Longleaf Pine and Payments for Watershed Services

Forest Landowners

Research supported by
Longleaf Stewardship Fund of the National Fish and Wildlife Foundation

Research Objective

<u>Payments for Watershed Services</u>

Assess feasibility of PWS to serve as a market-based tool to incentivize

- Cultivation
- Retention and
- Management

of longleaf pine by private forest landowners.

Fig. 1. Longleaf pine habitat (USFWS 2019).

Research Methods

Interviews

18 public and private sector experts in forest and watershed science, policy and management.

Literature Review

Almost 60 publications, including journal articles, grey literature, and book chapters and technical reports.

Research Findings

Feasible

PWS may serve as a market-based tool to incentivize the cultivation, retention and management of southern pine – *including longleaf* – by private forest landowners.

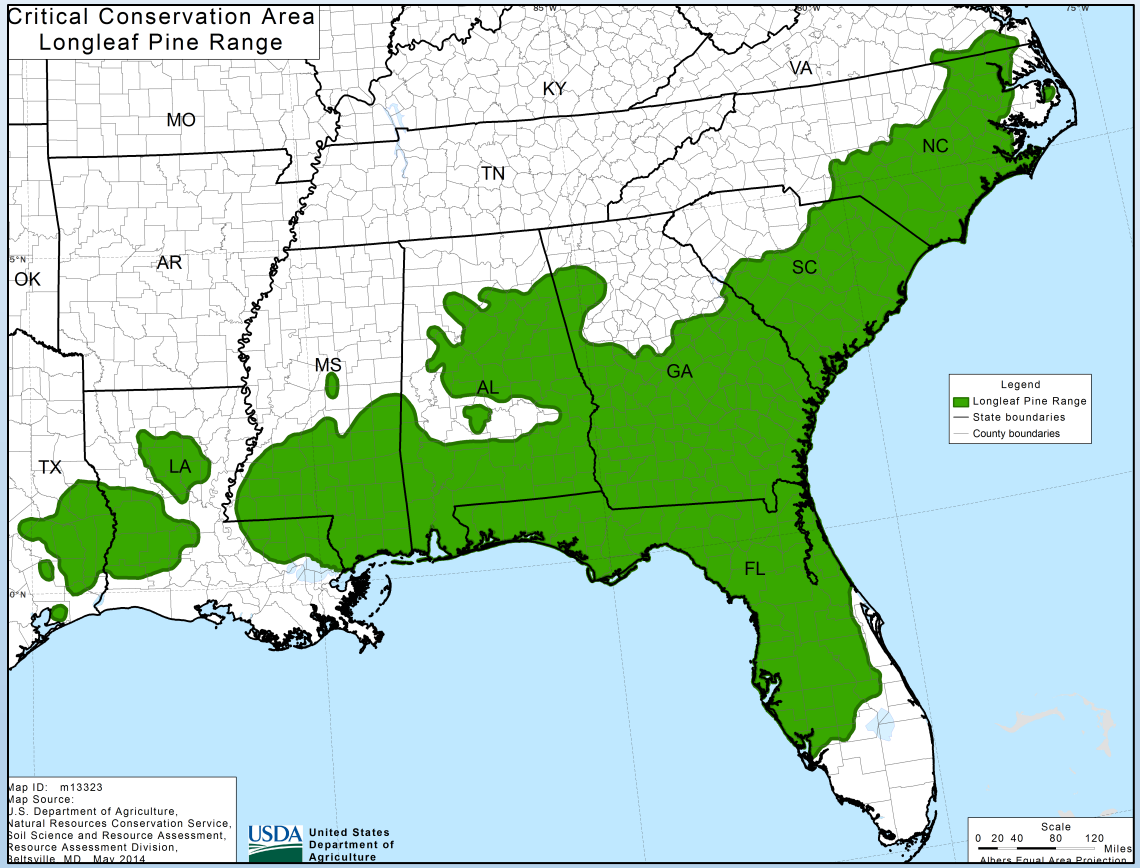

Fig. 2. Historic range of the longleaf pine ecosystem (USDA NRCS 2014).

Significance

Benefits of Forested Watersheds

- Water supply, purification and flow regulation
- Erosion control
- Habitat and biodiversity
- Carbon sequestration
- Forest products
- Recreational, cultural and aesthetic

Fig. 3. Pony Ranch Pond, De Soto National Forest, MS (USDA 2017).

Significance

Trends

In the Southeast, *forest* and *water* resource management challenges are driven by changing:

- Climate
- Land use
- Population

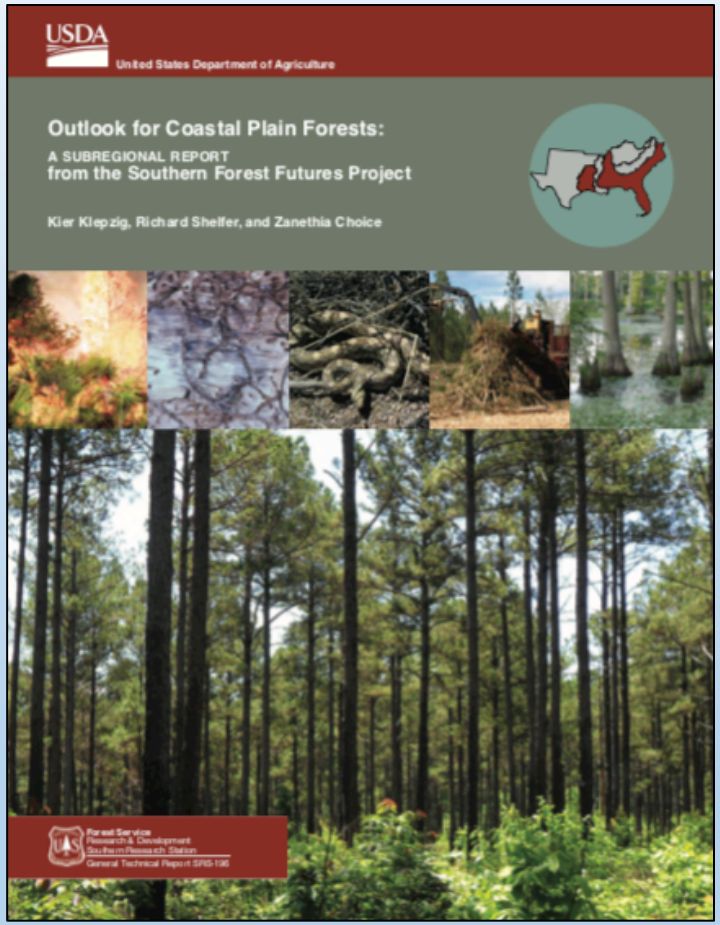

Fig. 4. *Outlook for Coastal Plain Forests* (Klepzig et al. 2014).

Significance

Climate

- Less water availability and lower water quality
- Greater intensity, frequency and duration of forest disturbance
  - Droughts and cyclones
  - Insects, pathogens and invasives
  - Wildfires

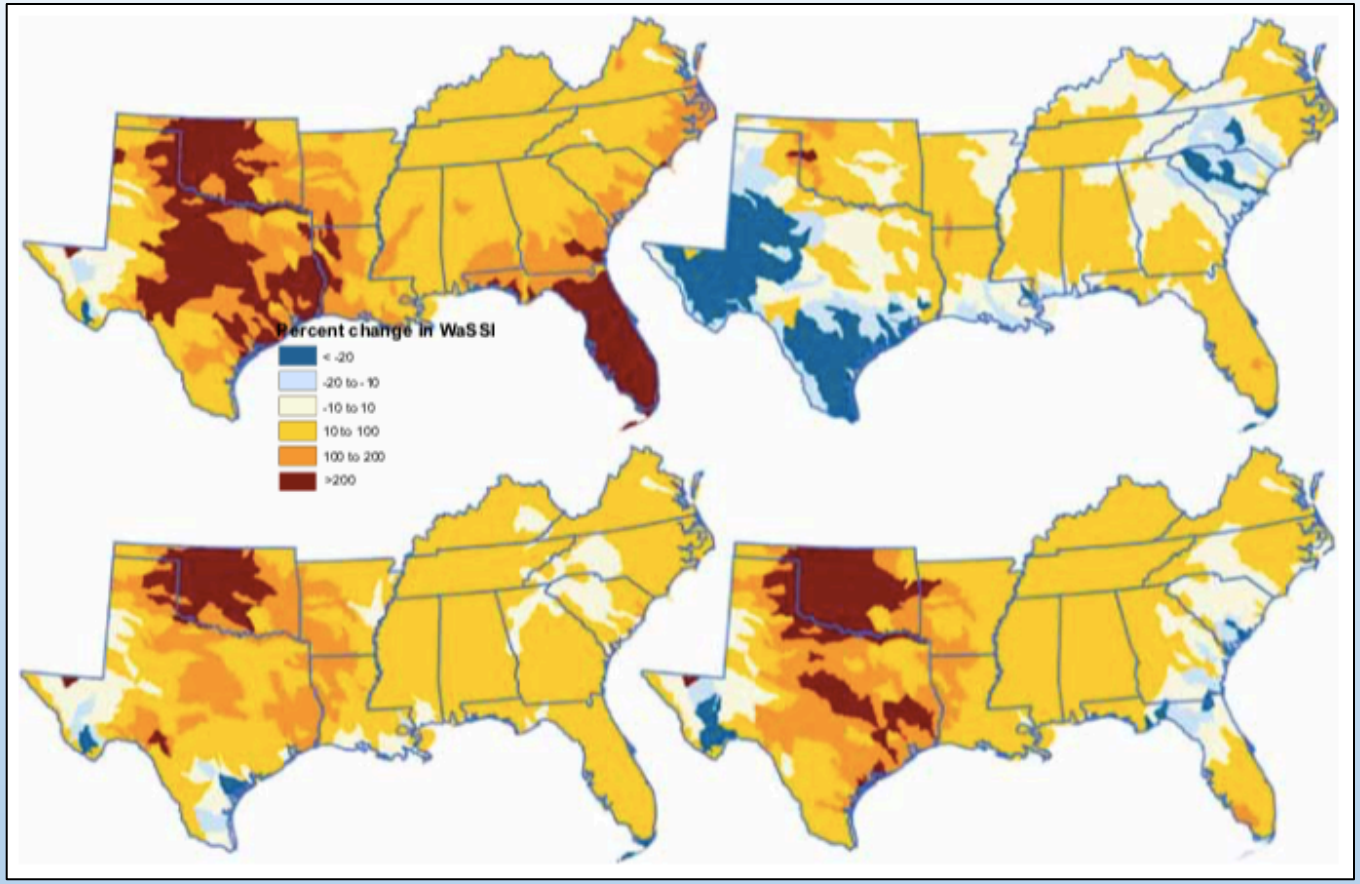

Fig. 5. Water supply stress in 2050 under four climate, land use, forest products markets and bioenergy scenarios (Wear and Greis 2012).

Source:
Klepzig et al. 2014, Wear and Greis 2012

Significance

Land Use and Population

By 2060

- 60% population growth
- Loss of 11-23M acres forest
- 10% increase in water stress and worsening water quality
- More planted pine?

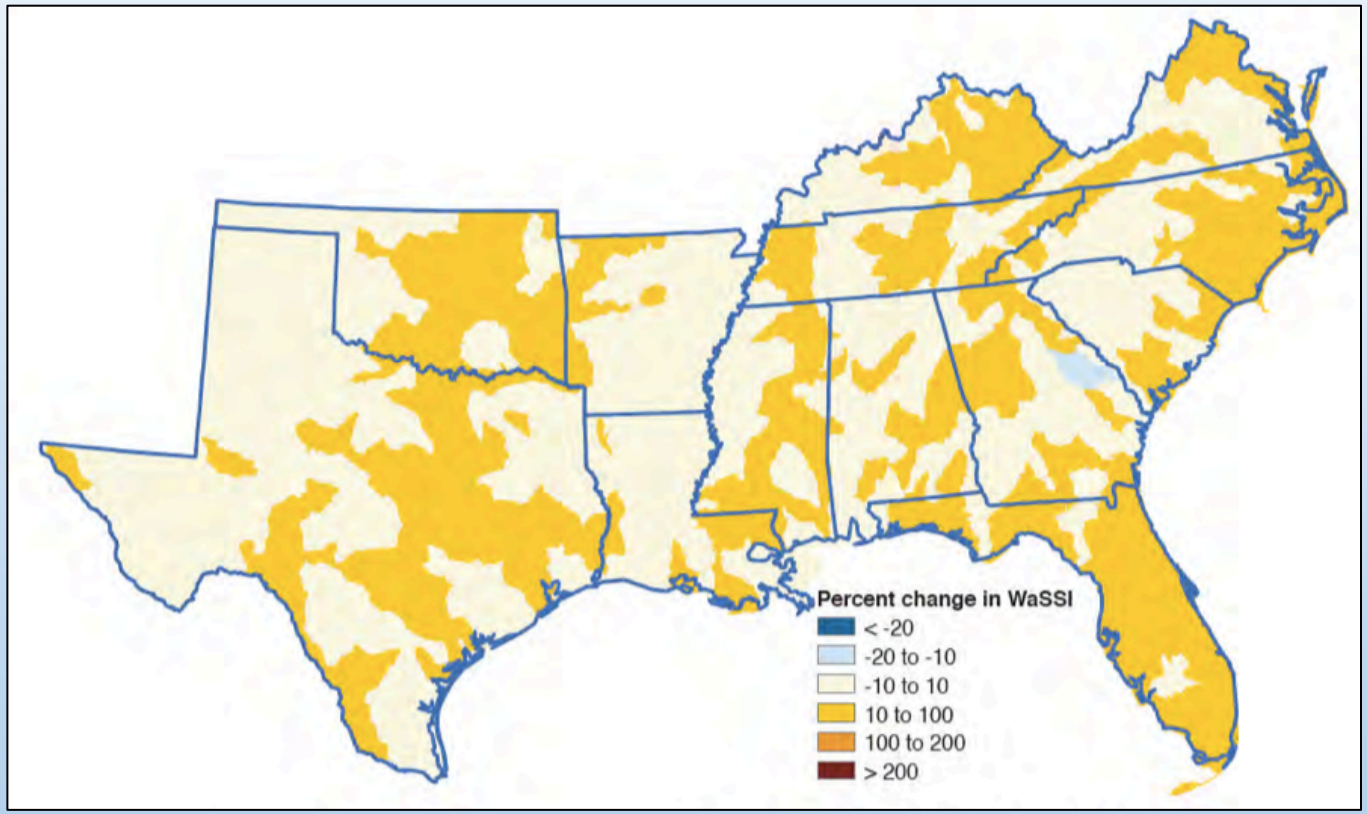

Fig. 6. Water supply stress in 2050 due to population growth and land use change (Klepzig et al. 2014).

Sources:
Klepzig et al. 2014, Wear and Greis 2012

Significance

Private Forests

- Unstable ownership
- Vulnerable to land use change
- Private/state forests account for 44% of surface drinking water supply in Southeast

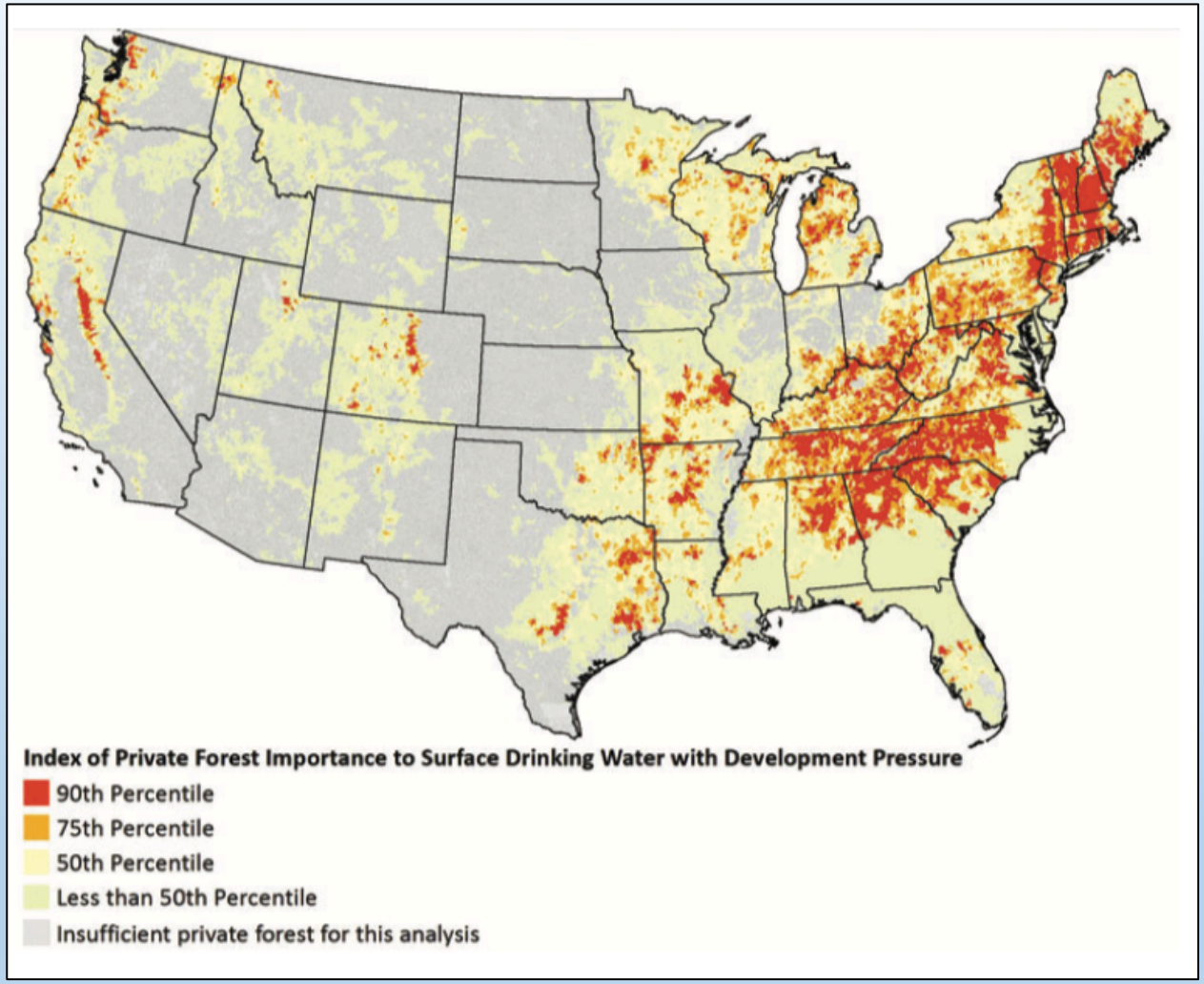

Fig. 7. Land use change threatens drinking water supply (Mockrin et al. 2014).

Source:
Liu et al. 2020

Longleaf Pine and Water

<u>Tree Level</u>

- Efficient in use of water
- Low drought mortality
- Better adapted to drier conditions than slash and loblolly pine

Fig. 8. Illustration of longleaf pine (University of Maryland Center for Environmental Science 2020)

Sources:
Samuelson et al. 2012 and 2019

Longleaf Pine and Water

Stand and Plot Level

Fire-maintained longleaf pine ecosystem uses

- 15% less water than fire-excluded mixed pine-hardwoods
- 30% less water than intensive slash and loblolly plantations

Vegetation type	Transpiration	Source
Longleaf pine savanna	244	Ford and others 2008
Old field	250	Stoy and others 2006
Oak-pine-hickory forest	278	Oren and Pataki 2001
Upland oak forest	313	Wullschleger and others 2001
Mixed pine hardwood	355	Phillips and Oren 2001
Mixed pine hardwood	442	Stoy and others 2006
Planted loblolly pine	490	Stoy and others 2006
Mixed pine hardwood	523	Schafer and others 2002
Slash pine flatwoods Eucalyptus hybrid plantation	563 882	Powell and others 2005 Estimated for Baker County, southwestern Georgia in 2006 for an average climate and rainfall year[a]
Planted loblolly pine (early rotation)	328	Domec and others 2012; Sun and others 2010
Planted loblolly pine (mid-rotation)	777	Domec and others 2012; Sun and others 2010

[a]Derived from a model that used data collected in 2006 by the Joseph W. Jones Ecological Research Center, 3988 Jones Center Drive, Newton, GA 39870. Model assumed no soil water limitation; all trees at age 5; 1,111 trees ha^{-1}; and a leaf area index of 6 m^2 m^{-2} (Mielke and others 1999).

Fig. 9. Mean annual transpiration (mm yr^{-1}) for forest cover types in the Southeast (Lockaby et al. 2013).

Source:
Brantley et al. 2018

Longleaf Pine and Water

Stand and Plot Level

In multi-year study across 36 plots of southern pine in Florida:

- Tree species *not* significant predictor of water yield
- Strong associations between leaf area index and evapotranspiration
- Long-term fire effects (e.g., forest structure) on water yield were significant
- High water quality across all forest types

Source:
Cohen et al. 2017

Longleaf Pine and Water

Watershed Scale

- Long-term, empirical paired watershed study underway at Santee Experimental Forest
- Models show longleaf restoration would increase water availability in:
  - ACF River Basin
  - Altamaha River watershed

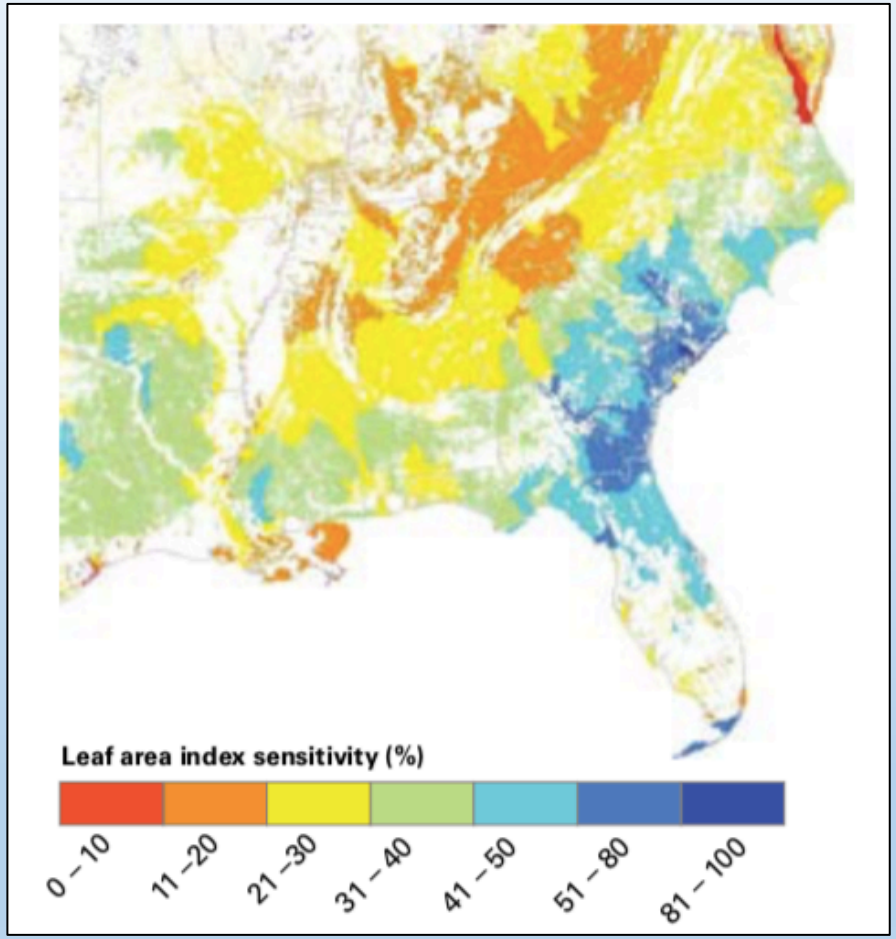

Fig. 10. Water yield response to 50% reduction in leaf area index (Vose et al. 2019).

Sources:
Brantley and Gollady 2020, Hallema et al. 2019, Trettin et al. 2019

Net Benefits & Tradeoffs: Water

Low Tree Density

Supply

More water yield

Quality

- High baseline water quality
- Lower risk of severe wildfire impacts

Flow Regulation

- Mitigates floods
- Higher baseflows

High Tree Density

Supply

Less water yield

Quality

- High baseline water quality
- Higher risk of severe wildfire impacts

Flow Regulation

- Mitigates floods
- Lower baseflows

Net Benefits &Tradeoffs: Resilience

Low Tree Density

Drought

More water available for fewer trees

Insects and Pathogens

Lower risk of insects and pathogens, including as secondary effect of drought

Wildfire

Lower risks of severe wildfire due to lower fuel loads, including from tree mortality from drought, insects and pathogens

High Tree Density

Drought

Less water available for more trees

Insects and Pathogens

Higher risk of insects and pathogens, including as secondary effect of drought

Wildfire

Higher risks of severe wildfire due to higher fuel loads, including from tree mortality from drought, insects and pathogens

Net Benefits & Tradeoffs: Other

Low Tree Density

Habitat and Biodiversity

Higher quality aquatic and terrestrial habitat and biodiversity values

Carbon

Less carbon sequestration with lower risk of release due to severe wildfire

Forest Products

Less fiber and timber production

High Tree Density

Habitat and Biodiversity

Lower quality aquatic and terrestrial habitat and biodiversity values

Carbon

More carbon sequestration with higher risk of release due to severe wildfire

Forest Products

More fiber and timber production

Payments for Watershed Services

Overview

- Market-based tool to align interests
- Clear linkage between upstream management practices and downstream water conditions
- 380+ programs, 60+ countries, $25B

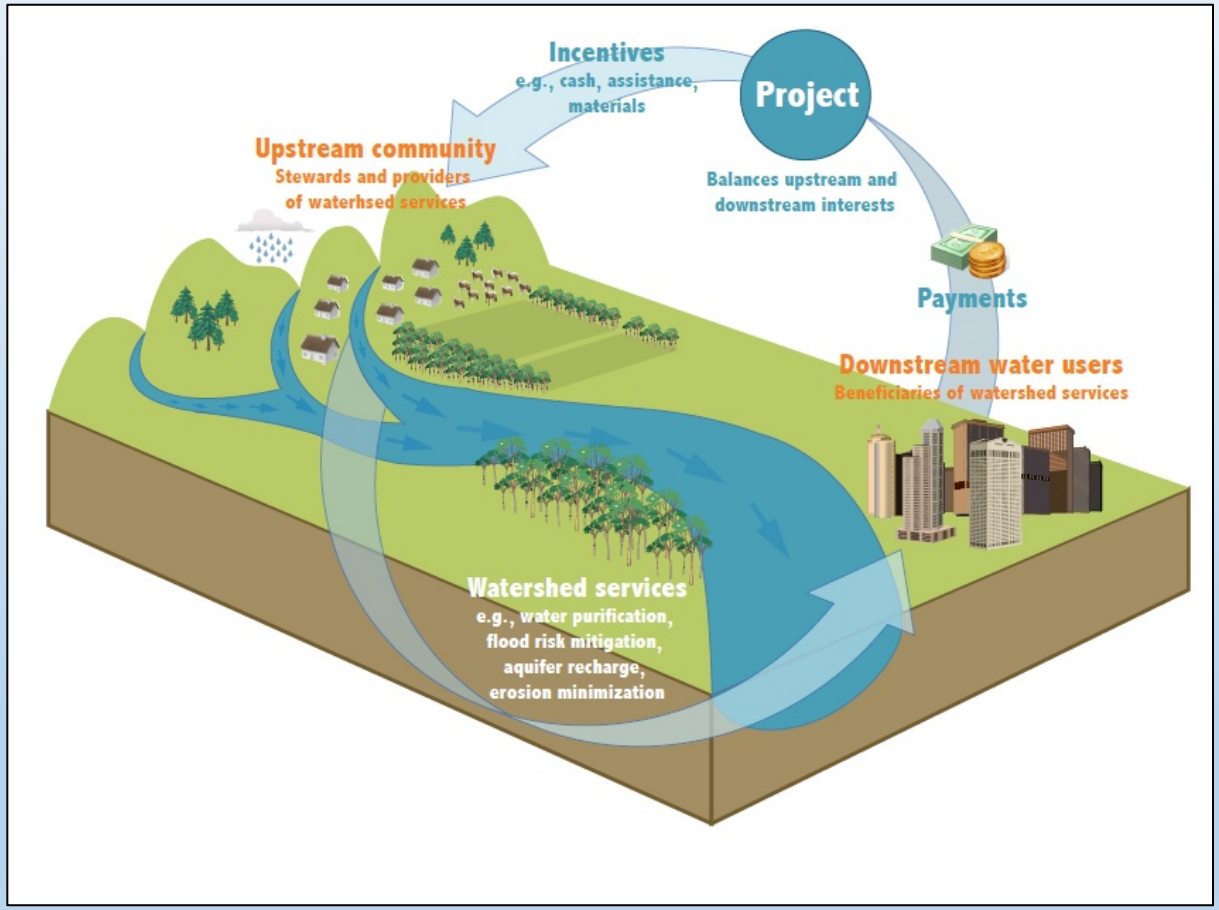

Fig. 11. Payments for watershed services transaction (Forest Trends Ecosystem Marketplace 2013)

Source:
Salzman et al. 2018

Payments for Watershed Services

Program Types

- Source water protection programs
- Fire risk mitigation programs
- Voluntary customer offsets

- Point source pollution offsets
- Hydropower mitigation initiatives

Source:
Bennet et al. 2014

Payments for Watershed Services

<u>Funding Mechanisms</u>

- Ratepayer surcharge (City of Raleigh)
- Municipal bonds (City of Austin)
- Sales tax (City of San Antonio)
- Donated water conservation savings (City of Tucson)
- Voluntary ratepayer contributions (Oregon)
- Revolving impact funds (City of Wilmington, DE; SW Colorado)

Source:
Bennet et al. 2014

Payments for Watershed Services

<u>Regional Success Stories</u>

- Upper Neuse Clean Water Initiative
- Savannah River Clean Water Fund
- Northwest and Central Arkansas
- Central Texas

Longleaf Pine and PWS

<u>Opportunities</u>

- Support for forested watershed protection and landowner assistance among general public in Southeast
- Growing interest in watershed conservation among utilities and municipalities
- Growing interest in PES among landowners
- Institutional buy-in and momentum for longleaf restoration
- PWS models from which to borrow and adapt
- Bundle with other PES schemes (biodiversity, wildfire risk reduction, etc.)

Source:
Kang et al. 2019, Kreye et al. 2019

Longleaf Pine and PWS

<u>Challenges</u>

- Economies of scale
- Valuation and forecasts
- Sustainability
- Institutional, financial and technical capacity

Longleaf Pine and PWS

Thought Experiment 1:
Low Tree Density, Fixed Rate

Transaction Design

PWS program pays landowners a per-acre rate to manage for low tree density and implement regular prescribed fire and silviculture BMPs for watershed protection.

Forest Outcomes

Ecological restoration with longleaf and/or slash canopy

Benefits

- Water supply and quality
- Climate resilience and risk reduction
- Habitat and biodiversity

Tradeoffs

- Forest products
- Carbon storage

Longleaf Pine and PWS

Thought Experiment 2:
Flexible Tree Density, Fixed Rate

Transaction Design

PWS program pays landowners a fixed per-acre rate to implement silviculture BMPs for watershed protection.

Forest Outcomes

Commercial silviculture is most likely outcome, though restoration/conservation forestry would also benefit.

Benefits

This approach would likely skew towards the benefits provided by high-density forests.

Tradeoffs

This approach would likely skew towards the tradeoffs provided by high-density forests.

Longleaf Pine and PWS

Thought Experiment 3:
Flexible Tree Density, Tiered Rate

Transaction Design

PWS program and possibly other partners pay landowners a per-acre base rate to implement silviculture BMPs for watershed protection *plus* higher rates for additional benefits as applicable (water supply, resilience/risk reduction, habitat/biodiversity, etc.).

Forest Outcomes

Allows for flexible management over time and space.

Benefits

Programs could attempt to balance incentives to achieve a wide range of local objectives

Tradeoffs

Program transaction costs may increase as a result of greater complexity. Additional payors may need to be identified for non-water benefits (e.g., biodiversity/habitat).

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