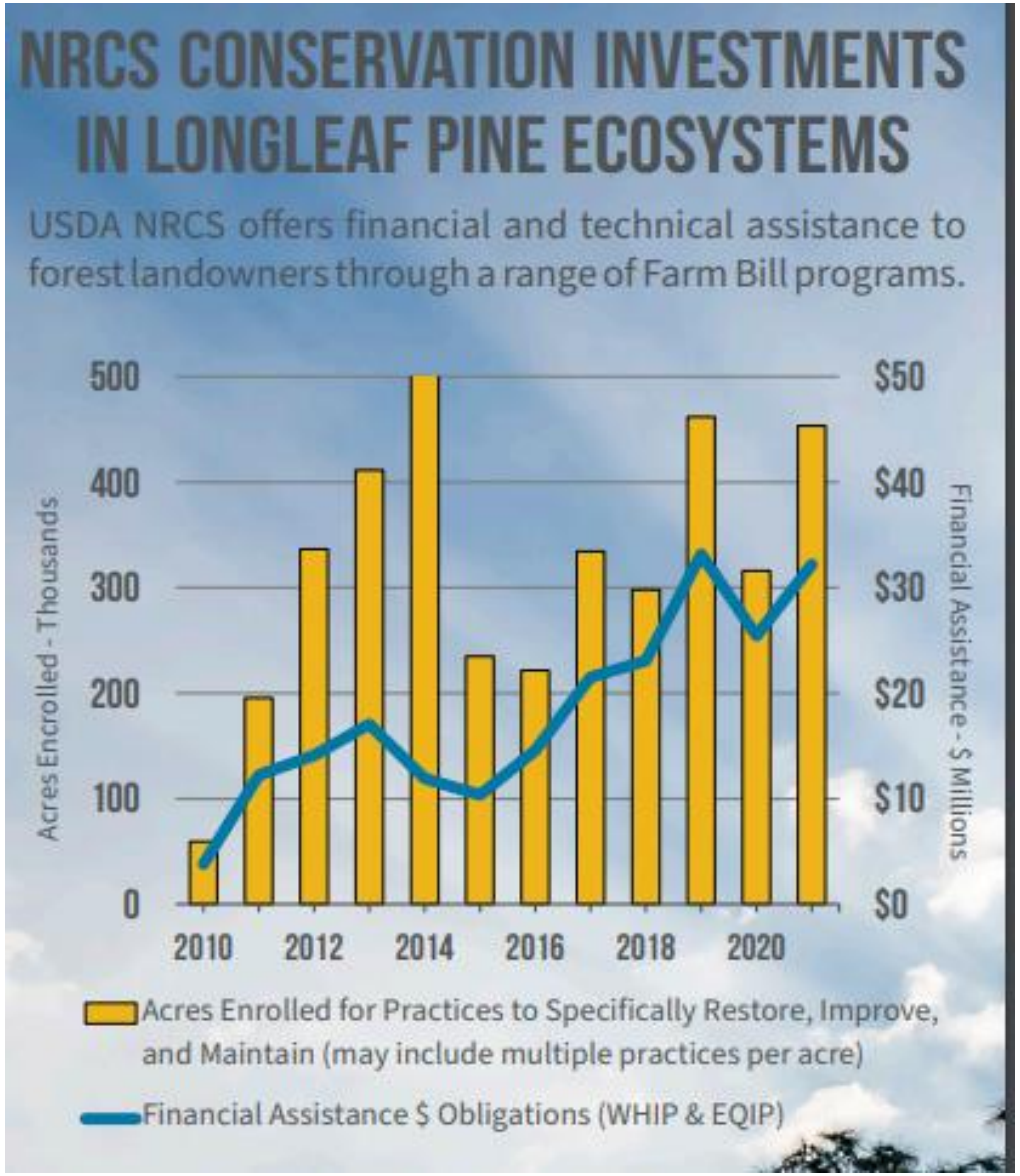
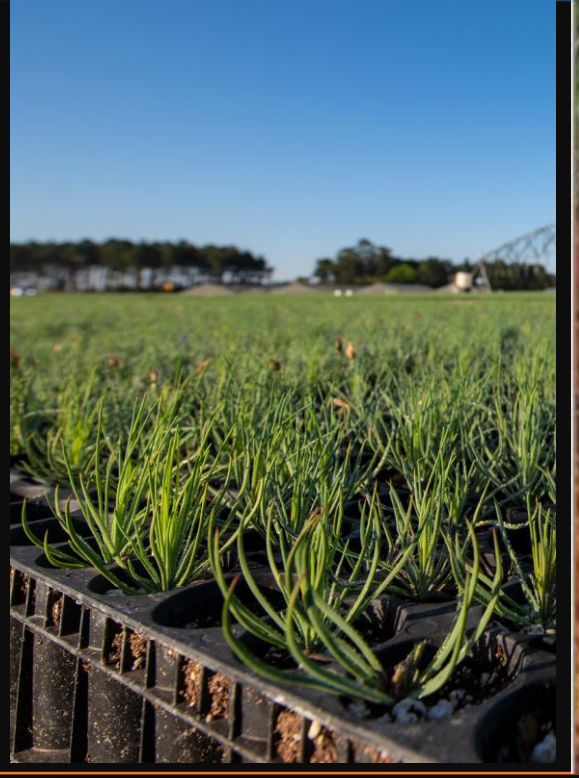


Image: America's Longleaf Restoration Initiative

USDA

Farm Service Agency



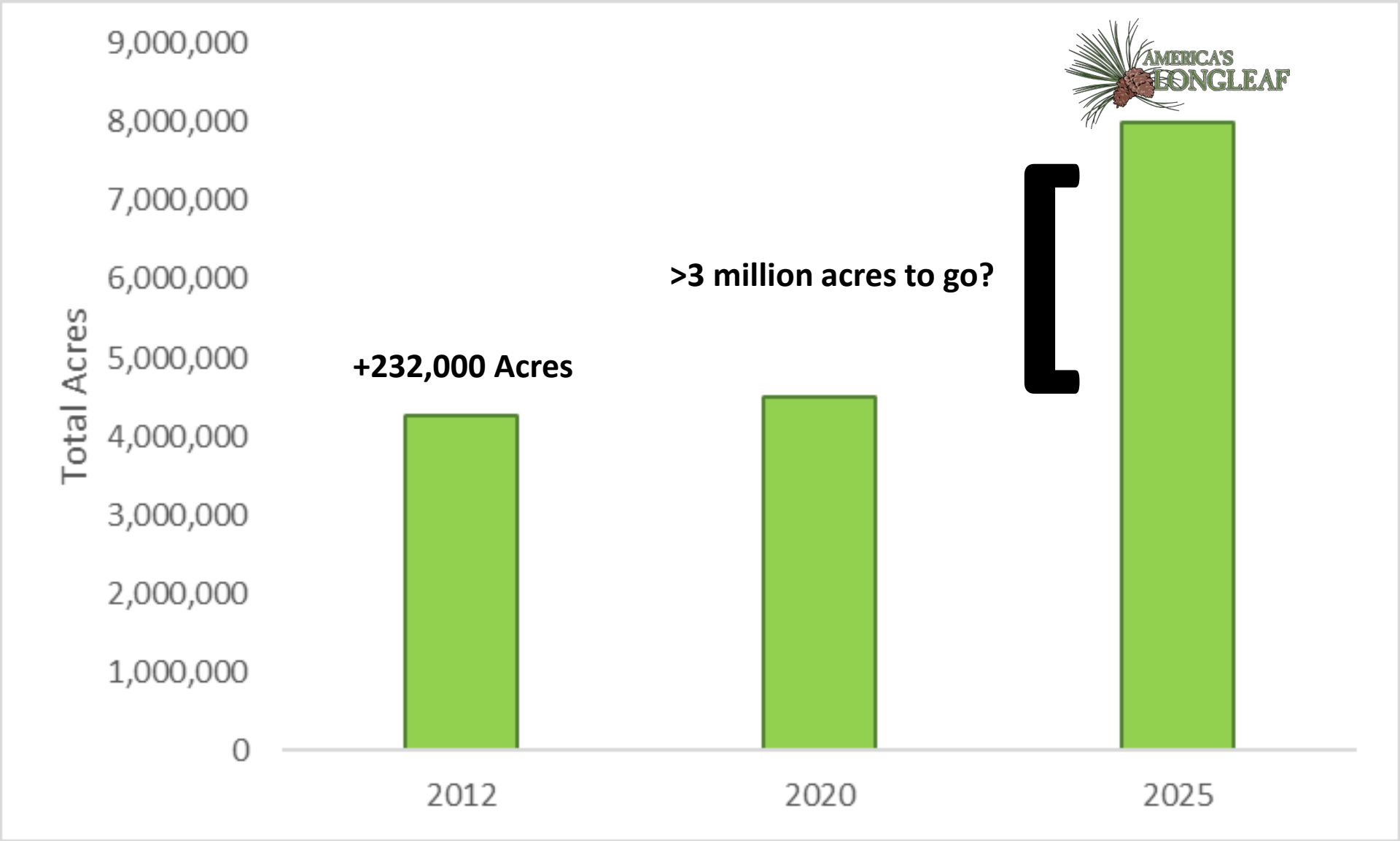
Conservation Reserve Program (CRP): 250,000 Acres Established with native grasses on marginal croplands

Image: Natural Resources Conservation Service, United States Department of Agriculture,

Million-acre challenge for longleaf on public land – 80% complete!

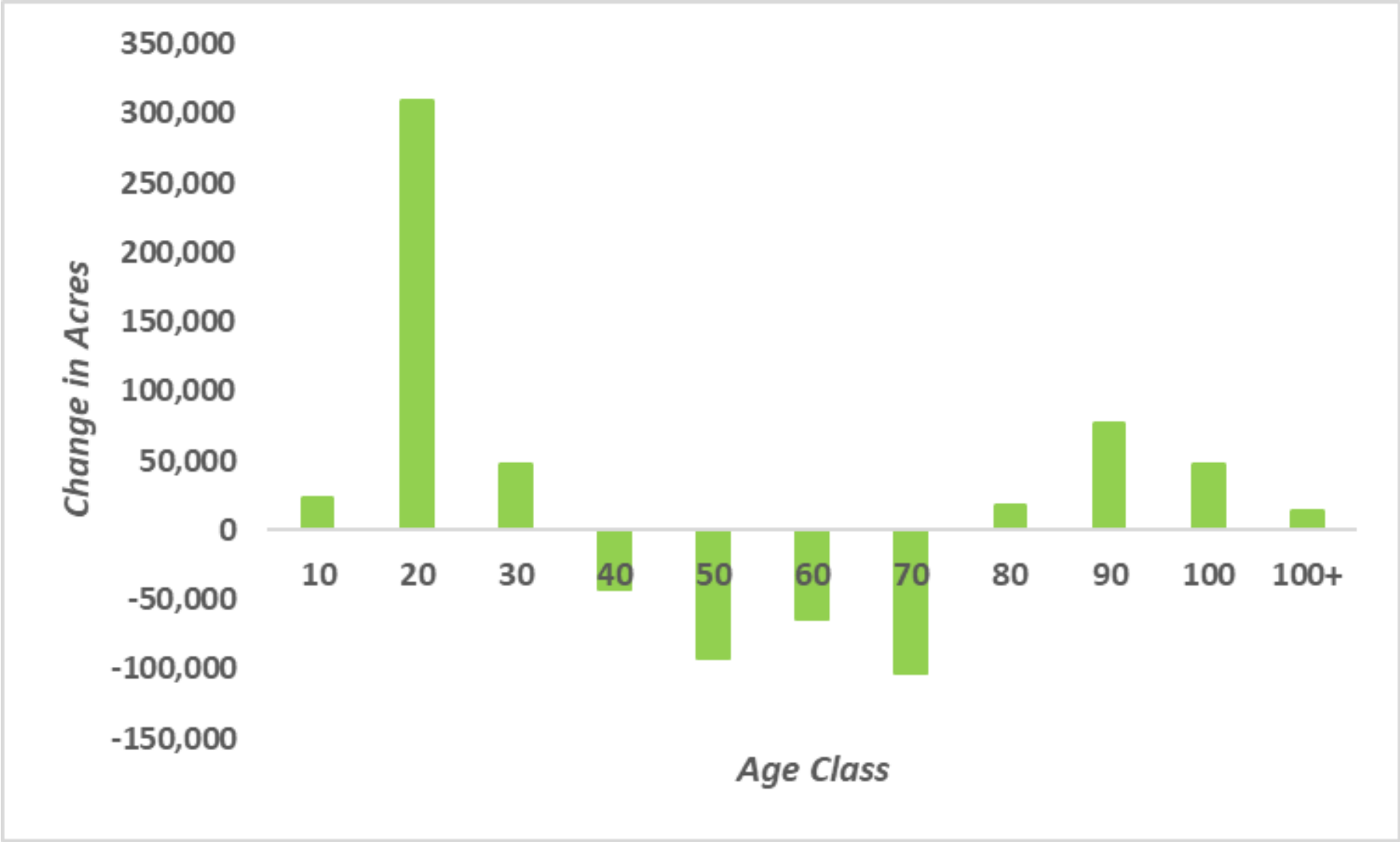
Image: United States Forest Service

USFS Forest Inventory and Analysis Data



Data: Oswalt et al. 2012, 2021

USFS Forest Inventory and Analysis Data



Data: Oswalt et al. 2012, 2021

A Sobering Reality

How to incentivize the continued management of longleaf pine into older age classes and desired conditions?

-Private lands restoration

-Corporate partnerships

-Fee simple and easement acquisitions

McIntyre et al. 2016

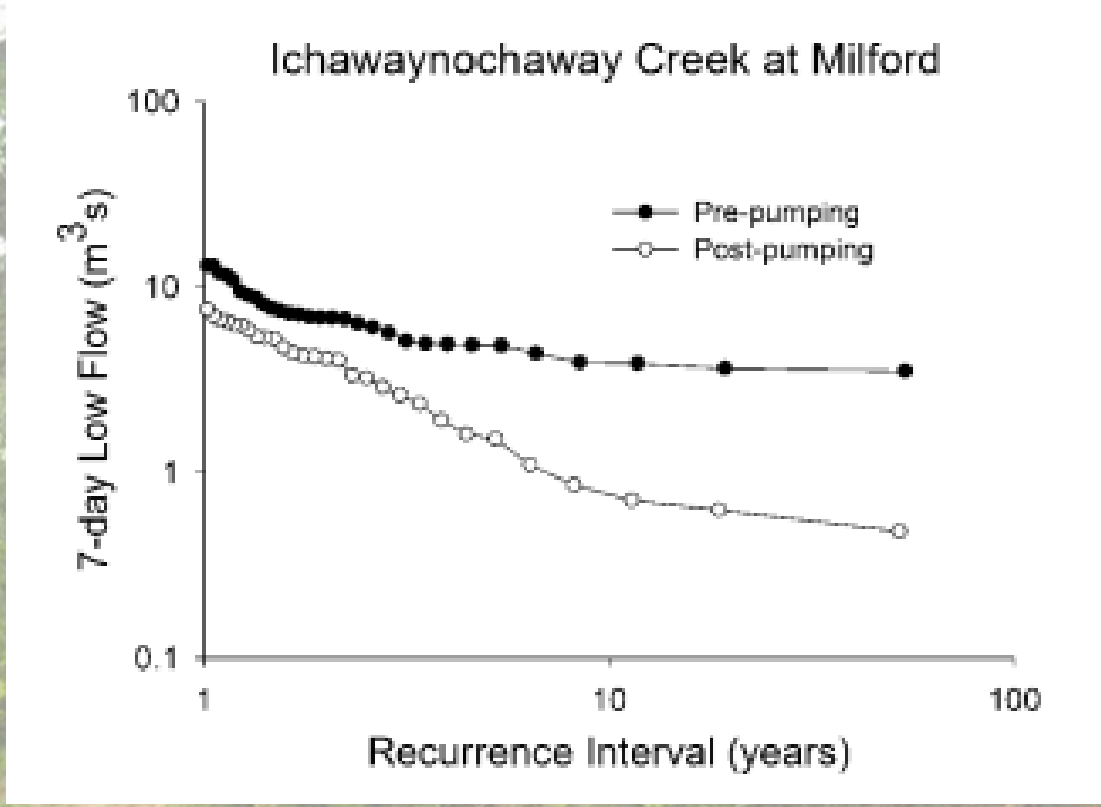
Image: Chambers English

Emerging Ecosystem Service Markets

CARBON

WATER QUALITY

WATER QUANTITY?



Low Flows Threaten Aquatic Habitats Downstream

(Rugel 2012)

Steamflows decrease during drought periods after groundwater withdrawals for agricultural irrigation.

Image: Rugel et al. 2012, Chambers English

Low Flows Threaten Aquatic Habitats Downstream

(Dubose et al. 2019)

Aquatic species of concern affected may lose habitat connectivity or living conditions during low flows.

Image: University of Georgia, Chambers English

Image: Natural Resource Conservation Service

Improved forest management.

Image: Google Earth


Improved forest management.
Image: Google Earth


Loblolly Pines: Native but offsite?
UGA0016213

Loblolly Pines: Primary Commercial Pine

Image: Georgia Forestry Commission, Georgia Forestry Association


Improved forest management.
Image: Google Earth

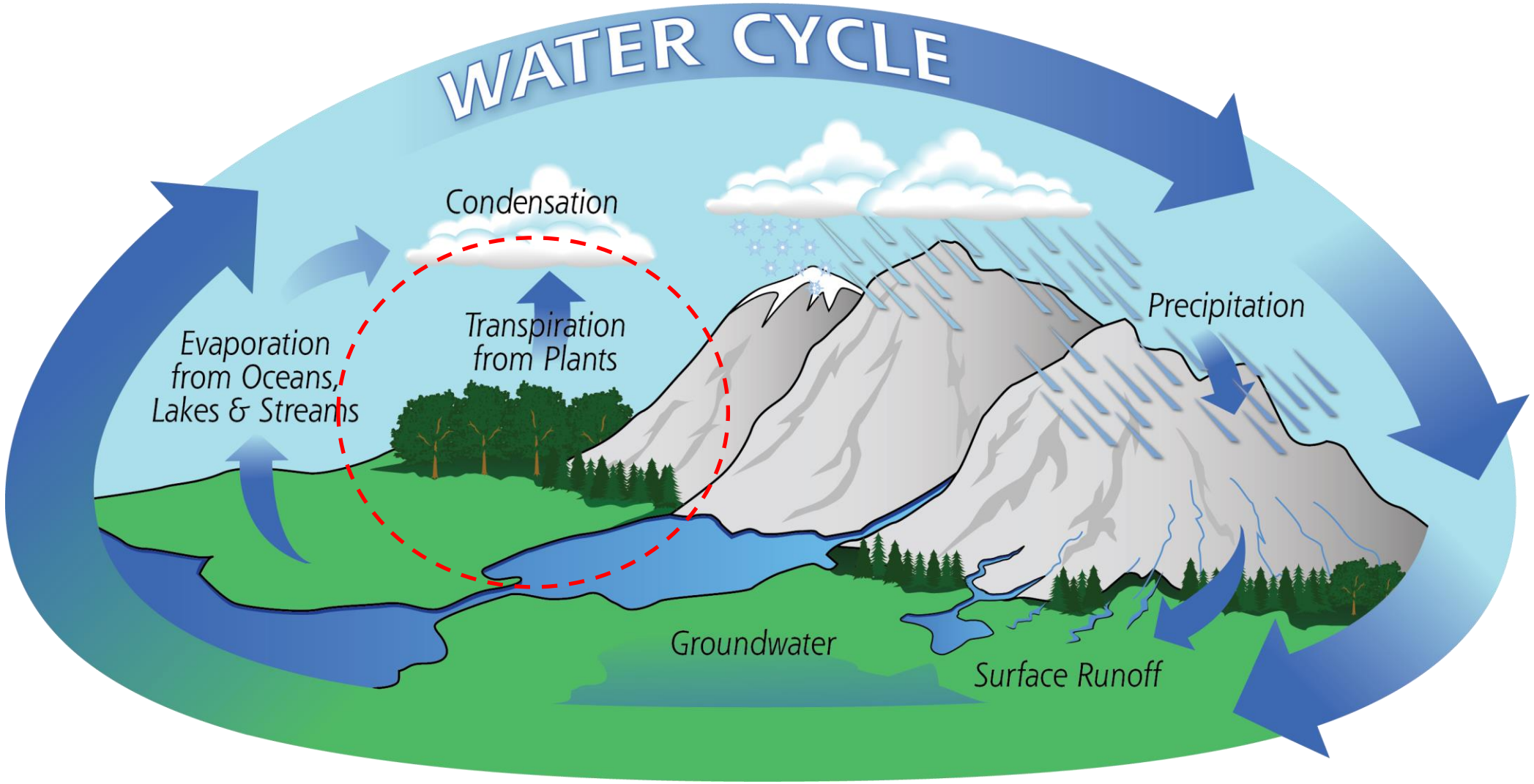


Image: National Aeronautics and Space Administration

Longleaf Savanna Advantages

Sparse overstory.

Grass-dominated understory.

Drought-hardy plant adaptations.

Image: Chambers English

Loblolly Savanna Advantages

Sparse overstory.

Grass-dominated understory.

~~Drought-hardy plant adaptations.~~

Image: Chambers English

Research Questions

What are the economic barriers for landowners to adopt forest restoration?

What are the hydrologic impacts of restoring longleaf pine savannas compared to other forest management scenarios?

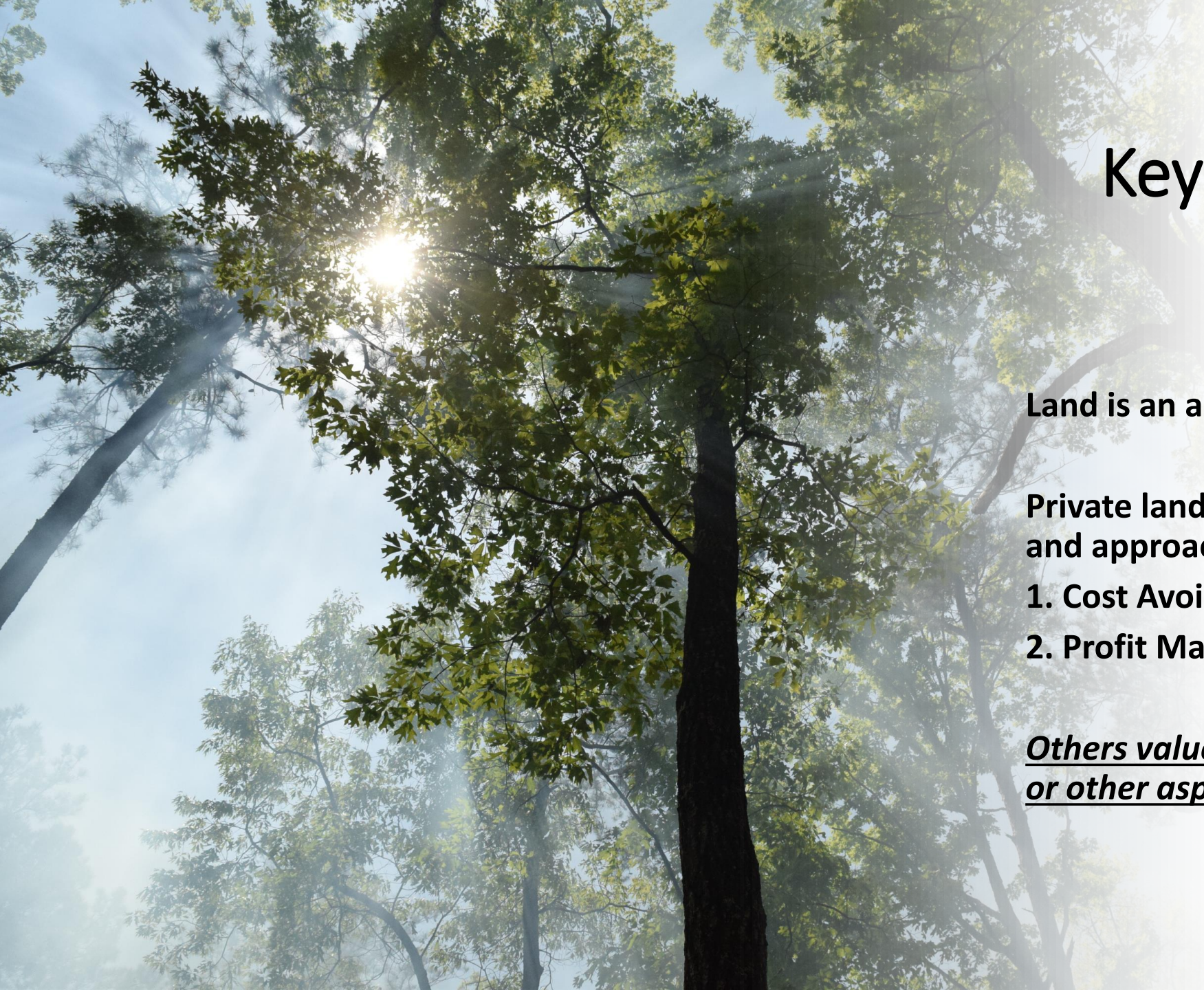
How could landscape-scale restoration improve water flows - and at what cost?

Image: Chambers English

Methods

Forest planning
Vegetation modeling
Discounted cash-flow analysis
Hydrological Modeling

Image: Chambers English



Key Assumptions

Land is an asset (and a liability).

Private landowners are diverse in objectives and approaches but generally share:

1. Cost Avoidance – *financial assistance*

2. Profit Maximization – *management*

Others value wildlife, aesthetics, recreation or other aspects more than strict economics!

Image: Chambers English

Short-rotation Forest Management Parameters

Draw financial distinction from long-rotation practices which improve ecosystem health.

Longleaf Management: (Dickens, Paudel)

- Pine straw raking age 10 to first thinning;
- Thin at 115 ft2/acre to 65 ft2/acre
- Final harvest when Net Present Value maximized
- No burning

Loblolly Management: (Dickens, Paudel)

- Thin at 115 ft2/acre to 65 ft2/acre
- Clearcut when Net Present Value is maximized
- No burning

Image: Microsoft Stock Art

100-Year Restoration Management Parameters

Draw ecological distinction from short-rotation practices which maximize income.

Longleaf: (NRCS and literature recommendations)
- 40-70ft2/acre
- 2 Year Fire Return Interval
- Native Warm Season Grass, pollinator establishment
- Density and competition control

Loblolly: (Tall Timbers, Piedmont NWR)
- 40-70ft2/acre
- 2 Year Fire Return Interval (After Year 12)
- Native Warm Season Grass, pollinator establishment
- Density and competition control

Image: Chambers English

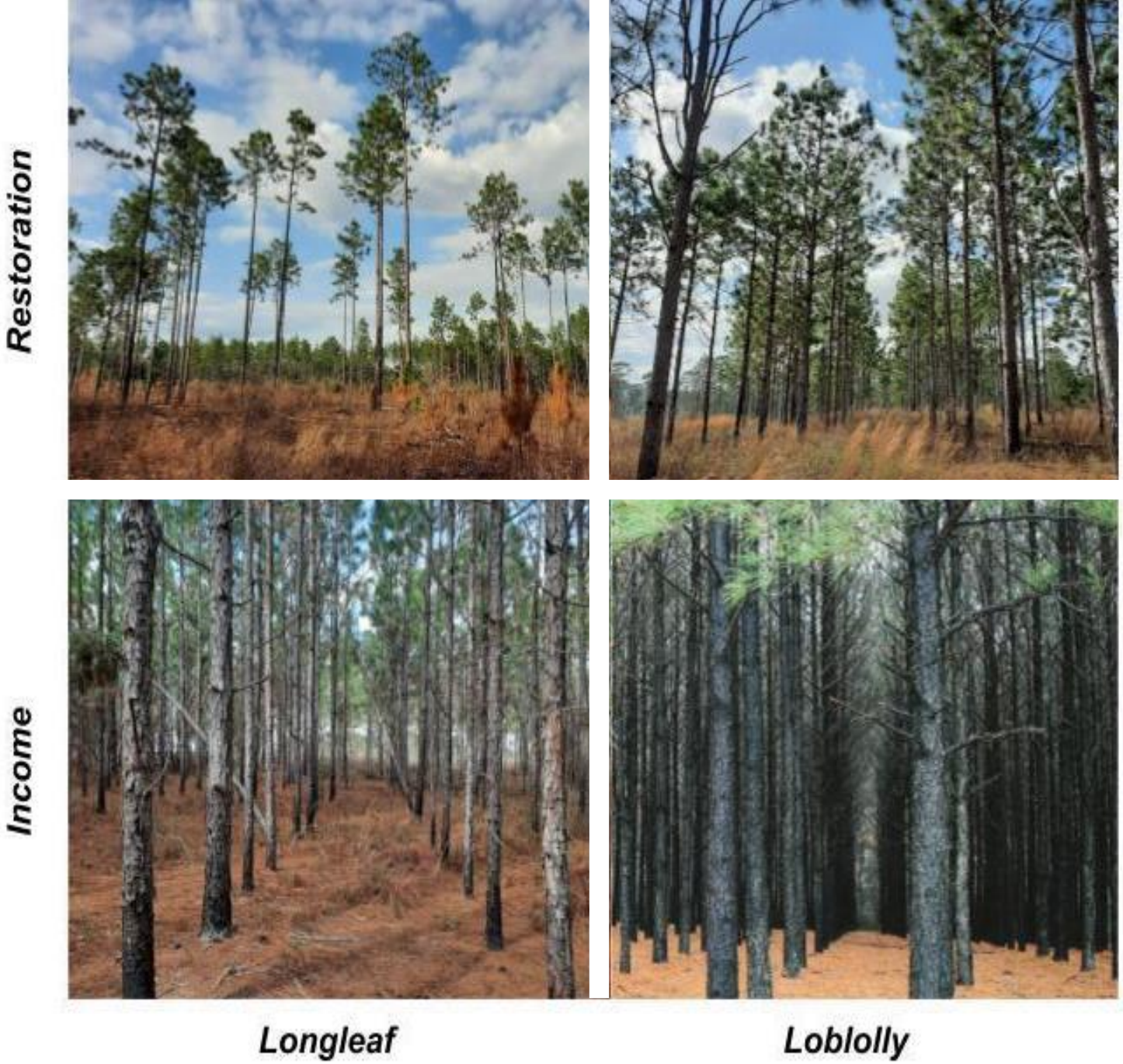


Image: Chambers English, BugwoodCloud.org

Financial Calculations

Net Present Value (NPV)
Annualized Equivalency Value (AEV):

$$NPV = \frac{R_t}{(1+i)^t}$$

$$AEV = NPV\left(\frac{i(1+i)^t}{(1+i)^t - 1}\right).$$

R = revenue (cost)
i = discount rate
t = time (years)

Image: Microsoft Stock Art

Financial Calculations

Net Present Value (NPV)

Annualized Equivalency Value (AEV):

R = revenue (cost) = $100

i = discount rate = 5%

t = time (years)

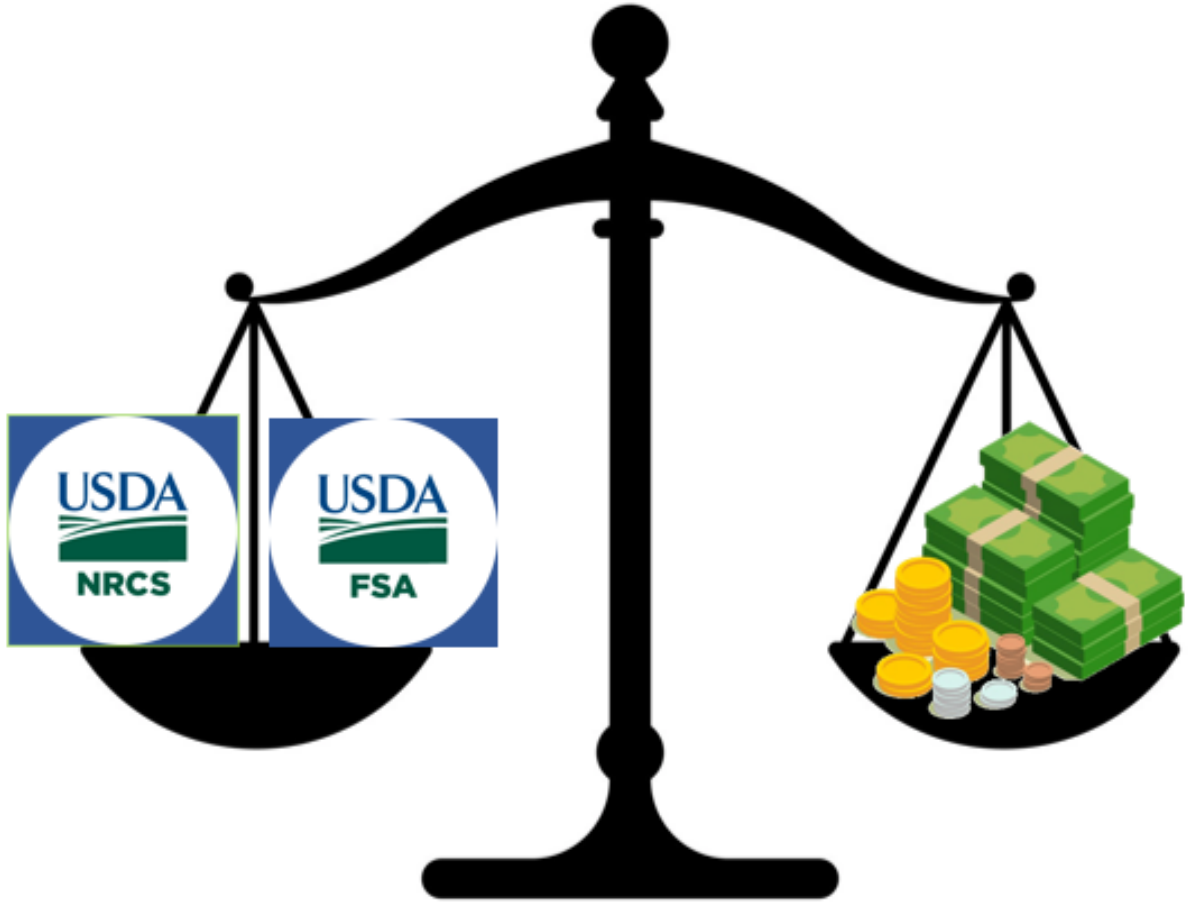
t (Years)	0 (Today)	5	10
NPV	$100	$78	$61
AEV	*Present!*	$18	$8

Image: Microsoft Stock Art

Example Timeline: *Longleaf Restoration*

Practice	Rotation Year	Cashflow
Site preparation, tree establishment	0	(-)
Prescribed fire	Biennial	(-)
Firebreak, property maintenance	Annual	(-)
Taxes	Annual	(-)
Timber revenue	20, 30, 55, 85	(+)

CRP: 50% financial assistance, Sign-up Incentive, and 10-year rental payment



EQIP: 75% financial assistance

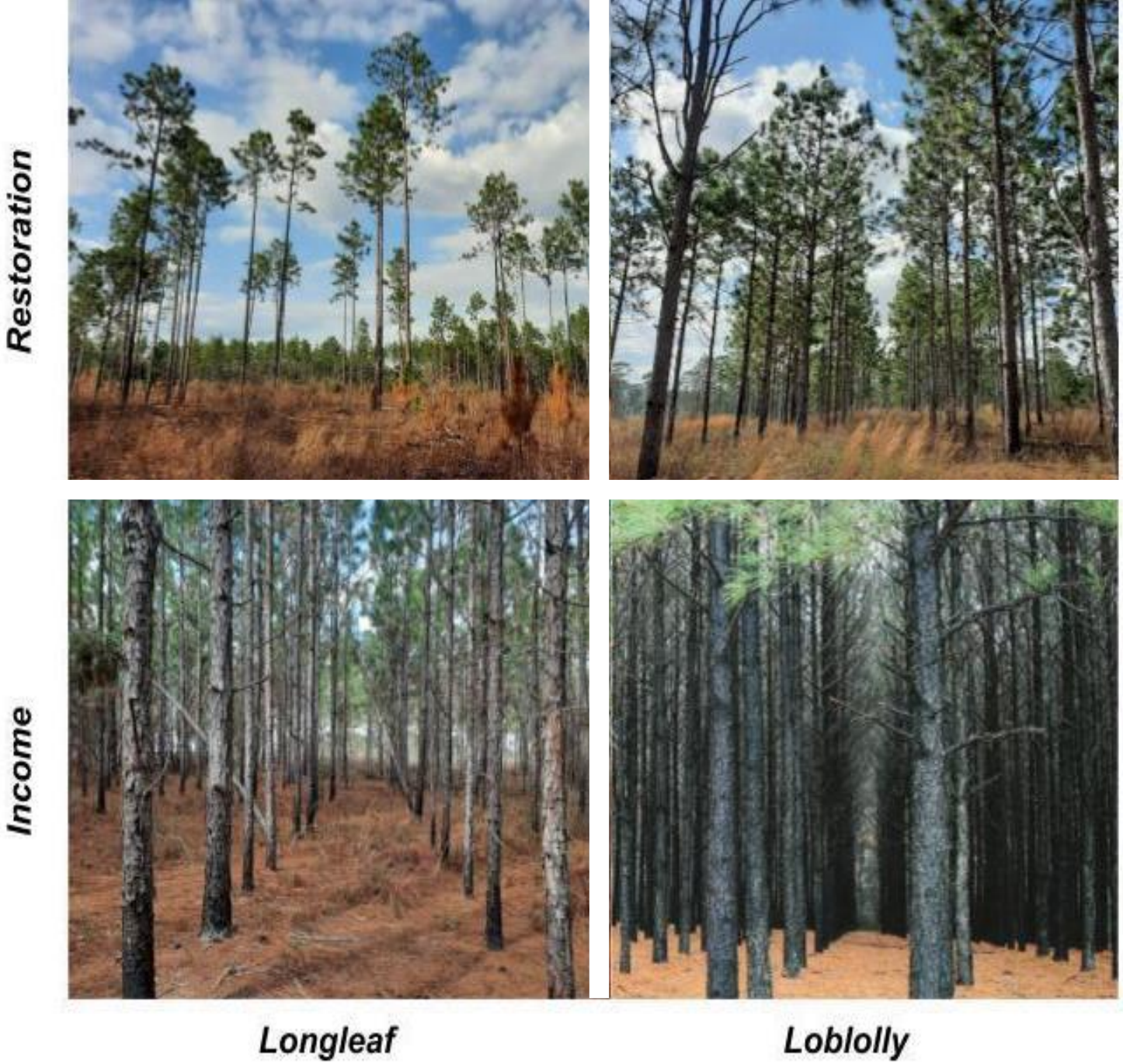
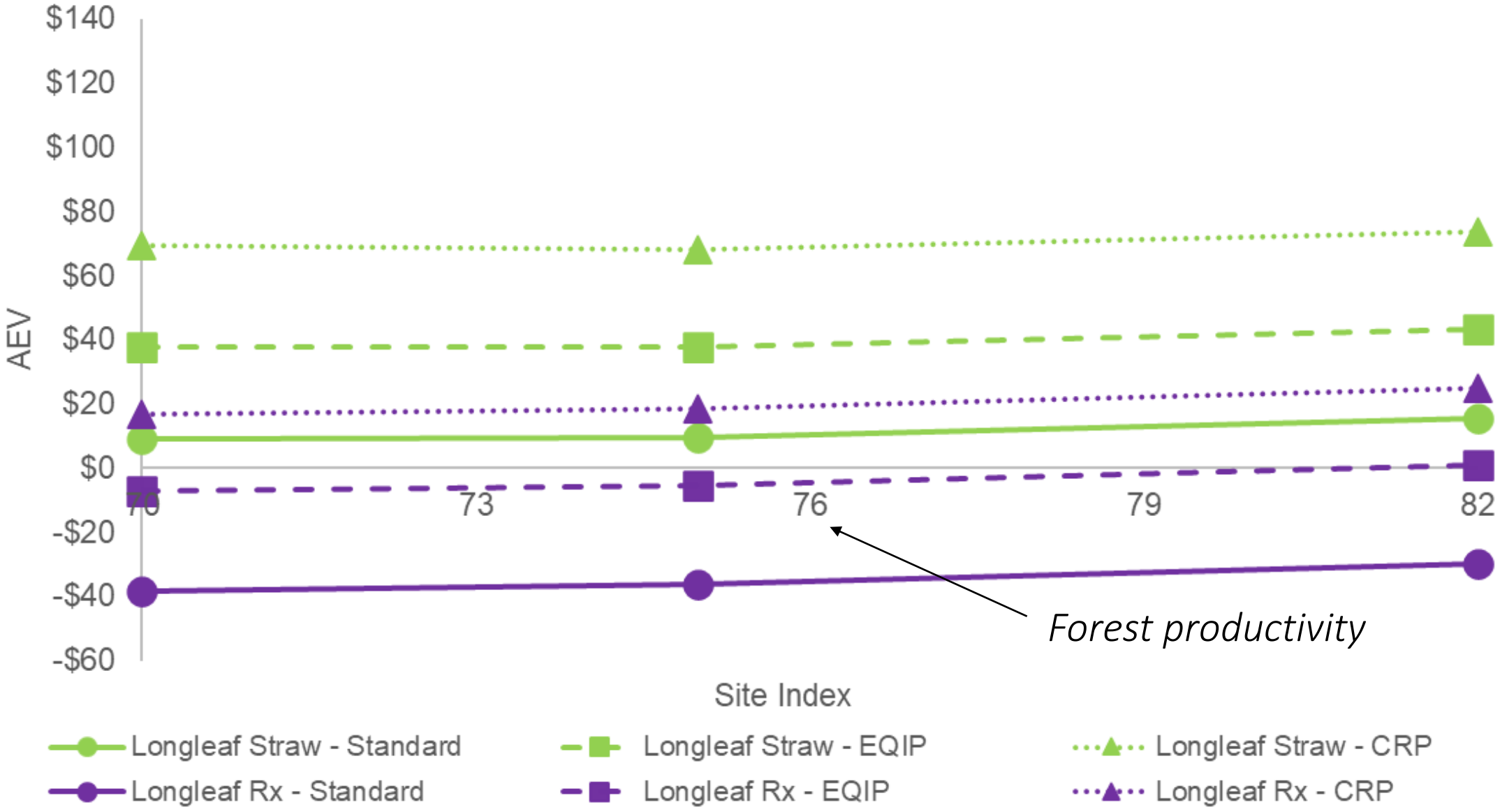
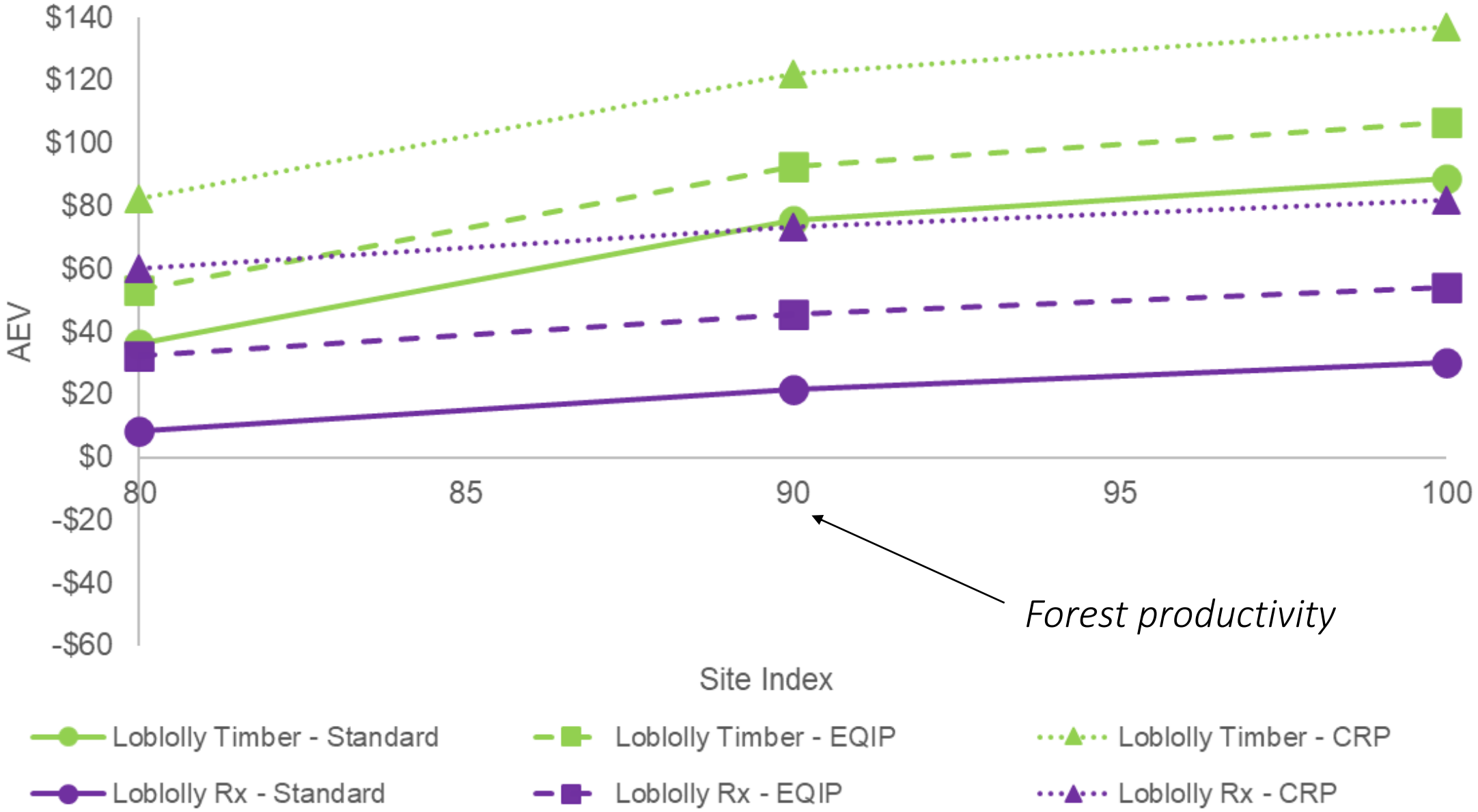


Image: Chambers English, BugwoodCloud.org

Longleaf Pine



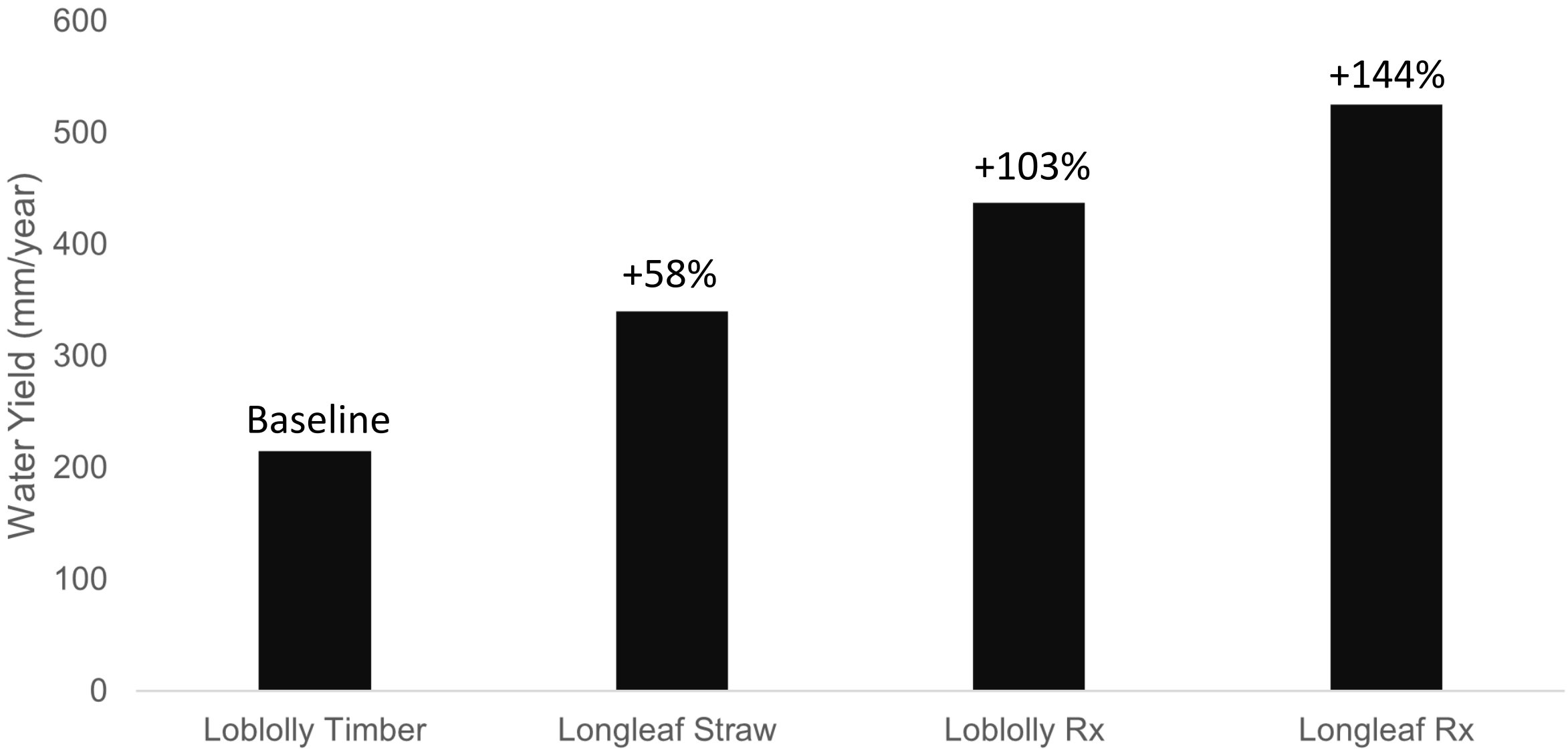
Loblolly Pine



Hydrological Impacts

Image: Chambers English


700
600
500
400
300
200
100
0
Water Yield (mm/year)
0
20
40
60
80
100
Planning Year
Longleaf Straw
Longleaf Restoration
Loblolly Timber
Loblolly Restoration


600
500
400
300
200
100
0
Water Yield (mm/year)
Baseline
+58%
+103%
+144%
Loblolly Timber
Longleaf Straw
Loblolly Rx
Longleaf Rx

Hydrologic Discussion

Gallons per acre

Dollars per gallon

Time to benefit

Image: Chambers English

Broader Implications

Ecosystem service objectives

Long-term commitments

Contract existing stands:

-Improve AND retain long-term

-Opportunities beyond longleaf

Image: Chambers English

Carbon versus Water?

Carbon offset markets

Trees ~50% carbon - Aboveground carbon most easily quantified

Pay landowners to plant more trees, grow longer, or otherwise manage to increase carbon

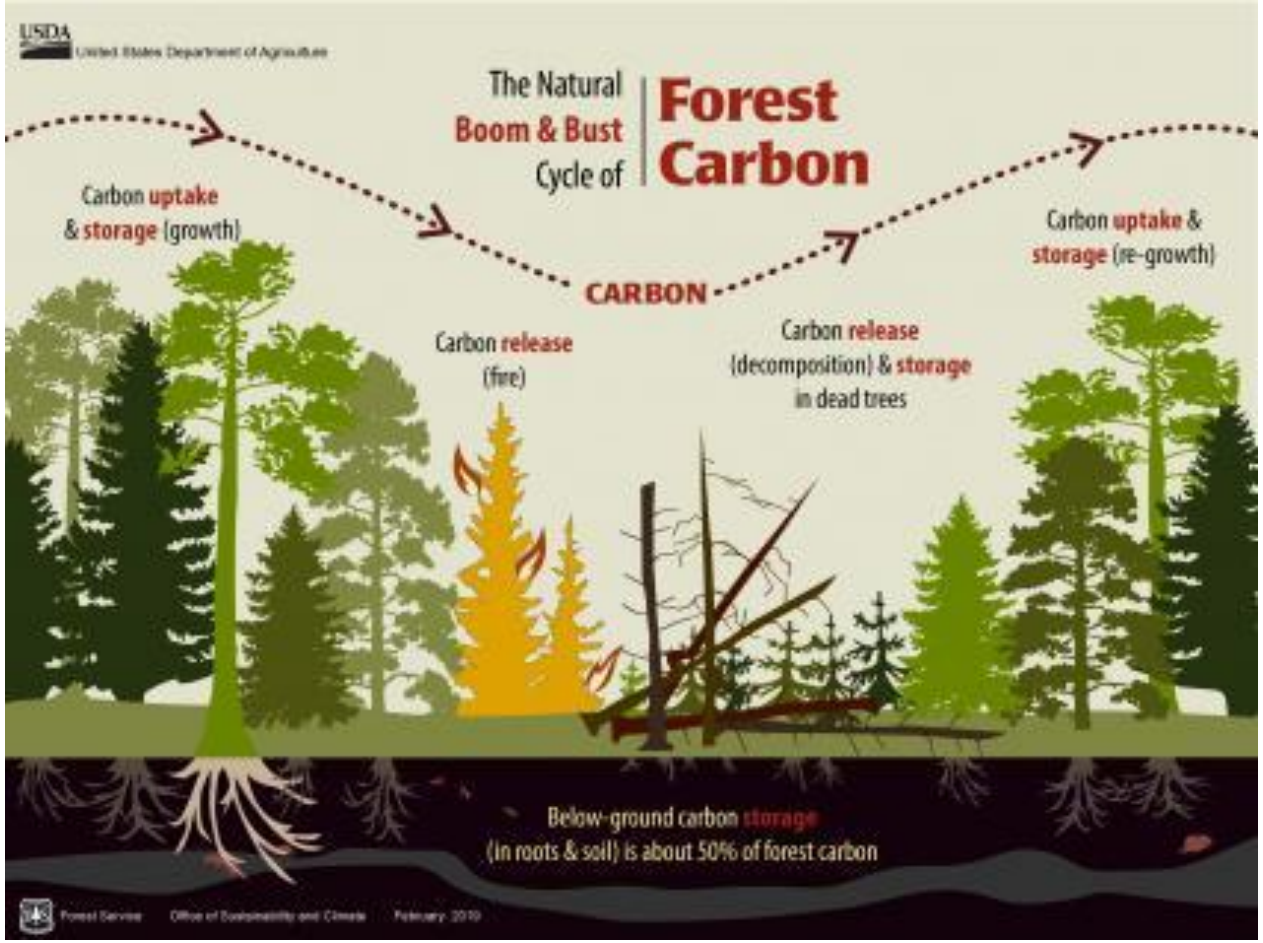


Image: US Forest Service

Carbon versus Water?

General hydrologic tradeoffs and specific regional ecological impacts have been highlighted.

Global vs. local markets:

1. **Specific focal watersheds**
2. **Higher premium for restored open pine systems**
3. **Quantifying belowground carbon stocks**

Jackson, Robert B., Esteban G. Jobbágy, Roni Avissar, Somnath Baidya Roy, Damian J. Barrett, Charles W. Cook, Kathleen A. Farley, David C. le Maitre, Bruce A. McCarl, and Brian C. Murray. 2005. **"Trading Water for** Carbon with Biological Carbon Sequestration." *Science (New York, N.Y.)* 310 (5756): 1944–47. https://doi.org/10.1126/science.1119282.

Puhlick, Joshua J., Steven T. Brantley, Thomas L. O'Halloran, Lucas Clay, and Kier D. Klepzig. 2022. "Perspectives: Carbon Markets Might Incentivize Poorer Ecological Outcomes in Longleaf Pine Ecosystems." *Forest Ecology and Management* 520 (September): 120421. https://doi.org/10.1016/j.foreco.2022.120421.

Image: Chambers English

Easements or Annuities?

Long-term commitments to compensate landowners for timber value lost while managing restoration scenarios.

Plant and walk away is not working!

Easements or Annuities?

Difference in NPV may indicate potential easement values depending on site productivity above "baseline" loblolly income scenarios:

Easement values: $160-$700/acre

Annual payments: $11-$48/acre/year

Longleaf restoration cost 2-3x as much as loblolly restoration from this baseline.

Image: Chambers English

Key Take-Aways

1. Open pine system management may improve wetland hydrologic function during drought periods.
2. Loblolly open pine systems may even be more cost-effective measure for water use management.
3. Where strong pine straw markets exist, longleaf pine straw is profitable without financial assistance.
4. Additional payments or restructuring of benefits could realize full benefits of loblolly and longleaf open pine systems.

Image: Chambers English

Future Work

Spatial prioritization and optimization

Quantifying local stream impacts of restoration efforts

Bring forest to water markets to life in Georgia and beyond!

Image: Chambers English

Image: Chambers English