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Southern Forest Outlook
MARKETS

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An Analysis to Support the Southern Forest Outlook

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Abstract

The last decade's economic, social, and environmental changes have affected the production, consumption, prices, and trade of forest products in the United States. This report provides an overview of how future potential societal and biophysical changes in the U.S. South, the country, and the world may influence the region's forest sector. Changes are modeled with six scenarios that offer alternative trajectories for socioeconomic change (rates of growth in income and population), climate warming, technology, and trade openness. Among these are two scenarios exploring (1) the accelerated adoption of mass timber products in construction, and (2) a large, hypothetical increase in trade restrictions. All scenarios are summarized in terms of changes in production, consumption, prices, and trade in forest products. Results of this study can facilitate more fully informed choices by landowners, policymakers, and industry decisionmakers as they prepare for an uncertain future.

Keywords: Timber market, forest products, trade barriers, forest disturbances.

Contents

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Preface

The *Southern Forest Outlook* (SFO) adds to the regional landscape-level Southern Forest Assessment library. The South has a long history of regional assessments to address uncertainties within the forestry sector. Wheeler published *The South's Third Forest* in 1970, which evaluated trends and synthesized the peer-reviewed literature to examine the future of timber supply given increasing demand and concerns of underinvestment in private forest land. That report was followed by *The South's Fourth Forest* in 1988 (USDA Forest Service 1988), which focused on re-evaluating many of the same questions. However, research for *The South's Fourth Forest* relied on using timber market models and policy analyses to examine alternatives for reversing underinvestment in nonindustrial private forests. By the late 1990s, growth in forest management and timber production largely anticipated by those reports, coupled with the emergence of satellite chip mills, raised concerns about the sustainability of forests in the South, which motivated the *Southern Forest Resource Assessment* (SFRA) in 2002 (Wear and Greis 2002). *The Southern Forest Futures Project* (SFFP) (Wear and Greis 2013) was completed in 2013; it updated and expanded the analysis conducted for the SFRA. The SFFP was driven by increasing urbanization, land ownership dynamics, and markets and included integrated change scenarios based on population, economic factors, and climate change.

Analyses and results detailed in the Southern Forest Assessment library have been used to support planning and policy discussions for decades. *The South's Third Forest* identified strategies to encourage planting and increase management on private forests; protect forests from insects, diseases, and fires; and build stronger institutions for forestry training, technology transfer, and research. Its forecasts of population-driven urbanization and expansion of tree planting and timber production have been realized in the South. *The South's Fourth Forest* anticipated the growth in timber production realized through 2000 and informed a suite of programs and policies to encourage reforestation, management, and forest protection. The SFRA led to improved best management practices monitoring, helped to expand the Forest Inventory and Analysis Program, provided a wealth of information for the first State Forest Action Plans, and led to broader engagement across the forestry community. Findings from the SFFP helped set research priorities at the U.S. Department of Agriculture, Forest Service, Southern Research Station; provided motivation for a high priority regional working forest conservation initiative known as Keeping Forests; and increased emphasis on understanding socioecological systems related to water resources.

In 2019, the Forest Service and Southern Group of State Foresters (SGSF) leadership recognized a need to update the Southern Forest Assessment library with a new regional assessment—the SFO. Recent changes in land use, forest disturbances, forest management, and forest product markets have led to increasing uncertainty about the future of the sector. Though much of the assessment library remains relevant, new data, research results, and projection models allow for new insights into critical issues facing the South.

The SFO is a four-part synthesis of the following issues: (1) timber market conditions and futures, (2) water and forest interactions, (3) fire in a changing ecological and social landscape, and (4) forest dynamics and land-use change. These issue areas each leverage the work of the 2020 Resources Planning Act Assessment in terms of overall drivers (climate, population, and income), land-use change, forest condition (dynamics), and markets. The Southern Research Station and Southern Region, along with the SGSF, led the SFO with the objective of informing forest sector decisionmakers and the interested public about observed trends, anticipated futures, and critical issues based on authoritative synthesis and interpretation of existing science, data, and 50-year projections.

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Key Messages

- Across all major categories of forest products, the South's exports are projected to continue to exceed its imports over the coming 5 decades.
- Prices of industrial roundwood are projected to rise into the future, reversing recent trends.
- Jobs are projected to decline in numbers, regardless of scenario, primarily due to labor-saving technology change, with the steepest declines in the pulp and paper sector.
- The U.S. forest sector continues to experience significant structural changes, largely due to advancements in technology and shifting demands for forest products. Notably, the trend towards a paperless society is contributing to the decline of the newsprint and graphic paper industries.
- A rapid expansion of mass timber production and consumption would primarily strengthen southern softwood net exports compared to business-as-usual rates of market development.
- Trade barriers have significant impacts on Southern U.S. softwood and hardwood markets. Raising barriers would positively impact softwood exports from the South, because of enhanced market opportunities within the United States arising from higher import barriers, despite reduced foreign market access from higher tariffs. Hardwood net exports, however, would decline with increased trade barriers.
- Wood pellet production in the South is projected to rise across most scenarios, nearly doubling under the HH (high warming with high socioeconomic growth, RCP 8.5-SSP5) and LM (least warm with moderate socioeconomic growth, RCP 4.5-SSP1) scenarios, with most added production exported, consistent with recent trends.

Introduction

The southern forest products sector has changed since *The Southern Forest Futures Project* (SFFP) was completed in 2012 (Wear and Greis 2013). Product markets have grown, harvests have grown, and overall demand for wood has increased along with overall economic output and residential construction. Other changes include increased barriers to international trade, ongoing shrinkage in the size of the forest sector workforce, rising standing timber inventory, declining prices for pine sawtimber, and increased foreign direct investment. Foreign direct investment has been directed at the still small but rapidly growing wood pellet manufacturing industry.

Since the SFFP, the U.S. Department of Agriculture, Forest Service, has carried out a national assessment, the 2020 Resources Planning Act (RPA) Assessment, providing alternative visions of the future of the forest sector to 2070 (USDA Forest Service 2023). A central component of the national assessment has been projections of the forest sector domestically and globally through 2070 under four main scenarios describing the future along two main axes of uncertainty: climate change and socioeconomic change (see Scenarios section). The four main scenarios—least warm with moderate economic growth (LM), high warming with low economic growth (HL), high warming with intermediate economic growth (HM), and high warming with high economic growth (HH)—are described in detail in another part of the *Southern Forest Outlook* (SFO); they are abbreviated as LM, HL, HM, and HH, with the first letter indicating the degree of projected climate warming and the second letter describing the projected rates of economic growth (fig. 1). Dominant aspects of these four main scenarios include assumptions about economic development, technology change, and changes in the demand and supply of wood-based energy. Although modeling for the 2020 RPA Assessment is complete, the modeling platform enabling projections of the forest sector to 2070 can be employed to evaluate additional what-if scenarios. Such what-if scenarios could seek to reveal the effects of specific policy changes, technology developments, or climate change aspects not already captured in the four main scenarios.

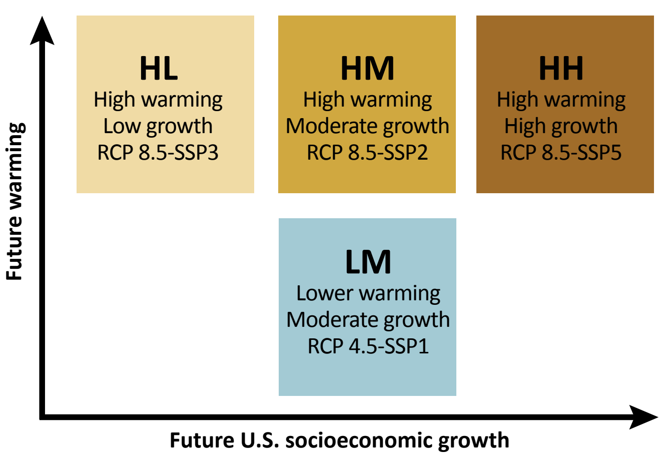

Figure 1—Scenarios developed for the 2020 Resources Planning Act. Source: USDA Forest Service (2023: 3-3).

The socioeconomic and climate dimensions of the four main scenarios are modeled in the 2020 RPA Assessment's forest products chapter with a three-component modeling platform consisting of the Forest Resource Outlook Model (FOROM), RPA land-use model, and the RPA Forest Dynamics Model. The FOROM model (Johnston et al. 2021) projects U.S. and global forest resources to 2070, including forest area, timber stocks (standing timber inventory volumes), roundwood removals, and market outcomes for 20 categories of forest products. Detailed projections are made for the four RPA regions in the United States (Pacific Coast, Rocky Mountain, South, North), with further disaggregation of the North into two subregions (Northeast, North Central) and the South into two subregions (Southeast, South Central). This Outlook gives specific attention to the two South subregions, with many results provided at the level of their constituent States: Florida, Georgia, North Carolina, South Carolina, and Virginia for the Southeast, and Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, and Texas for the South Central. As we describe in the methods section of this report, some of the RPA region-level and subregion-level projections can be downscaled to finer spatial units, and this Outlook demonstrates how this can be done to provide information more useful for decisionmakers at the State level.

Developments Since *The Southern Forest Futures Project* (SFFP)

A discussion of the key findings on forest products markets sets the stage for revisiting some issues and provides the backdrop for addressing new questions potentially facing the region's sector in the next 5 decades. The SFFP was completed in 2012 (Wear and Greis 2013) and included a chapter that focused on forest product markets in the Southern United States (Wear and Greis 2013: chapter 9). Among the SFFP key findings were that timber product outputs had declined since the 1990s. Among the main reasons for such declines were declining construction, declining investment in mill capacities, a shrinking demand for hardwood because of a loss of furniture manufacturing capacity, a shrinking paper manufacturing industry due to electronic media substitution and a shrinkage of the manufacturing sector in the United States leading to reduced demand for packaging papers. Although hardwood product prices remained high or were increasing due to robust overseas demand for U.S. hardwood logs and hardwood lumber, softwood log and softwood lumber prices were dropping. Along with the falling softwood product prices and output came an increasing standing softwood timber inventory. Future market projections in the South indicated prospects for higher forest products output, due in part to long-run expectations of expanding economies worldwide. The wood energy sector was highlighted as a possible new and growing timber demand source, but prospects were highly uncertain, and the small size of that sector meant that price pressures would be minimal. The outcome of low timber product and final product demand and little price increase expected for softwood, in particular, meant that prospects for increased investment in intensive forestry that furthers an objective of keeping forests in forest were limited. Along with stagnant demand came increased capital intensification (Prestemon et al. 2015), implying shrinking prospects for jobs in the forest sector.

Sector wide analyses of the U.S. forest sector have updated some of what we learned in the SFFP. Brandeis and Hodges (2015) focused on short-run changes following the 2007–2009 recession, documenting some growth but noted labor demand shrinkage. Prestemon et al. (2015) and Wear et al. (2016) examined long-term trends in the sector, including its receding yet still dominant stature in global markets. Brandeis et al. (2021) documented the key market variables of interest through the second decade of the 2000s, including a focus on its continued reliance on imports for many categories of wood building products but balanced trade in pulp and paper.

Specific aspects of the changes in the sector, both short-run and long-run, have been the subject of many research efforts. Buongiorno and Johnston (2018) quantified the effects of hypothetical trade barriers in the United States and globally. Nepal et al. (2019) focused on the emerging wood pellet industry. Prestemon et al. (2018, 2022) outlined prospects for the residential housing sector to 2070. Buongiorno (2021) and Prestemon and Guo (2022) examined the effects of the global pandemic on forest product markets.

There are several aspects of recent literature worth highlighting. Demand for wood products by the construction sector, following the 2007–2009 recession, grew steadily through 2021, linked particularly to rising new residential construction, which reached a level by the first quarter of 2020 that approximated average rates observed prior to the housing bubble of the mid-2000s. As Prestemon et al. (2018, 2022) point out, future prospects are linked to uncertain rates of future income and population growth. There was an uptick in trade frictions between the United States and its major trading partners, making an analysis by Buongiorno and Johnston (2018) particularly prescient. Some of the market effects modeled by Buongiorno and Johnston (2018) were likely realized in the United States, especially on U.S. consumers and producers of export products. In actuality, the expiration of the Softwood Lumber Agreement (USTR 2006) with Canada (replacing export taxes in Canada with import tariffs in the United States) likely served to push up domestic U.S. softwood lumber prices and depressed U.S. imports from Canada. For U.S. exports, retaliatory tariffs against U.S. forest products levied by China and the European Union, in response to new U.S. tariffs on steel and other products, beginning in 2017, lowered prospects for some exporters, including southern wood product manufacturers. Steady growth in European demand for wood pellets has pushed up demand for small diameter and less economically valuable species in the U.S. South and put some upward pressure on pulpwood prices (Nepal et al. 2019). The global COVID-19 pandemic had both short-run and likely some long-run impacts on the sector, particularly in wood products, with sharply higher prices in 2020–2021 but a return to normalcy by mid-2022 (Prestemon and Guo 2022). Science shows that climate change, including potentially increased rates of large-scale disturbances, could affect the future of southern markets. Climate change could impact both supply, such as those arising from more severe hurricanes, leading to damaged timber inventory and increased salvage (Henderson et al. 2022; Prestemon and Holmes 2000, 2004), and demand, including for rebuilding of houses post hurricane (e.g., Lazarus et al. 2018) and for the replacement of houses lost to rising seas (Nepal et al. 2022).

New Research Questions

Combining the information generated from the SFFP, insights from the recent literature on several aspects of the U.S. and global forest products market, meetings with stakeholders, and new forward-looking projections emerging from the 2020 RPA Assessment, we seek to advance our understanding of long-term trends of relevance for southern markets. The modeling framework of the 2020 RPA Assessment provides an opportunity to explore the implications of alternative rates of warming and socioeconomic change (rates of growth in income and population) in the United States and the South, quantify the short-run and long-run effects of the global pandemic, evaluate how trade frictions have affected southern markets, and examine possible scenarios of increasing timber demand arising from technology change such as mass timber products and the growth of the wood energy sector. This exploration allows us to also newly evaluate the employment prospects in the sector, which have been receding for decades due to technology change and alterations in final product demand. Besides the quantitative results produced by the RPA modeling system, we provide descriptive analyses of the effects of possible changes in rates or intensities of natural disturbances, the effects of trade barriers on southern forest product producers and consumers, and predictions of the short- and long-run effects of the pandemic on key market variables, done as an adjunct to the 2020 RPA Assessment.

Modeling Framework

RPA models to project to 2070

The markets component of the SFO is based on a foundation of quantitative modeling done with the 2020 RPA forest sector modeling system. The system combines the RPA Forest Dynamics Model, a land use model, and a market model called FOROM (Johnston et al. 2021). The modeling system was applied to four main RPA scenarios—LM, HL, HM, HH—discussed in the Scenarios section of the SFO (fig. 1). To tackle the new challenges arising in the forest product markets, two new scenarios are explored that evaluate accelerated adoption of mass timber products in the United States and across several large consumers of mass timber products (Ganguly 2021), as also explored by Nepal et al. (2021), which we label the HM-Mass Timber scenario, and the effects of sharply higher trade costs for both imports into the United States and exports from the United States, which we label the HM-Restricted Trade scenario. Each of the six scenarios of this Outlook are summarized in terms of effects on State-level jobs by 3-digit North American Industry Classification System (NAICS) and market variables: prices, production, consumption, and trade.

Downscaling methods

The four main 2020 RPA Assessment projection scenarios and the two additional scenarios on mass timber and increased trade costs generate results from 2020 to 2070 by RPA region. RPA region- and subregion-level projections can be downscaled to the State level for some product categories by combining statistical models with subregion-level projections. Such statistical approaches can be used to generate projections of forest sector jobs at the State level. More specifically, the outputs of all four RPA scenarios and two additional policy variants are summarized in this Outlook by State in terms of jobs by 3-digit NAICS forest sector industrial groupings (forestry and logging, wood product manufacturing, paper manufacturing); by State for market variables (production, consumption, and prices) for softwood and hardwood industrial roundwood, softwood and hardwood lumber, and wood pellets; and by RPA subregion for market variables for plywood, particleboard (mainly OSB), pulp (chemical, mechanical, waste, other fiber), newsprint, printing and writing paper, other paper and paperboard, softwood and hardwood fuelwood, particles and residues, and recovered paper. Projections of trade quantities for all product categories are summarized by RPA South subregion.

Prices of timber are downscaled to the State level using the subregional price projections and indices of their changes by scenario. Downscaling equations were estimated from southwide (Southeast, South Central) timber prices and observed timber prices by State from TimberMart-South (2022) and Forest2Market (2022).

To downscale lumber production to the State level, the share of Mill Capacity (Forisk Consulting 2020) and lumber production data for the South Central and Southeast subregions from the 2020 RPA Assessment were utilized. Given the limited information, we assumed that the mill capacity share remained constant throughout the simulation. Downscaling consumption projections to the State level requires additional trade data. Such data are often reported only at the national level. Therefore, projections of consumption for all product categories are reported by RPA South subregion. Jobs in the forest sector are downscaled to the State level using statistical model estimates of jobs per unit of forest product output and recent time trends (1990–2021) by State, based on the U.S. Bureau of Labor Statistics' (2022) Quarterly Census of Employment and Wages.

Details of the downscaling approaches are described in an online appendix (https://ars.els-cdn.com/content/image/1-s2.0-S1389934123001867-mmc1.docx) available from Guo et al. (2023).

Data sources

Background descriptions of recent history and current status of southern, U.S., and global forest products markets are available from Wear et al. (2016), Brandeis et al. (2021), Johnston et al. (2022a, b; 2023), FAO (FAOSTAT 2021), and the latest data from the U.S. Bureau of Labor Statistics (2022) on employment, the U.S. Bureau of Economic Analysis (2022) on domestic aggregate economic output, the U.S. Census Bureau (2020) on population, timber product output by State from the Forest Service, Forest Inventory and Analysis and Oswalt et al. (2019), southern U.S. timber prices (TimberMart-South 2021, Forest2Market 2022), and southern forest product prices (Fastmarkets RISI 2022).

SFO Scenarios

The SFO, much like the SFFP (Wear and Greis 2013), relies on scenarios that combine varying assumptions about socioeconomics with an appropriate range of warming. In this manner, a range of plausible potential futures can be evaluated. The SFO relies on the same core scenarios as the 2020 RPA Assessment. Within the RPA Assessment, a set of core scenarios was developed from the Intergovernmental Panel on Climate Change (IPCC 2014) scenarios. The IPCC provides a global context for a range of potential futures, with the climate futures defined in terms of differing representative concentration pathways (RCPs) (IPCC 2014). The RCPs are defined by radiative forcing (W/m^2). In simple terms, radiative forcing is the difference between energy being absorbed by the Earth and the energy being reflected and emitted back into space. When the balance is greater than zero, warming occurs. For the 2020 RPA Assessment, RCP 4.5 and RCP 8.5 were selected. RCP 4.5 has a radiative forcing of 4.5 W/m^2 at stabilization (after year 2100), with a carbon dioxide (CO_2)-equivalent concentration of approximately 650 ppm. RCP 8.5 has a radiative forcing of more than 8.5 W/m^2 in 2100, with a CO_2-equivalent concentration of >1370 ppm (Moss et al. 2010).

Scientists are challenged to align socioeconomic paths that are consistent with RCP paths (van Vuuren et al. 2014). Shared socioeconomic pathways (SSPs) were developed after the RCPs, and the SSPs offer economic and demographic storylines at a global scale that align with the RCP levels (O'Neill et al. 2017). The four SSPs used in the RPA Assessment (SSP1, SSP2, SSP3, and SSP5) range from a wealthy and increasingly economically equal world that has a focus on climate change mitigation and slowing population growth (SSP1), an economically wealthy world with more focus on adaptation and high U.S. population growth but slower global population growth (SSP5), a less wealthy world with continued inequality and low U.S. population growth and high global population growth (SSP3), and an intermediate case intended to roughly replicate current rates of economic and population change (SSP2). The RPA scenarios are based on combining RCPs and SSPs (fig. 1). Langner et al. (2020) provide a description of the scenarios for the United States. These scenarios are also evaluated as part of the SFO.

The LM scenario is based on the combination of RCP 4.5 and SSP1 and describes a future with medium growth (3.0 times current) in U.S. real gross domestic product (GDP), medium population growth (1.5 times current), and lower global emissions (table 1). The HL scenario, combining RCP 8.5 and SSP3, suggests low U.S. population growth (1.0 times current) and low growth in U.S. real GDP (1.9 times), but high emissions (table 1). The HH scenario, the combination of RCP 8.5 and SSP5, describes a future with high warming and high U.S. socioeconomic growth: U.S. real GDP increases 4.7 times current levels, and population growth increases by 1.9 times. Under the HH scenario, these growth increases are coupled with high global emissions. Between the HL and HH scenarios is the HM scenario (RCP 8.5 and SSP2), which has high global emissions and, consequently, high warming. Under the HM scenario, U.S. socioeconomic growth is moderate: a 2.8 times increase in U.S. real GDP and a 1.4 times increase in U.S. population growth. More information about these scenarios is available in Langner et al. (2020).

Wear and Prestemon (2019a) downscaled U.S. population and income projections to the county scale. Based on those projections the Southern U.S. population is expected to increase between 1.5 (SSP1) and 1.9 (SSP5) times, which suggests that population growth in the South is expected to outpace the rest of the country. Though downscaled GDP projections were not available from Wear and Prestemon (2019b), their per capita income projections suggest increases of between 1.7 (SSP3) and 2.4 (SSP5) times in the South.

Johnston et al. (2023) outline the assumptions regarding technology change, bioenergy preferences, and trade preferences. Primary inspiration for the bioenergy assumptions derives from Bauer et al. (2017) and Riahi et al. (2017), on technology change from O'Neill et al. (2017), and trade preferences from Popp et al. (2017) and O'Neill et al. (2017). These categories of assumptions are also summarized and more finely elaborated by Daigneault et al. (2019). Two special scenarios carried out for this Outlook address the potential increase in consumption and production of mass timber products, as outlined by Ganguly (2021), implementing increases in mass timber use across 12 major potential producing and consuming markets, including the United States.

RCPs are designed to capture the range in projected radiative forcing (W/m^2) found in scientific literature. Radiative forcing is also used as an input into General Circulation Models (GCMs), which are used to model future climates. There are numerous

Table 1—Characteristics of the four 2020 Resources Planning Act Assessment scenarios

	Scenario			
Scenario characteristic	**LM** Lower warming and moderate U.S. growth	**HL** High warming and low U.S. growth	**HM** High warming and moderate U.S. growth	**HH** High warming and high U.S. growth
Global warming and U.S. socioeconomic growth	Low	High	High	High
Global real GDP growth, 2020–2070	Medium (4.9x)	Low (3.2x)	Medium (4.6x)	High (6.9x)
Global population growth, 2020–2070	Low[1] (1.2x)	High (1.6x)	Medium(1.4x)	Low(1.2x)
U.S. real GDP growth, 2020–2070	Medium (3.0x)	Low (1.9x)	Medium (2.8x)	High (4.7x)
U.S. population growth, 2020–2070	Medium (1.5x)	Low (1.0x)	Medium (1.4x)	High (1.9x)
Global emissions	Lower	High	High	High
Technology change	High	Low	Moderate	High
Bioenergy preferences	High	Low	Moderate[2]	High
Trade openness	Moderate	Low	Moderate[3]	High
Global scenario links	RCP 4.5-SSP1	RCP 8.5-SSP3	RCP 8.5-SSP2	RCP 8.5-SSP5

LM = lower warming-moderate economic growth; HL = high warming-low economic growth; HM = high warming-moderate economic growth; HH = high warming-high economic growth.
Numbers in parentheses are the factors of change in the projection period. For example, U.S. real gross domestic product increases by a factor of 3.0 between 2020 and 2070 in scenario LM.
GDP = gross domestic product based on estimates by the International Institute of Applied Systems Analysis (2019).

[1] Low population involves initial increase with declines in the later decades of the projection period.

[2] Under the HM-Mass Timber scenario for this Outlook, projections align with the "Optimistic" scenario for the United States and 11 other countries, as described by Ganguly (2021) and Nepal et al. (2021).

[3] Under the HM-Restricted Trade scenario for this Outlook, U.S. imports have a simulated ad valorem tariff applied at 30 percent and U.S. exports have a simulated ad valorem tariff applied by all foreign destination countries of 20 percent.

Source: Langner et al. (2020).

competing GCMs; for the RPA Assessment and for SFO, five of those GCMs were selected to pair with each scenario. The five GCMs can be classified into least warm, hot, dry, wet, and middle climate futures for the United States (table 2).

We note that the GCM classification into least warm, hot, dry, wet, and middle is based on long-term average departures (1971–2000 versus 2041–2070) over the entire United States; this classification is relevant to the South (fig. 2). In the South, under the least warm model, average annual temperature is projected to increase 1.1 °C (RCP 4.5) to 2.75 °C (RCP 8.5). The wet model projects a substantial increase in annual precipitation, surpassing other projections after 2025 under RCP 4.5 and around 2050 under RCP 8.5. In contrast, the dry model anticipates a decline in precipitation after 2025 under both scenarios, consistently remaining below the projected precipitation of all other models. The middle climate model demonstrates a middle ground between the wet and dry models under RCP 4.5. Conversely, under RCP 8.5, the precipitation projection is more pronounced than that of the hot model but falls short of reaching the level observed in the wet core model.

Table 2—General Circulation Models used with each Resources Planning Act Assessment scenario

	Least warm	Hot	Dry	Wet	Middle
General circulation model	MRI-CGCM3	HadGEM2-ES	IPSL-CM5A-MR	CNRM-CM5	NorESM1-M
Source institution	Meteorological Research Institute, Japan	Met Office Hadley Centre, United Kingdom	Institut Pierre Simon Laplace, France	National Centre of Meteorological Research, France	Norwegian Climate Center, Norway

Source: Langner et al. (2020).

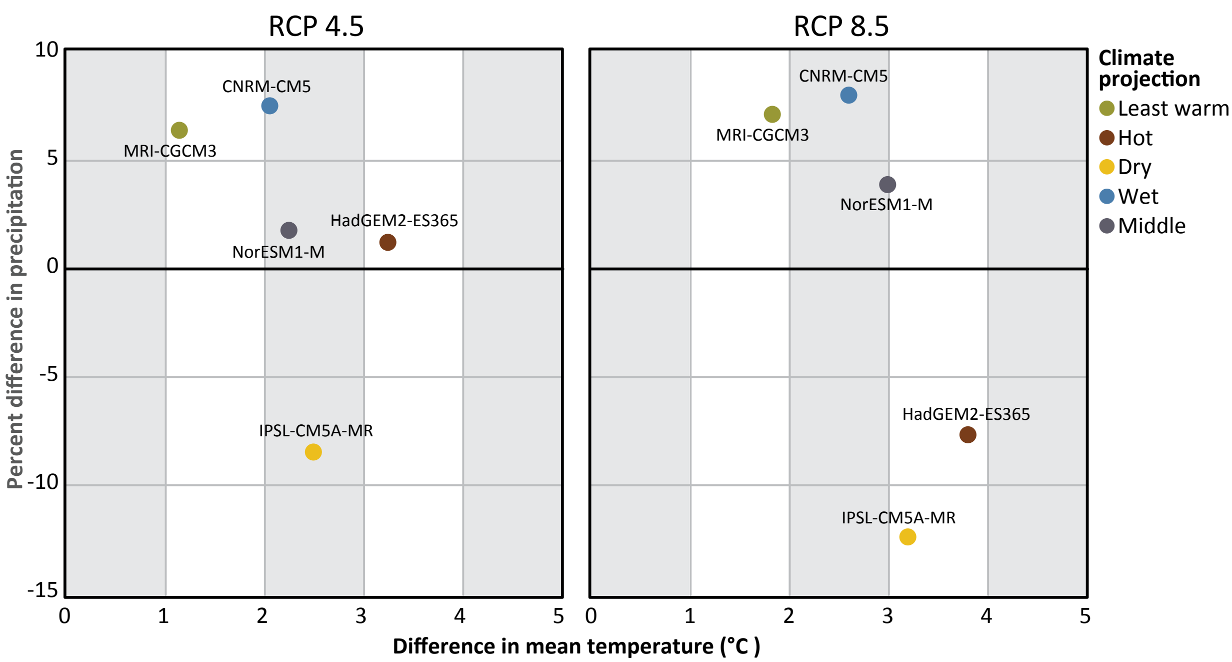

Figure 2—Comparison of the climate projections used in the *Southern Forest Outlook* for two representative concentration pathways (RCP, emissions future), showing differences in mean annual temperature and percent differences in mean total annual precipitation between the 1971–2000 and 2041–2070 time periods in the U.S. South. Model names corresponding to the projections are listed under each colored dot; the descriptive names of the projections are in the legend. Source: Joyce and Coulson (2020: 84).

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The four different RPA scenarios (table 1) are combined with the five different climate models to produce 20 different scenario-climate futures (When specified, these are denoted with an RPA scenario-climate model format.) These scenario-climate futures represent a broad range of socioeconomic futures, warming futures, and temperature and precipitation futures; together, these futures create an envelope under which the forests of the Southern United States might exist.

For the markets analysis of the SFO, we designed two additional scenarios that each depart only one way from the HM scenario described previously. The HM-Mass Timber scenario is based on all the HM scenario assumptions except for a hypothetical rapid expansion in the consumption of mass timber products in 12 selected countries across Asia, Europe, North America, and South America that extends until 2060 and remains constant thereafter (Ganguly 2021). Besides the United States, mass timber adoption is assumed to accelerate in the following countries: Brazil, Argentina, Chile, Spain, Italy, France, Germany, the United Kingdom, Poland, the Netherlands, and Austria. In these countries, and under the Optimistic Estimate scenario, total mass timber consumption is assumed to increase from 0.656 million MBF (1.553 million m^3) in 2025 to 10.5 million MBF (24.816 million m^3) by 2060 (and then remain constant from that point onward). For the United States, consumption is assumed to rise from 0.017 million MBF (0.037 million m^3) in 2025 to 1.298 million MBF (3.064 million m^3) by 2060. For context, under the HM scenario, U.S. consumption of softwood lumber, the input to mass timber products, is projected to increase from 31.86 million MBF (77.23 million m^3) in 2015 to 40.661 million MBF (98.584 million m^3) in 2060. It is expected that this scenario would lead to a rise in softwood lumber prices, softwood lumber production, and softwood lumber consumption, with uncertain impacts on markets for softwood industrial roundwood, wood-based panels, and pulp and paper, and have uncertain additional effects revealed in the form of changes in net trade to and from the RPA South Central and Southeast subregions. Overall, the jobs impact of this scenario is likely to be positive but potentially small, due to interproduct substitution, which mutes overall wood product demand due to price changes.

The HM-Restricted Trade scenario is based on the HM scenario assumptions, except for a hypothetical simulated increase in trade costs on U.S. imports and exports of forest products. Under this scenario, trade costs are assumed to increase in 2020 by 25 percent relative to recent history (i.e., over and above changes recently experienced in the U.S. trade posture), effectively modeling the effect of increased barriers against U.S. exports to all other countries by about 20 percent and increased barriers against U.S. imports from all other countries by about 30 percent. This scenario is intended to reveal how trade barriers, or a trade war involving the United States would create changes in several market variables for all product categories. The effects of such a broad increase in trade costs would imply a reduction in trade volumes across the U.S. border but have uncertain effects on intraregional trade (i.e., across regions of the United States, including the RPA South Central and Southeast subregions). A principle of trade theory would also predict lower prices for products that the United States currently has a trade surplus of (e.g., many paper products, hardwood lumber) and higher prices for products for which the United States currently has a trade deficit (e.g., softwood lumber, wood-based panels). Effects on prices, production, consumption, and trade in the South Central and Southeast RPA subregions, which are exporters to either overseas destinations or other regions of the United States, are uncertain, depending on how increased trade costs favor greater intra-U.S. exports and disfavor exports to overseas destinations.

Results

Production, Consumption, Prices, and Trade Projections to 2070

The subregional, regional, U.S., and global projection data for this Outlook are available from Guo and Prestemon (2024).

Industrial roundwood

Both softwood and hardwood industrial roundwood produced in the South are projected to rise over time, although the scenario with the lowest rate of economic growth, HL, projects small to near zero change from 2020 to 2070. Figures 3 and 4 show that Georgia, Alabama, and Mississippi are projected to remain the region's largest softwood and hardwood industrial roundwood producers. For hardwood industrial roundwood, projections also show rises except under HL, with the highest output and most vigorous growth projected for North Carolina and Virginia, then Alabama and Georgia. Under the HM-Mass Timber scenario, in which the demand for wood is greater for the construction of multifamily residential and nonresidential structures, projections show little change in softwood industrial roundwood production (higher by 0.1 percent in the South Central and by 0.2 percent in the Southeast in 2070, relative to the HM scenario in 2070; fig. 3) or hardwood industrial roundwood production (lower by 1.2 percent in the South Central and by 0.9 percent in the Southeast in 2070, relative to the HM scenario in 2070; fig. 4). Because most mass timber products are manufactured from softwood lumber, this scenario shows an increase in the consumption of softwood industrial roundwood. As a result, the byproducts generated from softwood industrial roundwood processing, such as residuals and offcuts, are utilized more extensively, reducing the overall demand for hardwood industrial roundwood. This shift in the market dynamics is expected to result in a decline in hardwood industrial roundwood production. Under the HM-Restricted Trade scenario, softwood industrial roundwood production is 0.1 percent lower in both southern subregions (fig. 3), and hardwood industrial roundwood production lower by 1 percent in the South Central and by 3.9 percent in the Southeast in 2070 compared to the HM scenario in 2070 (fig. 4). That result is due to higher tariffs applied against hardwood log exports, in which the United States has been and is projected to continue to have positive net exports (i.e., exports minus imports is a positive figure). Softwood industrial roundwood output is unchanged by the restricted trade (fig. 3), the net outcome of higher demand for wood domestically to manufacture softwood lumber and plywood and the reduced export demand for softwood products is due to the higher tariffs applied by foreign buyers.

Prices for softwood industrial roundwood have trended broadly downward over the past 2 decades, due to the rising abundance of softwood standing timber in the South, but projections show a turnaround in those prices out to 2070 under most scenarios (fig. 5). The turnaround reflects the increased relevance of rising global prices on southern pine prices as global markets for softwood expand, and projected price trends are consistent with Buongiorno et al. (2012). For hardwood, history has also shown an increasing price trend, with wide variations in trends among States (fig. 6). Export markets for hardwood roundwood (and hardwood lumber) are projected to put upward pressure on prices out to 2070.

Under the HM-Mass Timber scenario, the increasing demand for mass timber is projected to raise the price of softwood industrial roundwood by 0.2 percent by 2070 compared to the HM scenario (fig. 5). Hence, the additional wood demand to manufacture mass timber products is projected to not be enough to appreciably affect either production or prices, even though both softwood industrial roundwood production and prices would rise to accommodate greater wood needs of mass timber manufacturing facilities. Likewise, trade in industrial roundwood did not significantly change.

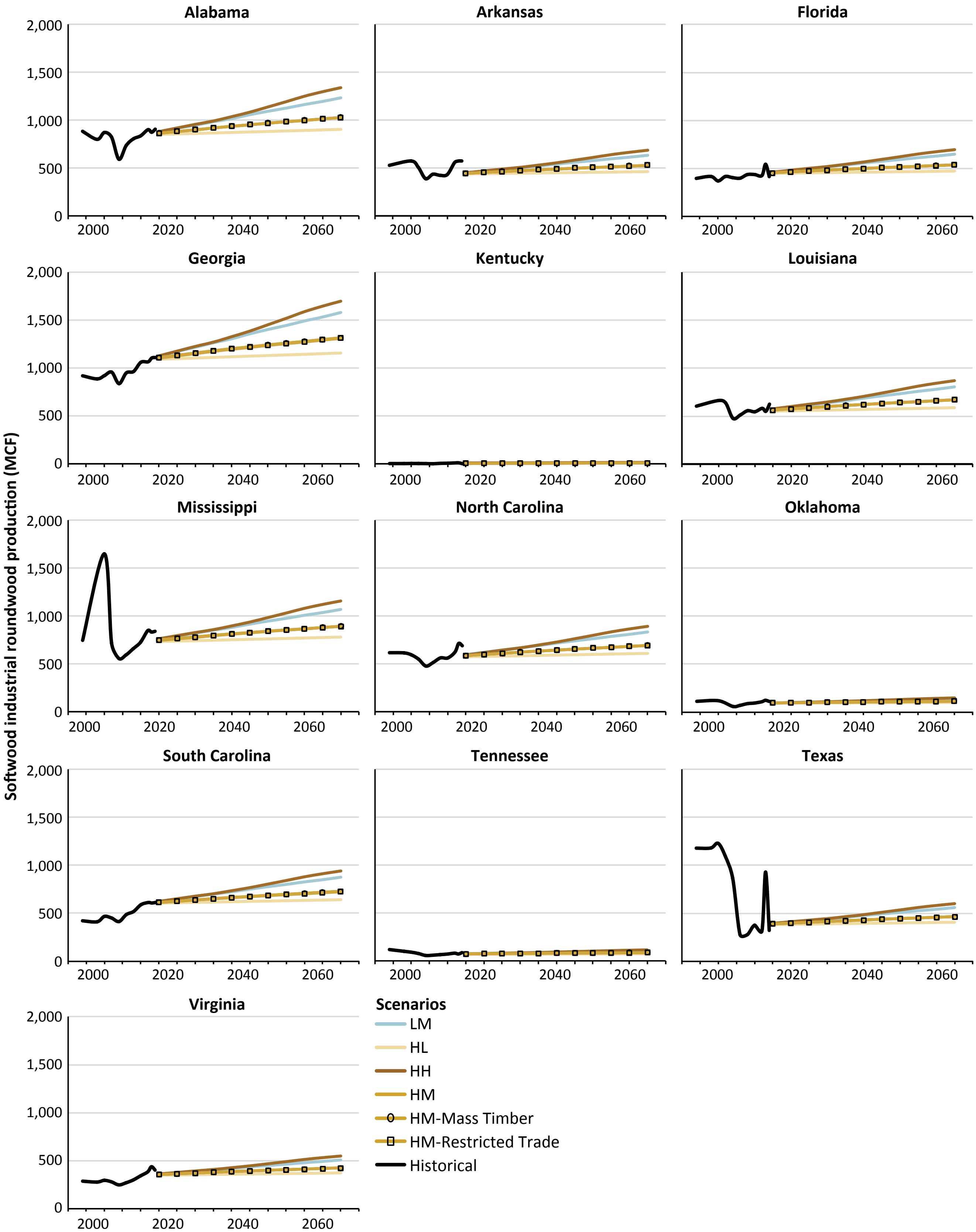

Figure 3—Softwood industrial roundwood production by State, scenario, and projected year (2020–2070). MCF = thousand cubic feet.

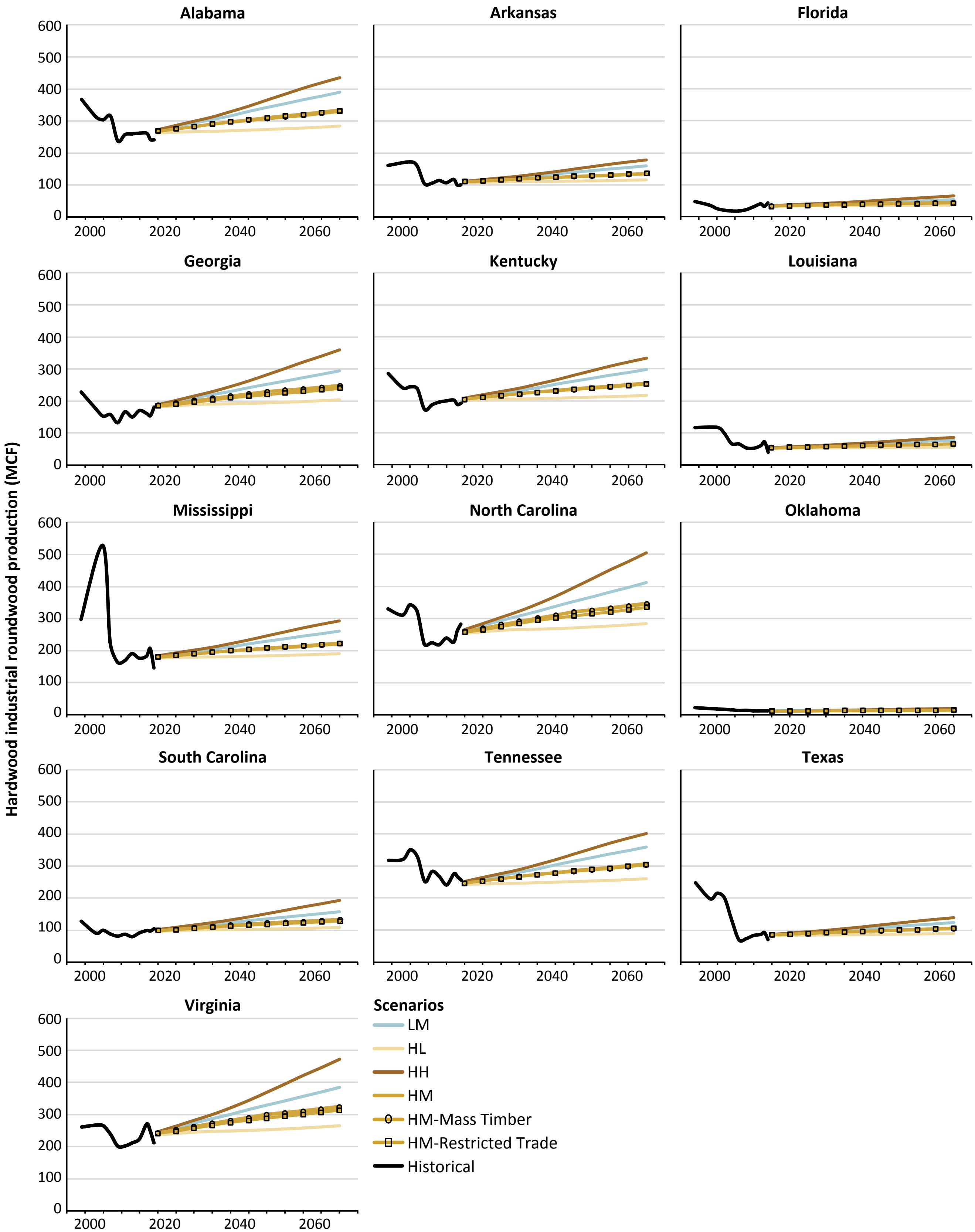

Figure 4—Hardwood industrial roundwood production by State, scenario, and projected year (2020–2070). MCF = thousand cubic feet.

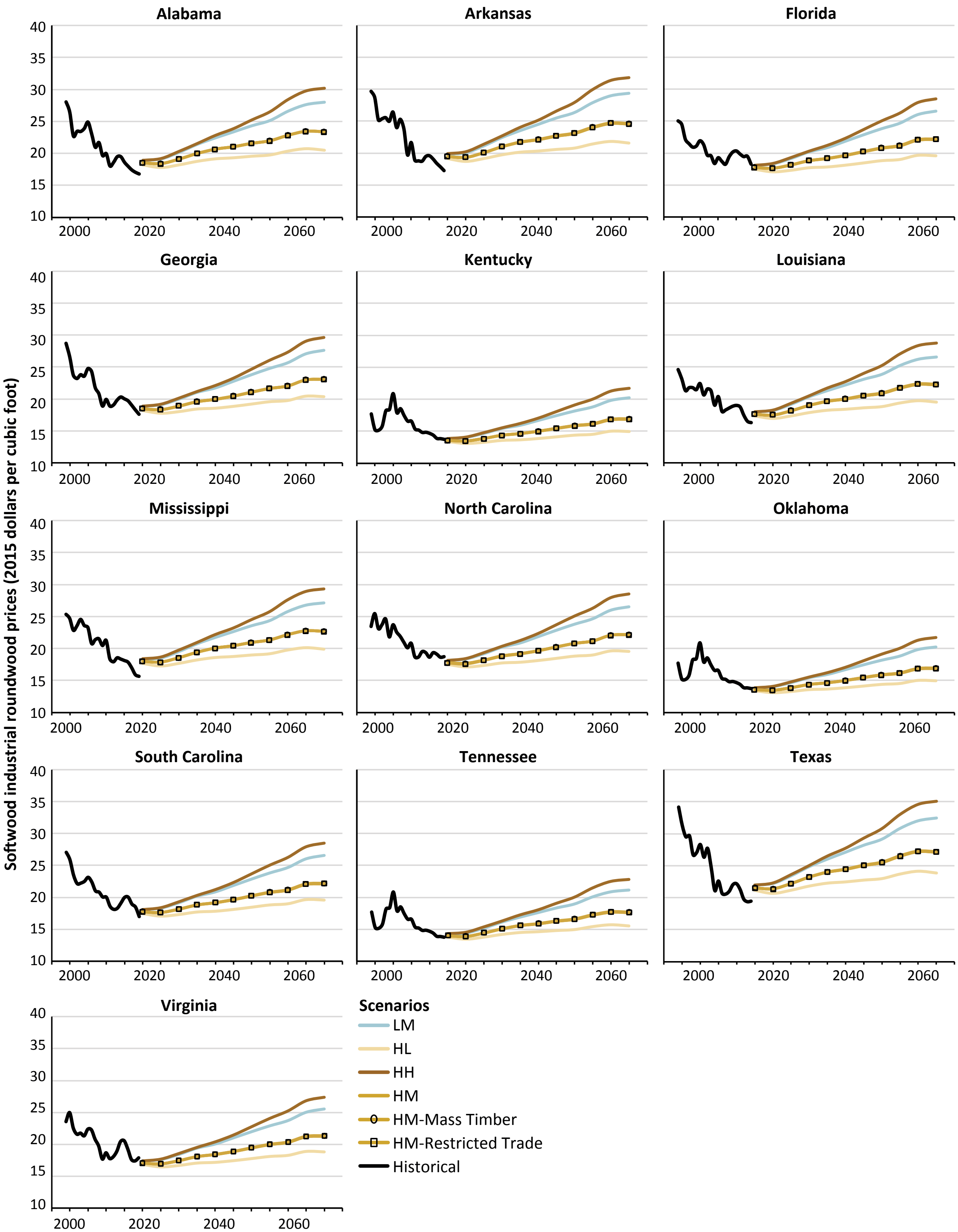

Figure 5—Softwood roundwood price by State, scenario, and year (historical, 2000–2019; projected 2020–2070).

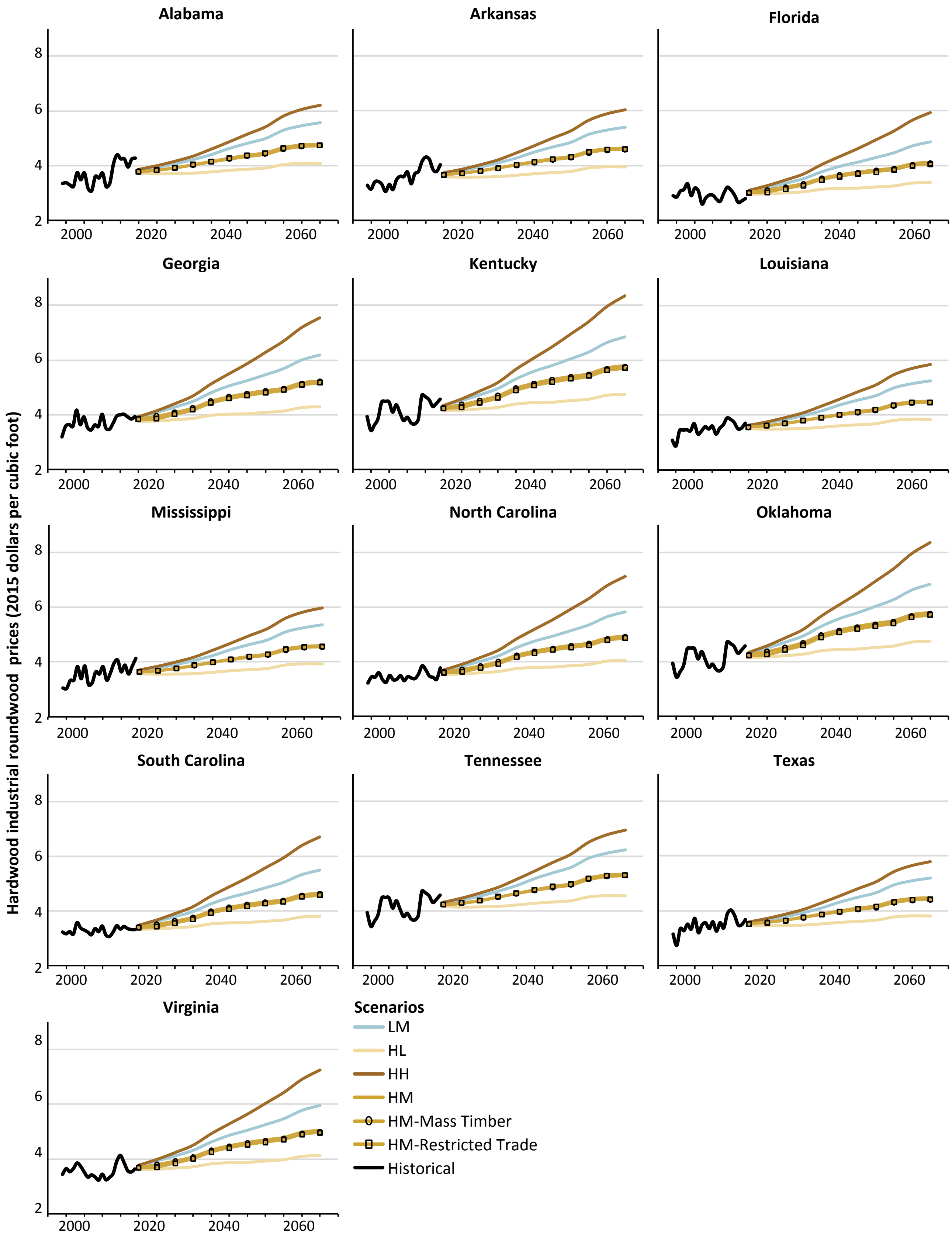

Figure 6—Hardwood roundwood price by State, scenario, and year (historical, 2000–2019; projected 2020–2070).

For hardwoods under the HM-Mass Timber scenario, prices are projected to be 1.2 percent lower in the South Central and 0.9 percent lower in the Southeast in 2070, relative to the HM scenario in 2070 (fig. 6), aligning with their projected declines in production (fig. 4).

Under the HM-Restricted Trade scenario, softwood industrial roundwood prices are 0.1 percent lower in both southern subregions in 2070, relative to the HM scenario in 2070 (fig. 5). For hardwoods, prices are 1 percent lower in the South Central subregion and 3.9 percent lower in the Southeast subregion in 2070 relative to prices in those subregions under the HM scenario in 2070 (fig. 6). Overall, the South is a net exporter of both softwood logs and hardwood logs. Simulated higher external barriers against U.S. exports are shown to put downward pressure on hardwood log export demand, driving down log export prices (and as seen in the Manufactured products section of this report, lower demand for hardwood lumber exports, as well, with a similar effect). The result for softwood is similar but of lower magnitude, in part because softwood logs can be exported to other regions of the United States, and higher barriers against softwood lumber imports translates into greater softwood lumber demand within the United States, placing upward pressure on softwood industrial roundwood prices that largely counters the downward pressure on log prices due to fewer log external export opportunities.

Despite rising production and prices for both softwood and hardwood industrial roundwood, standing timber inventories of both are projected to rise into the future across all scenarios, including in the baseline business-as-usual scenario HM; figure 7 reports this as the change in net growing-stock volume. Some of the projected rise can be attributed to climate change effects on growing conditions for most of southern forests, favoring higher growth rates. Furthermore, the growth and removal rate, most recently measured for the region across all growing stock at 1.6 (FIA 2021), meaning that only 62.5 percent of net growth is harvested, a fact reflected in recent historical increases in standing timber inventory volumes and aligning with projected futures across all scenarios. Standing timber inventory is projected to rise under the HM scenario by 52.6 percent (ranging from 47.0 to 56.1 percent across scenarios) in softwood and 59.0 percent (ranging from 46.9 to 61.0 percent across scenarios) in hardwood in the South by 2070 relative to 2020.

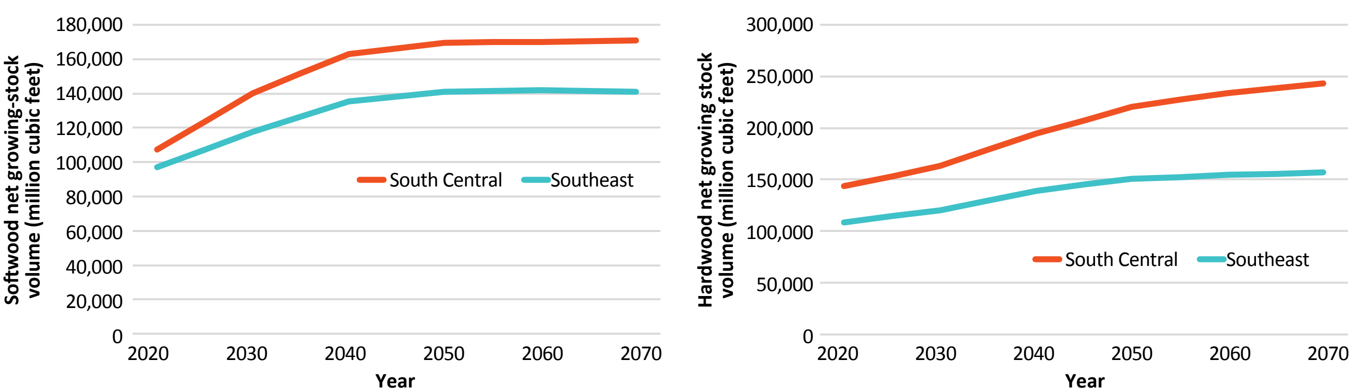

Figure 7—Net growing-stock volume on timberland by Resources Planning Act Assessment subregion under the HM scenario for (left) softwood and (right) hardwood.

Manufactured products

SOFTWOOD LUMBER—Softwood lumber production is projected to rise in the next 50 years across all 13 States under all scenarios, although low growth is projected for the States with the smallest softwood resource (fig. 8). Production is highest for the same States with the largest softwood industrial roundwood harvests: Georgia and Alabama. Under the HM-Mass Timber scenario, an expanded market for softwood lumber feeding into mass timber manufacture drives up demand for southern pine lumber. Softwood lumber production is projected to be 5.2 percent higher on average in the States of the South Central subregion and 3.9 percent higher in the States of the Southeast subregion by 2070, relative to the HM scenario (fig. 9a, b). Under the HM-Restricted Trade scenario, production averages 1.1 percent higher in the States of the South Central subregion and lower by 1.9 percent in 2070 in the States of the Southeast subregion, relative to production in 2070 under the comparison HM scenario. These divergent results across the two South subregions indicate that lower softwood imports into the United States from Canada and other trading partners favors South Central producers more than reduced export opportunities disfavors them. In the Southeast, the effects line up differently, as the Southeast is more heavily connected to export markets (fig. 9g, h).

Softwood lumber prices are projected to rise under all scenarios, for both the South Central and Southeastern United States (fig. 9e, f). The rise in lumber prices are moderate under projected low economic growth (HL) and highest under projected high economic growth (HH). Consistent with the results on production under the HM-Mass Timber scenario, prices are higher because of increased lumber demand to manufacture mass timber. Because the United States as a whole is import-dependent in softwood lumber, and the Southern United States is a positive net exporter (exports exceed imports), restricted imports into the United States favor southern producers, particularly in the States of the Southeast subregion, where prices average 5.8 percent higher in 2070 than prices in those States projected for 2070 under the comparison HM scenario.

For softwood lumber, projections of net exports (export quantity minus import quantity) reveal differing trends across scenarios (fig. 9g, h). Net exports from the South Central subregion rise until 2030 or 2040 and then fall under all but the HM-Mass Timber scenario but remain higher than the HM scenario. Under conditions of highest economic growth, the HH scenario, net exports in the South Central subregion are projected to fall from the 2020s out to 2070, a result that we attribute to vigorous economic growth, which increases consumption faster than production. Similarly, for the Southeast subregion, net exports under the HM-Mass Timber scenario rise through 2050 before leveling off. Under the HM-Restricted Trade scenario, because the South is an exporting region, we see higher net exports in all years in both southern subregions compared to the HM scenario. These higher net exports result from a reduction in imports by a larger magnitude than the reduction in exports.

HARDWOOD LUMBER—Production of hardwood lumber is projected to rise under all scenarios for all States, with the highest total output and overall quantity rises observed for North Carolina and Georgia (fig. 10). Under the HM-Mass Timber scenario, production is higher by 0.1 percent in the States of the South Central subregion and by 0.8 percent in the Southeast subregion, relative to production in 2070 under the comparison HM scenario (fig. 11a, b). Under the HM-Restricted Trade scenario, production is unchanged on average in the States of the South Central subregion but 4 percent lower than levels projected in 2070 under the HM scenario. This decline can be attributed to the U.S. South being the largest exporting region for domestically produced hardwood lumber. Restrictions on trade volumes and flows under this scenario would reduce hardwood lumber exports from the South. With fewer opportunities to sell to international markets, southern lumber producers would experience declining production.

Hardwood lumber prices are projected to rise in both the South Central and the Southeast subregions across all scenarios between 2020 and 2070, with the lowest growth under the HL scenario and highest under the HH scenario (fig. 11e, f). Under the HM-Mass Timber scenario, prices are 0.7 percent lower in the South Central and 0.6 percent higher in the Southeast subregion, a net wash regionwide, because reduced external exports are largely compensated by higher domestic intraregional export demand.

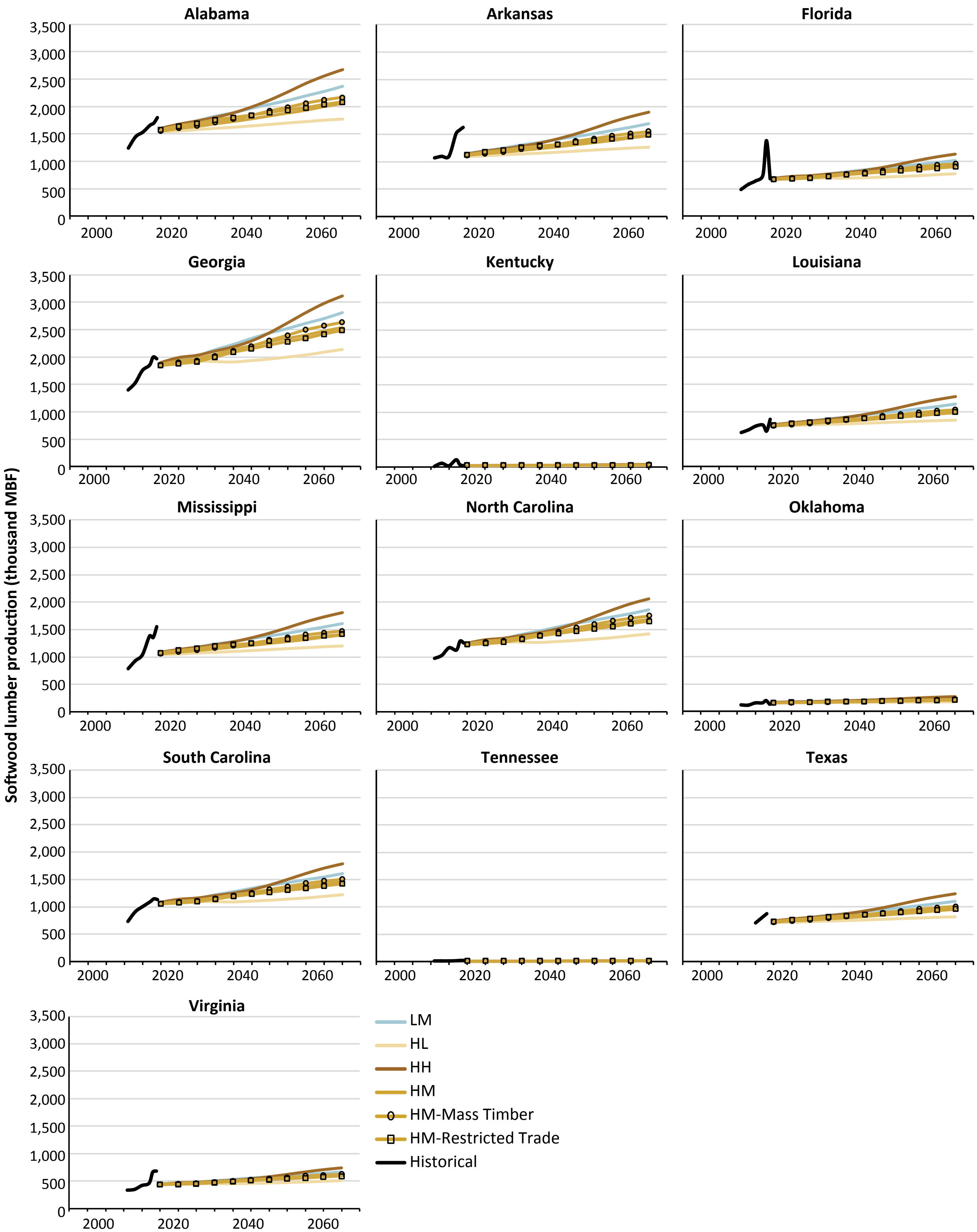

Figure 8—Softwood lumber production by State, scenario, and projected year. MBF = thousand board feet.

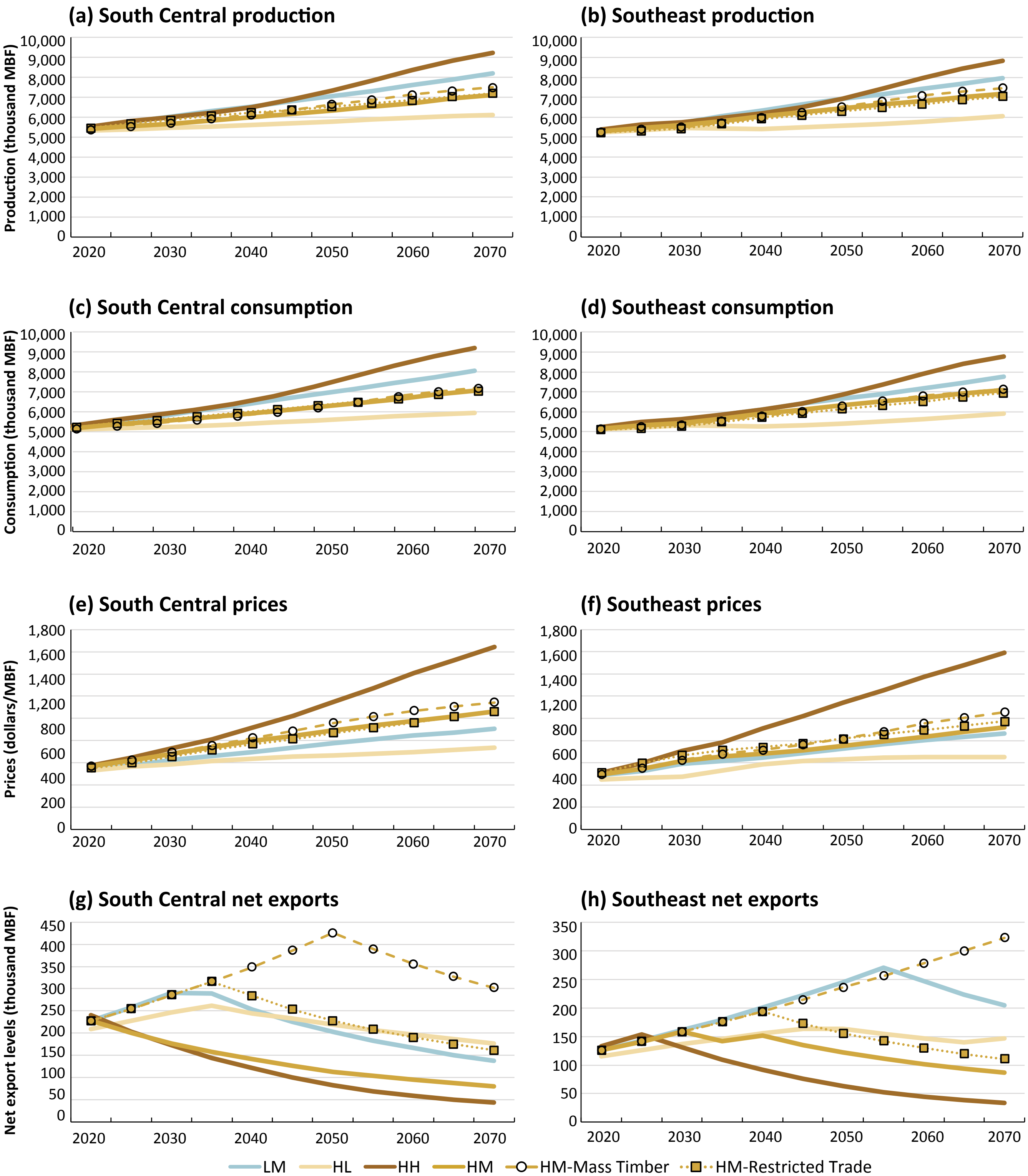

Figure 9—Projections of South Central and Southeast production, consumption, prices (in 2015 dollars per MBF), and net exports of softwood lumber by scenario. MBF = thousand board feet.

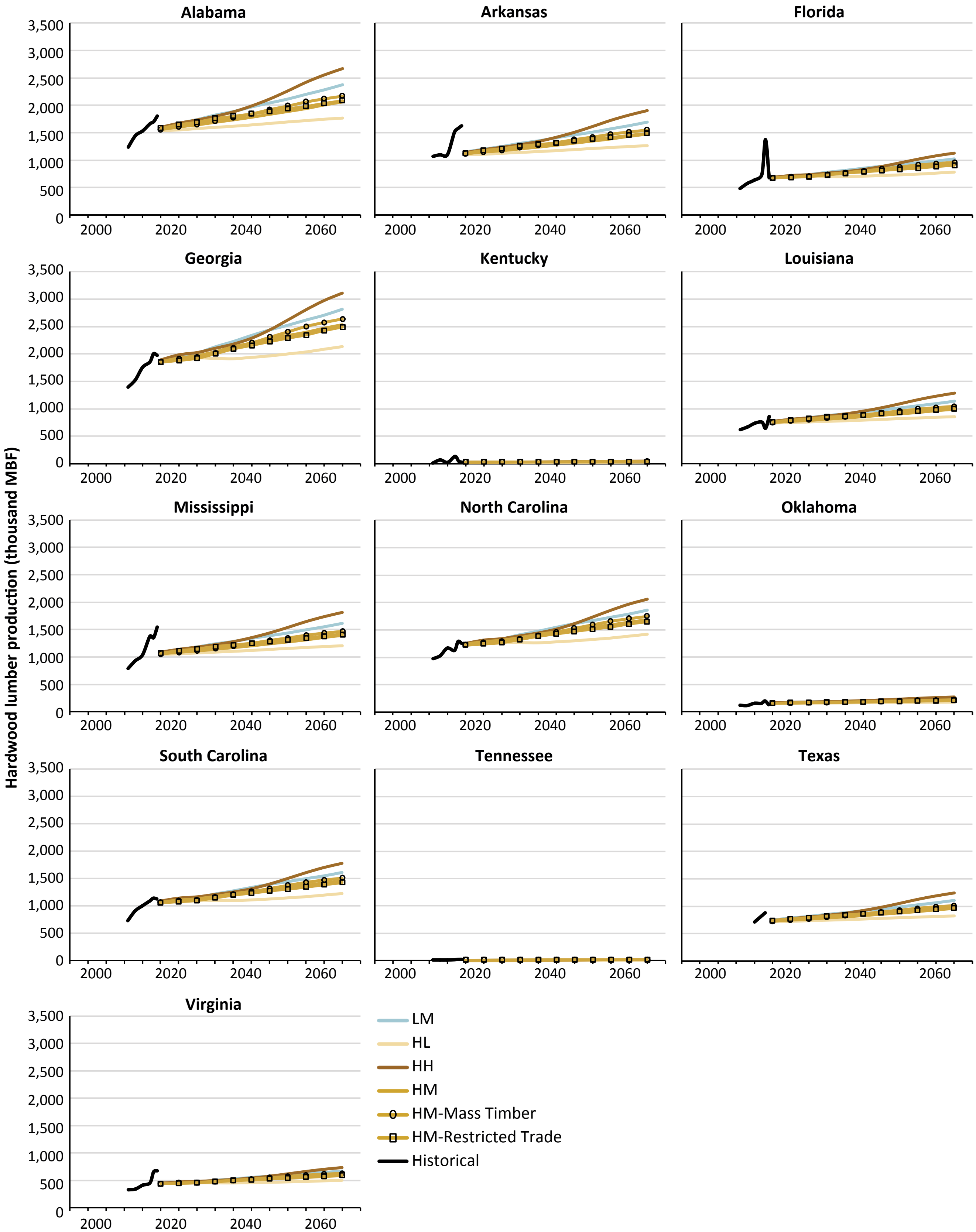

Figure 10—Hardwood lumber production by State, scenario, and projected year. Some lines overlap, indicating nearly identical time trends. MBF = thousand board feet.

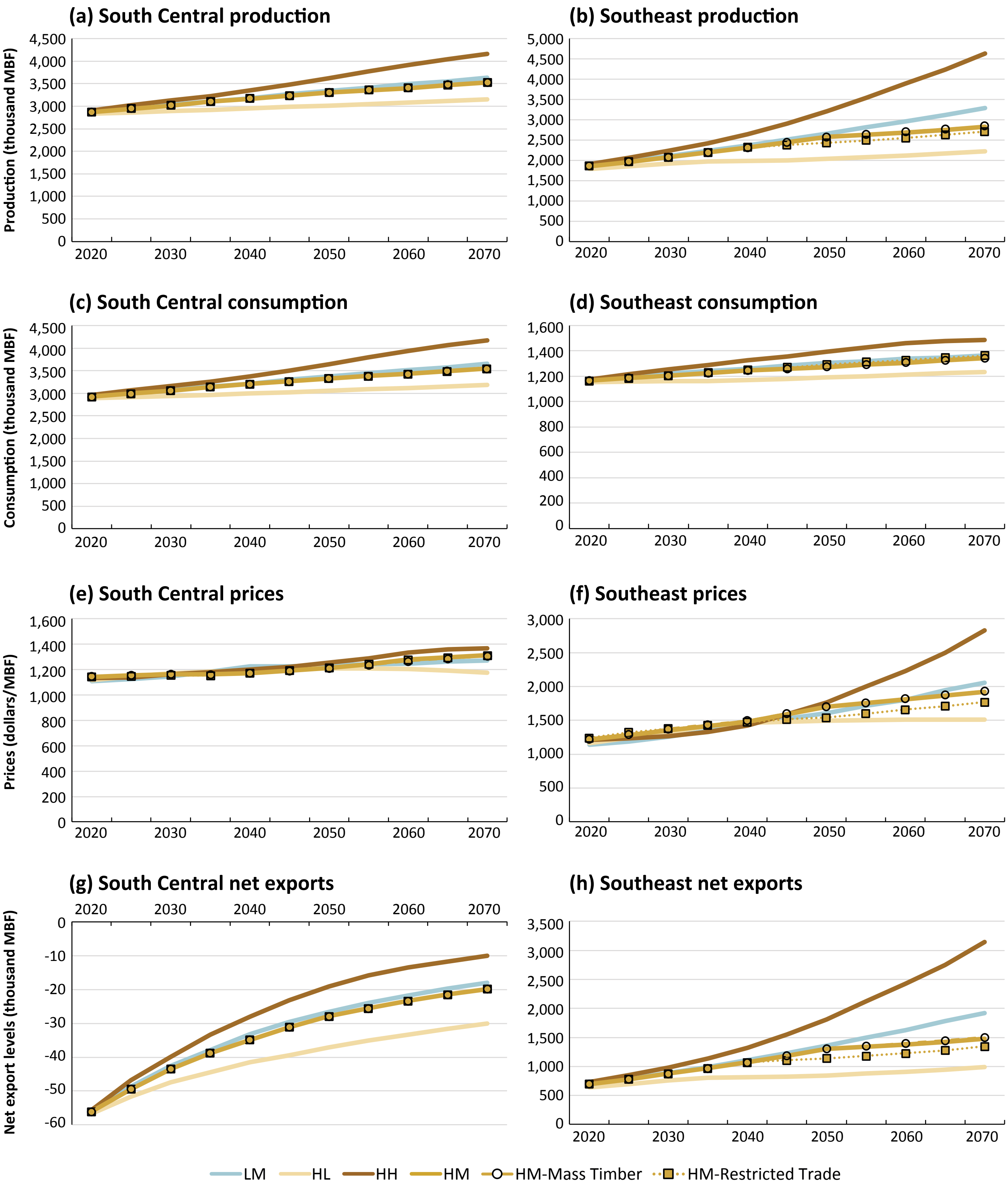

Figure 11—Projections of South Central and Southeast production, consumption, prices (in 2015 dollars per MBF), and net exports of hardwood lumber by scenario. Some lines overlap, indicating nearly identical time times trends. MBF = thousand board feet.

The observed price disparities between the HM-Mass Timber scenario and the HM scenario are relatively moderate. Notably, the substantial decline in hardwood industrial roundwood prices in the South Central subregion (fig. 6) drives down production costs for hardwood lumber. Conversely, the Southeast subregion, with its more modest reduction in hardwood industrial roundwood prices and bolstered by an expanded export market, is projected to experience a slight uptick in hardwood lumber prices. The effect of the reduced export opportunities is to induce a slower rate of price growth for hardwood lumber under the HM-Restricted Trade scenario compared to the HM scenario.

Because of its higher production (fig. 11a, b) relative to consumption (fig. 11c, d) of hardwood lumber, net exports (export quantity minus import quantity) are projected to rise across all scenarios (fig. 11g, h). The Southeast is the only subregion with significant net exports of hardwood lumber. Under conditions of high economic growth, the HH scenario, net exports are projected to increase from the 2020s out to 2070, a result that we attribute to vigorous economic growth, which increases consumption faster than production. Under the HM-Mass Timber scenario, States in the Southeast subregion have their net exports rise through 2050 before leveling off. In the Southeast subregion under either the HM-Mass Timber scenario or the HM-Restricted Trade scenario, exports are essentially unchanged compared to the HM scenario, reflecting the balance of forces both discouraging external exports and encouraging internal exports to other parts of the United States.

PLYWOOD—Plywood (the sum of hardwood plywood and softwood plywood) production in the South is projected to rise under all scenarios (fig. 12a, b). The annualized rate of growth, 2020–2070, of plywood production in the South Central subregion ranges from 0.10 percent under HL to 1.44 percent under HH. For the Southeast subregion, plywood production ranges from 0.21 percent under HL to 1.12 percent under HH. Under the baseline HM scenario, production rises by about 50 percent over the next 50 years in both the South Central and Southeast subregions. Compared to the HM scenario, the HM-Restricted Trade scenario projects a production level by 2050 that is 3.3 percent lower in the South Central subregion and 1.9 percent lower in the Southeast subregion, confirming the negative impacts of higher tariffs imposed against U.S. exports. Under the HM-Mass Timber scenario, increased demand for wood to manufacture mass timber products causes downward pressure on lumber production, by 2.5 percent in the South Central subregion and 4.0 percent in the Southeast subregion, relative to the HM scenario. This decline is primarily driven by the increased allocation of softwood roundwood for the manufacture of softwood lumber, in response to the escalating demand for mass timber, which diverts resources from plywood production. Consumption of plywood (fig. 12c, d) is projected to rise through 2050 under all scenarios, but the rate of increase is slightly lower than for production.

Although plywood prices are projected to rise for most scenarios throughout most of the projection to 2070, under the LM scenario the rise halts by 2035 and then drops in the South Central subregion (fig. 12e). In the Southeast, prices rise across all scenarios, except under the HL scenario where prices begin to drop around 2045 (fig. 12f). This decline can be attributed to a situation where the growth in the supply of plywood has outpaced the growth in the demand of plywood. Consequently, this surplus in supply has led to increased production and lower prices. For the United States as a whole, plywood imports exceed exports (net exports are negative). Projections show that this negative trade balance for the South would be smaller across all scenarios for the South, except for the low economic growth HL scenario due to lower overall trade openness in this scenario, which reduces plywood exports from the South. It is therefore logical that a scenario in which trade is restricted translates into greater domestic demand and less negative net exports (fig. 12g, h) for plywood under the HM-Restricted Trade scenario compared to the baseline HM scenario, resulting in higher prices, by 8.6 percent in the Southeast subregion and 4.0 percent in the South Central subregion, relative to the HM scenario (fig. 12e, f). Under the HM-Mass Timber scenario, as well, effects on plywood trade are similar to the HM-Restricted Trade scenario, but for a different reason; more softwood industrial roundwood is needed to manufacture softwood lumber for mass timber products, so plywood becomes more expensive by 6.5 percent in the South Central subregion and 8.4 percent in the Southeast subregion, relative to the baseline HM scenario.

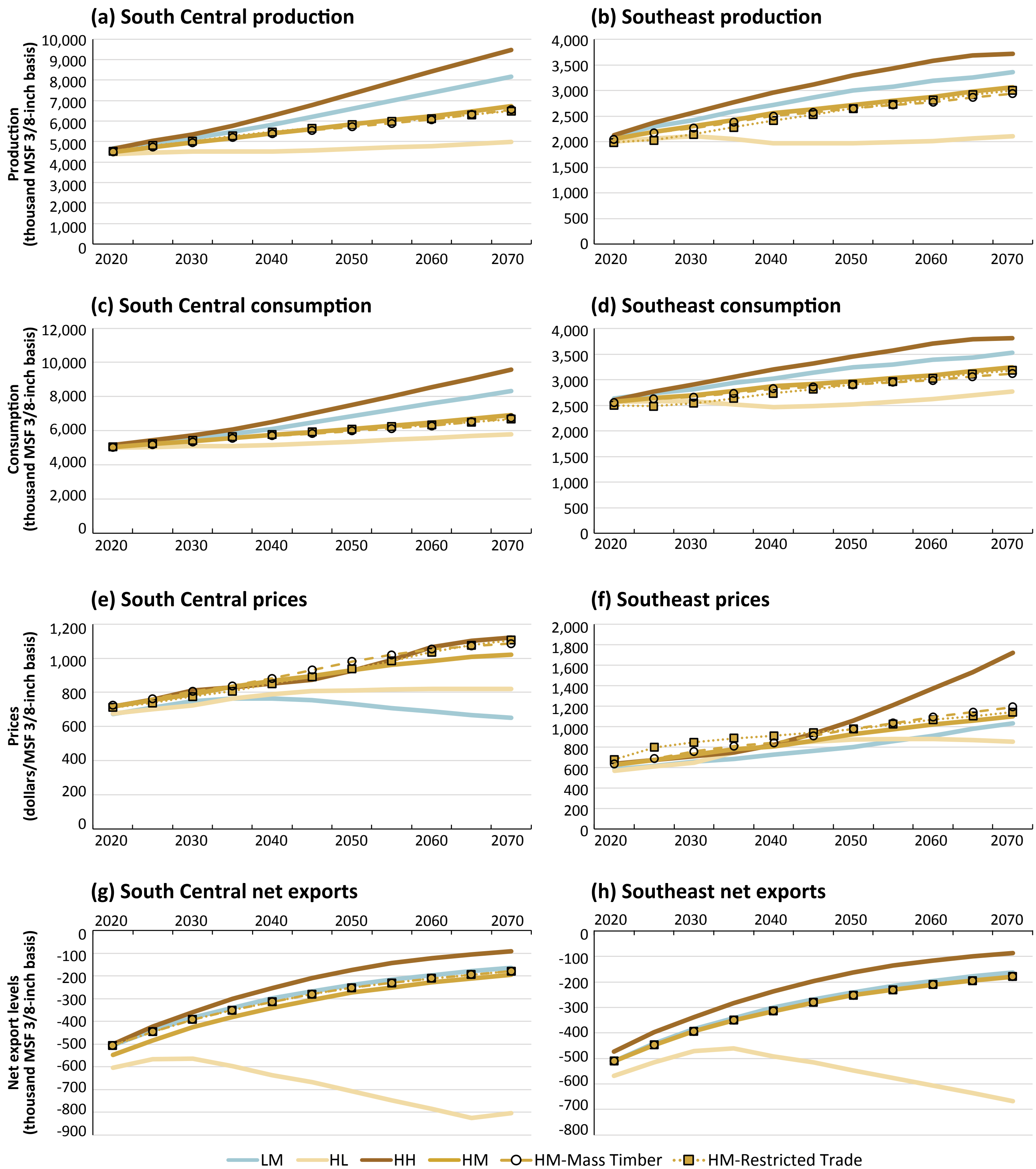

Figure 12—Projections of South Central and Southeast production, consumption, prices (in 2015 dollars per MSF), and net exports of plywood by scenario. Some lines overlap, indicating nearly identical time trends. MSF = thousand square feet.

PARTICLEBOARD—Particleboard is the aggregate of the structural panel oriented strand board (OSB) and nonstructural panels made from wood but not including fiberboard, including medium-density particleboard (MDP), waferboard, and flaxboard. Most of this category is OSB, so it is accurate to consider the projections of the future across scenarios described in fig. 13 to be representative of projected trends for OSB.

Projections of production of particleboard (OSB) show increases across all scenarios, ranging from a low of 12.7 percent for the South Central and 15.3 percent for the Southeast under the HL scenario to 46.8 percent and 50.3 percent under the HH scenario for these subregions, respectively, by 2070 (fig. 13a, b). Similar to the trade situation for plywood, the United States as a whole has negative net exports of particleboard so that consumption exceeds production for the country as a whole. However, the South is a net exporter of particleboard products (fig. 13g, h), and that status is projected to continue into the future. Similarly, prices are projected to rise across all scenarios (fig. 13e, f). The South is a net exporter in aggregate to the rest of the United States and to the rest of the world, so under the HM-Restricted Trade Scenario, in which imports shrink relative to domestic demand, production is higher, by 1.1 percent in the South Central subregion and by 1.2 percent in the Southeast subregion, relative to production projected in 2070 under the HM scenario. For the HM-Mass Timber scenario, production increases in the South Central subregion by 1.2 percent and decreases in the Southeast subregion by 1.3 percent by 2070, relative to production projected under the HM scenario. Net exports in this scenario are higher for both subregions. In contrast, prices are projected to be 1.8 percent lower in the South Central subregion and unchanged in the Southeast subregion in 2070 compared to prices in those subregions under the HM scenario in 2070, indicating that total revenue effects of mass timber are small and variable.

OTHER PANELS—Projections done for this Outlook also include results for the final category of wood panel product, fiberboard, but we leave those results in an online data archive (Guo and Prestemon 2024) that can be viewed by interested readers.

Pulp and paper sector

The pulp and paper sector is projected to have a mixed future, depending on the category of product. Projection results for the intermediate input to paper, including chemical, mechanical, other fiber pulp, and recovered (waste) paper, are available in an online data archive (Guo and Prestemon 2024). In the interest of space, we omit discussion of projections for those products and instead move directly to a presentation of three paper categories: newsprint, printing and writing paper, and other paper and paperboard.

NEWSPRINT—Historical declining trends in the newsprint market are projected to continue under all scenarios. Production in the South Central subregion is expected to decline by more than 50 percent across all scenarios by 2070 compared to 2020 (fig. 14a, b). In the Southeast subregion, a complete halt to newsprint production by 2060 is projected across all scenarios and by as soon as 2040 under the HH scenario. These results are primarily due to a more imminent collapse to zero consumption (fig. 14c, d). The United States is a net importer of newsprint overall, even though the South Central subregion (in particular) is a positive net exporter (exports exceed imports), including to the rest of the United States and overseas. The more pronounced reduction in newsprint in the Southeast subregion is connected to the expansion of wood pellet manufacturing, which utilizes much of the same feedstock as that used in newsprint manufacture, and wood pellet production is projected to increase by more in total volume in the Southeast subregion (especially Georgia and North Carolina), compared to the South Central subregion.

The decline in domestic demand for newsprint exerts strong negative pressure on newsprint prices throughout the projection under most scenarios (fig. 14e, f). And though the remaining South Central production projected to 2070 is not consumed in the South Central subregion under any scenario by 2070, there is sufficient demand domestically and overseas to motivate some positive net exports to partially compensate for lost subregional demand. Under the HM-Restricted Trade scenario, the import dependence is softened relative to the baseline HM scenario, implying that net exports would rise from 2030 onward, particularly in the South Central subregion (fig. 14g, h).

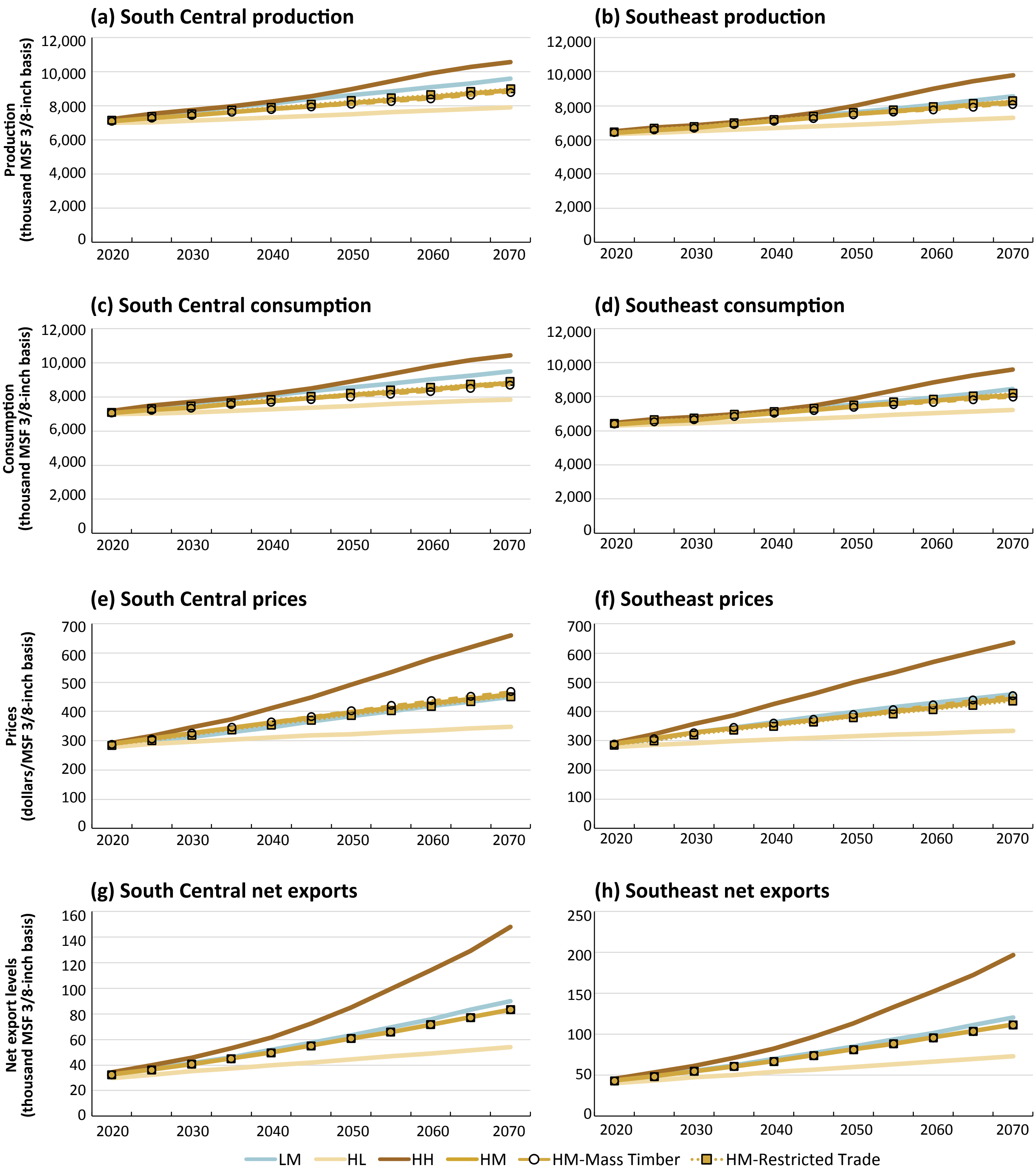

Figure 13—Projections of South Central and Southeast production, consumption, prices (in 2015 dollars per MSF), and net exports of particleboard by scenario. Some lines overlap, indicating nearly identical time trends. MSF = thousand square feet.

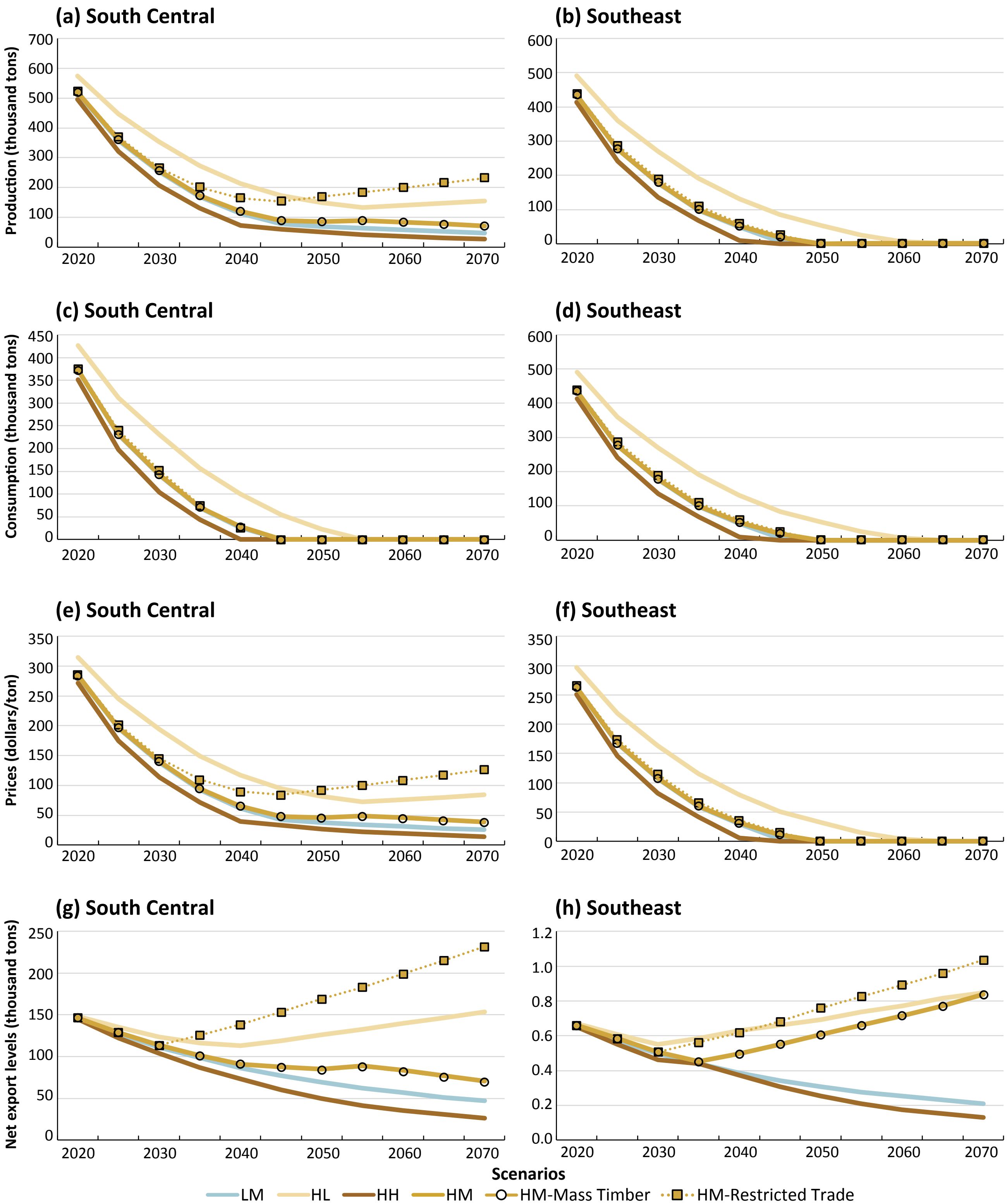

Figure 14—Projections of South Central and Southeast production, consumption, prices (in 2015 dollars per ton), and net exports of newsprint by scenario. Some lines overlap, indicating nearly identical time trends.

Under the HM-Mass Timber scenario, higher demand for wood to manufacture mass timber products puts upward pressure on prices, strengthening the projected South Central increase in net exports of newsprint from 2030 onward.

PRINTING AND WRITING PAPER—Printing and writing paper's declining historical trends have been similar but lower in magnitude compared to those exhibited by the newsprint manufacturing industry. Projected changes in production in percentage terms are nearly identical in the South Central and Southeast subregions. Production is projected to decline by nearly 70 percent southwide under the HH scenario and by 24 percent under the HL scenario, compared to the 2020 production level (fig. 15a, b). Consistent with the effects of increasing competition by electronic media on consumption, projections show declines across all scenarios (fig. 15c, d). Prices follow a similar trajectory (fig. 15e, f).

Due to its abundance of fiber from mill residues and thinning, the South is a net exporter (exports exceed imports) of printing and writing paper, and projections point to a continuance though a steady contraction of this situation (fig. 15g, h) for all scenarios except for the HM-Restricted Trade scenario, in which net exports become more positive in comparison to the HM baseline scenario, rising to 2040 before beginning to decline. This unique pattern is likely due to the greater domestic demand compared to import demand in the situation of simulated higher tariffs applied against the import-source country (mainly Canada). Under the HM-Mass Timber scenario, printing and writing paper production, consumption, prices, and net exports change only by 0.1 percent up or down, compared to the baseline HM scenario by 2070.

Other paper and paperboard

The aggregate category of other paper and paperboard primarily includes packaging, wrapping, and sanitary and household papers. Unlike trends for the graphic paper categories of newsprint and printing and writing paper, whose demand is negatively related to the growth in the electronic media sector, production (fig. 16a, b) and consumption (fig. 16c, d) of other paper and paperboard have trended upwards, and projections show a continuation. This paper category is more closely connected to economic growth, so trends in production and consumption move with overall economic growth. This pattern explains why production and consumption are highest under the high-growth HH scenario and lowest under the HL scenario. Prices rise across all scenarios (fig. 16e, f). The connection to economic growth also helps to explain rising net exports of this category from both subregions under the LM and HH scenarios but with varying trends to 2070 under other scenarios in either subregion (fig. 16g, h). The United States overall has balanced to slightly positive net exports of other paper and paperboard (exports exceed imports), and the South is one reason why, with positive net exports of about 3 million metric tons in both subregions in 2020, rising to as high as 8 million tons in the South Central subregion and 7 million tons in the Southeast subregion by 2070 under the HH scenario.

Simulated higher tariffs under the HM-Restricted Trade scenario bring down prices relative to the HM scenario (fig. 16e, f). Although net exports trend lower for both the South Central and Southeast subregions, they trend higher in the South Central subregion after 2050 while the Southeast subregion continues to decline relative to the HM scenario in 2070 (fig. 16g, h). For the HM-Mass Timber scenario, trade effects vary—smaller in the South Central subregion and higher in the Southeast subregion, but about 1 percent smaller in 2070 compared to the baseline HM scenario. Also under the HM-Mass Timber scenario, prices are higher because of the increased wood needed to manufacture mass timber.

WOOD PELLETS—Wood pellet projections show rising production across all Southern States under all but the HL scenario (fig. 17). Production of wood pellets is projected to be highest in North Carolina and Georgia under all scenarios, especially the LM and HH scenarios, where wood pellets are increasingly sought as an input to energy production in Europe, more than doubling output (except under HL) by 2070 compared to 2020. Under the LM scenario, which has the highest rate of increase projected for wood pellets, wood pellet production in the South is projected to increase to over 20,000 thousand (M) tons (oven-dried) by 2070, representing the equivalent of 4 percent of total annual roundwood removals in the United States. For the South Central subregion, production rises from about 2.825 M tons in 2020 to as high as 7,988 M tons under the LM scenario by 2070 (fig. 18a, b). For the Southeast subregion, which produces more than the South Central subregion,

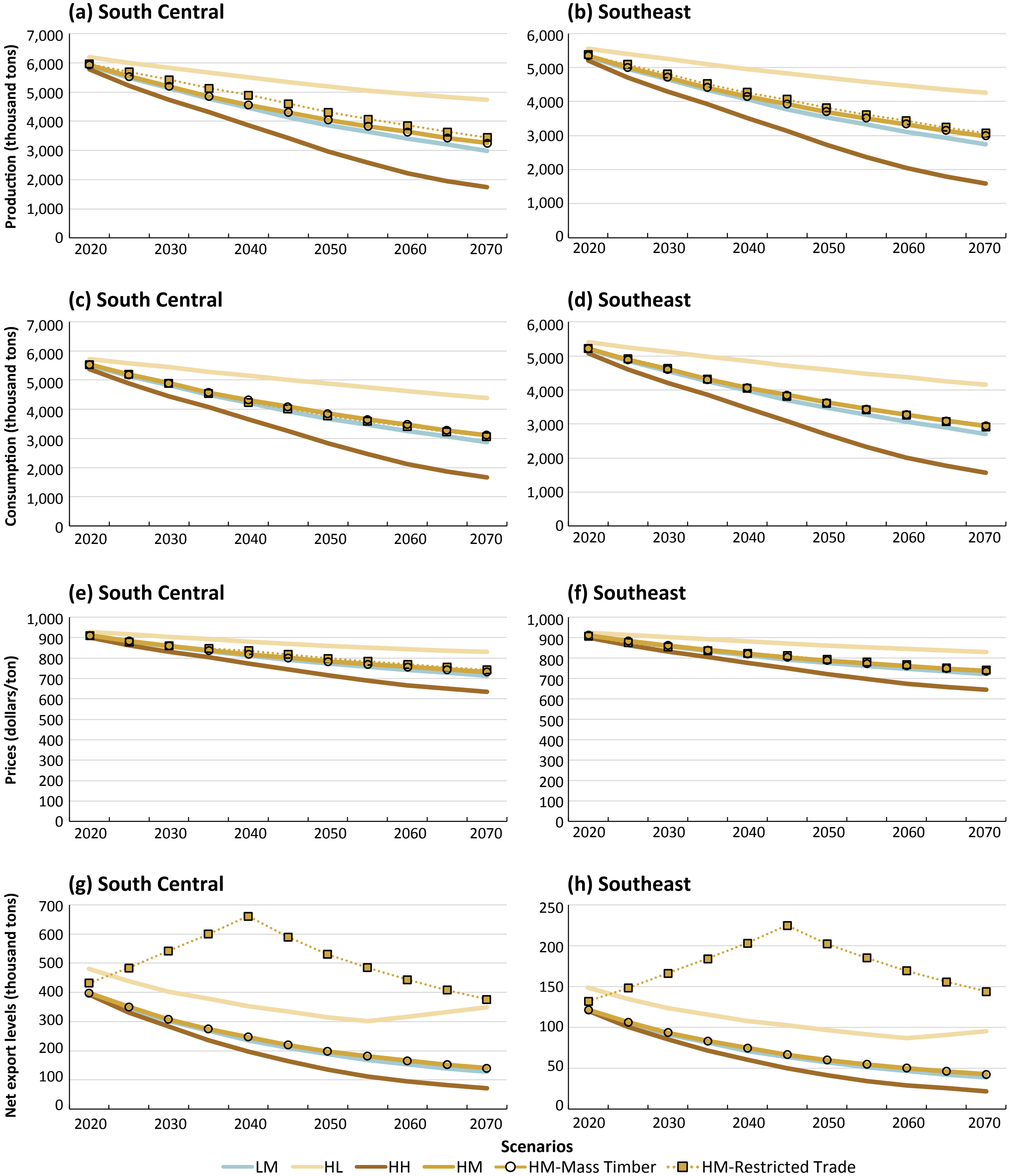

Figure 15—Projections of South Central and Southeast production, consumption, prices (in 2015 dollars per ton), and net exports of printing and writing paper by scenario. Some lines overlap, indicating nearly identical time trends.

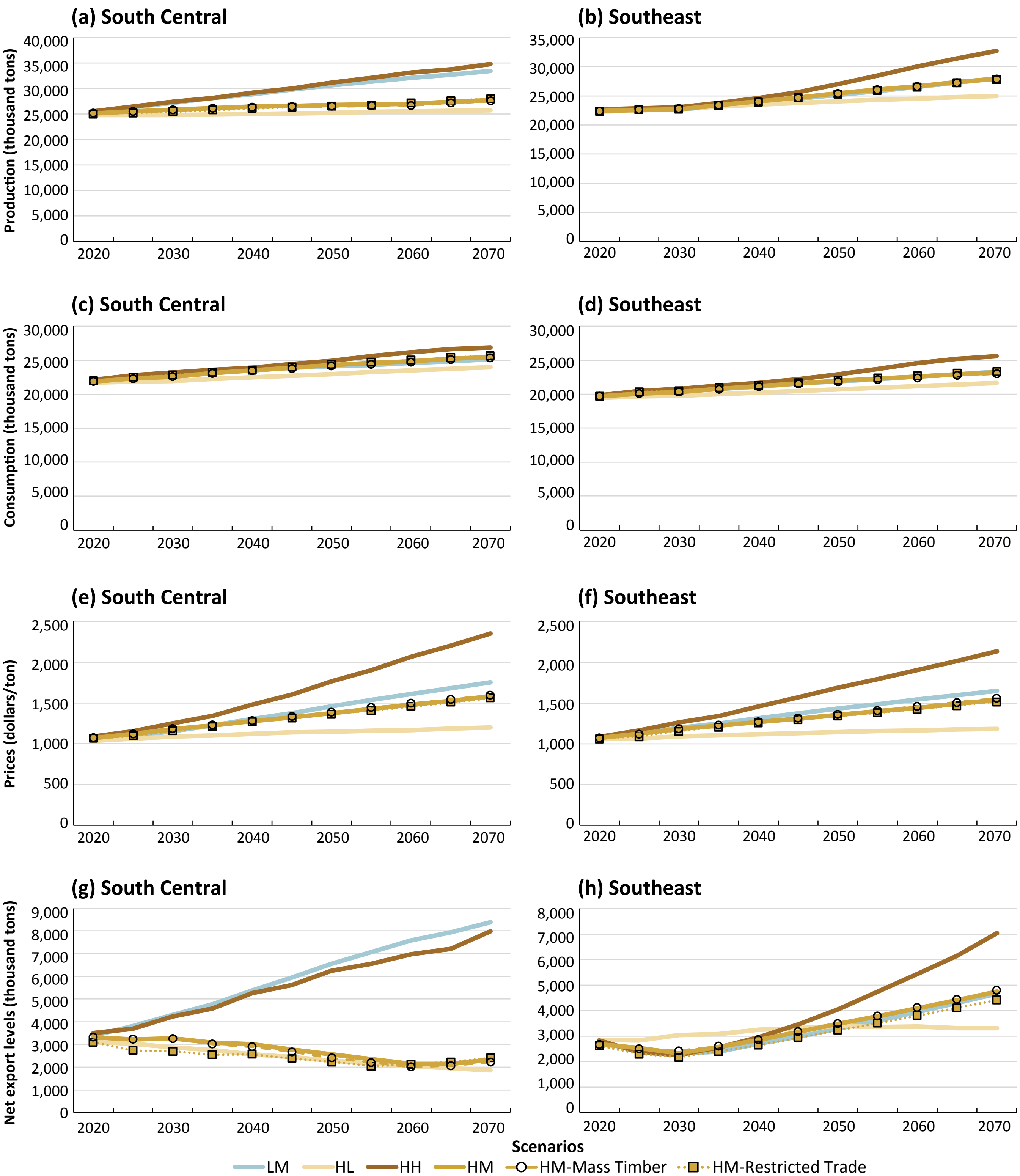

Figure 16—Projections of South Central and Southeast production, consumption, prices (in 2015 dollars per ton), and net exports of other paper and paperboard by scenario. Some lines overlap, indicating nearly identical time trends.

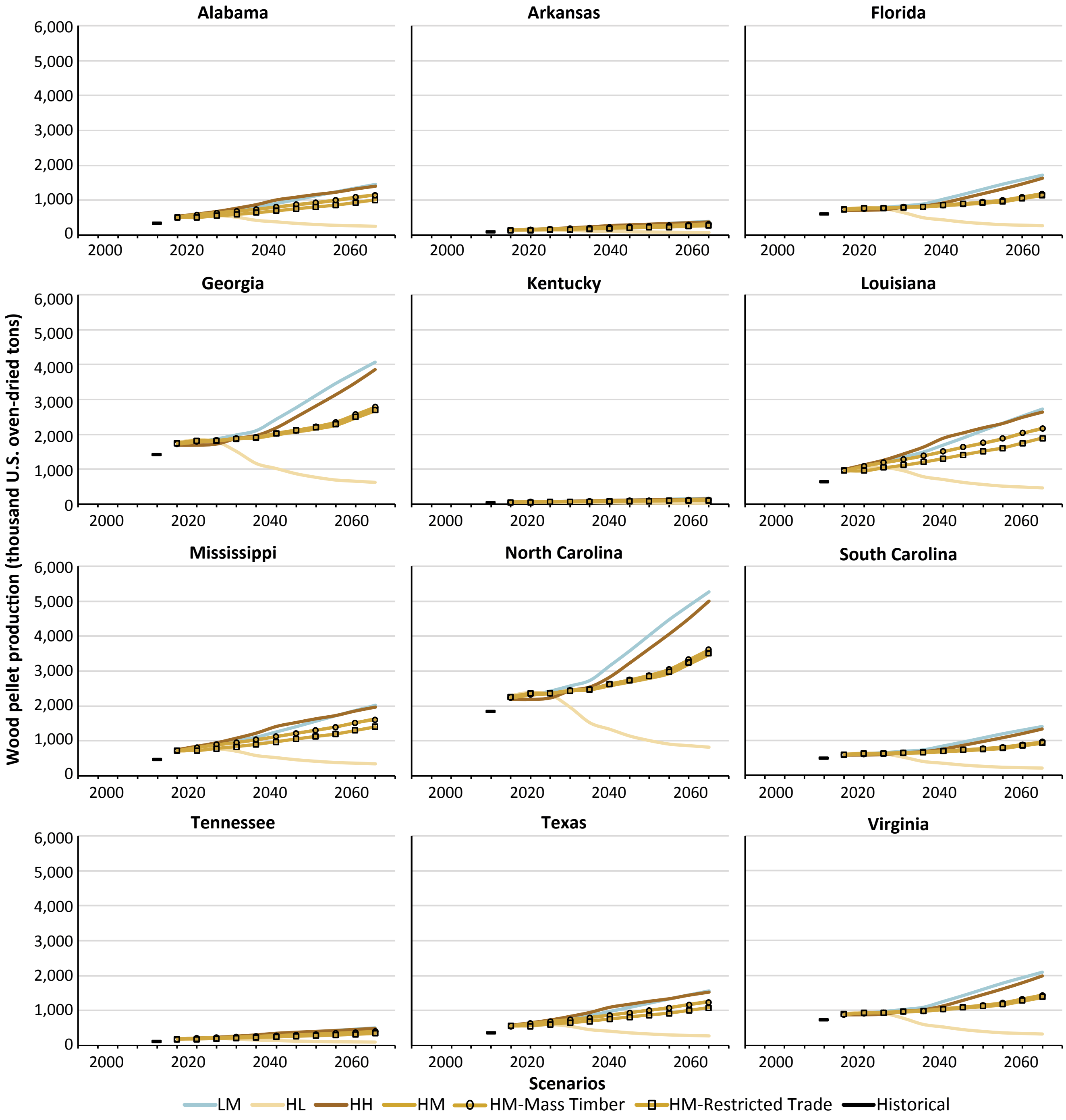

Figure 17—Production of wood pellets by State and scenario.

production rises from about 5,700 tons to about 13,210 M tons by 2070. Under the HM-Restricted Trade scenario, although still rising substantially by 2070 compared to 2020, production rises are substantially smaller overall, compared to the baseline HM scenario. They are lower by 13.5 percent in the South Central subregion but 1.4 percent higher in the Southeast subregion, a net drop of 4.9 percent southwide compared to the HM scenario. The large differences in trends between the South Central and the Southeast subregions is likely connected to the higher mill residues from lumber manufacturing. Although lumber production increases in both subregions, in the Southeast subregion, the amount of wood residue supply increase is greater than in the South Central subregion, enabling greater wood pellet production in the former compared to the latter, compared to the HM scenario. The HM-Mass Timber scenario shows slightly higher production across States compared to the benchmark HM scenario; a result driven mainly by higher production of residues that serve as feedstock for pellet manufacturers.

The effect of rising output due to high export demand for wood pellets is that prices increase between 2020 and 2070 across all but the HL scenario (fig. 18e, f). The effect of simulated higher tariffs under the HM-Restricted Trade scenario is to decrease prices southwide, including by 18.3 percent for the South Central subregion and 17.3 percent for the Southeast subregion, relative to the HM scenario in 2070. Net exports, while still positive (exports exceed imports) under the HM-Restricted Trade scenario, are smaller by 22 percent in the South Central subregion and by 2.6 percent in the Southeast subregion in 2070, relative to the HM scenario (fig. 18g, h). The effect of higher quantities of residues generated by sawmills under the HM-Mass Timber scenario compared to the HM scenario is to increase wood pellet output and to increase net exports of wood pellets by 3 percent overall in the South. This change is the net of growth in net exports by 8.6 percent from the Southeast subregion and a slight shrinkage from the South Central subregion (fig. 18g, h). Prices are also lower, by 4.3 percent in the South Central subregion and 5.2 percent by 2070 in the Southeast subregion (fig. 18e, f), due to lower wood input costs due to greater residue generation by sawmills under the HM-Mass Timber scenario compared to the baseline HM scenario.

Forest sector jobs projections

Forest sector jobs in forestry and logging, wood products manufacturing, and paper manufacturing are expected to decrease in all scenarios, as shown in figures 19 through 21. The forestry and logging industry (fig. 19) experiences a sharp decline, which continues the trend of the past 2 decades. In wood products (fig. 20), the decline in projected jobs runs counter to the increasing trends observed since the 2007–2009 recession but continues the negative trend observed over a longer span of history. Nearly all States exhibited increases in wood product manufacturing industry jobs since 2009, but those job gains appeared to have been leveling off by 2020. Data from the U.S. Bureau of Labor Statistics (2022) also show a slowdown or reversal in job growth since 2019.

The trend in the paper manufacturing industry (fig. 21) is consistent with historical patterns in all 13 States, but the decline is steeper due to rapid technology change. Projected changes in job numbers are not as widely varying across scenarios as the projected changes in prices and production across scenarios. Because of that lower variation, table 3 only provides numerical details of the projections at the State level under the HM scenario.

Paper manufacturing jobs dynamics varied widely across States, even while overall declines are projected across all scenarios. Two forces help explain the observed and projected long-run declines in the paper industry: labor-saving technology change, and reduced demand for newsprint and printing and writing paper. Although production of other paper and paperboard is projected to rise slightly or remain stagnant to 2070 (fig. 16), the shrinkage in the graphics paper market (figs. 14 and 15) acts to drive down overall jobs in the industry, a phenomenon projected for every Southern State by 2070.

Projected in this Outlook, the job impacts across the three industries are expected to vary across States based on either a rapidly growing mass timber subsector of the wood product manufacturing industry (HM-Mass Timber) or tighter trade restrictions (HM-Restricted Trade).

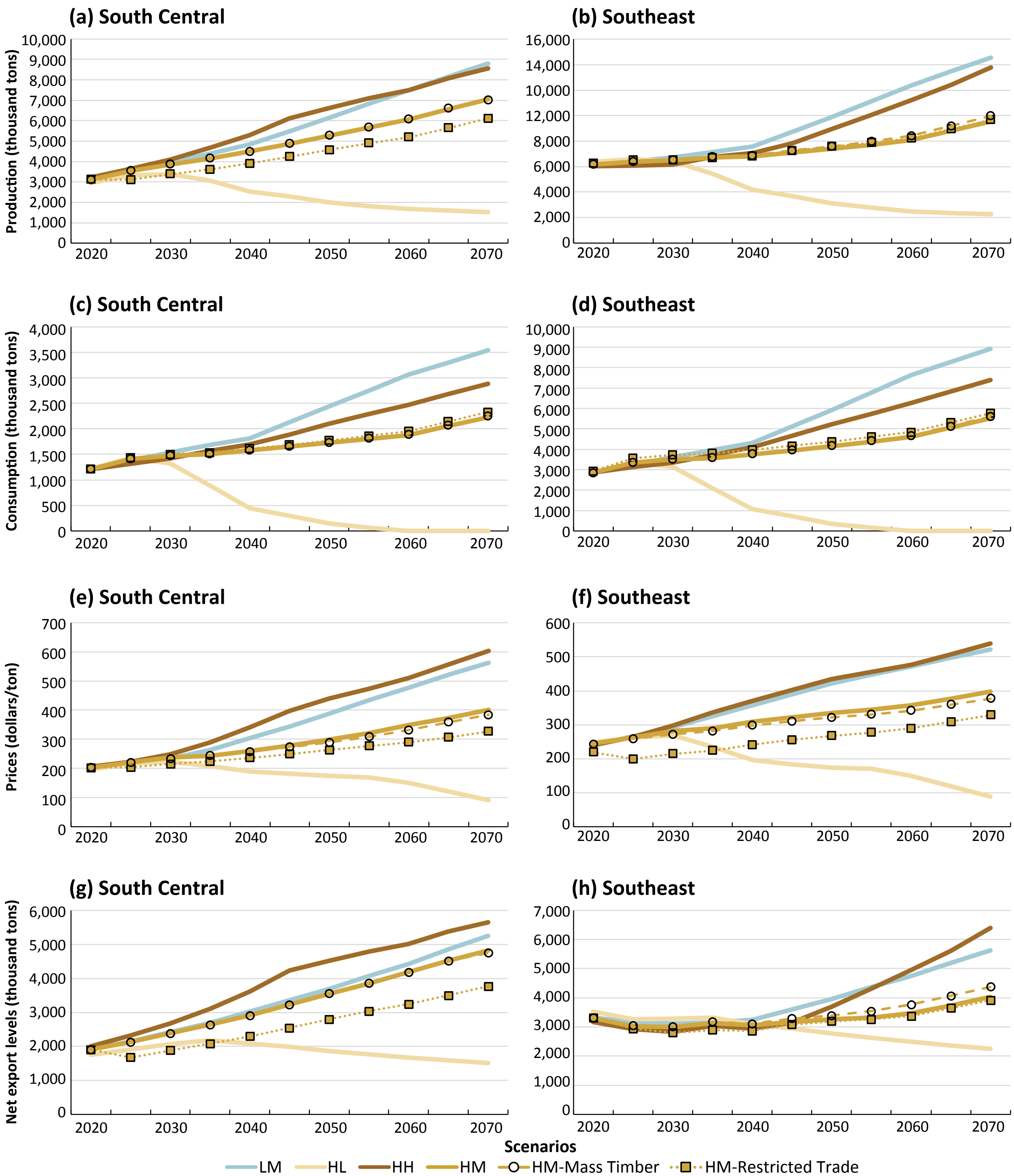

Figure 18—Projections of South Central and Southeast production, consumption, prices (in 2015 dollars per ton), and net exports of wood pellets by scenario. All values refer to oven-dried tons.

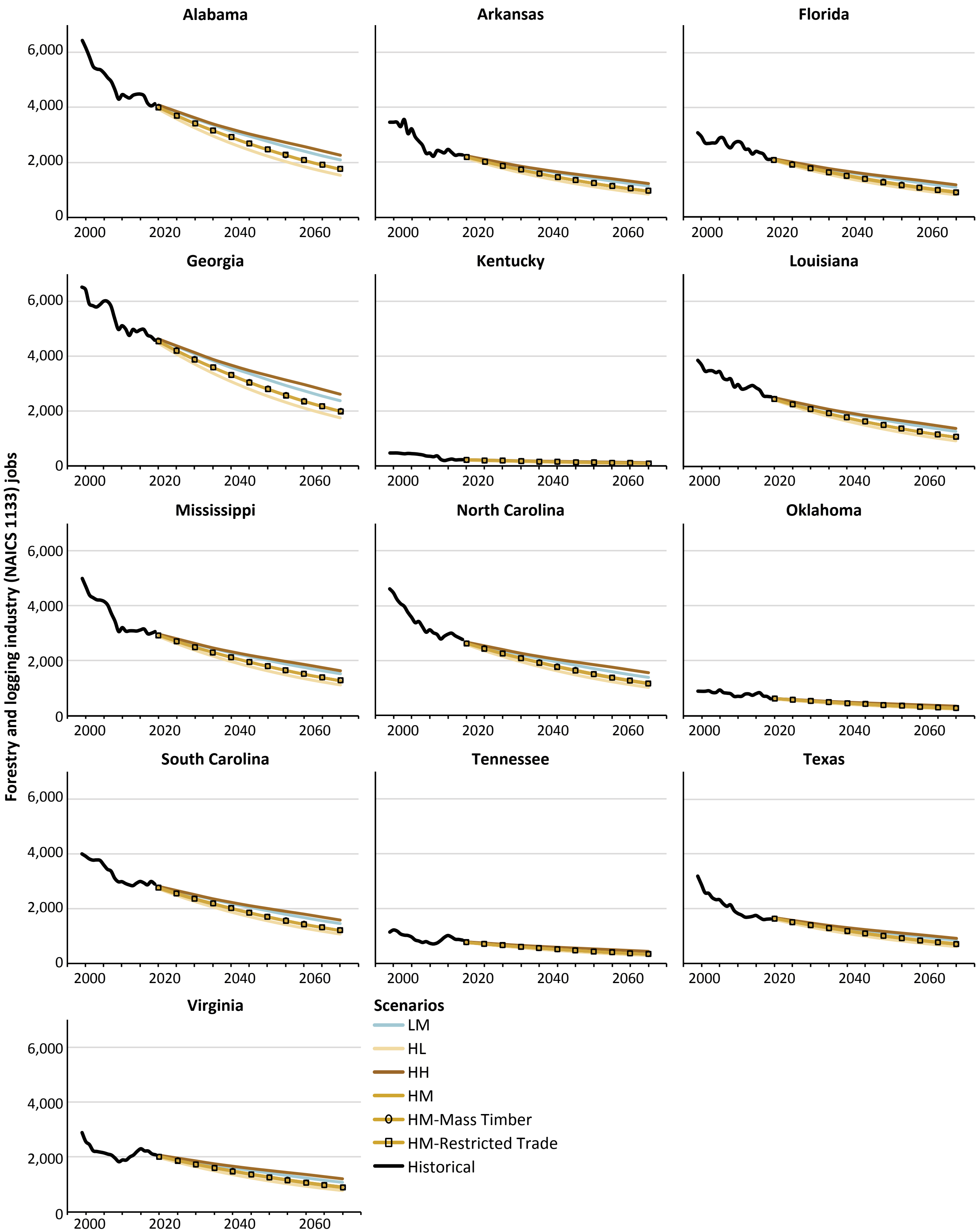

Figure 19—Forestry and logging jobs by State and year (historical, 2000–2019; projected 2020–2070 by scenario).

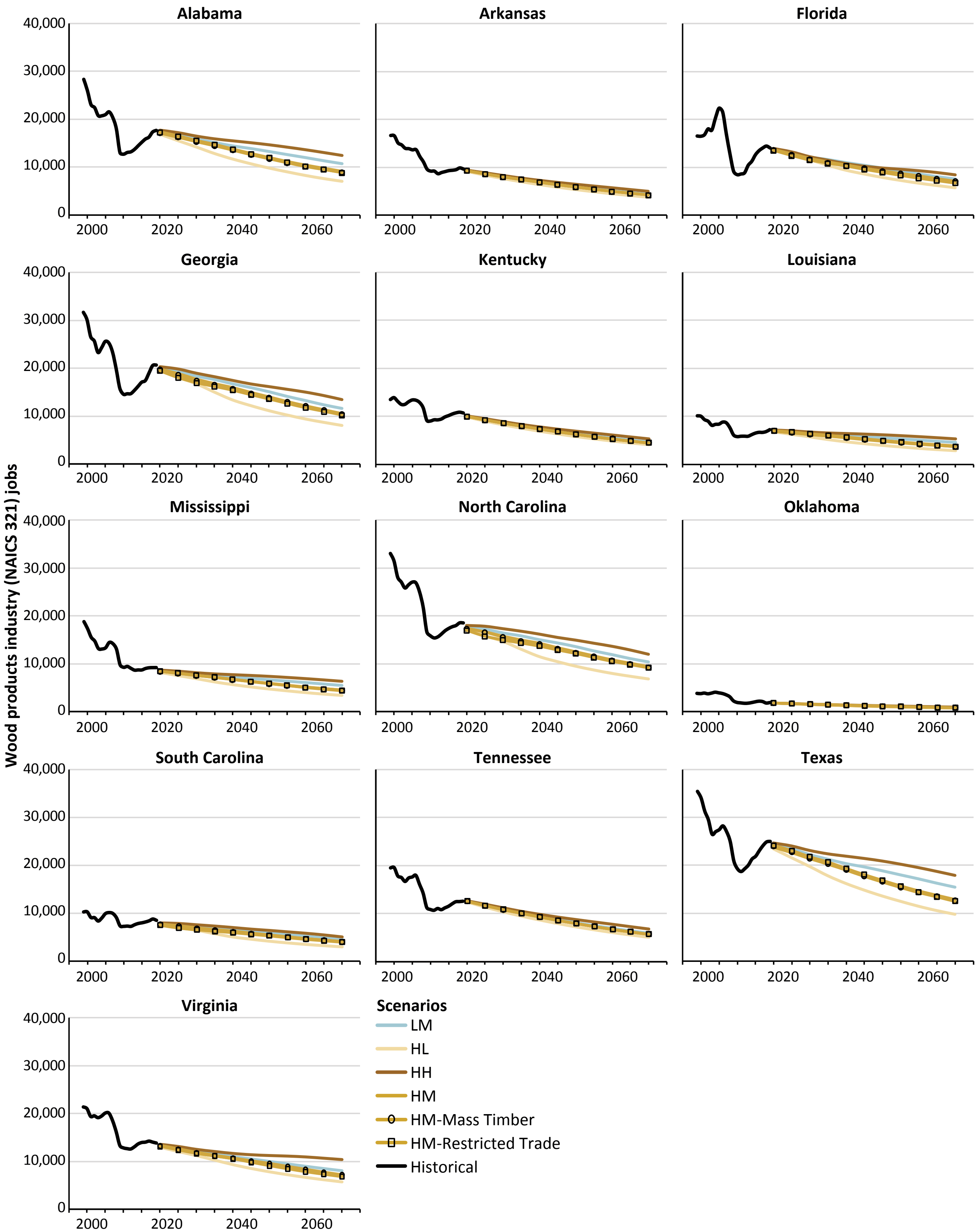

Figure 20—Wood product manufacturing jobs by State and year (historical, 2000–2019; projected 2020–2070 by scenario).

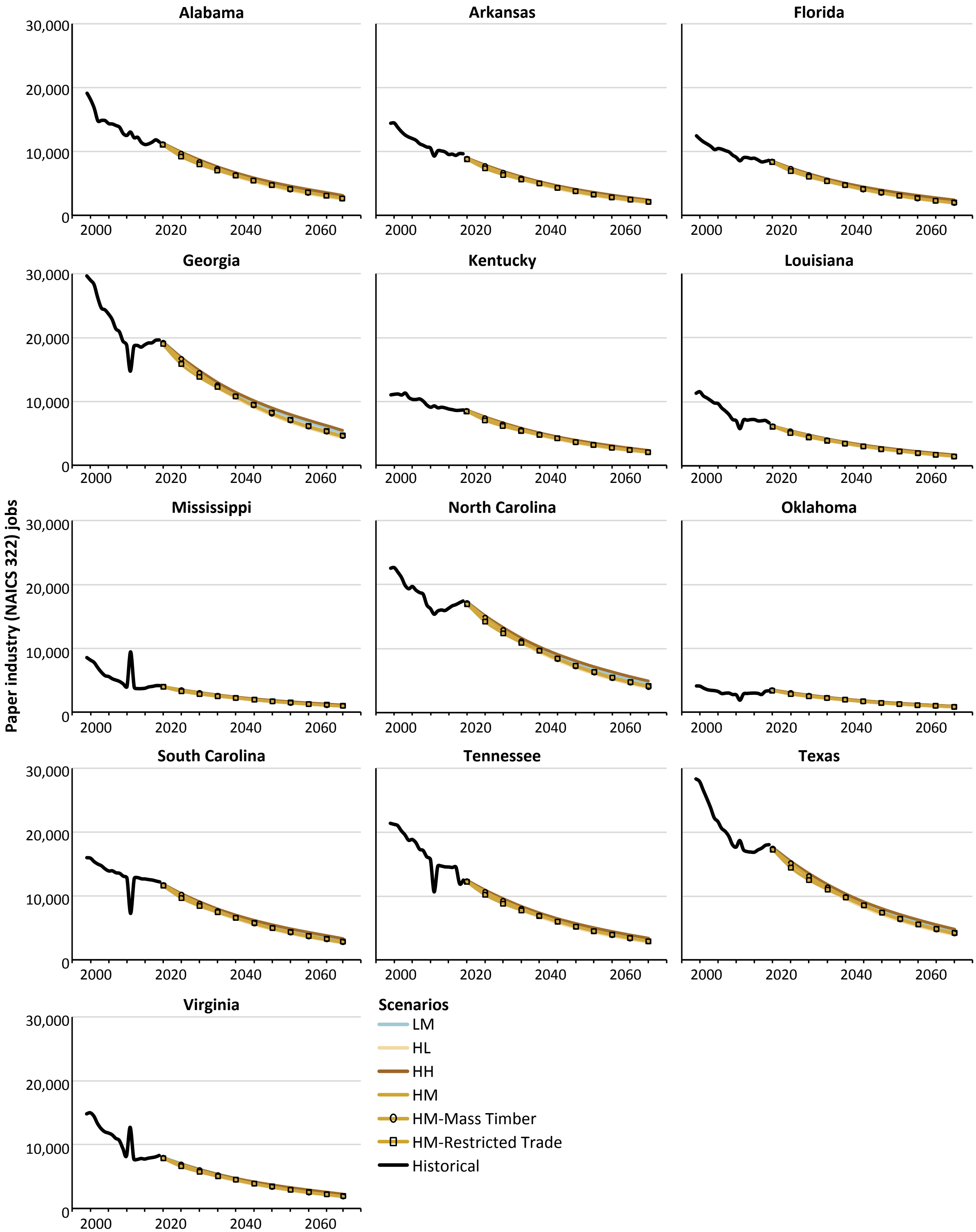

Figure 21—Paper manufacturing jobs by State and year (historical, 2000–2019; projected 2020–2070 by scenario).

For the HM-Mass Timber scenario, forestry and logging industry (NAICS 113, fig. 19) effects are negligible, differing from baseline HM scenario projections in 2070 by -0.97 percent to 0.02 percent, averaging -0.15 percent in the South by 2070 compared to the HM scenario that year. In the wood product manufacturing industry (NAICS 321, fig. 20), 2070 job differences range from -2.45 percent (Louisiana) to 3.93 percent (Florida) and average -0.55 percent southwide. For the paper manufacturing industry (NAICS 322, fig. 21), job differences range narrowly, from -0.72 percent to -0.85 and average -0.78 percent southwide.

In the HM-Restricted Trade scenario, the projected number of jobs is lower than the comparison HM scenario levels, because higher barriers to trade reduce exports more than increase domestic production. In the forestry and logging industry in this scenario, jobs are lower by 0.48 percent relative to the HM scenario. In the wood product manufacturing industry, projections show 2.11 percent fewer jobs compared to the HM scenario. In the paper manufacturing industry (NAICS 322, fig. 21), on the other hand, because domestic demand for southern paper expands more than export opportunities for paper contract, southwide jobs increase by 1.03 percent, compared to the jobs projected under the baseline HM scenario.

We end this section by recognizing the limits of our employment analysis. First, we note that we did not project jobs in transport industries associated with any of the three industries reported in this industry. It is uncertain whether such transport industry changes would emerge, and we leave it to future research to project such changes. Second, linked to our projections of the future of the forest sector are assumptions, based on the RPA scenarios, of changes in technology. However, these changes did not directly model how technology change would lead to jobs changes, so in this analysis we modeled jobs changes by applying historical per-unit trends to projected output volumes. Future research could enlighten our understanding of these technology-jobs-wages linkages.

Table 3—Observed (2020) and projected changes in employment (2030, 2070) by North American Industry Classification System (NAICS) industry and State in the South under the HM scenario

	NAICS Industry 113 Forestry and Logging			NAICS Industry 321 Wood Product Manufacturing			NAICS Industry 322 Paper Product Manufacturing		
	2020	2030	2070	2020	2030	2070	2020	2030	2070
State	Total	*Percentage of change from 2020*		Total	*Percentage of change from 2020*		Total	*Percentage of change from 2020*	
Alabama	3,997	-14.6	-56.2	17,117	-10.4	-47.0	11,158	-24.9	-76.0
Arkansas	2,184	-14.7	-56.3	9,336	-13.9	-54.8	8,889	-24.9	-76.0
Florida	2,090	-14.7	-56.4	13,715	-13.4	-50.0	8,401	-25.1	-76.2
Georgia	4,557	-14.5	-56.1	19,886	-10.7	-47.3	19,170	-25.1	-76.2
Kentucky	220	-14.1	-55.5	9,920	-13.9	-54.8	8,508	-24.9	-76.0
Louisiana	2,438	-14.8	-56.4	6,878	-9.6	-45.0	6,197	-24.9	-76.0
Mississippi	2,916	-14.7	-56.3	8,363	-9.9	-45.8	3,946	-24.9	-76.0
North Carolina	2,626	-14.1	-55.6	17,438	-9.4	-46.1	17,149	-25.1	-76.2
Oklahoma	621	-14.8	-56.4	1,819	-13.9	-54.8	3,395	-24.9	-76.0
South Carolina	2,774	-14.5	-56.2	7,739	-9.9	-46.7	11,693	-25.1	-76.2
Tennessee	773	-14.2	-55.6	12,576	-13.9	-54.8	12,345	-24.9	-76.0
Texas	1,644	-14.7	-56.3	23,846	-9.9	-45.9	17,439	-24.9	-76.0
Virginia	2,015	-14.0	-55.3	13,294	-10.6	-46.8	7,915	-25.1	-76.2

Market-Level Effects

The COVID-19 Pandemic

The second decade of the 21st century ended with a global pandemic caused by the SARS-CoV2 virus and the illness it produces, COVID-19. With the illness came private sector and government actions to contain the spread of the virus. Such actions caused a sharp economic contraction, and that contraction and ongoing illness had significant implications for the forest products sector, including in the South. For the first few months of the pandemic in the United States, construction slowed, and wood product manufacturing was reduced. An overview of the sector through mid-2021 was provided by Prestemon and Guo (2022).

Broadly, waves of pandemic illness corresponded with contractions in labor supply at mills and in the transport industry, leading to intermittent supply bottlenecks that manifested in markets as periods in which prices for softwood lumber and wood-based structural panels rose to nearly three times their pre pandemic levels. Due to labor supply issues at demanding mills, prices for roundwood inputs to mills did not change significantly during most of 2020 and 2021 (TimberMart-South 2021). Employment in NAICS 113 (forestry and logging) was generally lower in 2020 and 2021 compared to 2018 and 2019 in Southern States, exceptions being Texas and Kentucky. In NAICS 321 (wood product manufacturing), about half of Southern States had increases, the others decreased. In NAICS 322 (paper product manufacturing), four States had increases, the rest decreases (U.S. Bureau of Labor Statistics 2022).

Timber harvests in the South varied substantially across counties between 2019 and 2021 (figs. 22 and 23). Softwood harvests increased slightly in 2020, by 1.1 percent overall, although some areas, such as Appalachia and parts of Louisiana and Arkansas, saw small declines. In 2021, softwood harvests rebounded significantly in many counties, rising 10.4 percent over 2019 levels. Hardwood harvests decreased more steadily, with a 10.5-percent drop in 2020 and a further 12.6 percent decrease in 2021 compared to 2019, although harvests did increase in some western counties of the region and in parts of Mississippi and Alabama. Although the specific causes behind the fluctuations observed in each of the counties of the South between 2019 and 2021 (the pandemic, co-occurring natural disturbances) are not identified by this study, the maps illustrate how the COVID-19 pandemic may have broadly impacted regional timber supply in the short and long term at a local scale.

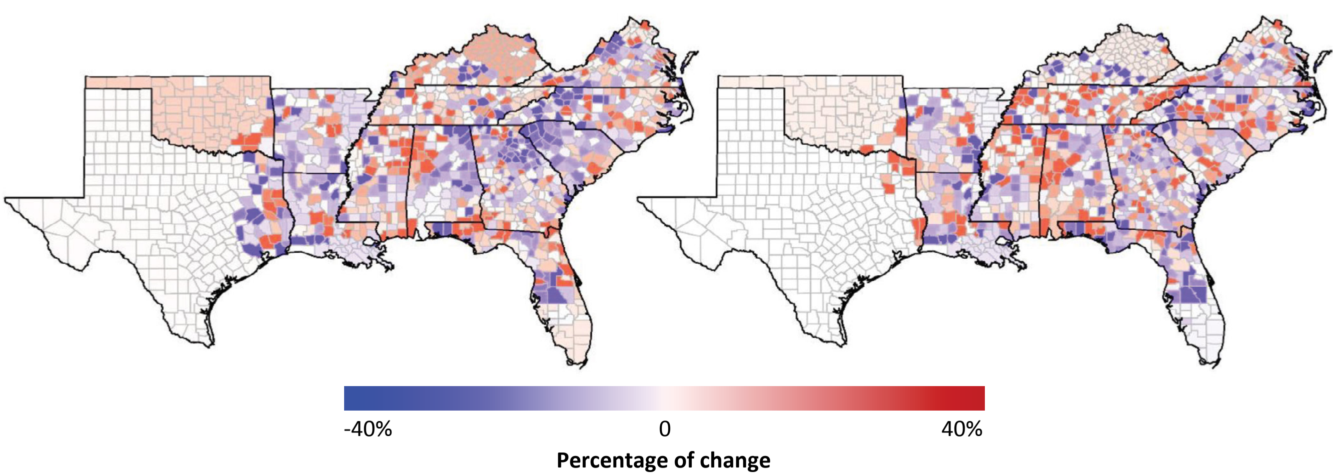

Figure 22—Softwood harvest change by county, (left) 2020 and (right) 2021, compared to 2019.

MARKETS

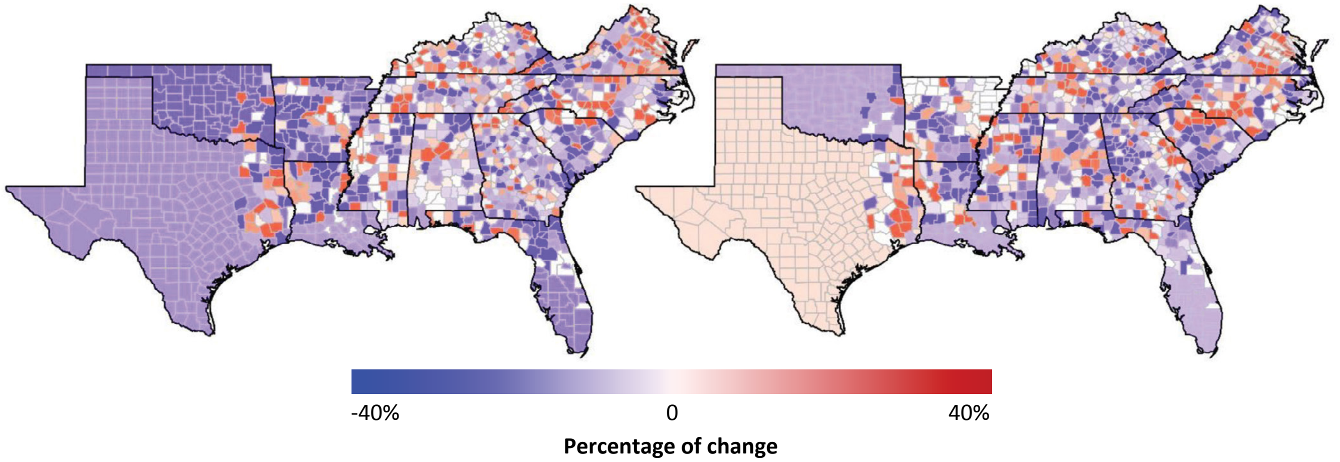

Figure 23—Hardwood harvest change by county, (left) 2020 and (right) 2021, compared to 2019.

For the 2020 RPA Assessment, we caried out a short-run market analysis using FOROM to quantify the implications of the pandemic for the U.S. forest sector (with no special focus on the South, although the South comprises over 60 percent of the forest products sector in the United States). Here, we applied an annualized version of FOROM containing the essential features of the periodic FOROM used to carry out the long-run projections reported in the main body of the chapter. In carrying out what we label a COVID-19 scenario, we updated the starting conditions of the projections to 2018 (rather than 2015, the starting point of the projections in this Outlook and the RPA Assessment) and, in place of scenario-based projections, used the annual GDP forecasts of the Organization for Economic Cooperation and Development (OECD) for the world (OECD 2020) and the U.S. Congressional Budget Office (CBO) for the United States (CBO 2020). We carried out four alternative projections of the future through 2030 only, comparing three pandemic scenarios of varying severities of economic growth impacts with a fourth, counterfactual scenario that projects to 2030 without the pandemic growth impacts. Both the OECD and the CBO forecasts for GDP envisioned a V-shaped recovery path, which is what was simulated for this study. The modeling presented here also abstracts from the main chapter by not interacting (harmonizing) with the RPA Forest Dynamics Model in identifying model solutions. The pandemic V-shaped recovery path scenarios, C19-3, C19-6, and C19-8, quantify the effects under alternative annual average 2020 U.S. GDP annual growth rates of -3 percent, -6 percent, and -8 percent, respectively. To identify the net effect of COVID-19 on the sector, we compared C19-3, C19-6, and C19-8 with a counterfactual projection of the U.S. and world economy made prior to the pandemic by OECD (2020) for 2020 and 2021. Assumed GDP growth from 2022 to 2030 is the same for all three pandemic scenarios and the counterfactual scenario. Our analysis focuses particularly on lumber markets.

According to the projections (USDA Forest Service 2023: fig. 7-2), the pandemic was simulated to have time-varying impacts on lumber markets. Softwood lumber consumption, after an initial drop, quickly rebounds and exceeds what it would have been with no COVID-19. The difference increases to 1.0 to 1.5 million MBF (by 2030), depending on the recovery path scenario. Hardwood lumber consumption, in contrast, is projected to remain below the no-COVID-19 counterfactual level after its initial drop, 0.4 to 0.7 million MBF less in 2030, depending on the recovery path scenario. The combined effects of the changes in lumber consumption are to some extent consistent with Buongiorno (2021).

Evidence shows significant disruptions in the wood product manufacturing industry early on in the pandemic, but domestic U.S. production and imports returned to near-normal levels 3 to 4 months after the United States first entered a broad lock down nationwide in March of 2020 to limit the spread of the virus (USDA-FAS 2021).

Despite the rapid increase in wood product demand following 3 to 4 months of subdued activity, the wood product manufacturing industry was not immune to the multifaceted impacts of the pandemic. Producers were unable to respond to high demand promptly due to labor shortages and jumbled global supply chains (Riddle 2021). Because of the limits on production caused by those factors, timber prices remained low during the pandemic (TimberMart-South 2021). Data showed how prices for softwood lumber and wood-based structural panels underwent changes during 2020–2021 that reflected the time-varying severity of the pandemic, with 3- to 4-month lags (Prestemon and Guo 2022). The most recent data show that prices have returned to approximately prepandemic levels, signaling the end of the pandemic's effects by early to mid-2022 (Fastmarkets RISI 2022).

The pandemic's impacts on especially the building products sector brings with it implications from economics about how softwood lumber and structural wood-based panel manufacturers in the South could be expected to respond. In addition to transport constraints on the supply chain, manufacturers of these products reduced labor availability and higher labor costs per worker, which provided a short-run incentive to accelerate the long-term process of capital intensification observed by Prestemon et al. (2015). Higher output per worker and the ability to employ capital instead of labor in times of high demand could help producers to respond more easily to market price signals. The high net revenues experienced by manufacturers, despite higher wage bills (U.S. Bureau of Labor Statistics 2022), were enabled by stable to declining raw material prices (TimberMart-South 2021) as well as the high output prices (Fastmarkets RISI 2022). Therefore, the pandemic temporarily created profit incentives which would favor higher rates of future investment in new mill capacity in the region. Nonetheless, our projections of market futures for roundwood under the six scenarios presented earlier in this Outlook hint that such profit earning opportunities could be attenuated by higher long-run roundwood prices.

Natural Disturbances

Natural disturbances such as wildfires, insect or pathogen, storms, and droughts are influenced by environmental factors, forest history, and forest management. They affect supply and demand of forest products as well as forest conditions (Holmes et al. 2008). Climate change may affect the frequency, severity, and spatial extents of disturbances. In the South, the most frequent large-scale disturbances currently affecting the timber sector are hurricanes, southern pine beetle outbreaks, and wildfires, although other pests may emerge in the future. Science currently conflicts (Emanuel 2011, Emanuel et al. 2008, Sobel et al. 2021) on how ocean temperature and pressure indices and associated wind shear environments may change with a warming climate, so it is uncertain how hurricanes will change and lead to altered impacts on the forest sector of the South. Projections of future wildfires vary widely by climate model and by projected changes in temperature and precipitation (Prestemon et al. 2016, USDA Forest Service 2022). Projections of shifting patterns and severities of bark beetle epidemics have revealed that there are long-run trends related to changes in both forest management (Asaro et al. 2017, Clarke et al. 2016) and climate (Fettig et al. 2022, Lesk et al. 2017). Definitive conclusions about the future, therefore, are elusive. Instead, in this section, we offer our current understanding, based on existing literature, of how disturbances affect markets, information that provides the backdrop for more definitive projections of disturbance changes in the coming decades.

Forest disturbances have effects on forest product markets that are dependent on the spatial scale of individual events (Prestemon and Holmes 2008), rates of wood decay, and the size of demand for wood near the site of the disturbance. Larger disturbances have bigger impacts on prices, production, and forest inventory. In the warmest and wettest parts of the South, wood decay can be rapid (Highley 1999), shortening the timeframe in which damaged timber may be salvaged and have impacts on local markets. Locations with vigorous wood product markets may absorb such supply shocks with only small price impacts because timber harvesting can be reallocated across time and space. Evidence for the South shows that disturbance shocks to markets may dissipate over the span of several months (Holmes 1991) if timber mortality impacts are not large, with most price dynamics driven by salvage harvesting. Additional studies, focused on larger events such as hurricanes, have shown that the negative price effects of disturbance-related timber salvage harvesting dissipates quickly, within 1 to 2 years, and is replaced by a longer-run price elevation due to inventory reductions (Henderson et al. 2022; Prestemon and Holmes 2000, 2004). Empirical evidence of the effects of wildfires on product markets is limited, although some simulation studies have predicted them (Prestemon et al. 2006). Studies of bark beetle epidemics have shown regional impacts that are similar to those caused by hurricanes (Holmes 1991, Schwab et al. 2009, Thom et al. 2013), with significant economic impacts in some cases (Corbett et al. 2016).

Disturbance impacts on timberland owners vary widely by owner category. Prestemon and Holmes (2004) showed how damaged producers suffer from lost timber value, despite the salvage revenues obtained by the loss of timber inventory, which reduces future timber production. Undamaged producers, however, can benefit overall in the long run, despite short-run timber value losses during salvage. Long-run gains can accrue from higher prices caused by timber scarcity from regional inventory loss. Consumers may benefit in the short run from lower priced salvage wood for product manufacture, but they may experience losses due to higher long-run production prices.

Governments sometimes act to help owners of damaged timber cope, post disturbance. But such short-term actions, if they make salvaging cheaper, can have negative effects on owners of undamaged timber, unless the actions include policies and programs that boost salvage wood demand by wood consumers or alleviate local logger shortages. Salvage facilitation can be offered in the form of publicizing potential local markets for salvage logs, offering assistance (tax breaks, subsidies) to mills that are directly tied to the mills' purchase of salvage wood, raising weight limits on some roads to effectively lower log transport costs (as was done in South Carolina after Hurricane Hugo in 1989; see Sheffield and Thompson 1996), or reductions of harvests and salvage on local or regional public lands during the period of private sector salvage efforts. Long-term efforts to mitigate the effects of large-scale disturbances include providing enhanced landowner outreach to encourage landowners to establish the timber cost basis for their forest land, funding or carrying out research on novel technologies to reduce salvage harvest costs, stimulating research into new products that can utilize salvage materials, and encouraging research and development that can advance capital intensification in the logging industry.

We can summarize the expected effects of disturbances affecting southern forest product markets as follows:

- Salvage rates are dependent on the extent of damage and available mill processing capacity.
- Salvage drives down timber and roundwood prices, but those effects in the South are short-lived, due primarily to rapid wood decay.
- Large-scale disturbance timber mortality leads to local inventory shortages that can elevate timber product prices for several years.
- Salvage focused on one ownership category or location can have depressive effects on prices and the availability of logging contractors on other ownership categories or locations.

Discussion

The South has undergone several transitions over the last several decades. A dominant phenomenon has been the growth in southern pine plantation-based industrial style forestry. For hardwood forests, reduced demand for hardwood to manufacture furniture due to overseas capacity gains has led to a decline in harvests. The combined effect of these two phenomena has been a rise in total standing inventory volumes. An overlaying trend in standing timber inventory volumes relates to increased gross growth due to projected warmer temperatures and altered precipitation patterns over the coming 5 decades. These trends are projected to continue, leading to an increase of total inventory volume by around 50 percent in the South between 2020 and 2070. Differences in these projected trends across scenarios are small, implying that projected rising removals are not large enough, even under the most vigorous economic growth scenario considered (HH), to alter that trajectory. We note, however, that only hardwood inventory volumes increase through 2070 while softwood inventory volumes level off by 2050 in both the South Central and Southeast subregions.

Rising timber inventory volumes imply that production possibilities will rise, and our projections bear this out. Industrial roundwood production is projected to rise across all scenarios, but by the most under the high economic growth HH scenario, and this projection is common to both softwood and hardwood roundwood.

The most recent 2 decades of declining real softwood timber prices provide a counterintuitive backdrop to the projected future of rising timber prices in the South. Such a directional change in trend implies that, across all but the HL scenario, rapid growth in global roundwood markets would increasingly raise domestic price pressures for both softwood and hardwood roundwood. Prices are projected to rise across most scenarios and all States in the South, with HH registering a 50 percent price rise for both softwood and hardwood roundwood by 2070 compared to 2020. With the exception of the HL scenario, these futures imply that the rising standing inventory volumes in the South would be increasingly more valuable per unit. This inventory is projected to become increasingly more valuable in total across all scenarios, including under the HL scenario. In other words, we project a modest rise in overall timber wealth in the South.

Lumber production and prices, both softwood and hardwood, are projected to rise across all scenarios, but by little under the HL scenario. The HM-Mass Timber scenario produces significantly higher production and price rises compared to the HM scenario, demonstrating the effect on softwood lumber markets of higher demand for the softwood lumber input to mass timber products. One implication from the results is that the higher softwood lumber demand under the HM-Mass Timber scenario would drive up prices and reduce production of other mill residue utilizing manufactured products, although paper manufacturing appears to be either unaffected or slightly stimulated, due to the greater available supply of sawmill residues that are used in paper manufacture. Restricted trade opportunities have ambiguous effects on both softwood and hardwood lumber markets, due to the countervailing effects of greater intra-U.S. exports (to other U.S. regions) and smaller exports to other regions of the world. This Outlook could not directly track trade sources or recipients, so the details of the production and consumption reallocations by States due to greater restrictions on trade are left to further analysis.

Wood-based panel markets (including for plywood, particleboard, and fiberboard) are projected to generate higher output and experience higher prices under all scenarios, except under the LM scenario, in which prices are projected to decline in the South Central subregion. The increased demand for wood input for softwood lumber under the HM-Mass Timber scenario has a small impact on plywood production, shrinking it because of higher roundwood prices. Under the HM-Restricted Trade scenario, however, effects are small.

In the paper manufacturing industry, we project a continuous shrinkage in both production and consumption of graphics paper (newsprint, and printing and writing paper). Therefore, although other paper and paperboard production remains relatively steady into the future, with projected rising prices, production, and consumption in most cases, overall paper output is not projected to rise much across any scenario. Nevertheless, because of continued rising demand for paper outside the South, net exports are projected to rise overall, an outcome of higher projected declines in consumption than production.

Wood pellet output and prices are projected to rise across nearly all scenarios. The effects of high wood demand for mass timber and restricted trade are slight. Scenarios exploring increased output of mass timber products and tighter trade restrictions have some effects, but the common dominant factor driving the wood pellet market in all scenarios besides HL is rising overseas demand for wood pellets. That overseas demand implies higher prices and rising income for manufacturers of wood pellets. Nevertheless, wood pellets are projected to remain a small component of overall wood consumption into the future across all scenarios.

The most salient feature of the outlook for employment in the forest sector of the South is that the number of jobs is projected to decline, and differences across scenarios in these trends are small. The projected decline in employment can be attributed to several factors, such as increasing automation and adoption of advanced technology. However, a decline in jobs in the forest sector does not necessarily portend a decline in labor income. Increasing automation and adoption of advanced technology may lead to increased efficiency and higher labor productivity. Although we did not project wage rates in the forest sector of the South, long-standing economic theory (Solow 1956) predicts that rising sector labor productivity would be associated with rising wages.

This Outlook also projected markets for several product categories that we did not discuss, including other industrial roundwood, fiberboard, chemical pulp, mechanical wood pulp, recovered paper, particles and residues, and fuelwood. Projections are available in an online data archive (Guo and Prestemon 2024) for interested readers.

We described the effect of the COVID-19 pandemic on the forest products sector, which highlighted especially how harvests, employment, and forest products outputs shifted in response. We also discussed the reason behind the discrepancy between high lumber prices and high timber prices. Based on published data, we find that the pandemic altered harvests heterogeneously across the South, implying that effects will have impacts on standing timber inventory volumes for several years. It is possible, though, that such changes in production have been or will be partially offset by changing local prices for timber and local timber demand shifts in response to the inventory changes.

Disturbances in southern forests have well-known effects, which we have documented in this Outlook. Research shows that large-scale disturbances have market-level effects on prices and production and long-run effects on timber inventory volumes. A major challenge to southern landowners is responding to these events such that overall costs and losses are minimized, maximizing salvage of dead and damaged timber quickly to avoid decay-related quality losses, and timing their green harvests for after salvage is exhausted. Public landowners, including the Forest Service, whose salvage actions can affect private landowners, may weigh public land timberland recovery and the taxpayers when deciding on salvage amounts and timing. It has yet to be examined how market changes due to other forces may interact with post disturbance harvest planning and allocations.

Conclusions and Research Needs

The forest products market of the South has undergone many changes in history, including declining employment and softwood timber prices, rising timber inventories and export opportunities, and advancing timber harvesting and manufacturing technologies. It has experienced a global pandemic affecting harvests, sector employment, manufactured product output, and product prices. The region today faces uncertainties related to the impacts of new products and wood pellets on traditional products, the effects of climate change on forest growth and disturbances, an evolving trade posture, and economic and population growth. This Outlook sought to clarify the overall effects of some of these phenomena without asserting levels of confidence about their likelihoods.

The scenario structure was designed to reveal the effects of changes in drivers of markets. In carrying out the scenarios, the study highlighted several knowledge gaps and research needs. First, climate is affecting growth, but the growth effects of rising temperatures and higher CO_2 levels may be offset by changes in precipitation and shrinking CO_2 absorptive capacity of trees, attenuating anticipated increasing timber inventory volumes and hence production possibilities in the forest products sector. Such climate effects, however, would affect the South's main competitors in global markets, feeding back to domestic markets in uncertain ways. Alterations in disturbances from this changing climate also affect timber mortality, which may counteract increased forest gross growth caused by higher temperatures and CO_2 concentrations. Research that provides greater clarity on the order of magnitude of these various climate phenomena may help landowners and decisionmakers better prepare for the markets of the future.

This Outlook did not project forest sector wages, limiting findings related to labor income associated with projected employment changes. New modeling, based on the most recent data on technology change, wage rates, and employment levels, may help to uncover employment-wage linkages. Such linkages could then be included in new analyses focused especially on the forest sector workforce.

Projections reported in this Outlook ignored impacts of changes in specific components of final product demand, including the demand for wood products by the construction industry. Studies have projected the future of residential new construction, but less is known about the potential impacts of nonresidential construction, repair and remodeling of existing structures, or other uses of wood products in the U.S. economy. New research could decompose these demand components, allowing for an assessment of the potential effects of new policies favoring the use of wood in construction, including for mass timber, or in the manufacture of new paper or wood-based energy products.

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The last decade's economic, social, and environmental changes have affected the production, consumption, prices, and trade of forest products in the United States. This report provides an overview of how future potential societal and biophysical changes in the U.S. South, the country, and the world may influence the region's forest sector. Changes are modeled with six scenarios that offer alternative trajectories for socioeconomic change (rates of growth in income and population), climate warming, technology, and trade openness. Among these are two scenarios exploring (1) the accelerated adoption of mass timber products in construction, and (2) a large, hypothetical increase in trade restrictions. All scenarios are summarized in terms of changes in production, consumption, prices, and trade in forest products. Results of this study can facilitate more fully informed choices by landowners, policymakers, and industry decisionmakers as they prepare for an uncertain future.

Keywords: Timber market, forest products, trade barriers, forest disturbances.