

# SUSTAINABLE FORESTRY INITIATIVE REGIONAL CLIMATE CHANGE RISK SUMMARY: SOUTHEAST US





By: Greg Cooper, Lauren Cooper, Daphna Gadoth, Evan Beresford, Chad C. Papa

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## INTRODUCTION

Climate Smart Forestry (CSF) is defined as sustainable adaptive forest management to protect and enhance the potential of forests to adapt to and mitigate climate change (Bowditch et al. 2020, Cooper and MacFarlane 2024). The threats posed to these forests by climate change can be equally diverse, with variations across geographies and forest types in terms of risk level, frequency of occurrence, and severity of impacts. Therefore, implementation of CSF practices across the geographically diverse footprint of SFI-certified forests in North America necessitates regional approaches to promote climate change adaptation and mitigation.

Acting strategically on CSF requires strategic, science-backed approaches that address:

1. How climate change is affecting, or is expected to affect, forests, trees, and forestry operations across different regions
2. Forest vulnerability to climate change impacts
3. Principles and practices for adapting to and mitigating those risks, based on forest type group
4. Guidance to monitor and evaluate the effects [of those practices] to inform future decision-making

The rapid pace of climate change and the continuous emergence of new data also pose challenges in keeping strategies updated and relevant. Integrating evolving scientific knowledge into practical implementation remains a significant hurdle. Differing priorities and levels of interest can affect the cohesive implementation of CSF strategies. Overcoming these barriers will require continued innovation, investment, and cooperation among stakeholders involved in forest management.

The primary aim of this report is to advance a systematic approach for CSF across various geographies, utilizing diverse data sets and emerging research. This report is intended to reach other audiences interested in this topic including government agencies, users of forest products (e.g., those in building and construction), conservation groups, and interested members of the public including consumers.

The [Sustainable Forestry Initiative \(SFI\) 2022 Forest Management Standard](#) includes a Climate Smart Forestry objective that requires certified organizations to identify and address climate change risk by developing adaptation strategies and identifying opportunities to enhance mitigation. A key aspect of the CSF objective is a requirement to identify and prioritize climate risks based on the best available scientific information. In addition to adaptation, the CSF objective emphasizes identifying and addressing opportunities to mitigate climate change impacts associated with forest operations.

## SFI STANDARDS AND ADVANCING CSF

SFI is an independent, non-profit organization advancing the value of forests as a critical component to our collective future. With over 150 million hectares certified to the SFI Forest Management Standard in North America, and tens of millions more positively influenced by SFI Fiber Sourcing, SFI and SFI-certified organizations have the scale to implement solutions across the landscape. During the 2022 standard revision process, SFI enhancements objectives adding two new objectives focused on Climate Smart Forestry and Fire Resiliency and enhanced requirements on the conservation of biological diversity. These require certified organizations to identify and address climate change and fire risks to forests and forest operations and develop adaptation objectives and strategies.

The SFI 2022 Forest Management Standard, through its Climate Smart Forestry (CSF) objective incorporates performance measures for climate change adaptation and mitigation strategies, enhancing forest resilience and carbon sequestration capacities and reducing emissions associated with forest operations on public and private lands. This includes activities like enhancing climate benefits of forest



operations (via implementation of practices to improve forest health, productivity, and resilience), increasing the area and density of certified stands (via afforestation, prompt reforestation, and supplementation of understocked stands), and minimizing carbon losses during forest operations (via protection of advanced regeneration during harvest and retention of productive stems during partial harvest).

## Interpreting Climate Impacts and CSF Practices

Because SFI-certified forests span broad geographies across North America, they include a wide array of ecological zones (i.e., distinct elevations, climates), tree species compositions, site conditions, age classes, management histories, productivity levels, and patch sizes. This report provides foundational context to support systematic evaluation of climate risks and appropriate CSF interventions to address those risks. This approach involved a high-level assessment of climate change-related impacts to forests in each region and vulnerabilities of local forest type groups to those impacts. The review used large, recognized sub-national regions, within which ecologically significant information regarding dominant forest type groups, key species, and site considerations was synthesized to tailor to species- and condition-specific threats and vulnerabilities.

Advancing CSF can be supported with hierarchical decision-making linking climate-driven forest threats and impacts from regional geographies (ecoregions), forest type groups, with site- or species-specific concerns. Critical evaluation of climate-driven impacts to local forest communities provides a foundation for which Climate Informed Principles and Practices (CLIPPs) can be applied.

## Regional Considerations

Climate change will affect forests and trees differently across North American geographies. This analysis uses sub-national regions in both the US and Canada. Boundaries for US regions largely follow state groupings used by the US Forest Service (USFS), with ecoregions presented at 2 scales (Level II & III) based on definitions by the Commission for Environmental Cooperation (CEC Working Group 1997). The boundaries of the Forest Regions of Canada are based on Rowe (1972) and are characterized by ecological features, climatic conditions, and forest community types.

Forest community groupings align with definitions used by national natural resource agencies. For US regions, definitions of Forest Type follow USFS Forest Inventory and Analysis definitions of Forest Type Groups while for Canadian regions, the framework follows definitions of Species Group used by Canada's National Forest Inventory. Tailoring the design and structure of the decision support framework to account for regional considerations such as subregional delineations, forest type groups, climate impacts, and management practices will allow for consistent communication and advancement on Climate Smart Forestry.

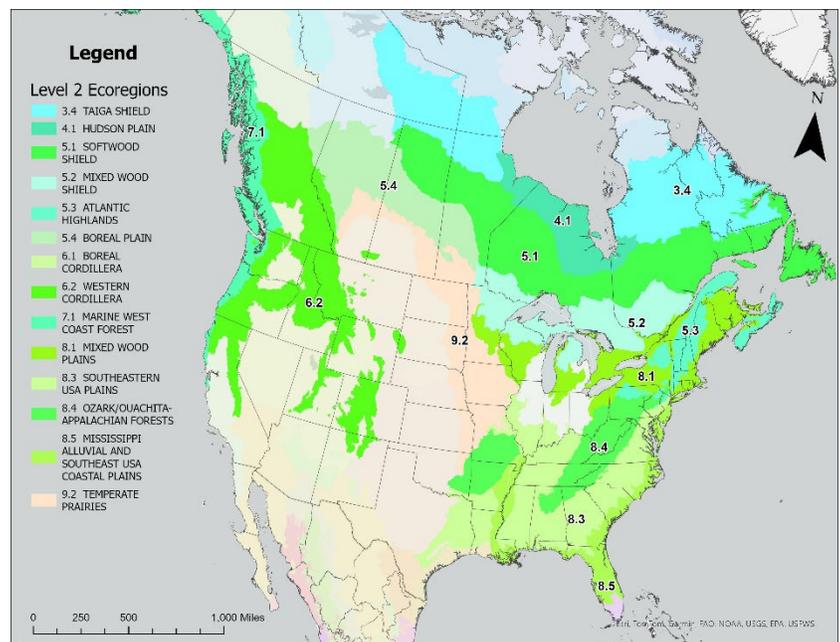


Figure 1. Map of Level II ecoregions (CEC Working Group 1997).



Data and information relating to regional climate change stressors to forests were also sourced differently for the US and Canada. For regions of both countries, data on climate change impacts were synthesized from a diversity of scientific resources. Some important resources for US regions included the [US National Climate Assessments](#), [Northern Institute of Applied Climate Science \(NIACS\) Vulnerability Assessments](#), the [USFS Tree Atlas](#), and feedback from regional forest experts. For Canadian regions, important sources of this data included Natural Resources [Canada's Canada in a Changing Climate: Regional Perspectives Report](#), [The State of Canada's Forests Annual Reports](#), and [Canada's Changing Climate Reports](#), among others.

Geographic distinctions were also considered regarding formulation and framing of climate smart forest interventions. For Canadian regions, the [Canadian Forest Service Database of Adaptation Options](#) served as a valuable resource and supported identification of adaptation options to address forest vulnerabilities based on peer-reviewed publications. For US regions, adaptation pathways were framed around concepts of strategies, approaches, and tactics published in Adaptation Menus developed by NIACS and the USFS (Ontl et al. 2020 and Swanston et al. 2016). These resources inform the categorization and framing to downscale adaptation responses from broader approaches to specific activities for regions in both the US and Canada.

Using the geopolitical boundaries of the USFS Forest Service, the Southeast US includes the states of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia. Forests in this region are highly productive and supply a significant share of US domestic timber. The prevalence of fast-growing tree species along with humid temperate and subtropical climates contribute to high levels of productivity, allowing forests in the Southeast US to develop more rapidly than in other regions (Wear & Greis 2012).

### *Ecoregions of the Southeast*

There are three major forest ecoregions with distinct ecological traits such as major climatic zones, native vegetation, and biomes. Ozark/Ouachita-Appalachian Forests, Southeastern US Plains, and Mississippi Alluvial and Southeast US Coastal Plain (Figure 2) (U.S. Environmental Protection Agency, 2013). These ecoregions can consist of 15 Level III ecoregions. A description of each ecoregion, including dominant forest cover types and key climate change impacts are summarized in Table 2.

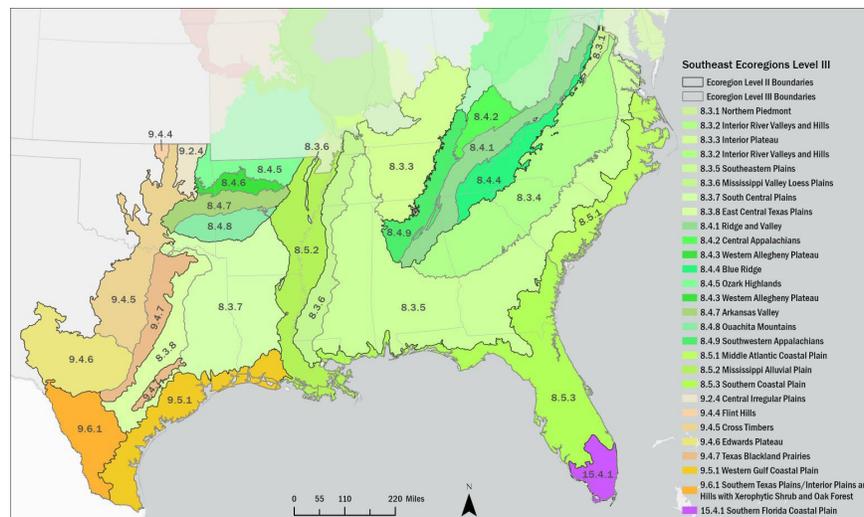


Figure 2. Level III Ecoregions of the Southeast US (U.S. Environmental Protection Agency, 2013)



## SOUTHEAST CLIMATE TRENDS AND IMPACTS ON FORESTS

In the Southeastern United States, climate change is having a range of impacts on the forested landscape. The forest impacts that are currently being observed, with anticipated increases, include wildfires, extreme storm events, droughts, sea-level rise and salinization, and an increase in pests and pathogens including damage from insects. It should also be noted that these impacts can co-occur, and combinations of these impacts can drive stressors that ultimately cause tree mortality.

**Temperatures** in the southeast are projected to get warmer. Currently, mean annual temperature can be as high as 77° F (25° C) in Southern Florida and Texas and around 45° F (7° C) in portions of the Appalachian Mountains of North Carolina and Virginia. The warmest temperatures occur in the summer months of June through August. In the 2000s, across the Southeast, an increase in temperature has been observed with the greatest differences occurring along the Gulf Coast of Texas and across Florida (Marvel et al. 2023).

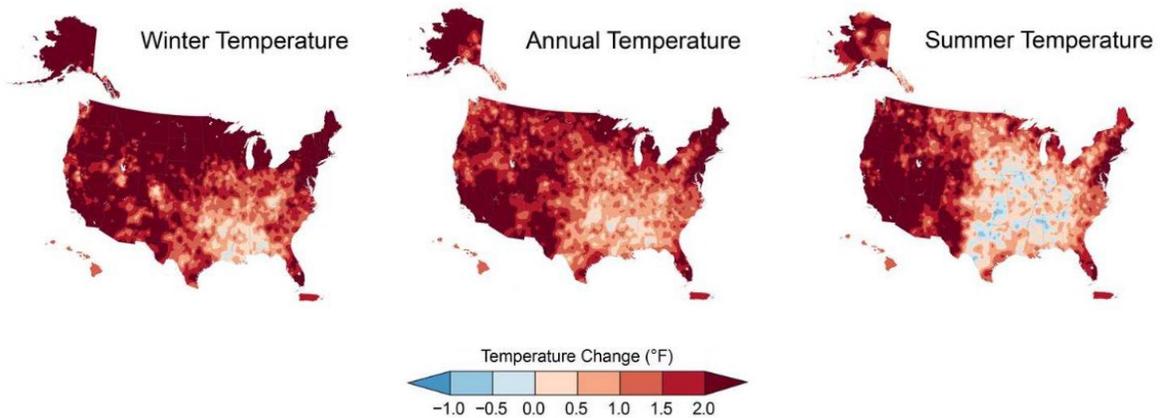


Figure 3. Observed Temperature Change 2002-2021 for the Winter, Annual Average, and Summer across the US based on 1901-1960 Averages (Marvel et al. 2023) (NOAA NCEI and CISS NC).

There is a projected increase in the number of warm nights where the minimum temperature is 75° F or greater (Figure 4). Historically, these nights were infrequent, with more frequency in southern Florida and along the Gulf Coast of Louisiana. Moving into the 21<sup>st</sup> century these nights are projected to increase in frequency and extend northwards in both the lower emission and higher emission scenarios. This has implications for forests by affecting trees and forest ecosystems through increased vapor-pressure deficits which can result in slower tree growth and increase wildfire behavior during the evening (Chiodi et al. 2021).

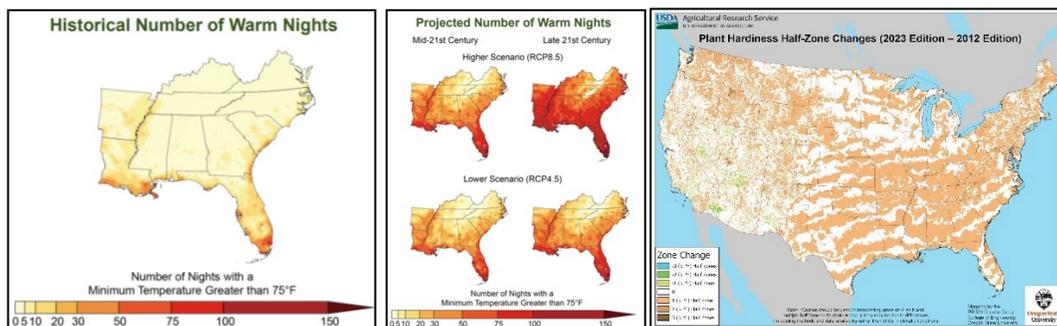


Figure 4. (Left) The historical number of warm nights (days with minimum temperatures above 75°F) per year in the Southeast over the period 1976–2005. (Center) The projected number of warm nights (days with minimum temperatures above 75°F) per



year in the Southeast for the mid-21st century (left; 2036–2065) and the late 21st century (right; 2070–2099) under a higher scenario (RCP8.5; top row) and a lower scenario (RCP4.5; bottom row). Sources: NOAA NCEI and CICS-NC. (Right) The shift in the plant hardiness zones based on observed temperature changes between 2023 and 2012 (USDA 2023).

Increasing temperatures are changing the plant hardiness zones (USDA 2023). This trend results in changes to ecosystems that allows northward and altitudinal expansion by species that are adapted to warmer temperatures and potentially outcompete species that are competitive on a site due to their adaptation to colder temperatures.

**Precipitation** is variable across the region. Generally, average annual precipitation is expected to increase with the greatest increases occurring in the winter months. Since the 1900s there has been a general increase in precipitation across the Southeast. The southern Great Plains in Texas and Oklahoma have seen a notable increase especially during the summer. Along the Gulf Coast, precipitation has increased annually and increased in the summer months. For the Atlantic Coast, there has been an increase in rainfall in the winter with a less observed precipitation in the summer months.

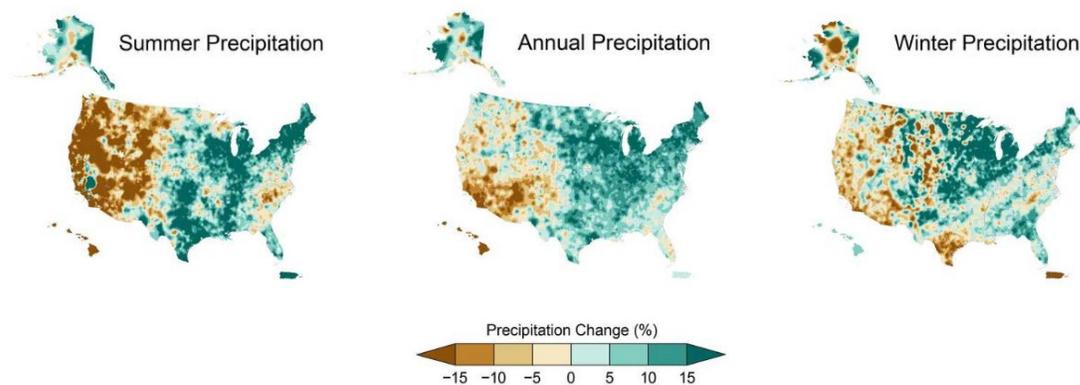


Figure 5. Observed change in Precipitation from 2002-2021 compared to 1901-1960 average for Summer, Annual, and Winter precipitation (Marvel et al. 2023) (NOAA NCEI and CISS NC).

Extreme precipitation events are predicted to increase with periods of more heavy rains but also periods of intense drought (Marvel et al. 2023). The severity and frequency of droughts have increased in the southeast US since the 1980s (Vose et al. 2016). Both extremes of precipitation and drought can cause tree stress and ultimately mortality.

**Drought** Climate change has direct and indirect impacts on water availability, evapotranspiration, and soil water balances. In forests, reduced water availability associated with periodic drought can restrict growth and slow productivity (Vose et al. 2016). This drought also causes physiological stress in trees which can be a threat multiplier leading to vulnerability of insect and pathogen infestations. Even in relatively moist forests, with increasing temperatures and stable precipitation, evapotranspiration will increase in forests which can lead to soil water deficits and reduced baseflow in streams (Mcquillan et al. 2024). Reduced water availability in soils leads to lower productivity in forests, limits available habitat for aquatic species, and decreases available water in watersheds that supply human populations.



**Wildfire** The projected changes in precipitation will affect the fuel conditions that can lead to wildfire (Christian et al. 2024). Figure 6 shows fire risk under current and hot climate scenarios, current increased risk can be found in eastern Kentucky and along the Atlantic Coast. The projection shows an increase region-wide with the highest risk along the Gulf Coast and Southern Appalachians.

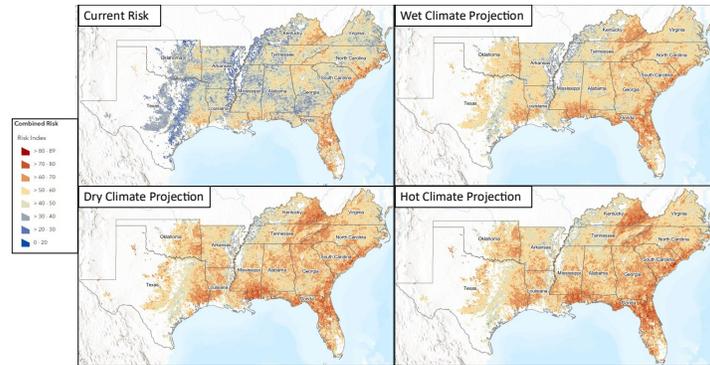


Figure 6. Wildfire risk under different climate scenarios (<https://southernwildfirerisk.com/>)

**Storm Events** Hurricanes and tropical storms have been becoming more powerful and more frequent (Figure 7, Emanuel 2021). Such storms impact forests through high winds, heavy precipitation, flooding and salinization. Along coastal regions the storms can cause a storm surge sending salt water inland and cause flooding which can negatively impact forests. If hurricanes recur in an area with more frequency, forests can lose the ability to rebound between disturbances. The large amounts of precipitation can also affect inland areas by flooding riparian areas and causing landslides on steep slopes which create disturbances in forests as well as destroy road infrastructure.

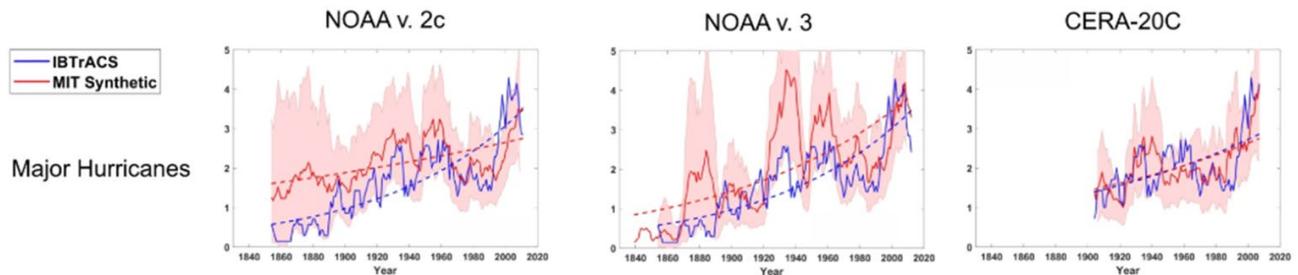


Figure 7. Time series of North Atlantic major hurricanes (Emanuel 2021)

More frequent and extreme weather events, including hurricanes, are predicted. The highest vulnerability to storm surges is along the coasts of Louisiana, Mississippi, North Carolina, and Virginia. This can result in saltwater intrusion further inland that negatively impacts riparian forests and bottomland hardwoods (DeJong et al. 2014), which can kill forests not adapted to the salinity. Coastal and even inland forests are experiencing high levels of mortality, resulting in a loss of aboveground biomass (O’Donnell et al. 2024).



**Pests and Disease** Rising temperatures in the region are contributing to significant shifts in local ecosystems, particularly in how forest pests are behaving. Warmer conditions are extending the active seasons of many pests, including bark beetles, defoliators, and other invasive insects that thrive in higher temperatures. These pests are not only becoming more abundant but are also expanding their range, moving into areas that were previously too cold for them to survive. This can lead to greater damage to forests as pests target trees already stressed by heat and drought. The increase in temperature can also disrupt natural predator-prey relationships, allowing pests to proliferate unchecked. The combination of these factors poses a serious threat to the health and biodiversity of Southeastern forests, making forest management and pest control more challenging. Pests such as southern pine beetle can take advantage of stressed trees, as seen in Figure 9, leading to widespread outbreaks in times of drought.

**Cumulative Effects** The interactions of these climate driven impacts can increase the severity of a disturbance, resulting in increased mortality. With increasing temperature, trees will increase their evapotranspiration thus using more water which can then exacerbate droughts increasing the severity of wildfires and susceptibility to insects and diseases. For example, in 2023, a drought in Mississippi contributed to massive beetle infestations causing the mortality of more than 12 million pine trees across 2.5 million acres (Mississippi Forestry Commission Report 2024) (see Figure 10).



Figure 8. Aerial view of a large, uncontrolled southern pine beetle infestation on loblolly pine in Sabine National Forest (Ronald F. Billings, Texas A&M Forest Service, Bugwood.org).

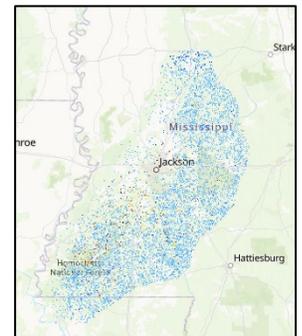


Figure 9. Widespread beetle caused pine mortality brought on by a regional drought (MFC 2024).



## SOUTHEAST US FORESTS



The region is dominated by seven key forest cover groups: oak/hickory, loblolly/shortleaf pine, oak/gum/cypress, oak/pine, longleaf/slash pine, and elm/ash/cottonwood. Figure 10 shows region-level data for total forested area and total forest carbon, respectively, for each of the major cover types (data source: USDA FS FIA 2025). Oak/hickory forests are regionally dominant with nearly 76 million acres and storing 6.4 billion tons of carbon. Loblolly/shortleaf pine, the most commercially valuable forest type group, spans nearly 62 million acres and stores nearly 4.8 billion tons of carbon. A comparison of the two figures shows that forest types store different amounts of carbon relative to their forested land area. For example, the oak/hickory group occupies about 76 million acres in the region, triple that of oak/gum/cypress at about 25 million acres. However, when comparing carbon storage between the two, oak/gum/cypress holds more carbon per unit area (92 tons/acre), storing, on average, 7 more tons per acre than oak/hickory stands (85 tons/acre) (data source: USDA FS FIA 2025).

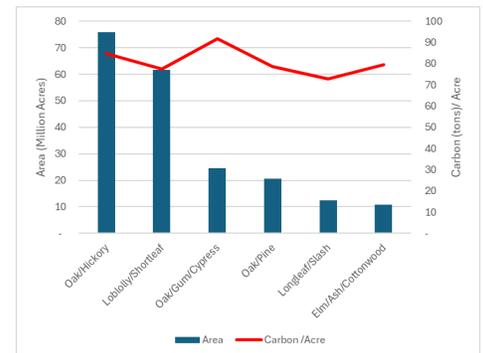


Figure 10. Total forest area (million acres) and average tons of Carbon per acre by forest cover group in the Southeast US (USDA FIA 2025).

### Forest Cover Group Climate Change Impacts

Some of the most significant threats to forests of the Southeast US include pests and diseases, barriers to regeneration (e.g., competing vegetation due to fire suppression), and altered hydrology (e.g., flood timing and intensity) resulting from more frequent and severe storm events. Table 1 below shows a snapshot of these threats for dominant forest covers of importance to the forest sector. This section includes a brief narrative of forest cover type groups that are priorities for SFI certified organizations.

Table 1. Climate-related threats of key concern to forest cover types of the Southeast US.

FOREST COVER GROUP	DROUGHT	EXTREME STORMS	PESTS & DISEASE	REGENERATION ISSUES	WARMING TEMPERATURES	WILDFIRE
<i>Oak / Hickory</i>			X	X		
<i>Loblolly / Shortleaf Pine</i>	X	X	X	X	X	X
<i>Oak / Gum / Cypress</i>		X	X			X
<i>Oak / Pine</i>			X	X		
<i>Longleaf / Slash Pine</i>						
<i>Elm / Ash / Cottonwood</i>		X	X			



## Oak/Hickory

Oak-hickory forests are abundant across the southeast and primarily located in the Appalachian and Ozark-Ouachita mountains. The species in this forest cover type group include White Oak, Chestnut Oak, Red Oak, Hickories, Sweetgum, Yellow Poplar, and other upland hardwoods (Eyre 1980). This forest cover type group is considered to have a relatively low vulnerability to climate change. Many species in this group are adapted to warmer and drier conditions. They are resilient to large-scale disturbances including extreme weather events and many are adapted to low intensity fires. With predicted climate change in the region, suitable habitat for the Oak-Hickory forest type group is projected to increase. However, the species in this group may not be able to migrate into the new range as it becomes suitable (Vose et al. 2012).



Figure 11. Oak / Hickory forest and distribution (inset) in the Southeastern US. Data: USFS FIA 2024

## Loblolly/Shortleaf Pine

This forest type group is the most prevalent on large forestland ownerships across the southeast and very economically important. This group is most abundant in the piedmont regions of the southeast. The most common species in this group are loblolly pine, shortleaf pine, and some hardwoods (Eyre 1980). Shortleaf pine has been declining on the landscape since the early 1900s. In some places, shortleaf has been replaced by agriculture and by loblolly pine plantations as they are faster growing. While shortleaf pine is better adapted to drought and fire, it will have a slow recovery in undisturbed natural systems due to its high intolerance for shade (Adhikari et al. 2021). Loblolly pine, the most planted tree species in the US, will likely have climate sensitivities with increased drought and warmer temperatures. However, given the robust breeding program there will likely be phenotypic selections made to account for climatic changes over time (Matillan-Ramirez et al. 2021).



Figure 12. Loblolly/Shortleaf Pine forest and distribution (inset) in the Southeastern US. Data: USFS FIA 2024



### Oak/Gum/Cypress

The Oak/Gum/Cypress group is considered the bottomland hardwoods that occur in riparian areas along the Atlantic Coastal plain and Mississippi Alluvial Valley. Dominant species in this group include Bald Cypress, Water Tupelo, Sweet Gum, Nuttall Oak, Willow Oak, Sweetbay Magnolia, Swamp Tupelo, and Red Maple (Eyre 1980). These forests are generally resilient to disturbances such as floods and changes in precipitation regimes. However, they can be susceptible to extraordinary storm events and saltwater intrusion in coastal areas (Napora et al. 2025). Due to the highly fertile nature of the sites where these forests occur, they are highly susceptible to invasion by non-native plant species.



Figure 13. Oak/Gum/Cypress forest and distribution (inset) in the Southeastern US. Data: USFS FIA 2024

### Oak/Pine

The oak/pine forest type group is widespread across the southeast co-occurring with other forest types primarily in the piedmont. This group is disturbance adapted, relatively drought tolerant, and thus expected to have moderate to low vulnerability to projected climate change in the region. In addition, this group has been shown to have high genetic diversity making it more resilient. This group is projected to gain suitable habitat and could replace other forest types on sites that become drier under climate change. However, the primary driver of disturbance, fire, has been suppressed in these systems leading to changes in the ecosystem.



Figure 14. Oak/Pine forest and distribution (inset) in the Southeastern US. Data: USFS FIA 2024

The altered fire regimes of this forest type group have resulted in a shift away from the dominant oak and pine species and towards less fire-adapted, mesic species. In addition, the dominant species in this group, oaks and pines, are susceptible to stressors (Vose et al. 2012). Oaks are susceptible to defoliators such as Spongy moth and fungal pathogens that lead to oak decline and thus have reduced rates of carbon sequestration and potential mortality. Pines are also prone to pest outbreaks and in conjunction with projected climate changes these outbreaks could become worse and lead to more mortality events.



## Longleaf/Slash Pine

The longleaf/slash pine group is largely found along the Gulf Coastal plain with some occurrence in sandy soils such as the sandhills within the piedmont region. Longleaf and slash pine are the dominant tree species in this group (Eyre 1980). This forest type group is considered resilient to climate change. It tolerates warm, wet conditions as well as dry conditions making it tolerant of a range of water availability. This group is resistant to disturbance including hurricanes and fire, in fact longleaf pine is fire dependent. These pines are less prone to pest infestations than other southern yellow pine species (Clark et al. 2018). It is predicted that the suitable habitats for this group will shift northwards and that slash pine is predicted to increase in productivity (Martin et al. 2017).



Figure 15. Longleaf/Slash Pine forest and distribution (inset) in the Southeastern US. Data: USFS FIA 2024

## Elm/Ash/Cottonwood

The Elm/Ash/Cottonwood forest type group is found in riparian areas in the piedmont and prairie regions of the southeast. The most common species in this group are sugarberry, hackberry, and green ash (Eyre 1980). This group is considered to have moderate to low vulnerability to climate change. However, due to this group being confined to flood plains and other riparian areas there is little opportunity for expansion in range for this forest cover group. It is relatively tolerant of variable precipitation and disturbance events resulting from extreme precipitation. Altered flood timing and intensity can impact the success of regeneration in this group. The dominant species in this group are expected to remain competitive such that this is a resistant forest cover type group to climate change. However, invasive species such as the Emerald Ash Borer, continue to affect key species within this group.



Figure 16. Elm/Ash/Cottonwood forest and distribution (inset) in the Southeastern US. Data: USFS FIA 2024



## ECOREGION IMPACTS WITH SPECIES-SPECIFIC INSIGHTS

This section presents a table with the climate risks by ecoregion and linking with the species-specific concerns presented in prior sections. Results in Table 2 shows which major Forest Cover Type Groups are present in each Level II Ecoregion (column 1). A description of the forests at the Level III ecoregion scale are provided for context in column 2. Additionally, a summary of the climate change vulnerability on the forests in the ecoregion are summarized in column 3. These data are pulled from wide ranging literature expanded upon in prior sections and includes Stewart et al. 2013, Oklahoma Forestry Service 2020, McNulty et al. 2013, NatureServe n.d., Hicks et al. 2004, Rose & Meadows 2016, Southern Group of State Foresters 2016, Clatterbuck & Kauffman 2006, Menard et al. 2011, Virginia Department of Conservation and Recreation 2021, Diop et al. 2009, Susaeta & Lal 2018 Wiken et al. 2011.



Table 2. Forest Types within Level III Ecoregions with anticipated climate change impacts (Wiken et al. 2011).

LEVEL II ECOREGION	LEVEL III ECOREGION DESCRIPTIONS	CLIMATE CHANGE VULNERABILITY
<p><b>Ozark/Ouachita-Appalachian Forests</b></p> <p><b>Forest Cover Type Groups</b></p> <ul style="list-style-type: none"> <li>• <i>Oak/Hickory</i></li> <li>• <i>Loblolly/Shortleaf Pine</i></li> <li>• <i>Oak/Pine</i></li> <li>• <i>Maple/Beech/Birch</i></li> </ul>	<ul style="list-style-type: none"> <li>• <b>8.4.1: Ridge and Valley:</b> Generally, Appalachian oak forest in the north, and oak-hickory-pine forest to the south.</li> <li>• <b>8.4.4: Blue Ridge:</b> Part of one of the richest temperate broadleaf forests in the world, with a high diversity of flora. Mostly Appalachian oak forests, but a variety of oak, hemlock, cove hardwoods, and pine communities within this forest type. Many forests once dominated by American chestnut, an ecologically and economically important tree that provided food and shelter to many animal species. The Chestnut blight, introduced to the U.S. around 1904, killed most of the chestnut trees by the 1930s. In place of the chestnut, other trees, such as tulip poplar, chestnut oak, white oak, black locust, red maple, and pine species have become important canopy dominants. At higher elevations, northern hardwoods of beech, yellow birch, yellow buckeye, and maples are typical. At the highest elevations, Southeastern spruce-fir forests of Fraser fir, red spruce, yellow birch, and rhododendron are found.</li> <li>• <b>8.4.6: Boston Mountains:</b> Mostly oak-hickory forests. Red oak, white oak, post oak, blackjack oak, and hickories remain the dominant vegetation types in this region, although shortleaf pine and eastern red cedar are found in many of the lower areas and on some south- and west-facing slopes. Some mesophytic forests in ravines and on north-facing slopes with sugar maple, beech, red oak, white oak, basswood, and hickory.</li> <li>• <b>8.4.7: Arkansas Valley:</b> Natural vegetation included oak savanna and oak-hickory-pine forests. Post oak, blackjack oak, southern red oak, hickory, shortleaf pine, some planted loblolly pine. Floodplains with bottomland oaks, sycamore, sweetgum, willow, eastern cottonwood, green ash, and elm.</li> <li>• <b>8.4.8: Ouachita Mountains:</b> Once covered by oak-hickory-pine forests, most of this region is now in loblolly and shortleaf pine. Remaining hardwood forests include southern red oak, black oak, post oak, white oak, and hickories.</li> <li>• <b>8.4.9: Southwestern Appalachians:</b> Upland forests are dominated by mixed oaks with shortleaf pine, and include white oak, southern red oak, and some</li> </ul>	<ul style="list-style-type: none"> <li>• Changes to temperature and precipitation patterns are threatening survival of some species</li> <li>• Climate change driving compositional changes</li> <li>• Slower growing hardwood-dominated communities such as Oak/Hickory may transition to pine and other fast-growing species when stressed</li> <li>• Pest outbreaks such as spongy moth can cause mortality in oak dominated systems</li> </ul>



LEVEL II ECOREGION	LEVEL III ECOREGION DESCRIPTIONS	CLIMATE CHANGE VULNERABILITY
<p><b>Southeastern US Plains</b></p> <p><b>Forest Cover Type Groups</b></p> <ul style="list-style-type: none"> <li>• <i>Loblolly/Shortleaf</i></li> <li>• <i>Oak/Hickory</i></li> <li>• <i>Oak/Pine</i></li> <li>• <i>Oak/Gum/Cypress</i></li> <li>• <i>Longleaf/Slash Pine</i></li> <li>• <i>Elm/Ash/Cottonwood</i></li> </ul>	<p>hickories. Mixed mesophytic forests with maple, buckeye, beech, ash, basswood, sweetgum, and oaks are restricted mostly to the deeper ravines and escarpment slopes.</p> <ul style="list-style-type: none"> <li>• <b>8.3.3: Interior Plateau:</b> Natural vegetation is primarily oak-hickory forest, with some areas of bluestem prairie, cedar glades, and mixed mesophytic forest. White oak, northern red oak, black oak, hickories, yellow poplar, red maple, eastern red cedar are typical.</li> <li>• <b>8.3.4: Piedmont:</b> The historic oak-hickory-pine forest was dominated by white oak, southern red oak, post oak, and hickory, with some shortleaf pine and loblolly pine.</li> <li>• <b>8.3.5: Southeastern Plains:</b> Natural vegetation was predominantly longleaf pine with smaller areas of oak-hickory-pine, and in the south some Southern mixed forest with beech, sweetgum, southern magnolia, laurel and live oaks, and various pines. Floodplains include bottomland oaks, red maple, green ash, sweetgum, and American elm, and areas of bald cypress, pond cypress, and water tupelo.</li> <li>• <b>8.3.6: Mississippi Valley Loess Plains:</b> In the more gently rolling plains portion to the east, upland forests are dominated by oaks, hickories, and both loblolly and shortleaf pine. To the west, in the more rugged Bluff Hills portion, oak hickory forest along with southern mesophytic forests contain beech, maples, sweetgum, basswood, tulip poplar, southern magnolia, and American holly.</li> <li>• <b>8.3.7: South Central Plains:</b> Natural vegetation of uplands was historically dominated by longleaf pine woodlands and savannas in the south, and shortleaf pine/hardwood forests in the north. Southern red oak, post oak, white oak, hickories, and loblolly pine were common, with small areas of beech and magnolia in the south. Southern floodplain forest of water oak, willow oak, swamp chestnut oak, sweetgum, blackgum, red maple, bald cypress, and water tupelo typify bottomlands.</li> <li>• <b>8.3.8: East Central Texas Plains:</b> Originally covered by post oak savanna vegetation, in contrast to the more open prairie-type ecoregions to the north, south, and west, and the pine forests to the east. Oak savannas or</li> </ul>	<ul style="list-style-type: none"> <li>• Forest dieback driven by increased drought stress and increasing temperatures</li> <li>• Increasing drought frequency, severity, and extent</li> <li>• Cumulative impacts of concurrent stressors such as drought, wildfire, or pest and disease outbreaks are what makes them lethal to otherwise healthy and productive trees</li> </ul>



LEVEL II ECOREGION	LEVEL III ECOREGION DESCRIPTIONS	CLIMATE CHANGE VULNERABILITY
	<p>oak-hickory forest with post oak, blackjack oak, black hickory, and grasses of little bluestem, purpletop, curly threeawn, and yellow Indiangrass. Understory of yaupon, eastern red cedar, winged elm, American beautyberry, and farkleberry.</p>	
<p><b>Mississippi Alluvial and Southeast US Coastal Plain</b></p> <p><b>Forest Cover Type Groups</b></p> <ul style="list-style-type: none"> <li>• <i>Longleaf/Slash Pine</i></li> <li>• <i>Oak/Gum/Cypress</i></li> <li>• <i>Loblolly/Shortleaf</i></li> <li>• <i>Oak/Hickory</i></li> <li>• <i>Oak/Pine</i></li> <li>• <i>Elm/Ash/Cottonwood</i></li> </ul>	<ul style="list-style-type: none"> <li>• <b>8.5.1: Middle Atlantic Coastal Plain:</b> Forest cover in the region was once dominated by longleaf pine, with more oak-hickory-pine to the north. It is now mostly loblolly and some shortleaf pine, with patches of oak, gum, and cypress near major streams. On southern barrier islands, some maritime forests of live oak, sand laurel oak, and loblolly pine. Cordgrass, salt grass, and rushes in coastal marshes; beach grass and sea oats on dunes.</li> <li>• <b>8.5.2: Mississippi Alluvial Plain:</b> Bottomland deciduous forest covered the region before much of it was cleared for cultivation. It is one of the most altered ecoregions in the U.S. Floodplain forest communities</li> </ul>	<ul style="list-style-type: none"> <li>• Sea level rise: salinization + forest conversion</li> <li>• 1900-2000: Coastal areas experienced an average rise in sea level of 2.5 cm per decade</li> </ul>



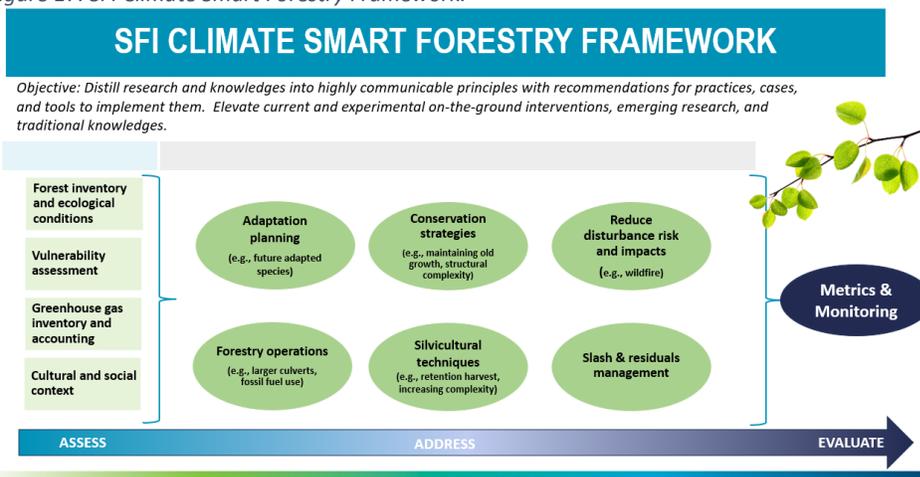
LEVEL II ECOREGION	LEVEL III ECOREGION DESCRIPTIONS	CLIMATE CHANGE VULNERABILITY
	<p>are affected by hydroperiod. River swamp forests contain baldcypress and water tupelo. Hardwood swamp forests include more water hickory, red maple, green ash, and river birch. Higher, seasonally flooded areas, add sweetgum, sycamore, laurel oak, Nuttall oak, and willow oak.</p> <ul style="list-style-type: none"><li>• <b>8.5.3: Southern Coastal Plain:</b> Once covered mainly by longleaf pine flatwoods and savannas, this ecoregion also had a variety of other communities that supported slash pine, pond pine, pond cypress, beech, sweetgum, southern magnolia, white oak, and laurel oak forest. Southern floodplain forests with bald cypress, pond cypress, water tupelo, bottomland oaks, sweetgum, green ash, water hickory.</li></ul>	<ul style="list-style-type: none"><li>• Low-lying coastal forests highly vulnerable to transitioning to marshland</li><li>• Increased flooding from severe precipitation events expected to increase under climate change</li></ul>



## DECISION-MAKING FOR FORESTS AND CLIMATE

The threats posed from climate change to forests can be diverse, with variations across geographies and forest types in terms of risk level, frequency of occurrence, and severity of impacts. Implementation of climate-informed forestry practices across the geographically diverse footprint of SFI-certified forests in North America inherently needs regional approaches to promote climate change adaptation and mitigation, however, there are cross-cutting themes that can shape climate-informed forestry across the entire geography and at multiple scales. For example, managing forests for climate benefits requires key input information like a vulnerability assessment and greenhouse gas inventory. Drawing from this foundational information, forest managers can determine which practices to deploy (e.g., fuel treatments, adaptive management, or conservation strategies). The effects of such interventions can be monitored over time and inform future decisions. See the figure below for more details along with an accompanying table that includes descriptions in Appendix A.

Figure 17. SFI Climate Smart Forestry Framework.



### SFI Climate Informed Principles (CLIPs)

In line with the SFI 2025-2030 SFI Strategic Direction, SFI has launched a [Climate Smart Forestry Initiative](#) that reaches across our Canadian and US landscapes. As part of this, SFI is developing Climate-Informed Principles (CLIPs), which aim to:

- Support systematic decision making for climate-informed interventions,
- Improve understanding of climate implications of different management options,
- Enhance the communicability of climate benefits of forestry interventions, and
- Support certified organizations in meeting the SFI Forest Management standard.

**Principle:** The vision and direction for sustainable forest management as embodied in the principles of the SFI 2022 Standards.

**Practice(s):** The actual application or use of an idea, belief, or method, as opposed to theories relating to it.

Source: SFI Standards, Section 14: Definitions (2022)

Each CLIP will present a principle, its scientific rationale and a list of related practices, potential resources and tools, and case study examples. The SFI CLIPs will leverage and align with existing frameworks from partners like the United States Forest Service, the Adaptive Silviculture for Climate Change (ASCC) network, and Natural Resources Canada (Brandt et al. 2016, Ontl et al. 2020, NRCan 2025, Swanston et al. 2016).



## Conclusion

Managing forests in a changing climate requires multiple temporal and spatial scales of information and decision-making. Like tree ring growth on a tree, climate interactions with forests and benefits of forestry interventions accrue over time. This creates immediate challenges for forest managers making decisions in forests with both observed and projected climate changes. These uncertainties mean strategies that work today may fail in the future, requiring that managers balance immediate needs with long-term resilience.

However, there are a range of potential interventions and practices that can be applied to reduce uncertainty and pursue net positive outcomes. Practices to improve forest resilience and climate contributions depend on the site and the goals of the individuals managing it. Some actions will result in more stored carbon, others keep current levels steady, and some cause losses to ensure forest health and maintain carbon over time, such as thinning forests to reduce wildfire risk or reintroducing fire. Ultimately, the best approach will likely be a mix of strategies that balance immediate outcomes with the forest's future health and resilience.

## Contact

### **Greg Cooper (US)**

Director, Conservation Implementation

[greg.cooper@forests.org](mailto:greg.cooper@forests.org)

### **Lauren T. Cooper**

Chief Conservation Officer

[lauren.cooper@forests.org](mailto:lauren.cooper@forests.org)



## Appendix A. Initial SFI Climate Smart Forestry Themes

	Climate Informed Principle	Climate Rational	SFI Standard
ASSESS	Access the best data on <b>Forest Inventory and Ecological Condition</b>	Forest inventory and ecological condition data provide critical insight into carbon storage, forest health, and biodiversity. In turn, this information supports efforts to enhance carbon sequestration and increase forest resilience, which are essential for climate change adaptation and mitigation.	SFI FM Objective 1, PM 1.1.4; Objective 4.1.7-8; Objective 9, PM 9.1.2.a-c
	Complete a <b>Vulnerability Assessment of climate change impacts on forests and forestry operations</b>	Vulnerability assessments identify regions, ecosystems, or communities most at risk from climate change impacts, enabling targeted adaptation and mitigation strategies. By understanding these vulnerabilities, mitigation efforts can focus on reducing climate-related risks to forests and forestry operations and enhancing resilience to future climate change.	SFI FM Objective 9, PM 9.1.1
	Develop a robust <b>Greenhouse Gas Inventory</b>	Greenhouse gas inventory and accounting track emissions from forestry activities, providing a clear picture of the sources and quantities of greenhouse gases. These data help identify emission reduction opportunities, set targets, and measure progress toward mitigating climate change.	SFI FM Objective 9, PM 9.2.3
	Determine relevant <b>Social and Cultural Context</b> including priorities and sources of knowledges	Ensuring management practices reflect the values, traditions, and needs of the people who depend on the forest. Integrating this knowledge helps build community support, protect culturally important species or landscapes, and create strategies that are both ecologically effective and socially acceptable.	SFI FM Objective 1, PM 1.1.6; Objective 5.4.1; Objective 6.1-2; Objective 8
ADDRESS	Develop and implement <b>Adaptation planning</b> for Forest Management (e.g. assisted migration, conversion to future adapted species)	Forest adaptation planning involves adjusting forest practices to anticipate and respond to changing climate conditions, such as introducing future-adapted species. This helps maintain carbon sequestration capacity, ecosystem health, and biodiversity and supports both adaptation and mitigation objectives.	SFI FM Objective 1.2.2a; 2.5.1; 9.1.2.c



	Climate Informed Principle	Climate Rational	SFI Standard
ADDRESS	Implement climate mitigation and adaptation strategies in <b>Forestry operations</b>	Forestry operations contribute to climate change by using fossil fuels and disrupting stored carbon. Adjusting operations can help mitigate climate change and reduce greenhouse gas emissions by reducing fossil fuel use, increasing operational efficiency, and using forest biomass for renewable energy instead of fossil fuels. In addition, forestry operations can be adapted to be resilient to climate change impacts such as shorter winters, severe storms, and wildfire.	SFI FM Objective 9.2.1
	Implement <b>Conservation strategies</b> for climate and biodiversity	Forest conservation strategies protect and restore vital ecosystems, enhancing forests' ability to sequester carbon and maintain biodiversity. By reducing deforestation and degradation, these strategies help prevent the release of stored carbon and strengthen the forest's role in climate change mitigation.	SFI FM Objective 4.1.2,4-8; 4.2.2
	Modify <b>Silvicultural techniques</b> for adaptation and mitigation outcomes	Forest silvicultural techniques, like retention harvesting, can help maintain forest structure and health, allowing forests to continue sequestering carbon and supporting biodiversity, contributing to climate change mitigation. Maintaining or increasing forest complexity, such as promoting diverse tree species and varied age structures, enhances ecosystem resilience and carbon storage. This approach strengthens forest ability to adapt to climate change, supports biodiversity, and boosts long-term carbon sequestration, aiding in climate change mitigation (Messier 2019).	SFI FM Objective PM 1.1.1.i; PM 2.3.4; PM 2.4.2; PM 9.2.2.a-d
	Taking action to <b>address and reduce the impacts of climate-driven disturbance</b> (e.g. catastrophic wildfire)	Activities that reduce the risk of disturbance and impacts from disturbance (such as wildfires) prevent the release of large amounts of carbon stored in forests. Implementing strategies like controlled burns and creating firebreaks, help maintain forest health, resilience, and carbon sequestration capacity, thus supporting climate change mitigation. (Beverly et al. 2021). Post-disturbance forest restoration helps mitigate climate change by enhancing carbon	SFI FM Objective 2.4.1-3; SFI FM Objective 10.1.1-2



	Climate Informed Principle	Climate Rational	SFI Standard
		sequestration and storage, reducing soil erosion, further supporting ecosystem resilience in the face of climate impacts.	
	Minimize waste and ensure efficient utilization in <b>Slash &amp; Residuals management</b>	Changes to slash management can mitigate climate change by reducing emissions from slash burning, increasing carbon stored on the landscape, or reducing wildfire risk. Residuals management can mitigate climate change by reducing waste and preventing the release of greenhouse gases from woody waste materials. Repurposing waste materials for energy production, new final products, or recycling decreases fossil fuel use and promotes a circular bioeconomy.	SFI FM Objective 2.3.3; Objective 7.1.1
<b>EVALUATE</b>	Utilize appropriate <b>Metrics and Monitoring</b> to measure impacts of adaptation and mitigation strategies over time	A program that measures and monitors the impact of any action that addresses climate change risk can assess change over time. With these measurements, metrics can be established. Information gathered through a monitoring program can then be used to guide future steps to Assess and Address climate change impacts.	SFI FM Objective 4.4.2; SFI FM Objective 4.4.1; Objective 9.1.4; 9.2.4



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